



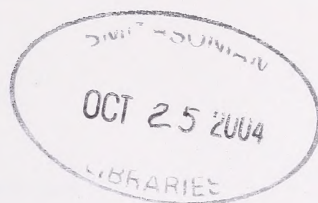


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Errata

p. 111 (table) line 3	For: <i>palustris</i> read: <i>palustre</i>
p. 111 (table) line 8	For: <i>aquatis</i> read: <i>aquaticus</i>
p. 111 line 24 up	For: <i>Centaurea</i> read: <i>Centaureum</i>
p. 136 (table) line 5	For: <i>E.</i> read: <i>Epilobium</i>
p. 137 (table) line 15	For: <i>S.</i> read: <i>Salix</i>
p. 138 (map) line 2 up	For: <i>Alchemilla</i> read: <i>Achillea</i>
p. 150 line 5 up	For: <i>wilmottii</i> read: <i>wilmotii</i>
p. 239 line 6 up	For: <i>sylvatica</i> read: <i>silvatica</i>
p. 296 line 12 up	For: <i>Onopordium</i> read: <i>Onopordum</i>
p. 338 (text) line 2 up	For: <i>vulgare</i> read: <i>vulgaris</i>
p. 344 (text) line 5	For: <i>palustris</i> read: <i>palustre</i>
p. 458 line 15	For: <i>gigantea</i> read: <i>giganteum</i>
p. 529 line 15	For: <i>pratensis</i> read: <i>pratense</i>
p. 537 line 12 up	For: <i>pubens</i> read: <i>pubens</i>
p. 539 line 3 up	For: <i>wilmotii</i> read: <i>willmotii</i>
p. 543 line 14	For: <i>Quercus rosacea</i> read: <i>Quercus × rosacea</i>
p. 543 line 14 up	For: <i>desicatum</i> read: <i>desiccatum</i>
p. 555 line 25	For: <i>truncatuca</i> read: <i>truncatula</i>
p. 563 line 7 up	For: <i>R. × robertsii</i> read: <i>M. × robertsii</i>
p. 564 line 5 up	For: <i>scottica</i> read: <i>confusa</i>
p. 569 line 13 up	For: <i>arbrotanum</i> read: <i>abrotanum</i>
p. 572 line 1	For: <i>germanica</i> read: <i>germanicum</i>

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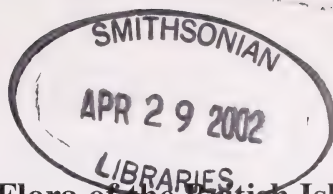
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The cover illustration of *Potentilla anglica* Laich. (Trailing Tormentil) was drawn by Rosemary Wise.



The struggle to produce a Flora of the British Isles (1933–1952)

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ABSTRACT

The reasons for the failure of the 'New Students' British Flora project (1933–1945) have been investigated. This project, edited by Sir A. G. Tansley (Chairman), J. S. L. Gilmour and A. J. Wilmott, is interesting not only for historical reasons, but also because it highlights many of the key issues faced by taxonomists writing Floras. We have also examined the relationship between the abandoned Flora and the successful publication in 1952 of the *Flora of the British Isles* by A. R. Clapham, T. G. Tutin and E. F. Warburg.

KEYWORDS: New Students' British Flora, writing Floras, Flora of the British Isles, history, Sir A. G. Tansley, A. J. Wilmott, J. S. L. Gilmour.

INTRODUCTION

In the foreword to Clapham, Tutin and Warburg (1952) *Flora of the British Isles* (hereafter CTW), Tansley writes: 'A new British Flora has been a desideratum for the past half century and urgently needed during the last thirty years.....The absence of such a Flora has seriously hampered the teaching and learning of field botany. Time and again I have been asked by visiting foreign botanists to recommend a good modern British Flora and have been ashamed to confess that no such thing existed. In this whole sphere the lack of an adequate handbook has indeed been something of a national scandal. Several attempts have been made to fill the gap but none has been carried through to success, largely because they were all too ambitious, aiming at a completeness and exhaustiveness unattainable except through many years of laborious effort and the collaboration of a large body of specialists.'

Tansley was clearly referring, in part, to *The Cambridge British Flora* (incomplete) of C. E. Moss and others [Vol. i was not published; Vol. ii, 1914; Vol. iii, 1920]. The complex reasons for the abandonment of this encyclopaedic Flora have been investigated by Bunting, Briggs & Block (1995). What Tansley does not report, but is certainly alluding to is that he, as Chairman, with J. S. L. Gilmour (Assistant Director of the Royal Botanic Gardens at Kew - 1931–1946) and A. J. Wilmott (Deputy Keeper, - 1931–1950 - Department of Botany, British Museum (Natural History); hereafter the Natural History Museum) were involved in another unsuccessful attempt to write a New Students' Flora in the 1930s.

In investigating this 'Flora', we have studied a large number of papers and letters in the Gilmour archive (Cambridge University Botanic Garden) and the correspondence of Wilmott and others (held in the Natural History Museum, London).

AIMS

The New Students' British Flora project (hereafter NSBF), despite its eventual abandonment, raises a number of interesting historical questions. How was the project begun, and what were its aims and objectives? How did the writing progress, and how did the editorial committee tackle problems as they arose? What happened to the NSBF, and what was its relationship to the *Flora of the British Isles* produced by CTW in 1952?

The NSBF is interesting not only for historical reasons but also because it highlights many of the key issues faced in writing any Flora, namely determining the purpose(s) for which a particular Flora is being planned and written; choosing the most appropriate form, content, and classification to use, and facing all the practical questions involved. Furthermore, it is interesting how the NSBF aimed to deal with critical groups, such groups being found in genera evolving through polyploidy and/or hybridisation, and/or reproducing by apomixis or persistent selfing.

THE INITIAL PHASE (1933)

The project was an initiative of the Clarendon Press, Oxford prompted by MacGregor Skene. Thus, on 10 February 1933, K. Sisam wrote to Sir Arthur Hill, Director of Kew -1922-1941: 'Professor Skene of Bristol has more than once told us that the time is coming when there ought to be a new critical flora to replace Babington's book. Do you think there is a real need, or do the existing books do well enough for the majority of readers?'¹. Sisam was referring to the *Manual of British Botany* by Professor C. C. Babington, University of Cambridge, which, in 1922, was in its 10th edition. This work was edited by A. J. Wilmott, one of the three editors of the NSBF Project.

Hill replied on 14 February 1933: 'We are interested in Professor Skene's suggestion as to the need of a new critical Flora to replace Professor Babington's old book. I called together two or three of my staff who are keenly interested in the British Flora'². An account of the meeting survives, and is signed by W. B. Turrill³. Hill continues: 'Their unanimous view is (1) that a new British Flora is very desirable, (2) that, if it is produced, it should approximate to the size and species standard of Schinz & Keller, *Flora der Schweiz*, ed. 4 (1923), and (3) that if the Clarendon Press would be prepared to undertake its publication it would be an opportunity that should not be missed'². The letter continues: 'We feel that in the preparation of a Flora of this sort there should be cordial co-operation between Kew and the Department of Botany of the British Museum (Natural History), and that specialist contributors should be called in to deal with certain families or groups of families. We also feel that it would be desirable to form a small "editorial committee", which might consist of one representative from Kew, one from the British Museum and an outside Chairman. The Chairman is an important person and we suggest that Professor Tansley should be asked to serve in that capacity. On the Kew side, my Assistant Director, Mr Gilmour, would be a very useful representative, and the British Museum representative should be Mr. Wilmott. I think before anything is said to the authorities at the British Museum about the proposal, Prof. Tansley - should he agree to act as Chairman - should be asked to meet two or three of us here to discuss several points...'².

Sisam discovered that the Flora proposed as a model, Schinz & Keller (1914, 1923), was not in the Bodleian Library in Oxford⁴, and Hill offered to send the copy from Kew on loan, noting that it is in two volumes, 'the first running to 792 pages and the second, which is of a more critical character, to 528 pages'⁵. Hill gives his personal view, running counter to the memorandum from Turrill, that 'personally, I think a single volume sufficient for the proposed British Flora, which would then be a fairly convenient size'⁵.

Sisam replied to Hill on 23 February: 'I have heard from Tansley who agrees that the *Flora* would be a good thing, but owing to the number of his editorial commitments, he is a little doubtful whether he could undertake much work. I have told him I thought you probably did not envisage him undertaking the routine, but rather giving his advice and help in planning or any special difficulties'⁶. The letter notes that Tansley had arranged to meet Gilmour and 'agrees with you that the Natural History Museum should not be consulted until something definite can be put forward'⁶.

A letter from Tansley to Hill on 28 February reports that he had had a 'very satisfactory talk with Gilmour. We see eye to eye on most relevant points and I am sure I could work with him happily'. Tansley had clearly decided to take the position of Chairman of the project, for he continues: 'I am accordingly sending you a more or less official letter and, simultaneously, an identical one to Ramsbottom' [Keeper of Botany at the Natural History Museum - 1930-1951]⁷. In the official letter he writes: 'the Clarendon Press have asked me if I would act as Chairman...and after careful consideration I have decided that I would be willing to do so, provided that the authorities at the British Museum and Kew welcomed the scheme'⁸. Tansley clearly recognised the sensitivity in the dealings between Kew and the Natural History Museum, for in his private letter he writes: 'When you receive this you will note that it is not perfectly ingenuous, since I take credit to myself, directly or by implication, for proposals which really originated from Kew! But, that I expect you will agree, it is a wise course under the circumstances'⁷. Given the sometimes acrimonious relations between the Natural History Museum and the Royal Botanic Garden (Stearn 1981), Hill approved of Tansley's action and in a letter saying how pleased he was that Tansley was accepting the Chairmanship, he adds the comment: 'I fully approve of your assuming the responsibility ...as it might have led to difficulties had the suggestion appeared to emanate from

Kew⁹. The reaction from the Natural History Museum is reported in a letter from Tansley to Gilmour: 'I have been in correspondence with Ramsbottom about the proposed flora and he is in general agreement with the scheme suggested, and has obtained the sanction of his Trustees, and agrees that Wilmott should represent the Museum'¹⁰.

It is interesting that the Committee did not devise their own scheme for the writing of the Flora, for the next step was to send out a circular letter to canvas opinions about its form and content¹¹. In preparation for the first Flora Editorial Committee the three editors exchanged opinions on crucial issues. Wilmott writing to Tansley on 6 May 1933 provides very important insights, particularly about his own potential contribution. 'Having had the production of a Flora in my mind for many years, I have accumulated considerable knowledge and material of many of these genera, and after a winter's work I should be able to judge what I could hope to do'¹². Earlier in the same letter he writes: 'I have had a talk with Gilmour in order to get his point of view concerning farming out work. My view is that except insofar as time is the limiting factor it is preferable to restrict farming out to experts with whose methods we could agree, i.e. who would send in MS which we could print more or less as it stood.This may be ideal, but on the other hand the work must be got through, and the choice would seem to be between 1) farming out uncritical families and doing as much as possible of awkward genera myself; 2) farming out awkward genera and doing as much as possible of the mass of the flora ourselves.... I would prefer to defer farming out the "critical groups with undoubted experts" till April 1934 in order to see during next winter how far I could be responsible for them....'¹².

At the first Committee meeting, held at the Natural History Museum on 26 May¹³, the editors considered the question of the allocation of the detailed work, the remuneration of contributors and committee, and general questions about the taxonomic system to be adopted. The results of the meeting were set out in an extremely brief list¹⁴.

Genera to be divided into 5 categories:

- a) 30 groups were to be offered immediately to specialists.
- b) Following Wilmott's suggestion, 39 groups were assigned to him, with eight of the group in this category to be left for a year and then farmed out if necessary.
- c) For six groups there was no obvious specialist.
- d) Non-critical groups which Wilmott and Gilmour will divide between them (majority to be done by Gilmour (i.e. c. half the flora).
- e) Then followed a list of groups to be farmed out *en bloc* if necessary.

Regarding payment, it was decided to pay contributors c. 5/- [=25p] per page plus bonus for difficult genera. The editors would have a small c. £50 lump sum on completion of the Flora and subsequently some percentage of the profits. Also, it was agreed that the Flora should contain c. 2000 species, in 800–1000 pages, at a price not exceeding 15/- [=75p]. It was decided to use a hybrid classification between Engler (1924) and Bentham & Hooker (1862–1883).

By 31 May, Gilmour wrote to Tansley to report that he and Wilmott had tentatively approached the majority of people mentioned in the list a)¹⁴. However, in a letter on the 1 June, Tansley wrote to Gilmour expressing his concern about opening discussions with potential contributors too early before the next meeting of the Committee. 'I have particularly in mind the desirability of laying down the treatment of species, sub-species and varieties...it is important that these specialists should realise the general plan so that they do not send in manuscripts with a large number of small forms designated as species'¹⁵.

By 2 June the replies to the questionnaire were available, together with a detailed tabulated summary¹⁶. Majority support was revealed for:

- 1) using italics to indicate key features in diagnoses;
- 2) providing synopses to families, but keys to species; and
- 3) giving only the most important synonyms, indicating life-form, and providing information in distribution, habitat, and relevant literature, but with genetical information only in special cases.

- 4) The inclusion of cytological information was not supported by a majority.
- 5) A small minority supported the provision of a glossary; information on flowering time, pollination, dispersal, altitudinal range, viability of seed, shape, number of seeds, fruits; references to exsiccatae; etymology of names etc.
- 6) A majority a) did not wish the critical groups to be treated in full; and b) supported the inclusion of only well-established aliens and escapes, the provision of details of extinct plants; and the inclusion of the plants of the Channel Islands.
- 7) It is interesting to examine some of the minority opinions e.g. Pugsley, an acknowledged expert on critical groups, considered that '*Hieracium* and *Rubus* should be dealt with in detail'¹⁷.

On 4 July, Tansley again discussed with Sisam the vexed question of finance¹⁸. The Clarendon Press proposed the payment of royalties as 'editorial expenses', which would not be subject to income tax. It was also proposed that: 'If any payments to indispensable contributors should eventually be found necessary or desirable these could be made at the Committee's discretion out of the sum received for editorial expenses'¹⁸.

At the second meeting of the Editorial Committee on 5 July¹⁹, there was further discussion of financial arrangements. Minutes of the meeting²⁰ reveal that the method of payment of expenses was provisionally approved. It was agreed to send official invitations to specialists without referring to remuneration, and to include a preface containing a statement about the origin of the work, its relation to previous floras etc. The introduction would include a full glossary of terms; diagrams, list of abbreviations, symbols etc. It was decided to ask that manuscripts should be submitted without abbreviations. A conspectus of the classification would be provided in the sequence Pteridophyta, Gymnospermae, Angiospermae (Dicotyledons, Moncotyledons). Consideration of the form and content of the descriptions was deferred until the next meeting fixed for 19 July.

In a note to Hill on 12 July, Sisam indicates that the Editorial Committee may be focusing too much on royalties etc. for he writes, prophetically as it turned out: 'I am glad to hear from Tansley that negotiations about the Flora are proceeding. I hope too many fine points of conscience, difficulties of remunerating contributors evenly etc. will not be raised at the outset, because they are probably insoluble by any plan, and in practice they may never arise'²¹.

By 17 July, Gilmour had prepared a first incomplete draft of a lay-out of *Medicago*. He also enclosed a list of 'Kew opinions' on some points e.g. the Flora should include: extinct plants; plants of the Channel Islands; only provide English names in common use; and include only well-established aliens. Descriptions were to be in one paragraph with synonyms in use in existing British Floras. Also to be included were Raunkiaer's life-forms; information on important economic properties e.g. forage plants; and details of hybrids should be included within the accounts, not at the end of the genus²².

THE ONSET OF DIFFICULTIES (LATE 1933-1935)

Just as the arrangements for the Flora were to be set in place, there was a setback. At the beginning of July, Tansley had most of his teeth removed²³. He was unable to attend the next third meeting of the Committee and had a prolonged period of ill health^{24 & 25}.

From this time forward little progress was made. Indeed, there is a two year gap in the correspondence in Gilmour's Archive from mid-1933 to mid-1935, and scant material in the Wilmott Archive. It is significant that this was the period when Tansley was working on his magnum opus: *The British Islands and their Vegetation* (1939).

THE RECOMMENCEMENT OF THE PROJECT (1935-1939)

On 4 July 1935, Gilmour wrote to Wilmott: 'To put things frankly, we have undoubtedly let the whole question of the flora drag on much longer than we ought. This is partly due to the fact that

we are all very busy - that Tansley was ill for some time - & partly, I think that there has been no "urgency" to keep us up to the mark! I think personally (& I think you will agree) that we cannot hope for much "directive" power from Tansley - he is so occupied with other things and has not really been enough on the project to make the constant effort necessary to keep things going'.²⁶

Tansley too was considering the project, for, on 15 July 1935, he wrote to Gilmour in exasperation: 'I think some definite steps must be taken about the proposed Flora; it looks to me as if it would never get done if Wilmott continues to be as dilatory as he has been the last year'.²⁷ He did not confront Wilmott himself, but urged Gilmour to do so. 'Perhaps you had better write to him first rather urgently and see what he says. Unless he is prepared to subordinate other work to getting on with the Flora it is useless for me to have anything to do with the scheme. This need not necessarily be said to him at the moment, but the issue must be forced soon. I do not however want to write to Hill and Ramsbottom until the situation is clarified'.²⁷

In the Gilmour archive there are two letters^{28 & 29} from Wilmott, both of which make it clear that Wilmott was still finding difficulty in committing time to the Flora. In the first letter dated 13 August he writes: 'As regards the Flora I don't seem to get any time to settle down to it, and I really don't see how I am likely to get much more for a year or two. You will remember that I said at one of our meetings that I was not quite ready for it!'.²⁸

In a letter to Tansley on 3 September, Gilmour reports that he and Wilmott have met and propose a major change to the arrangements for the Flora: 'We have reluctantly come to the conclusion that we neither of us have the necessary spare time to give to the undertaking if it is to be produced within a reasonable period. We perhaps ought to have realised this at the out-set, but it is difficult to judge these things beforehand. We have therefore been discussing possible means of continuing the work....I would suggest that two more botanists, who have the time, knowledge and inclination to produce such a Flora, should be co-opted onto the committee; and that *they should be responsible for the actual work of preparing the typescript, both by their own work and by obtaining contributions from other botanists*' (our italics)³⁰. Gilmour and Wilmott were reluctant to withdraw completely from the project for the letter continues: 'The question of authorship on the title page could be settled after discussion, but it might appear as by "Brown and Smith, in co-operation with Tansley, Wilmott and Gilmour", or some such phrase as that. As to the two further botanists, possible names will probably occur to you. The two I have thought of are R. W. Butcher and J. E. Lousley....I do not of course, know whether either would be willing to participate in such a scheme, but they both have the time, knowledge and, I believe, the inclination to write a Flora of Britain...We feel sorry that at this rather late hour we have been forced to this conclusion, but I feel it is best to face the fact and to try to make some arrangement that will ensure that the Flora is produced in a reasonable time'.³⁰ It is ironic that Butcher (who had a full-time research post) and Lousley (with an onerous position at Barclays Bank) were regarded as having more time than Gilmour and Wilmott (David Allen, pers. comm.).

The suggestion for a larger committee made by Gilmour and Wilmott was rejected out of hand by Tansley. In letters to Hill and Ramsbottom on 26 September Tansley writes: 'I feel that the suggestion now made is open to rather serious objections. A committee of 5 is much less easy to work than a committee of 3, and it would be much harder to obtain practical working unanimity on questions of principle and of general treatment. Nor do I think that the position of Gilmour and Wilmott on such a committee "in a general advisory capacity and as a link with the British Museum and Kew" would be satisfactory. I think they should have more direct responsibility. My present feeling is one of reluctance to take part in such a scheme, though I have made no final decision'.^{31 & 32} Earlier in the letter he expresses his dismay: 'When the arrangements were first made, now nearly 2½ years ago, I assumed, rightly or wrongly, that Gilmour and Wilmott would be able to devote some of their official time to this work; since both Kew and the British Museum were, at least semi-officially, behind their participation. I think it is clear that they could not possibly complete the undertaking, within any reasonable term of years, in their "spare" time'.^{31 & 32} Tansley also wrote to Gilmour on the same day stating: 'I do not like the new suggestion'.³³ Tansley then arranged a meeting with Hill and Ramsbottom to discuss the issues involved.

Ramsbottom writing on 3 October to Tansley clarified a crucial question: 'So far as Wilmott is concerned it is not a matter of being prevented from devoting official time to the work'.³⁴ Ramsbottom discussed the position with Wilmott and in a further letter to Tansley³⁵ a way forward was agreed: 'Wilmott should not attempt the working out of a larger number of critical families

and genera... He should restrict himself to those he has already more or less worked through. The families or genera should be farmed out in pretty liberal way..... After the talk with you and Hill it seemed clear to me that Wilmott was failing in that he had in mind an old scheme for a flora to be produced in a certain way'.

Tansley writing to Gilmour concludes that: 'We must now push on with the scheme and hope for the best'³⁶. In the same letter, dated 18 October, he urges, as a priority, the drawing up of a specimen diagnosis. Wilmott suggests to Gilmour that both should prepare accounts of *Medicago*³⁷. By 3 December, Tansley is again stressing the urgency of the situation. 'It is clear that no rapid progress will be made until the "farming out" has been done, so I think it is important we should take the preliminary steps as soon as possible'³⁸.

During the next few months a four page set of 'Rules and Suggestions for Contributors' was printed, together with specimen accounts. The copy in Wilmott's papers is dated August 1936³⁹. However, Turrill, a potential contributor, in a letter to Tansley⁴⁰ indicates that he received his invitation to contribute on 2 July 1936. In the early correspondence the Flora is referred to informally by various names e.g. the 'British Flora', 'New British Flora' etc. The printed document for Contributors makes it clear that the Flora was to be given the somewhat ambiguous title the 'New Students' British Flora'.

It is clear from the Rules and Suggestions³⁹ that the NSBF had become a very ambitious project. First, the editors revealed that, yet again, they had changed their minds on the classification to be used and had chosen to use *Families of Flowering Plants* (1926, 1934) by J. Hutchinson (Keeper of the Kew Museums, 1936–1948) (Staffleu & Cowan 1979). His phylogenetic system, which divided the dicotyledons into woody and herbaceous lines, was controversial (Stace 1989). For example it separated by a very long way the *Apiaceae* from the *Araliaceae*, the *Lamiaceae* from the *Verbenaceae*. A description and key to families was also to be prepared by Hutchinson. Synopses of the genera in each family would be prepared partly by Hutchinson and partly by contributors. The document stated that the form and scope of these synopses 'can be settled by consultation between Dr Hutchinson, the contributors and the editors'. It is important to note that no glossary of approved terms was prepared and there were no arrangements set out in the Rules and Suggestions for ensuring that strictly comparable descriptions would be prepared for families, for genera within families and species within genera. Also, the geographical range to which the descriptions should apply was not defined. For example, was the Verbenaceae to be a family of herbs (as in Britain), or herbs, shrubs, trees and woody climbers (as in the world)?

The account of each genus would include Latin names, etymology and popular name; generic description with best diagnostic characters underlined; information on biology, genetics, cytology & ecology, number of species and World distribution; reference should be made to a recent monograph; and a key to species should be provided.

For each species the following information was required: name, reference to figures, synonyms in common use, popular names & Raunkiaer's life-forms; the description should open with a succinct "word portrait" to include times of flowering, fruiting and germination and intraspecific units; next, facts relating to pollination, insect visits, flowering and germination should be given, together with important genetical and cytological information, including the chromosome number; the status (native, alien etc.) should be noted, together with an indication of the distribution, followed by the part played in important plant communities or successions, and the British distribution and altitudinal range. Hybrids were to be included in the Flora, with brief descriptions and distributional information. With regard to aliens, every species which can be found growing at all commonly without being intentionally planted by man should be mentioned. The treatment of large critical genera was to be discussed between editors and authors. Distributional details were to be given without abbreviations, editorial condensation according to a fixed scheme would follow later.

In the letter of invitation three interesting points emerge³⁹. First, the Committee asked for first drafts to be submitted by 28 February 1938, with the hope of bringing the material to a finished form by early 1939. Secondly, remuneration would ordinarily be confined to a free copy or copies of the book, but claims for special remuneration would be considered individually. Finally, contributors were asked to revise herbarium collections. 'To ensure adequate treatment and to make available for consultation material named in accordance with the Flora, authors are asked to consult and revise the collections in the National Herbaria of the British Isles, or at least the British

TABLE 1. CONTRIBUTORS TO THE NSBF LISTED IN THE *JOURNAL OF BOTANY* 1938

Airy-Shaw*, H. K.; Alston*, A. H. G.; Anthony, J.; Ash, G. M.
 Baker, E. G.; Ballard, F.; Briton, C. E.; Bullock, A. A.; Burt*[†], B. L.; Butcher, R. W.
 Clark, W. A.
 Dandy*, J. E.
 Exell, A. W.
 Gilmour*, J. S. L.
 Hall, P. M.; Howarth, W. O.; Hubbard*, C. E.; Hyde, H. A.
 Jackson, A. B.; Jackson, A. K.
 Lousley, J. E.
 Marsden-Jones, E. M.; Melville*, R.; Milne-Redhead, E.
 Nelmes*, E.; Norman, C.
 Philipson, W. R.; Pugsley*, H. W.
 Rendle, A. B.; Richards*, P. W.
 Sealy, J. R.; Sledge*, W. A.; Stearn*, W. T.; Still, A. L.
 Taylor*, G.; Turrill, W. B.; Tutin, T. G.
 Valentine*, D. H.
 Warburg, E. F.; Wade*, A. E.; Watson, W.; Weiss, F. E.; Wilmott*, A. J.; Wolley-Dod, A. H.

(Anon. 1938a & b). Those who are also acknowledged in CTW (1952, p. xvii) as providing accounts or 'help with special problems' are marked*.

Herbarium of the British Museum'. The suggestion for revising herbarium collections came from Wilmott, for in a letter to Tansley⁴¹ he notes: 'Our collections are so large that if they are put in order nothing very serious can be omitted, and the doing of this should ensure that the treatment is adequate'.

The contributors to the NSBF were also invited to join the Panel of Referees of the Botanical Society and Exchange Club of the British Isles, and a formal list of names and addresses, and families that they had undertaken to write, were set out in a Supplement to the Report for 1936 (Anon. 1936). Lists of contributors and groups were also published in the *Journal of Botany* (Anon. 1938a) with a list of corrections and additions (Anon. 1938b) (Table 1). It is interesting that while botanists working in England, Scotland and Wales were associated with the project, no botanists based in Ireland were invited to contribute.

With regard to the new proposal to use Hutchinson's scheme, Gilmour, writing to Tansley, predicted that there would be difficulties ahead: 'I think the position was that you and Wilmott were very much against using either Bentham and Hooker or Engler and, after some discussion, we decided to promulgate a new system of our own - rather against my judgement. When, therefore Wilmott himself proposed using Hutchinson's system I thought that it was preferable to using one manufactured by Wilmott. I expect we shall have quite a storm over choosing Hutchinson's system, but, if we are not going to use either Bentham and Hooker or Engler, personally I do not think we could do better'⁴².

The storm that Gilmour predicted was not long in arriving, as a letter from Tansley to Gilmour dated 14 July 1936 reveals⁴³. 'There is a regular revolt in the Kew Herbarium against using Hutchinson's system; and it looks to me as if we shall be forced to reconsider this matter if we are to enlist the help of Sprague, Turrill, Sandwith etc.'. Tansley began to have second thoughts: 'I am inclined to favour reversion to the Bentham & Hooker sequence'. (Tansley to Gilmour 21 July⁴⁴). In the face of this difficulty Gilmour took a more robust view; (Gilmour to Tansley 22 July⁴⁵). 'As regards the vexed question of the system to be adopted for the Flora, I am in entire agreement with the idea that the primary consideration should be one of convenience of consultation. On these grounds, personally I would advocate an alphabetical arrangement, treating the Flora as a collection of monographs of families. Failing that, I think Bentham and Hooker, or Engler, have both strong arguments in their favour - provided we put in the Preface that we do not consider either system gives an adequate phylogenetic picture and that it is not our aim in employing it. On the other hand, we definitely took the view, as a committee, that we should try and inculcate

phylogenetic ideas in the Flora, and given that, I think Hutchinson's system is as good a one to use as any. Having decided that, and having asked Hutchinson to prepare descriptions of families, and having circulated our decision to contributors, personally I feel it will require a rather bigger storm than has been raised to alter our decision'⁴⁵.

There was at least one adverse reaction to the proposed arrangements for editing the manuscript etc. In a letter to Tansley dated 2 July 1936, Turrill wrote that, in response to the circular letter received this morning: 'I shall be pleased to undertake... the Caryophyllaceae and the Illecebraceae...under the following reasonable conditions. ...That I am allowed a perfectly free hand, within the form and scope set out in the papers received, in the synopses of the families and the genera, and keys to the latter.... It seems illogical that an author who has worked through the species should not be allowed to prepare (entirely and not merely partly) the generic and family synopses....That any alterations made in my manuscript should be submitted to me before being sent to the printers, and that in any botanical matters my acceptance or rejection of such alterations should be final...That I be allowed to make my own condensation of distribution, or alternatively be allowed to check and, if necessary, alter that made by the editors before the manuscript is printed'. With regard to revising material Turrill continued: 'I shall be pleased to consult but owing to the time involved I cannot promise to revise the collections in the British Museum unless these are sent on loan to Kew and permission to dissect be given by the authorities. I am, however, willing to prepare a standard set of the species of the two families in the Herbarium at Kew....I may add that in common with some of my colleagues, I am doubtful as to the advisability of following in the sequence of families a new and untested scheme, to which many strong objections have been raised'⁴⁰.

Taking up the points raised by Turrill, Gilmour wrote to Tansley stating that he did not foresee any particular difficulty in meeting Turrill's wishes⁴². He noted that the wording of the paragraph about family descriptions and synopses was purposely left vague so that contributors wishing to do their own could do so. He also imagined that the other points could be satisfied by showing the contributors the proofs. Although how the proofs would be circulated to such a large number of contributors is not confronted.

The editors encountered other difficulties. They were not efficient in keeping in touch with the many contributors, especially those working on critical groups. For example, Wolley-Dod wrote to Gilmour that he was having difficulties with *Rosa*. 'I think *Rosa* the most complicated and unstable genus I have ever had to deal with, which does not lend itself to a similar treatment to that of other genera'. He proposed to produce a series of keys to varieties of each species and reported having 'a very disjointed correspondence over the last twelve months with Wilmott concerning the treatment of the genus'⁴⁶. The arrangements for *Rubus* were also unsatisfactory. Riddelsdell was originally asked to work on the genus with Barton. However, in a letter to Gilmour in December 1937, Riddelsdell revealed that: 'Barton and I both received a request some time ago to "do" *Rubus* for the new Students' Flora; we did not answer it in our uncertainty. Barton said he does not know *Rubus* well enough, for the job; and that is true. For myself, I do not think I am competent for it'⁴⁷. The editors apparently only discovered the problem in December 1937, shortly before the date of submission of the first drafts from contributors. Very late in the day, the editors approached another botanist, W. Watson, to ask him to prepare an account of *Rubus*. This mistake put in jeopardy the proposed date for the publication of the Flora. There was also much concern when Watson wrote: 'In answer to your invitation I am quite ready to prepare a condensed account of the British Rubi for the new British Flora. There would be rather over three hundred forms to be dealt with, and I estimate that these could be adequately described in about 36 to 40 pages of print as in Hooker's Students' Flora, but making the fullest use of contractions....I would like to have until Oct. 1939 to complete the manuscript'⁴⁸. Gilmour questioned whether it was really worthwhile to delay the Flora⁴⁹, and the editors asked Watson for a shorter account of the genus: 'with which the general student can start to obtain a knowledge of the genus'⁵⁰.

The treatment of critical groups was clearly a major issue. With hindsight this is not surprising as the Rules and Suggestions for Contributors did not offer guidance. How to treat large and critical groups was included on the agenda for the Committee meeting held on 10 December 1936. Unfortunately, the minutes have not survived and therefore the only evidence available is in the letters between the editors and contributors. Some of the exchanges were not very informative. For example, Wilmott sent a letter to Wolley-Dod, who was responsible for *Rosa*. 'As regards the

scope of the Flora, it is in general desired to give a fairly full account of the groups, but it is evident that in *Rubus*, *Rosa* and *Hieracium* it is impossible to deal with everything since if we did, the work would be quite overloaded and quite unfit for use as a manual, which is what was intended⁵¹. By February 1939, as far as we can judge by the surviving papers, few had submitted their first drafts. In August 1939, the editors circulated a note to contributors enquiring when draft accounts would be available⁵².

THE FLORA PROJECT DURING WORLD WAR II (1939–1945)

Early in 1939, a rival to the NSBF was mooted by the publishers Macmillan. They contacted Hill at Kew⁵³, in March 1939, to propose that Hooker's *Student's Flora of the British Islands* be completely revised and were seeking a team of two to four taxonomists to carry out the work. However, when they heard about the NSBF project, they apparently abandoned the suggestion⁵⁴.

There is very little evidence concerning the later stages of the project in the Gilmour papers, however, the Wilmott archives contains a number of important documents. First, there are notes for a meeting of editors on 3 May 1939⁵⁵. A number of matters were discussed, including the Macmillan proposal; the question of whether to use metric measurements; and the problems of including flowering times in the Flora [e.g. in the south of England Primrose could be found flowering in every month of the year, while cliff plants at say 2500 ft in Scotland and Wales might be in flower only from June–July]. The Committee also discussed the proposal to circulate to authors a) a list of standard abbreviations of periodicals; and b) a complete listing of all general British Floras in chronological sequence, so that contributors could follow through the history of species and genera.

Towards the end of the year, as World War II became imminent, the Editorial Committee considered how they should react. Tansley was clear that: 'some of the contributors will be able to go on working at their stuff and would naturally do so, others will be prevented, and there will undoubtedly be delay. But I do not see that there need or should be any idea of *abandoning* the work'⁵⁶ [Tansley's emphasis]. Finally, in November 1939, the editors decided to send round a circular which stated that 'it would be undesirable to suspend the work altogether because of the abnormal conditions now existing...The Committee will, therefore, be grateful, if you will inform Mr. Gilmour as soon as possible the position in regard to your own contribution, and, if you are able to continue, the approximate date of completion'⁵⁷.

AFTER WORLD WAR II

Early in 1945 yet another flora project emerged, namely the proposal that led to the writing of *Flora of the British Isles*, by Clapham, Tutin and Warburg, published in 1952. Interestingly, Tansley played a key role in the setting up of the project. While a letter from Tutin to Wilmott⁵⁸ claimed that in no way was it duplicating 'the big flora', nevertheless, especially with hindsight, it was indeed a rival project. The circumstances of Tansley's involvement and the correspondence between Tutin and Wilmott are both very illuminating, especially Tutin's attempts to mollify Wilmott, and the information given about how CTW planned their Flora.

Evidence concerning Tansley's role in the 'rival' project is given in a *Memorial Volume* (1975) prepared to celebrate Humphrey Gilbert-Carter, former Director of the University Botanic Garden, Cambridge (1921–1950). Amongst the Memorials and Reminiscences is a piece by Professor T. G. Tutin. He recalls the circumstances and outcome of a meeting with Tansley, engineered by Gilbert-Carter. Although the meeting apparently happened by chance, perhaps it was not entirely accidental. 'On a winter afternoon shortly after (sic) the war we walked together through Trumpington to Grantchester and, as we were about to come back across Grantchester Meadows, he suggested that we might see if Tansley was in. He was, and on his own, so he asked us to stay for tea. Over tea Tansley asked me to write a British Flora. I had never thought of such an undertaking, but before we left plans had been drawn up and were speedily put into action'.

A letter from Tutin to Wilmott dated 15 March 1945 makes it plain that the walk to Grantchester had taken place recently (indeed before the war had ended), and gives the following details⁵⁸.

'A short while ago Tansley urged Clapham and me to write a flora for the use of students and after considering the matter, together with Warburg, we have decided to attempt it. Our intention is not to produce a work for the expert ...but to produce as rapidly as possible a book suitable for students in Universities to enable them to identify the plants they meet on excursions with reasonable ease and accuracy. This will of necessity be to a considerable extent a work of compilation and is obviously full of difficulties. We cannot hope for perfection but with the knowledge now available it is obviously possible to improve considerably on Hooker....With the large critical genera we have decided to try to describe aggregate species corresponding to sections, for instance, in *Rosa*, and to give references to detailed accounts. In other genera we may have to lump even further, since the object is to provide a usable tool for the ordinary student.' He then confronts the possible clash with the project: 'You will see from this that we are in no way duplicating the big flora, but are trying to provide speedily a makeshift to fill the gap that we have all felt so keenly in our teaching.' Wilmott's reply is generous, but foresees problems with the critical groups. 'I am glad to know of your project. It should fill a gap, as you say, and you and Clapham should make a good job of it. At the moment I am not in a position to help much with anything, as books and so many specimens are away and it is very difficult to work'. Wilmott was referring to the removal of specimens to safe storage during the war. His letter continues: 'Also we are very tired in London. But I wish you good luck. You will, of course, have a job with *Rosa*, *Rubus*, *Hieracium* and the like'⁵⁹.

About the same time that Wilmott received Tutin's letter, the Committee reviewed the state-of-play with their own project. A summary of how far the work on the Flora had progressed, by March 1945, has survived in Wilmott's papers⁶⁰. Six groups had been completed and sent in [*Polygonum* and *Melampyrum* (Britton); *Illecebraceae* (Turrill); *Lemnaceae* (Tutin); *Anagallis* (Weiss & Marden-Jones) and *Rosa* (Wolley-Dod)], and preparation was thought to be well advanced of 14 groups being worked on by contributors not involved in war work. The position of another 74 groups by contributors not involved in war work was not precisely known. A further 32 groups were being prepared by contributors on war work, and five uncompleted groups had been assigned to Britton and Hall, who had both died during the war.

The Editorial Committee concluded that a large part of the Flora was not near to publication. They then made the radical decision to publish the Flora in parts, starting with the material already submitted. In this way, the Committee judged that interest would be aroused in contributors and purchasers, and it would benefit from a greater number of sales, as more purchases would be made if it was sold "piecemeal". It was envisaged that it would take another five to ten years for all the parts of the Flora to reach publication. Moreover, the decision to publish in parts presented further difficulties. How were the pages to be numbered, so that the whole Flora might eventually be bound into a complete book by assembling the parts? Even more problematic was how to ensure that the published parts followed a satisfactory scheme of classification. The mode of publication was still being debated in September 1945, for Tansley wrote to Gilmour: '....I am inclined to think it may be best to arrange for the publication of the parts, i.e. each family or group of families, as they are ready, *quite separately as independent works*'⁶¹.

No correspondence has been found dated later than 17 September 1945 and nothing in the archives reveals how and when the project was finally abandoned. No material was published under the editorship of Gilmour, Tansley or Wilmott. Perhaps the project was finally abandoned with the premature death of Wilmott in 1950 (Ramsbottom 1950; Williams 1950).

What is interesting, however, is that one set of accounts in preparation for the NSBF was included in the text of CTW when it was published in 1952. The three authors are credited with writing all except one of the family accounts in the Flora (see CTW page 1507-8). Paul Richards, who was writing Juncaceae for the NSBF, was responsible for this family in CTW. The extent to which other material was used in CTW is revealed in a letter from Tutin to David Allen, dated 11 September 1980. 'Of course all Floras draw to some extent on their predecessors, but we certainly never saw any MSS of the earlier Flora (if there were any) apart from our own'⁶². It is, however, possible that some of the preparation made for the earlier Flora might have had some influence on CTW, as many of those working on the NSBF are acknowledged 'for help with special problems' (see CTW page xvii; and Table 1).

DISCUSSION AND CONCLUSIONS

The NSBF project failed for a number of reasons, some of which are problems faced by all editors of floras, others were peculiar to this attempt. Undoubtedly, the Second World War (1939–1945) interrupted the work, but several other major problems have been identified.

It is possible that Tansley was a reluctant Chairman. Also, he was not a taxonomist. In the early years of the project, Tansley was very active in many fields. He retired from the Sherardian Chair in Oxford in 1937 (Godwin 1958, 1977), and, therefore, potentially, he had more time to devote to the completion of the Flora. However, by 1945 Tansley had reached 74 years of age and was impatient to see the project come to fruition. Tansley, with his long experience as an editor of *New Phytologist* and *Journal of Ecology* was clearly very interested, probably over-interested, in uniformity of treatment and in the exercise of editorial authority. Thus, in a memorandum to contributors⁶³, he acknowledged the problems of bringing a multi-author work to fruition, and the distinct possibility of antagonising the contributors. 'It is clear that the scheme of publishing a flora.... written by a large number of contributors is not free from the danger of friction arising from honest differences of opinion'. If such differences arose, it was proposed to deal with some of them by means of footnotes, a plan which caused resentment. Tansley was driven to conclude that: 'Serious misapprehension seems to have arisen as to the nature and purpose of the proposal to add footnotes to authors' accounts of particular groups under certain circumstances. There is not and never has been the slightest intention of criticising authors' accounts in detail by means of footnotes. The proposal was made to meet the possible eventuality of an author's account failing to recognise a possible view of the taxonomic facts which might seem to the editorial committee of such scientific importance that it ought not to be neglected altogether. It is hoped and believed that in the great majority of such cases as may arise, perhaps in all, an author would be willing to modify his account...but it considered possible that an author might occasionally prefer merely to set out his own point of view, and leave it to the editors, if they thought it important, to make the briefest reference to the existence of another standpoint'⁶³. It seems with hindsight that it would have been politic to have waited until all the manuscript had been delivered and an actual problem detected, rather than contemplating such a solution to what might have been a purely hypothetical possibility.

At a personal level too there were difficulties. The kindhearted, courteous, master-diplomatist Gilmour (Walters 1987; Winsor 2000), who was only 27 at the start of the project, was on friendly terms with both Tansley and Wilmott. Tansley, however, had difficulty dealing with Wilmott and Hutchinson. Indeed, Tansley was candid in comments to Gilmour, for he wrote: 'It is indeed unfortunate that the Flora Scheme should have been linked with two personalities that seem so unpopular as Hutchinson and Wilmott'⁶⁴. With regard to his dealings with others, Allen (1986) concludes that Wilmott 'was volcanic, unpredictable'; a man who could be ferocious with his peers. He was also a perfectionist, and his fine logical intellect, and his outstanding knowledge of the European flora could make him a severe critic of the work of other taxonomists (Campbell 1951; Stearn 1981). The fact that he had once planned to write his 'own' critical flora is also important, as this probably contributed to a conflict of interests and to the lack of clear purpose, when he had to act in a group. It is not surprising that a taxonomist of his stature should have been contemplating writing his 'own' Flora. When he edited the 10th edition of Babington's *Manual*, he was 'strictly bound by Mrs Babington's instructions' (Alston 1951), and was only able to bring the names up to date and provide a short appendix to include the most important additions 'to our knowledge of the British Flora' (Wilmott 1922, p. ix). Furthermore, in his work with Moss on Volume iii of the abortive *Cambridge British Flora*, many problems were encountered (Bunting, Briggs & Block 1995), and Wilmott withdrew from the project in April 1923⁶⁵, before it was finally abandoned in September of the same year. No doubt the critical reviews of the two published volumes influenced his decision. For example, commenting on Volume iii published in 1920, W. H. Pearsall wrote: 'A study of this recently-issued volume of the Cambridge British Flora deepens the sense of disappointment created by its predecessor, and strengthens the opinion that the flora is largely an artificial erection founded upon a set of over-rated drawings' (Pearsall 1920).

Another problem faced by the project was the lack of communication of a common vision from the editors to the contributors. Apparently, no meetings were held to inform and encourage those

preparing the accounts for the NSBF. This was in contrast to the planning that proceeded the writing of the *Cambridge British Flora*. A meeting of potential contributors was held on 7 March 1912 at the Natural History Museum, which despite being heated, generated enthusiasm and interest in the project (Bunting, Briggs & Block 1995).

The Rules and Suggestions for Contributors³⁹ make it clear that the Flora Project aimed to secure very comprehensive accounts from the acknowledged experts of the day. With hindsight the project was too ambitious, especially in asking the contributors to revise material in the National Herbaria. There is also evidence from the archives of acute problems in organisation and delays in achieving key objectives. Thus, little progress was made in the early years and the specimen accounts and instructions to authors were not available at the start of the project. When the Rules and Suggestions for Contributors were sent out in 1936, no glossary was produced, (although a list of agreed abbreviations and symbols was belatedly circulated to contributors in September 1938⁶⁶). Without an agreed glossary, it is not clear how the Committee would have ensured the use of the same terminology and definitions throughout the Flora. Also, working with such large numbers of people was unwieldy. Moreover, Professor W. T. Stearn confirms that contributors were not chivvied for their accounts. Furthermore, two major issues were never successfully clarified. The Editorial Committee did not devise satisfactory means of dealing with the critical genera; and the committee kept changing its mind as to which classification to use. The choice of Hutchinson's system antagonised many professional botanists.

Our conclusions about the fate of the NSBF were deduced from archival and published sources. Through the kindness of David Allen it has been possible to test these ideas. While researching the history of the Botanical Society of the British Isles (Allen 1986), he received a letter from Tutin on 11 September 1980 about the NSBF and other matters. Tutin wrote: 'Warburg and I were both involved in the abortive Flora, but I don't think Clapham was. I think it never really got going, like most things that Wilmott was involved in; John Gilmour, a very dear and long-standing friend of mine, has never been very good at pushing people and Tansley was heavily involved with his magnum opus at that time. This seems to me to explain fully the failure of the attempt. I wrote the very small portion that was allotted to me, sent it in and heard no more. I think it is rather doubtful if Warburg got his part polished to the state that satisfied him. Anyhow, by the time the war was over that Flora was dead and pretty completely forgotten about. The war made a break in our lives much greater than would be expected from the time it lasted. However, once again it was Tansley who took the initiative. This is the only, somewhat tenuous link between the two Floras' [CTW and NSBF]⁶².

While detailed archival study of the writing of CTW has yet to be carried out, comparisons with the NSBF reveal that CTW was, in a number of ways, a much less ambitious project. Firstly, CTW was written by three enthusiasts, and avoided the problems of seeking a large number of accounts from acknowledged experts, many of whom were prima donnas. However, it is clear that they took advice from many taxonomists. For example, Wilmott was consulted by Tutin in the preparation of the account of *Salicornia*^{67 & 68}.

Secondly, as Tutin's letter to Wilmott⁵⁸ makes it plain, the *Flora of the British Isles* was seen as a compilation - a record of the taxonomic state-of-play. Tribute must be paid to Tansley and Humphrey Gilbert-Carter not only for providing the initial inspiration for the writing of this Flora, but also, most probably, for giving valuable advice on how to avoid the problems encountered with the *Cambridge British Flora* and the NSBF project. Thus, the three authors did not stop to resolve taxonomic difficulties as they emerged, by carrying out research. They reported the information then available, and commented on the problem areas requiring further study. It is of great interest also to consider how *Flora Europaea* was planned and written, for Tutin was one of the editors. While *Flora Europaea* was starkly different from CTW, for example in bringing together the work of a great number of specialists, in one very important respect the approach was similar to CTW. In the Preface (p. xii Volume 1, 1964) the basic philosophy is clearly set out. 'It should be emphasised that it has been, and remains, the intention of the Editorial Committee to produce a concise and complete Flora in the shortest possible time. Consequently, the principle has been adopted that publication of the Flora cannot be delayed for an indefinite period to allow the lengthy and detailed research required for a complete solution of all the problems that arise during its preparation. The committee believe that it is more valuable to have a complete Flora, representing a synthesis of available information, than a series of detailed monographs where

completion could not be foreseen'. The failure of the NSBF and the successful completion of CTW and *Flora Europaea* provide a cautionary tale to writers of other multi-author Floras, who are tempted, in the words of Tansley (p. ix in CTW) by the notion of achieving 'completeness and exhaustiveness'.

A third point of general interest concerns the publishing of a Flora in parts. As we have seen above, and despite some of the obvious problems, such a possibility was being contemplated by the editors of the NSBF in the post-war period. David Allen has drawn our attention to an interesting example that illustrates some of the difficulties. In the 1930s, The Royal Botanical Society of the Netherlands revived a plan for a national Flora to be published in parts. Only one part had been completed before the Second World War intervened and although work was resumed and further parts appeared, by the mid-1980s not only was commitment flagging, but publication was questionably still affordable. Finally, the funds set aside for that project were used instead to support the Society's Journal. Here is a salutary warning against publishing in parts over too long a period (Allen 1999).

Finally, reflecting on the demise of the NSBF project, it was clearly a missed opportunity to provide a much needed new National Flora. Of the books used in the 1930s, Babington's *Manual* was construed as 'a field-book or travelling companion for botanists' (Babington, 1922). Therefore, at this time, 'in the absence of any solid competitor, an inadequately modernised edition of Bentham's 1858 *Handbook* continued to dominate the market - and thereby persisted in foisting on the unwitting its misleadingly broad treatments of many of the species' (Allen 1986). Many of the acknowledged experts of the day were involved in the NSBF project, and, with the right organisation and financing, a definitive taxonomic work could have been produced, and would have provided a major stimulus to studies of British plants.

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SOURCES OF LETTERS AND OTHER PAPERS

GA - Gilmour Archive, Botanic Garden, Cambridge University.

NHM - Archives of the Natural History Museum.

CUP - Archives of papers of Cambridge University Press in the University Library, University of Cambridge.

- 1 Kenneth Sisam to Sir Arthur Hill, 10 February 1933. (GA).
- 2 Hill to Sisam, 14 February 1933. (GA).
- 3 Report signed by W. B. Turrill, 14 February 1933. (GA).
- 4 Sisam to Hill, 15 February 1933. (GA).
- 5 Hill to Sisam, 17 February 1933. (GA).
- 6 Sisam to Hill, 23 February 1933. (GA).
- 7 Professor A. G. Tansley to Hill, 28 February 1933. (GA).
- 8 Tansley to Hill, 28 February 1933. (GA).
- 9 Hill to Tansley, 2 March 1933. (GA).
- 10 Tansley to J. S. L. Gilmour, 25 April 1933. (GA).
- 11 Tansley to Gilmour: draft circular from Gilmour, Tansley and A. J. Wilmott, dated 12 May 1933. (GA).
- 12 Wilmott to Tansley, 6 May 1933. (NHM).
- 13 Agenda for First British Flora Editorial Committee Meeting, 26 May 1933. (GA).
- 14 Gilmour to Tansley, with account of the editorial meeting and lists of groups, 31 May 1933. (GA).
- 15 Tansley to Gilmour, 1 June 1933. (GA).
- 16 Joan Salzman to Gilmour with summary of questionnaires, 2 June 1933. (GA).
- 17 H. W. Pugsley to Tansley, 26 May 1933. (NHM).
- 18 Memorandum of Tansley's interview with Sisam, 4 July 1933. (GA).
- 19 Agenda for British Flora Editorial meeting, 5 July 1933. (GA).
- 20 Minutes of meeting held on 5 July 1933. (GA).

- 21 Sisam to Hill, 12 July 1933. (GA).
- 22 Gilmour to Tansley, 17 July 1933. (GA).
- 23 Tansley to Gilmour, 17 July 1933. (GA).
- 24 Tansley to Wilmott, 15 August 1933. (NHM).
- 25 Tansley to Wilmott, 13 July 1934. (NHM).
- 26 Gilmour to Wilmott, 4 July 1935. (NHM).
- 27 Tansley to Gilmour 15 July 1935. (GA).
- 28 Wilmott to Gilmour, 13 August 1935. (GA).
- 29 Wilmott to Gilmour, 30 August 1935. (GA).
- 30 Gilmour to Tansley, 3 September 1935. (GA).
- 31 Tansley to Hill, 26 September 1935. (GA).
- 32 Tansley to J. Ramsbottom, 26 September 1935. (NHM).
- 33 Tansley to Gilmour, 26 September 1935. (GA).
- 34 Ramsbottom to Tansley, 3 October 1935. (NHM).
- 35 Ramsbottom to Tansley, 17 October 1935. (NHM).
- 36 Tansley to Gilmour, 18 October 1935. (GA).
- 37 Wilmott to Gilmour, 29 October 1935. (GA).
- 38 Tansley to Gilmour, 3 December 1935. (GA).
- 39 New Students' British Flora letter to contributors, with Rules and Suggestions for Contributors and specimen descriptions, August 1936. (NHM).
- 40 Turrill to Tansley, 2 July 1936. (GA).
- 41 Wilmott to Tansley, 6 February 1936. (NHM).
- 42 Gilmour to Tansley, 6 July 1936. (GA).
- 43 Tansley to Gilmour, 14 July 1936. (GA).
- 44 Tansley to Gilmour, 21 July 1936. (GA).
- 45 Gilmour to Tansley, 22 July 1936. (GA).
- 46 Lt. Col. A. H. Wolley-Dod to Gilmour, 6 November 1937. (GA).
- 47 Rev. H. J. Riddelsdell to Gilmour, 5 December 1937. (GA).
- 48 W. Watson to Wilmott, 2 February 1938. (NHM).
- 49 Gilmour to Wilmott, 9 February 1938. (GA).
- 50 Wilmott to W. Watson, 17 March 1938. (GA).
- 51 Wilmott to Wolley-Dod, 5 November 1937. (GA).
- 52 Circular letter from the three editors to the contributors, August 1939. (GA).
- 53 L. J. F. Brimble to Hill, 6 March 1939. (NHM).
- 54 Brimble to Hill, 7 March 1939. (NHM).
- 55 British Flora: Notes for meeting, 3 May 1939. (NHM).
- 56 Tansley to Gilmour, 11 October 1939. (NHM).
- 57 Circular letter signed by Gilmour, Tansley & Wilmott, November 1939. (NHM).
- 58 T. G. Tutin to Wilmott, 15 March 1945. (NHM).
- 59 Wilmott to Tutin, 16 March 1945. (NHM).
- 60 British Flora, position in March 1945. (NHM).
- 61 Tansley to Gilmour, 14 September 1945. (NHM).
- 62 Tutin to David E. Allen, 11 September 1980. (GA).
- 63 Memorandum for contributors to the New Students' British Flora by Tansley, September 1936. (GA).
- 64 Tansley to Gilmour, 13 August 1936. (GA).
- 65 Minutes of the Committee meeting of the Syndics of Cambridge University Press 20 April 1923. (CUP).
- 66 Gilmour to Tansley, 23 September 1938. With list of Abbreviations. (GA).
- 67 Tutin to Wilmott, 16 December 1946. (NHM).
- 68 Wilmott to Tutin, 13 January 1947. (NHM).

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Hybrid origin of the Oxford Ragwort, *Senecio squalidus* L: morphological and allozyme differences between *S. squalidus* and *S. rupestris* Waldst. and Kit.

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ABSTRACT

Morphometric and allozyme variation was surveyed in *Senecio rupestris*, a species native to central and southern Europe, and compared with that within the Oxford ragwort, *Senecio squalidus*, and two Sicilian species, *S. aethnensis* and *S. chrysanthemifolius* and their hybrid offspring. In addition, a limited survey of chloroplast DNA variation was conducted in *S. rupestris* to augment previous results for this species. Canonical Variate Analysis of 32 morphometric traits recorded on plants raised under the same conditions showed that *S. squalidus* is morphologically distinct from *S. rupestris*, and is similar to hybrid material between *S. aethnensis* and *S. chrysanthemifolius* collected from Mt Etna, Sicily. *Senecio squalidus* produces leaves that are more dissected than *S. rupestris*, and which have a more acute angle between the apex of the primary vein and the apices of the adjacent marginal tooth sinuses. A UPGMA analysis of genetic distances between populations based on allele frequencies at eight allozyme loci also distinguished *S. rupestris* from *S. squalidus*. *Senecio squalidus* contained two alleles for acid phosphatase, one of which (*Acp-2b*) was not present in *S. rupestris*. Allozyme and chloroplast DNA variation was geographically structured within *S. rupestris*, such as to indicate that refugia may have existed for this species in central Italy and the Balkans during the last ice-age, and that alpine populations are a product of post-glacial colonisation. The close similarity in morphology and allozyme composition of *S. squalidus* to hybrid material of *S. aethnensis* and *S. chrysanthemifolius*, suggests that it is a hybrid derivative of these two Sicilian species rather than a derivative of *S. rupestris*.

KEYWORDS: hybrid speciation, introduced plants, population genetics, *Senecio*, Asteraceae.

INTRODUCTION

In a previous paper (Abbott *et al.* 2000), we presented evidence supporting the proposal by Crisp (1972) that Oxford ragwort, *Senecio squalidus*, L. (Asteraceae) is a diploid hybrid species which originated from hybrid material between *S. aethnensis* Jan. ex DC. and *S. chrysanthemifolius* Poir. that was introduced to the British Isles from Mt Etna, Sicily. Morphometric analysis of material raised under glasshouse conditions showed that *S. squalidus* ($2n=20$) was phenotypically intermediate in leaf shape and capitulum size to that of *S. aethnensis* ($2n=20$) and *S. chrysanthemifolius* ($2n=20$), and closely resembled hybrid material between these two species. Allozyme analysis further showed that populations of *S. squalidus* were very similar genetically to Sicilian material with some populations clustering tightly with hybrid material and with *S. chrysanthemifolius*. Most notably, *S. squalidus* and hybrid material were polymorphic at the *Acp-2* locus and exhibited almost identical frequencies for two alleles (*a* and *b*) that distinguish pure populations of the two parent species.

Prior to the above analysis, Walters (1963) had emphasized that *S. rupestris* Waldst. and Kit. ($2n=20$), a species that occurs on mountains in central and southern Europe was morphologically very similar to *S. squalidus* in the British Isles. Because of this similarity, Alexander (1979) in a taxonomic revision of Mediterranean *Senecio*, section *Senecio*, subsumed *S. rupestris* under

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S. squalidus although considered British plants to be atypical of the taxon. This would suggest that *S. squalidus* and *S. rupestris* have a common origin. For the purposes of this paper, we treat as separate species *S. squalidus* found in the British Isles and *S. rupestris* from central and southern Europe, and examine how similar they are in morphology and in allozyme composition.

A survey of chloroplast (cp) DNA RFLP variation in *S. squalidus*, *S. aethnensis*, *S. chrysanthemifolius* and *S. rupestris* (Abbott *et al.* 1995) showed that both British *S. squalidus* and Sicilian *S. chrysanthemifolius* are monomorphic for the same cpDNA haplotype (B). In contrast, *S. aethnensis* from populations occurring between 1650 to 1890 m on Mt Etna is polymorphic for haplotypes A and B as is hybrid material. Only one accession of *S. rupestris* (from Abruzzi, central Italy) was found to possess haplotype B; other accessions of this species contained either haplotype A (from the Italian Alps, Romania, N Bulgaria, and introductions to Germany), or haplotype C (from S Bulgaria and Greece).

Here we compare morphometric and allozyme variation in *S. rupestris* with that within *S. squalidus*, *S. aethnensis*, *S. chrysanthemifolius*, and *S. aethnensis* $\times$ *S. chrysanthemifolius* hybrid material. The results for material other than *S. rupestris* were published previously (Abbott *et al.* 2000). Consequently, we repeat these here in summary form and solely for comparative purposes. In addition, we report the results of a further survey of chloroplast DNA variation in *S. rupestris*, which augments previous results for this species and provides an improved understanding of the geographical distribution of cpDNA haplotypes in this material.

MATERIALS AND METHODS

PLANT MATERIAL

Seed was collected separately from approximately 30 plants from each of 18 populations of *S. rupestris* from central and southern Europe (Table 1, Fig. 1). Material raised from seed was compared with material cultivated from seed from 9 populations of *S. squalidus* from the British Isles, three populations of each of *S. aethnensis*, *S. chrysanthemifolius*, and three of their hybrid swarms occurring on Mt Etna, Sicily (Fig. 1 and Abbott *et al.* 2000).

MORPHOMETRIC ANALYSIS

Five plants (one offspring per mother plant) from each of 13 populations of *S. rupestris* (nine populations from Italy, two from Bulgaria, and one each from Romania and Greece) (Table 1) were raised with 5 plants from each of two populations of *S. squalidus* (from Oxford and Edinburgh) and five plants of each of *S. aethnensis*, *S. chrysanthemifolius*, and also of hybrid material from Mt Etna (two plants from population 7, and three plants from population 8). The 90 plants were grown from seed to maturity as single individuals in pots of 13 cm diameter containing compost. Pots were fully randomized in a 15 $\times$ 6 block within a greenhouse. Details of growth conditions are given in Abbott *et al.* (2000). On the day of full anthesis of the apical capitulum, each plant was harvested and measured for 32 characters. Fifteen of the characters were descriptors of the capitulum, while 15 described leaf size and shape. The remaining two characters were plant height and inflorescence length. Details of measurement are given in James (1995). Data of variables that were not normally distributed were transformed into natural logarithms before subjecting them to one-way ANOVA using SPSS Base (version 7.5, SPSS Inc. 1997) to detect differences between population means. Canonical variate analysis (CVA) conducted using NTSYSpc (version 2.0, Rohlf 1998) was also conducted. This analysis derives linear canonical variates that maximize the separation among groups (populations) relative to variability within groups. For the purpose of CVA analysis *S. aethnensis* $\times$ *S. chrysanthemifolius* hybrid plants were combined into one group. After testing for a significant difference between groups by single classification multivariate analysis (MANOVA), the relationships among groups were displayed by plotting mean canonical scores of each group against each other for the first two canonical variates. CVA was then repeated ten times with data of one *S. squalidus* plant omitted, in turn, each time. After each analysis the plant omitted was assigned to a group using the respective group discriminant function as criterion.

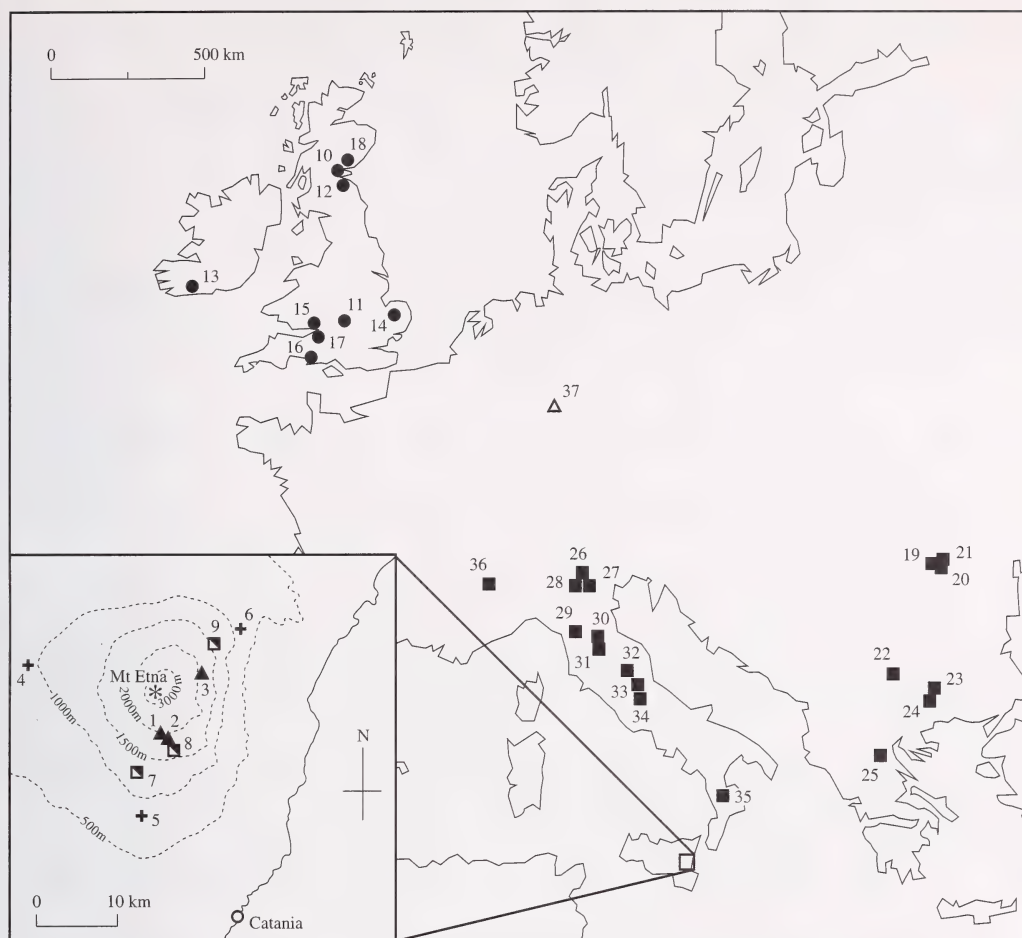


FIGURE 1. Locations of populations of *Senecio* surveyed. Main map: *S. squalidus* (●), *S. rupestris* (■). Map inset: *S. aethnensis* (▲), *S. chrysanthemifolius* (+), and *S. aethnensis* × *S. chrysanthemifolius* (◼). Key to population numbers of *S. rupestris* is given in Table 1, and for other taxa in Abbott *et al.* (2000).

ALLOZYME ANALYSIS

Allozyme variation was assayed in all populations for six enzymes by means of starch gel electrophoresis procedures described previously (Abbott *et al.* 2000). The enzymes assayed were acid phosphatase (*Acp*), aspartate aminotransferase (*Aat*), β -esterase (β -*Est*), glyceraldehyde-3-phosphate dehydrogenase (*G3pd*), phosphoglucisomerase (*Pgi*), and phosphoglucomutase (*Pgm*).

The genetics of electrophoretic variants were interpreted as described by Abbott *et al.* (2000). Allozyme variation was estimated by computing the mean number of alleles per locus (*A*) (including monomorphic loci), mean percentage of polymorphic loci (*P*), and mean unbiased expected heterozygosities (*He*) using the BIOSYS-1 software (vers. 1.7; Swofford and Selander 1989). Hardy-Weinberg equilibrium was tested at each locus in each population and across loci in all populations using the GENEPOP software (vers. 3; Raymond and Rousset 1995) probability test option (Fisher's method). Estimates of genetic distance between all populations were calculated (after Nei 1972) and subjected to an unweighted pair group analysis (UPGMA) using BIOSYS-2 (Swofford and Selander, 1997).

F-statistics (Wright 1951) were estimated for *S. rupestris* as outlined by Weir (1990) using the computer program FSTAT (vers 1.2; Goudet 1995). Mean values of *F*, θ and *f* (Weir and Cockerham's, 1984) estimators of Wright's (1978) parameters of total inbreeding (*Fit*),

TABLE 1. LOCATIONS, SITE DESCRIPTIONS, COORDINATES, AND ALTITUDE OF *SENECIO RUPESTRIS* POPULATIONS

No.	Locality	Lat. (N)	Long. (E)	Alt. (m)	Collector (date)
19	Romania, Sinaia, by stream approx. 3 km W. of Sinaia	45-20	25-32	1400	RIM (12.08.92)
20	Romania, Sinaia, roadside in forest, approx. 2 km W. of Sinaia	45-20	25-33	1500	RIM (12.08.92)
21*†	Romania, Sinaia, on shingle by river, 2 km N. of Sinaia	45-21	25-33	1400	RIM (13.08.92)
22*†	Bulgaria, Sofia, Mt Vitoshka, environs of hotels	42-21	23-16	1800	RIM (15.08.92)
23*†	Bulgaria, Pamporovo, near Smolyan, roadside	41-40	24-41	1550	RIM (18.08.92)
24	Bulgaria, near Smolyan, 10 km S. of Shiroka Laka, by stream	41-42	24-36	1500	RIM (19.08.92)
25*†	Greece, Mt Olympus, open disturbed habitat	40-04	21-25	2150	RIM (21.08.92)
26*†	Italy, Trentino, Molveno, environs of first chair lift station	46-09	10-59	1370	RJA & HPC (19.08.94)
27*†	Italy, Trentino, Lake Garda, Mt Baldo, environs of chair lift stn.	45-43	10-52	1850	RJA & HPC (18.08.94)
28*†	Italy, Trentino, Mt Tremalzo, Rif. Fco. Guella, disturbed ground	45-50	10-40	1580	RJA & HPC (19.08.94)
29*†	Italy, Tuscany, Abetone, carpark	44-11	10-40	1390	RJA & HPC (21.08.94)
30*†	Italy, Tuscany, Mt Falterona, roadside	43-52	11-42	1350	RJA & HPC (20.08.94)
31*†	Italy, Tuscany, Mt Secchieta, waste ground	43-43	11-37	1450	RJA & HPC (21.08.94)
32*†	Italy, Umbria, Mt Sibbelini, near Mt Prata above Pso. di Gualdo, environs of Rif. "La Baita"	42-52	13-12	1650	RJA & HPC (22.08.94)
33*†	Italy, Abruzzi, Gran Sasso d'Italia (southern range), by cable car stn. and roadside, calcareous rocks	42-27	13-34	2130	RJA & HPC (23.08.94)
34*†	Italy, Abruzzi, Mtn della Maiella, near La Maieletta, roadside exposed calcareous rock	42-09	14-07	2000	RJA & HPC (24.08.94)
35†	Italy, Calabria, La Sila Grande, Fago del Soldalo, environs of Rif. del Montanaro	39-15	16-35	1450	RJA & HPC (18.04.96)
36	France, la Vallee d'Aoste et la Savoie, Col du Petit Saint Bernard roadside, near La Thuile	45-40	06-52	2175	RJA & HPC (07.09.97)

* Populations included in survey of morphometric variation.

† Populations included in survey of cpDNA variation. Additional material examined was from Engadin (Switzerland), Pirin (Bulgaria) and Timfristos (Greece).

RJA (R. J. Abbott), HPC (H. P. Comes), RIM (R. I. Milne).

Details of locations of populations of *S. aethnensis* (1-3), *S. chrysanthemifolius* (4-6), *S. aethnensis* × *S. chrysanthemifolius* (7-9) and *S. squalidus* (10-18) are given in Abbott *et al.* (2000).

subdivision among populations (*Fst*), and inbreeding within populations (*Fis*)] were computed and their standard deviations were calculated by jackknifing over loci. To examine a possible genetic association between particular populations of *S. rupestris*, an analysis of hierarchical F_{XY} statistics (Wright 1978) was conducted using the BIOSYS-1 program. Here a two tier hierarchy was defined such that subscripts X and Y refer to populations within groups, and groups within the total.

CHLOROPLAST DNA ANALYSIS

Total genomic DNA for restriction analysis of cpDNA variation was extracted as described in Comes *et al.* (1997) from leaf tissues of individuals of *S. rupestris* from the populations indicated in Table 1. Methods for restriction enzyme digestion, fragment separation, DNA transfer, and hybridization were also as described previously (Comes *et al.* 1997). Filters were hybridized with cloned fragments of digoxigenin-labeled cpDNA from *Lactuca sativa* (Jansen and Palmer 1987).

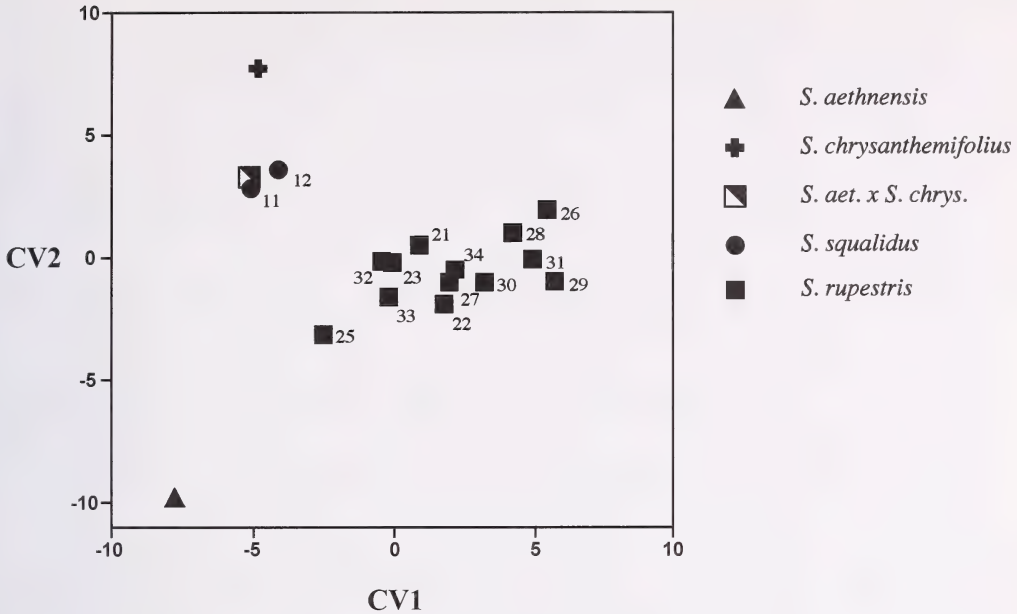


FIGURE 2. Plot of mean canonical scores for populations of *Senecio squalidus*, *S. rupestris*, *S. aethnensis*, *S. chrysanthemifolius*, and *S. aethnensis* $\times$ *S. chrysanthemifolius* on axes of canonical variates 1 and 2. Key to population numbers of *S. rupestris* is given in Table 1, and for other taxa see Fig. 1 and Abbott *et al.* (2000).

Hybridized probes were visualized using a digoxigenin nonradioactive labeling and detection kit (Boehringer Mannheim). The aim was to determine whether individuals possessed cpDNA haplotype A, B or C. This was achieved using a single probe-enzyme combination, *Lactuca sativa* probe pLsC 6/*Cla*I, which identifies a restriction site loss that distinguishes haplotype B from A, and also a 0.33–0.35 kb deletion which distinguishes haplotype C from A (Abbott *et al.* 1995).

RESULTS

MORPHOMETRIC ANALYSIS

The first three canonical variates derived from canonical variate analysis (CVA) accounted for 34.35, 25.44 and 11.51% of the total variance respectively. A MANOVA showed that differences between group means were highly significant ($p < 0.001$, according to Wilk's Lambda, Pillai's trace, and Hotelling-Lawley trace tests of significance). The plot (Fig. 2) of mean canonical scores of groups for canonical variate 1 (CV1) against variate 2 (CV2) clearly separated the two Sicilian taxa from one another along CV2 and less so along CV1. The two British populations of *S. squalidus* and the group of hybrid plants from Mt Etna clustered with each other, and were positioned between the two Sicilian taxa but more towards *S. chrysanthemifolius*. These five groups were clearly separated from *S. rupestris* populations by CV1 and CV2. An examination of population means for each character (Table 2) shows that *S. chrysanthemifolius* possesses highly dissected leaves in contrast to *S. aethnensis* which produces almost entire leaves. It is also evident that *S. squalidus* produces leaves that are more dissected than those of *S. rupestris*, and which have a more acute angle between the apex of the primary vein and the apices of the adjacent marginal tooth sinuses. The latter character had high weightings on both CV1 and CV2 (covariance was 1.91 and -2.82 respectively).

The assignment of *S. squalidus* individuals to groups after omitting each one, in turn, from a CVA, showed that two such plants were assigned to the *S. aethnensis* $\times$ *S. chrysanthemifolius* hybrid group (one each from Edinburgh and Oxford), six were assigned to the Oxford *S. squalidus*

TABLE 3. ALLELE FREQUENCIES AT POLYMORPHIC LOCI IN *SENECIO* TAXA AFTER POOLING DATA OVER POPULATIONS. (N = SAMPLE SIZE)

Locus/allele		Taxon				
		<i>S. aethnensis</i>	<i>S. chrysanth.</i>	<i>S. aet. × S. chrys.</i>	<i>S. squalidus</i>	<i>S. rupestris</i>
<i>Acp-2</i>	N	(62)	(95)	(76)	(209)	(483)
a		0.645	----	0.204	0.170	1.000
b		0.355	1.000	0.796	0.830	----
<i>Aat-3</i>	N	(62)	(94)	(76)	(214)	(483)
a		----	----	----	----	----
b		----	----	----	----	0.003
c		----	----	----	----	0.001
d		0.911	0.925	0.960	0.327	0.970
e		0.089	0.075	0.040	0.673	0.025
f		----	----	----	----	0.001
<i>β-Est-3</i>	N	(52)	(87)	(82)	(215)	(496)
a		----	----	----	----	0.001
b		----	----	----	----	0.009
c		----	----	----	----	0.040
d		----	----	----	----	0.065
e		0.673	0.632	0.591	----	0.531
f		0.327	0.368	0.409	1.000	0.352
g		----	----	----	----	0.002
<i>Pgi-2</i>	N	(61)	(88)	(84)	(211)	(478)
a		----	----	----	----	0.027
b		0.107	----	----	----	0.418
c		0.893	1.000	1.000	1.000	0.555
<i>Pgm-2</i>	N	(59)	(85)	(81)	(237)	(495)
a		----	0.023	----	----	0.022
b		0.881	0.906	0.920	0.996	0.974
c		0.119	0.071	0.080	0.004	0.004
<i>G3pd-1</i>	N	(63)	(89)	(84)	(197)	(480)
a		1.000	1.000	1.000	1.000	0.996
b		----	----	----	----	0.004

group (two Edinburgh and four Oxford plants), one was assigned to the Edinburgh *S. squalidus* group (an Edinburgh plant), and the remaining plant (from Edinburgh) was assigned to the *S. chrysanthemifolius* group. None of the *S. squalidus* plants was assigned to any of the *S. rupestris* groups, emphasising that these two species are distinguished morphometrically.

ALLOZYME ANALYSIS

Three of the eight loci investigated (*Acp-2*, *Pgi-1* and *Pgm-1*) were monomorphic in all populations of *S. rupestris* surveyed. At the *Acp-2* locus, all populations of *S. rupestris* were monomorphic for the allele *Acp-2a* (Table 3). In contrast, all populations of *S. aethnensis*, plus the *S. aethnensis* × *S. chrysanthemifolius* hybrid populations investigated, were polymorphic for the two *Acp-2* alleles (*a* and *b*) as were five of the nine populations of *S. squalidus*. The remaining four populations of *S. squalidus* were monomorphic for the *Acp-2b* allele as were the three populations of *S. chrysanthemifolius* surveyed.

Allele frequencies in *S. rupestris* were similar to those in the Sicilian taxa at the *Aat-3*, *β-Est-3*, *Pgm-2* and *G3pd-1* loci, except that *S. rupestris* normally possessed one or more rare alleles in addition to the common alleles at these loci (Table 3). There was a contrast between *S. squalidus* and the other *Senecio* taxa, in that it was monomorphic at the *β-Est-3* locus, and contained the *Aat-3e* allele at a much higher frequency.

TABLE 4. MEAN GENETIC DISTANCES AMONG POPULATIONS WITHIN AND BETWEEN *SENECIO* SPECIES (STANDARD ERRORS ARE IN BRACKETS).

	<i>S. aet.</i>	<i>S. chrys.</i>	<i>S. squal.</i>	<i>S. rupestris</i>
<i>S. aethnensis</i>	0-0127 (0-0019)			
<i>S. chrysanthemifolius</i>	0-0726 (0-0070)	0-0063 (0-0029)		
<i>S. squalidus</i>	0-1772 (0-0095)	0-1080 (0-0108)	0-0367 (0-0054)	
<i>S. rupestris</i>	0-0763 (0-0047)	0-2207 (0-0064)	0-3058 (0-0092)	0-0673 (0-0045)

UPGMA analysis of Nei's genetic distances between populations based on allele frequencies at all eight loci separated populations into two main clusters (Fig. 3). One cluster comprised all populations of *S. rupestris*, the three populations of *S. aethnensis* and one of the hybrid populations (population 9). The other cluster contained all populations of *S. squalidus* plus the three populations of *S. chrysanthemifolius* and two hybrid populations. Within this second cluster, two sub-groups were evident, one of which contained seven *S. squalidus* populations, while the other consisted of the *S. chrysanthemifolius* and hybrid populations, and two *S. squalidus* populations. All of the main branches of the dendrogram had low bootstrap support (<50%), which is expected when differences between taxa are based on only one or a few loci. It is clear in the present example that variation at the *Acp-2* locus is largely responsible for distinguishing taxa.

A comparison of mean genetic distances among populations within and between taxa (Table 4) shows that genetic distance between *S. aethnensis* and *S. chrysanthemifolius* is low, although considerably greater than that between populations within either of these two taxa. A similar genetic distance was evident between *S. aethnensis* and *S. rupestris*, while that between *S. rupestris* and *S. chrysanthemifolius* was approximately three times greater. The greatest mean genetic distance recorded was between *S. squalidus* and *S. rupestris*. This was considerably greater than that between *S. squalidus* and either Sicilian taxon.

Levels of diversity varied across populations of *S. rupestris* (Tables 5 and 6). Most diversity was present in populations from central Italy (Umbria/Abruzzi) in contrast to populations from the southern Alps which contained very little diversity (Table 5). Only in very few populations was the coefficient of inbreeding (f) high and deviations from Hardy-Weinberg equilibrium significant. Thus in most populations random mating was indicated.

In *S. rupestris*, population subdivision (θ) was significant while the mean coefficient of inbreeding within populations was not (Table 7). The very high f value recorded at *G3pd-1* was probably due to the extremely low level of polymorphism at this locus (Table 3). Hierarchical analysis of F statistics of these populations (Table 8) indicates that within *S. rupestris* most populations from the Balkans (19–21, 23–25) group with populations from central Italy (32–34), while most populations from the southern Alps (26, 28) cluster with populations from the Tuscany region of Italy (29–31) and with one population from the Balkans (22). However, the amount of genetic variation partitioned between these two groups ($F_{XY} = 0.142$) was less than that between populations within the groups ($F_{XY} = 0.183$).

CHLOROPLAST DNA ANALYSIS

Senecio rupestris surveyed for cpDNA variation was sampled from the central (Engadin) and southern Alps, Tuscany, central Italy, southern Italy and the Balkans (Romania, Bulgaria and Greece). The results (Table 9) confirmed previous findings (Abbott *et al.* 1995) that haplotype A is present in *S. rupestris* from the central and southern Alps, while haplotype B occurs in material from central Italy. Material from Tuscany and Calabria (not surveyed previously) possessed only haplotype A, indicating that haplotype B might be restricted in Italy to populations occurring centrally (Umbria and Abruzzi). However, haplotype B was also found in *S. rupestris* from two sites in the Balkans (Pirin, Bulgaria; and Timfristos, Greece), along with haplotype A in material from Romania and north Bulgaria and haplotype C in plants from south Bulgaria and Greece.

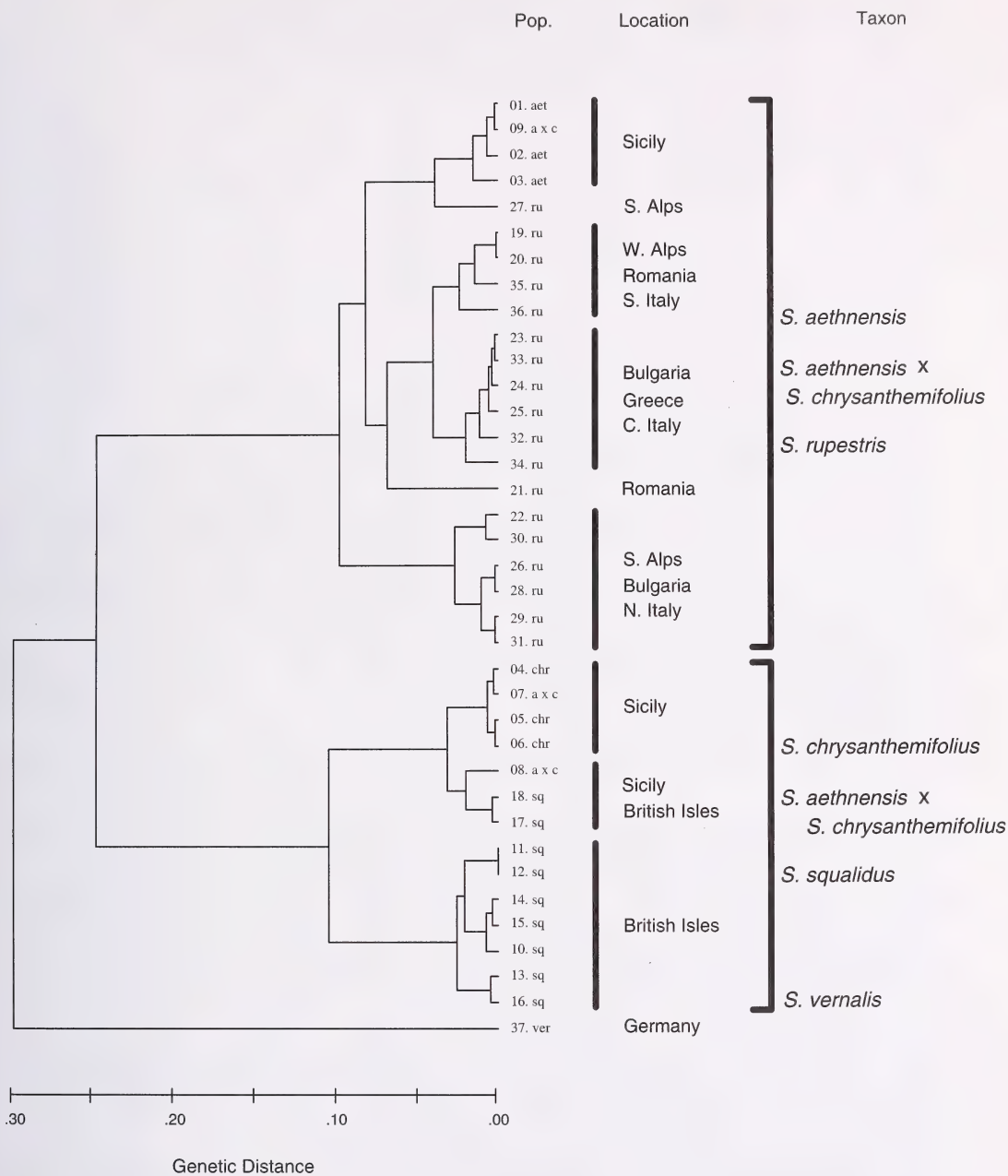


FIGURE 3. UPGMA tree constructed from genetic distances (after Nei 1972) between *Senecio* populations. Key to population numbers of *S. rupestris* is given in Table 1, and for other taxa see Fig. 1 and Abbott *et al.* (2000).

TABLE 5. ALLOZYME VARIABILITY ESTIMATES AND WEIR & COCKERHAM'S (1984) COEFFICIENT OF INBREEDING ($F = FIS$) IN POPULATIONS OF *S. RUPESTRIS*. TESTS OF HARDY-WEINBERG EQUILIBRIUM ACROSS LOCI WITHIN SAMPLES (FISHER'S METHOD) ARE INDICATED

Population	Sample size†	A†	P	He†	f††
19	19.9 (0.1)	1.4 (0.3)	25.0	0.096 (0.063)	-0.277
20	26.9 (0.1)	1.3 (0.2)	25.0	0.092 (0.060)	0.336*
21	17.0 (0.0)	1.5 (0.3)	37.5	0.157 (0.078)	0.257
22	27.3 (0.2)	1.8 (0.3)	50.0	0.161 (0.072)	0.130
23	24.1 (0.1)	1.4 (0.2)	37.5	0.130 (0.081)	0.097
24	29.9 (0.1)	1.8 (0.3)	50.0	0.141 (0.082)	0.191
25	30.0 (0.0)	1.5 (0.3)	37.5	0.128 (0.079)	0.323*
26	31.8 (0.5)	1.3 (0.2)	25.0	0.015 (0.010)	0.497
27	29.4 (0.2)	1.0 (0.0)	0.0	0.000	-----
28	28.1 (0.4)	1.3 (0.2)	25.0	0.040 (0.035)	-0.161
29	27.9 (0.6)	1.4 (0.3)	25.0	0.089 (0.062)	-0.069
30	26.0 (1.5)	1.4 (0.2)	37.5	0.082 (0.058)	0.021
31	27.9 (0.4)	1.4 (0.2)	37.5	0.110 (0.061)	0.010
32	31.4 (0.4)	1.5 (0.3)	25.0	0.156 (0.102)	-0.077
33	32.8 (0.3)	1.8 (0.3)	50.0	0.162 (0.088)	-0.010
34	30.0 (0.0)	2.0 (0.6)	37.5	0.178 (0.110)	0.063
35	12.0 (0.0)	1.1 (0.1)	12.5	0.010 (0.010)	0.000
36	34.0 (0.0)	1.4 (0.3)	25.0	0.076 (0.065)	0.086**

† Standard errors in parentheses

†† Hardy-Weinberg equilibrium rejected at * $P < 0.05$ and ** $P < 0.01$

A: mean no. of alleles per locus

P: percentage of polymorphic loci

He: mean expected heterozygosity

DISCUSSION

Morphometric analysis of material raised under the same greenhouse conditions showed that *S. rupestris* is morphologically distinct from *S. squalidus*. As previously reported by Abbott *et al.* (2000), *S. squalidus* closely resembles material sampled from the hybrid zone on Mt Etna, and possesses a phenotype intermediate to that of the two Sicilian taxa, although tending more towards that of *S. chrysanthemifolius* than *S. aethnensis*. The current analysis shows that *S. squalidus* produces leaves that are more dissected than those of *S. rupestris*, and which have a more acute angle between the apex of the primary vein and the apices of the adjacent marginal tooth sinuses.

The survey of allozyme variation confirmed the close similarity of *S. squalidus* to most *S. aethnensis* × *S. chrysanthemifolius* hybrid material and also to *S. chrysanthemifolius*. These were placed in a separate cluster from *S. rupestris*, *S. aethnensis* and one of the hybrid populations (9), in a UPGMA tree constructed from Nei's genetic distances between populations. The greatest mean genetic distance recorded between taxa was evident for *S. squalidus* and *S. rupestris* (0.306). This difference was considerably greater than that recorded between *S. squalidus* and *S. aethnensis* (0.177), and between *S. squalidus* and *S. chrysanthemifolius* (0.108).

S. rupestris populations from different parts of Europe differed greatly in level of allozyme diversity. Populations from central Italy and the Balkans contained relatively high levels of allozyme diversity based on mean number of alleles per locus and unbiased expected heterozygosity. In contrast, populations from the Alps contained very low levels or no diversity at all (Table 3), while populations from Tuscany contained intermediate levels of diversity. The relative high levels of allozyme diversity in central Italian and Balkan populations is of interest as except at high altitude these regions remained unglaciated during the last Ice Age (Hewitt, 1996)

TABLE 6. MEANS OF ALLOZYME VARIABILITY ESTIMATES (*A*, *P* AND *He*) IN SAMPLED *SENECIO*

Species	Populations	<i>A</i>	<i>P</i>	<i>He</i>
<i>S. aethnensis</i>	1-3	1.50	50.0	0.174
<i>S. chrysanthemifolius</i>	4-6	1.50	37.5	0.098
<i>S. aet.</i> × <i>S. chrys.</i>	7-9	1.50	50.0	0.117
<i>S. squalidus</i>	10-18	1.23	20.8	0.063
<i>S. rupestris</i> - All	19-36	1.46	31.2	0.101
Balkans	19-25	1.53	37.5	0.129
S Alps	26-28	1.20	16.7	0.018
Tuscany	29-31	1.40	33.3	0.094
Umbria/Abruzzi	32-34	1.77	37.5	0.165

A = average number of alleles per locus; *P* = percentage of polymorphic loci; *He* = expected heterozygosity

TABLE 7. WEIR & COCKERHAM'S (1984) ESTIMATES OF WRIGHT'S *F*-STATISTICS CALCULATED SEPARATELY FOR EACH LOCUS FOR ALL POPULATIONS OF *SENECIO RUPESTRIS*

Locus	<i>F</i>	θ	<i>f</i>
<i>Aat-3</i>	0.116 (0.094)	0.034 (0.017)	0.084 (0.096)
<i>β-Est-3</i>	0.540 (0.072)	0.453 (0.076)	0.159 (0.062)
<i>Pgi-2</i>	0.253 (0.105)	0.272 (0.094)	-0.026 (0.057)
<i>Pgm-2</i>	0.495 (0.207)	0.193 (0.087)	0.356 (0.172)
<i>G3pd-1</i>	0.972 (0.472)	0.065 (0.031)	0.938 (0.456)
Mean (Std. Dev.)	0.415 (0.162)	0.368 (0.111)	0.061 (0.101)
95% confidence interval	0.218-0.540	0.059-0.445	-0.013-0.271

Means and standard deviations were obtained by jackknifing over loci. Confidence intervals were obtained by bootstrapping over loci. Locus specific standard deviations were obtained by jackknifing over populations.

F = *Fit* (within total), θ = *Fst* (among populations), *f* = *Fis* (within populations)

TABLE 8. HIERARCHICAL *F*-STATISTICS FOR POPULATIONS OF *SENECIO RUPESTRIS* COMBINED ACROSS LOCI

Comparison		Variance component	<i>Fxy</i>
x	y		
Population	Group	0.1940	0.183
Group	Total	0.1757	0.142
Population	Total	0.3697	0.299

Groups: A (Balkans: 19-21, 23-25; central Italy: 32-34, populations)

B (S. Alps: 26-28; Tuscany: 29-31; and Balkan: 22, populations)

N.B. Populations 35 (La Sila Grande) and 36 (La Thuile) were excluded from analysis

and could have served as refugia for *S. rupestris* during this period. Populations of species that currently occur in areas that were refugia during previous glacial periods often contain high levels of genetic diversity relative to populations that occur in formerly glaciated regions (Comes & Kadereit 1998; Hewitt 2000). The low level of diversity within alpine populations of *S. rupestris* might stem, therefore, from the fact that these populations occupy formerly glaciated regions and are derived from colonists that sampled only a limited amount of genetic variation present in a refugial, source population.

TABLE 9. DISTRIBUTION OF CHLOROPLAST DNA HAPLOTYPES A, B AND C IN *SENECIO* MATERIAL

Taxon	No. of populations	Haplotype		
		A	B	C
<i>S. aethnensis</i>	3	(2)	(3)	--
<i>S. chrysanthemifolius</i>	7	--	(11)	--
<i>S. aet.</i> × <i>S. chrys.</i>	4	(2)	(6)	--
<i>S. squalidus</i>	21	--	(22)	--
<i>S. rupestris</i>	22	22 (7)	6 (1)	18 (12)
Balkans	9	8 (6)	2	18 (12)
S. Alps	5	9 (3)	--	--
Tuscany	3	3	--	--
C. Italy (Umbria/Abruzzi)	4	--	4 (1)	--
S. Italy (Calabria)	1	2	--	--

Numbers of each haplotype not in brackets are results from present study combined with those of Abbott *et al.* (1995); numbers in brackets are from Abbott *et al.* (1995).

N.B. Individuals haplotyped in present study were: Balkans (Romania - Sinaia 1A; Bulgaria - Mt Vitosha 1A, Pirin 1B, Pamporovo 1C; Greece - Mt Olympus 1 C, Timfristos 1B, Mistras 4C); C and S Alps (Engadin 1A, Mt Baldo 3 A, Mt Tremalzo 1A, Molveno 1A); Tuscany (Abetone 1 A, Mt Falterona 1A, Mt Secchieta 1A); C. Italy (Mt Sibbelini 1B, Gran Sasso 1B, Mt Maiella 1B); Calabria (La Sila Grande 2A).

Of further interest is the close genetic link between populations from central Italy (populations 32–34) and populations from the southern Balkans (23–25) indicated by hierarchical *F* statistics analysis (Table 8). This link might have arisen and/or been maintained by gene flow between these regions during previous glacial periods when a north-Adriatic land mass is believed to have connected the Balkans to central Italy (Witte, 1965). Although central Italian and southern Balkan populations investigated for allozyme variation differed for cpDNA haplotype, cpDNA analysis revealed that the B haplotype in central Italian material is also present in other material examined from the southern Balkans (from Pirin, Bulgaria, and Timfristos, Greece). Hence, cpDNA evidence agrees, in part, with allozyme evidence in suggesting a genetic link between populations from these two regions.

Also indicated by the hierarchical *F*-statistics was a close genetic affinity between two of the southern alpine populations (26, 28), three populations from Tuscany (29–31) and the population from Mt Vitosha in north Bulgaria (22). All material from these populations also contained cpDNA haplotype A. This close affinity might reflect the evolutionary history of these populations as affected by events occurring during and following the glaciations of the Pleistocene; however, it is not possible to differentiate between the possibility of whether the two alpine populations might be derived from Bulgarian or Tuscan source populations, if indeed either of these two groups served as ancestral, source material.

This study has shown that British material of *S. squalidus* can be distinguished from *S. rupestris* by its morphology (leaf shape) and allozyme make-up. It resembles more closely hybrid material of *S. aethnensis* and *S. chrysanthemifolius*, indicating that it is a hybrid derivative of these two species rather than a derivative of *S. rupestris*. Nonetheless, *S. squalidus* closely resembles *S. rupestris* in overall morphology and consequently the two taxa are difficult to distinguish. This led Alexander (1979) to place *S. rupestris* into synonymy under *S. squalidus*. However, the current study shows that the two taxa are separate entities from an evolutionary perspective.

A final point of interest concerns the introduction of *S. squalidus* to the British Isles. Druce (1927) proposed that *S. squalidus* was introduced to the Oxford Botanic Garden from Mt Etna in the latter part of the 17th century. However, Harris (2002) has questioned this assertion following a detailed analysis of relevant herbarium material and the historical literature. According to Harris (2002), plant material morphologically similar to *S. squalidus*, was first grown in Britain in the Duchess of Beaufort's Garden at Badminton, England, in the early part of the 18th century, from seed supplied from Sicily by Cupani. This material was most likely the source of *S. squalidus* later grown in Oxford, which subsequently spread to many parts of the British Isles during the 19th and 20th centuries.

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Introduction of Oxford ragwort, *Senecio squalidus* L. (Asteraceae), to the United Kingdom

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ABSTRACT

The introduction of *Senecio squalidus* L. (Asteraceae) to Oxford, from Sicily, in the late 17th century and its subsequent spread through the United Kingdom, via the railway lines, is one of the best-documented introductions. Evidence for the introduction of *S. squalidus* to the Oxford Botanic Garden has come from herbarium and literature records, but despite the conclusions of previous investigators, there is no evidence from dated sources showing that *S. squalidus* was growing in the British Isles before 1700. Furthermore, evidence for an initial introduction to Oxford is limited, although if the records cited by George Druce are correct then it is likely that *S. chrysanthemifolius*, rather than *S. squalidus* was the initial introduction. Specimen-based evidence suggests that a more likely initial route of *S. squalidus* introduction was via Francisco Cupani and William Sherard (probably between 1700 and 1702), to the Duchess of Beaufort's garden at Badminton, with a later transfer of material to Oxford before Jacob Bobart's death in 1719.

KEYWORDS: Species introduction, Compositae, botanical history.

INTRODUCTION

The introduction of *Senecio squalidus* L. (Asteraceae) to the Oxford Botanic Garden from Sicily in the late 17th century and its subsequent spread through the United Kingdom via the railway lines has caught the imagination of generations of British naturalists, horticulturists and botanists (Druce 1927b; Kent 1956). *Senecio squalidus* is now a common sight in most urban areas of the British Isles south of the Great Glen, and is still spreading (Kent 1956, 1957, 1960, 1963, 1964a, 1964b, 1964c, 1964d, 1966; Stace 1997). Moreover, it has had important influences on the evolution of the British *Senecio* flora (Abbott 1992).

Four botanists are associated with our knowledge of the introduction and spread of *Senecio squalidus* in the British Isles, John Sibthorp (1758–1796), James Edward Smith (1759–1828), George Claridge Druce (1850–1931) and Douglas Kent (1920–1998). In 1794, Sibthorp, in the preface to *Flora Oxoniensis* (p. 8), noted the occurrence of a plant on the walls of Oxford that he called “*Senecionis species*”. It was only in 1800 that Smith identified this plant as *S. squalidus*, and in 1825, he indicated that the plant was “very plentiful on almost every wall in and about Oxford, where it was first noticed by Sir Joseph Banks” (p. 431). *Senecio squalidus* was thought to be native to Sicily and the occurrence on the walls due to naturalisation from the Garden (Smith 1825). In 1927, Druce, in *The Flora of Oxfordshire* (pp. 239–242), stated that *S. squalidus* was cultivated in the Oxford Botanic Garden before 1699, based on specimens in the Bobartian and Du Bois herbaria (OXF) and a description in Morison's *Plantarum Historiae Universalis Oxoniensis* (Morison 1699). Linnaeus visited Oxford in 1736 (Clokier 1964) and Walker (1833) states that Johann Jacob Dillenius (1684–1747), first Sherardian Professor of Botany, sent “seeds” of the material growing in the Garden to Linnaeus. However, Smith (1825) considers that there is no evidence to indicate whether “seeds” were collected from the Oxford Garden or from the walls of the city, a point reiterated by Baxter in 1834.

In a vivid description, Druce (1927b, p. 241) described the spread of the *Senecio squalidus* along the railways lines: “the vortex of air following the express train carries the fruits in its wake. I have seen them enter a railway-carriage window near Oxford and remain suspended in the air in the

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compartment until they found an exit at Tilehurst". In addition to the role of express trains in creating eddies to carry the "seed" and aid in dispersal, Druce (1927b, p. 241) asserts that the railway lines "furnished the plant with a replica of the lava-soils of its native home in Sicily".

More recently, knowledge of *Senecio squalidus* introduction and its diverse interactions with the British *Senecio* flora has stimulated intensive evolutionary research, including investigations of: (i) the origin of *S. vulgaris* L. var. *hibernicus* Syme via introgression of *S. squalidus* into *S. vulgaris* subsp. *vulgaris* (Abbott *et al.* 1992; but see Stace 1977); and (ii) the dual origin in Wales and Scotland of the allohexaploid species, *S. cambrensis* Rosser, between the diploid *S. squalidus* and the tetraploid *S. vulgaris* (Ashton & Abbott 1992; Lowe & Abbott 1996; Rosser 1955). *Senecio squalidus* also commonly hybridises with *S. viscosus* L., to form the sterile hybrid *S. subnebrodensis* Simk. (Benoit *et al.* 1975), and there is circumstantial evidence to suggest that this hybridisation has led to the spread of *S. viscosus* (Crisp & Jones 1978). Moreover, Abbott *et al.* (2000), extending the work of Crisp (1972), have argued that *S. squalidus* is itself a hybrid of the two Sicilian species, *S. aethnensis* Jan ex DC and *S. chrysanthemifolius* Poir. Furthermore, the importance of incompatibility allele evolution in this introduced species has been emphasised (Hiscock 2000, Brennan, pers. comm.).

The evolutionary impacts of the introduction of *Senecio squalidus* into the British Isles raise issues associated with the true identity of the plants and the number of "seeds" originally introduced, and whether there was more than one introduction. The purpose of the present paper is to assess critically the historical evidence for the introduction of *S. squalidus* into the United Kingdom.

TAXONOMY OF *SENECIO SQUALIDUS*

Senecio squalidus was first described by Linnaeus in 1753 as an annual, based on material sent to him from Oxford by Dillenius, although there is some dispute as to whether the material was collected from the Oxford Botanic Garden or the walls of the city (Baxter 1834; Smith 1825; Walker 1833). However, the taxonomy of this species in the United Kingdom is complicated by morphologically similar taxa in continental Europe, the potential for gene flow between these taxa and the large number of applied names (Alexander 1979).

Senecio squalidus is part of a group of morphologically variable *Senecio* taxa whose taxonomic limits have been variously interpreted over the past 200 years (Alexander 1979; Arcangeli 1894; Chater & Walters 1976; de Candolle 1837; Fiori & Paoletti 1903–1904; Gussone 1843; Pignatti 1982; Pojero 1902; Tornabene 1890). Five names, in addition to *S. squalidus*, are associated with this problem: *S. aethnensis*, *S. chrysanthemifolius*, *S. incisus* (C. Presl) C. Presl, *S. siculus* All. and *S. rupestris* Waldst. & Kit. The most recent treatment of the European *Senecio* species in Section *Senecio* recognises three of these species, *S. squalidus* (syn. *S. rupestris*), *S. aethnensis* and *S. chrysanthemifolius*; *S. incisus* and *S. siculus* were not considered (Alexander 1979). Chater & Walters (1976), in *Flora Europaea*, recognise *S. aethnensis* and *S. squalidus* as species, and place *S. chrysanthemifolius* into synonymy under *S. siculus*. However, Chater & Walters (1976) emphasised that the distinction between the three species is complicated by the occurrence of *S. incisus*, which is identified as a potential hybrid between *S. aethnensis* and *S. siculus* (syn. *S. chrysanthemifolius*), at intermediate altitudes (500–1500 m) on the slopes of Mt Etna. The Central European *S. rupestris* is considered similar to, but morphologically less variable than, *S. squalidus*. Pignatti (1982), in *Flora d'Italia*, recognised on Mt Etna a single morphologically variable *S. aethnensis*, which shows distinct altitudinal patterns, with leaf dissection of individual plants decreasing from the base to the summit of the volcano (Buscalioni & Muscatello 1909). This pattern of variation was recognised as three species by Ronsisvalle (1968): *S. aethnensis*, *S. incisus* and *S. chrysanthemifolius*. Furthermore, Pignatti (1982) recognised *S. rupestris* and *S. siculus* as separate species, the former being synonymous with *S. squalidus sensu* Chater & Walters (1976). Earlier studies (e.g., Baxter 1834; Smith 1825) placed *S. chrysanthemifolius* into synonymy with *S. squalidus*. Similar nomenclatural complexities are found in the application of pre-Linnaean polynomials. Indeed, if one considers the numbers of polynomials applied to *S. squalidus* and its presumed close relatives, the problem of taxon delimitation pre-dates Linnaeus (Table 1). The taxonomy used in this paper is that of Alexander (1979), where three species are

recognised: *S. aethnensis*, *S. chrysanthemifolius* and *S. squalidus* (syn. *S. incisus*), which may most effectively be separated by a combination of leaf dissection and inflorescence size characters (Abbott *et al.* 2000; Crisp 1972).

Intraspecific variation in *Senecio squalidus* has been described in the United Kingdom, Continental Europe and North Africa. Druce (1897, 1905, 1923) described three intraspecific taxa using the illegitimate names, *S. squalidus* L. forma *grandiflorus* Druce, *S. squalidus* var. *forma subinteger* Druce and *S. squalidus* var. *leiocarpus* Druce. In contrast, Alexander (1979) recognised three subspecies, subsp. *squalidus* (from south and east Europe and North Africa), subsp. *aurasiacus* (Batt. & Trab.) Alexander (restricted to Algeria and Sicily) and subsp. *araneosus* (Emb. & Maire) Alexander (endemic to Morocco).

Crisp (1972) suggested that *Senecio squalidus*, introduced into the United Kingdom, was collected from *S. incisus* populations on the slopes of Mt Etna, and following a century of cultivation in the Oxford Botanic Garden, derivatives of this material escaped from the Garden and rapidly colonised the United Kingdom. However, Smith (1825) emphasised that the U.K. material does not have the same range of morphological variation as that found on Sicily. Abbott *et al.* (2000), using morphometric and allozyme analyses of United Kingdom *S. squalidus* populations, showed that they closely resemble samples from the hybrid swarms between *S. aethnensis* and *S. chrysanthemifolius* and produce phenotypes that are intermediate in leaf shape and capitulum size between the two putative parental taxa. These data have led to the proposal that U.K. *S. squalidus* is a diploid hybrid that has originated allopatrically through stabilisation of hybrid material introduced from Mt Etna. Furthermore, the reduced genetic variation of the U.K. material compared with the Sicilian material suggests that only a small population of material was introduced into the United Kingdom (Abbott *et al.* 2000).

EARLY RECORDS OF *SENECIO SQUALIDUS* IN UNITED KINGDOM

Druce (1927b) provides the earliest account of the introduction of *S. squalidus* to the Oxford Botanic Garden. Central to Druce's arguments are descriptions of *Jacobaea Sicula Chrysanthemi facie* in Morison (1699, p. 109) and herbarium collections made by Bobart and deposited in the Fielding-Druce Herbarium (OXF). Druce (1927b) states:

"We know *squalidus* was cultivated in the Oxford Physick Garden before 1699, for Bobart (Hist. Ox. 109, 1699) says '*Perennis est planta* (most British authorities wrongly term it annual) *hyememque facile sustinens. Ad Catanam et Taurominium frequens nascitur*', and of still earlier date are Bobart's specimens in his *Hortus Siccus*, and from a specimen in Herb. Dubois labelled *Jacobaea aetnea glauco folio* from Mr Bobart about 1690" (p. 241).

The history recorded by Kent (1956) is derived directly from Druce's (1927b) account, stating:

"*Senecio squalidus* L. was cultivated in the Oxford Botanic Garden at least 265 years ago, and early dried specimens from there are preserved in Hb. Du Bois (Oxford) and Hb. Sloane (British Museum) under the name '*Jacobaea aetnea glauco folio*'" (p. 115).

Since published information regarding the earliest records of *Senecio squalidus* in the United Kingdom appears to be limited to a description in Morison (1699) and herbarium specimens collected by Bobart in the Du Bois (OXF) and Sloane (BM) Herbaria and in Bobart's *Hortus Siccus* (OXF), it is necessary to critically evaluate these records. Evaluation of the earliest records of *S. squalidus* introduction into the United Kingdom is severely hampered by the fate of the Oxford Botanic Garden records. Turner (1835, p. ix) alludes to the destruction of Sibthorp's papers, and probably those of earlier botanists associated with the Garden, during the period when George Williams was Professor of Botany (1795–1834). Furthermore, Mr George Baker (*Horti Praefectus* Oxford University Botanic Garden, 1888–1942) destroyed records associated with the Oxford Botanic Gardens, during coal rationing, in 1942 (Allen & Walker 1995, p. 65). However, the extent of the records destroyed in 1942 is unknown since Druce (1927b), and all earlier workers on *S. squalidus*, make no mention of them. This implies a) that they were unaware of the existence of such records or b) that only those records now extant in the Plant Sciences Library (Oxford), the Sloane Collection (British Library) and the Sherard Collection (Royal Society of

TABLE 1. PRE-LINNAEAN POLYNOMIALS¹ APPLIED TO *SENECIO AETHNENSIS*, *S. SQUALIDUS* AND *S. CHRYSANTHEMIFOLIUS*

Binomial	Polynomial	Reference ²
<i>S. aethnensis</i> Jan ex DC	<i>Jacobaea aetnea</i> , <i>persicifolia angustiori</i>	Cupani (1696, p. 102)
	<i>Jacobaea aetnea</i> , <i>glastifolio</i> , <i>leviter dentate</i> , <i>umbellifera</i> ³	Cupani (1696, p. 102)
	<i>Jacobaea sicula glasti folio</i> ⁴	Tournefort (1700, p. 486)
	<i>Jacobaea aetnea</i> , <i>Persicifolio crasso</i> , <i>glauco</i>	Cupani (1807, t. 168)
	<i>Jacobaea orinos</i> , <i>latifolio</i> , <i>Isatidis sativi folio laeviter dentate</i> <i>Enensis</i>	Cupani (1713, f. 195), Cupani (1807, t. 161)
	<i>Jacobaea etnica</i> <i>Isatidis folio molli ac madido</i> , <i>flore medio albo</i> , <i>medio luteo</i>	Cupani (1807, t. 160)
	<i>Jacobaea Aetnea</i> , <i>Isatidis folio</i> , <i>leviter dentate</i> , <i>umbellifera</i>	Cupani (1696, p. 102)
	<i>Jacobaea Isatidis folio</i> , <i>Aetnensis</i>	Ray (1704, p. 179) with reference to Cupani
	<i>Solidago Isatidis folio</i>	Vaillant (1720, p. 293) ⁸
	<i>Hieracium montanum Conyza</i> aut <i>Dentillaria folio glabro ex monte Cenisio</i> ⁵	Boccone <i>Hortus Siccus</i> , on Sherard 5372 (OXF)
	<i>Hieracium latifolium montanum folio Conyza Monspesublamae majoris flore luteo</i>	Boccone on Sherard 5372 (OXF)
	<i>Jacobaea aetnea</i> , <i>foliis rigidulis</i> , <i>venosis</i> , <i>laciniatis</i> , <i>crispis</i>	Cupani (1696, p. 102)
	<i>Jacobaea aetnea</i> , <i>folio glauco laciniato</i>	Tournefort herbarium (P) in Gussone (1843)
	<i>Jacobaea chrysanthemi cretici folio</i>	Tournefort herbarium (P) in Gussone (1843)
<i>S. squalidus</i> L.	<i>Jacobaea aetnica</i> , <i>Chrysanthemi segetum cretici folio</i> , <i>umbellifera</i>	Cupani (1713, 2, t. 139, f. 2) in Gussone (1843)
	<i>Jacobaea etnica</i> , <i>Chrysanthemi segetum Lobfolio</i> , <i>umbellata</i>	Cupani (1713, f. 48), Cupani (1807, t. 167)
	<i>Jacobaea aetnensis</i> , <i>folio oblongo laciniato nervoso</i> ⁶	Cupani (1713, f. 195), Cupani (1807, t. 161)
	<i>Jacobaea laciniata</i> , <i>cornu cervi forcellae modo</i> ⁶	Cupani (1807, t. 160)
	<i>Jacobaea Aetnea glauco folio</i>	Du Bois herbarium and Sherard 5310 (OXF)
	<i>Jacobaea minor</i> , <i>Abrotani folio</i>	Barrelier (1714, p. 97, t. 262, fig. II) ⁷
	<i>Jacobaea Aetnensis coronopifolio</i>	Ray (1704, p. 178) with reference to Cupani
	<i>Jacobaea nebrodensis</i> , <i>fruticosa</i> , <i>oblongo folio</i> , <i>inferne ac superne candido</i> , <i>sinuato</i>	Cupani (1696, p. 102)
	<i>Jacobaea Montana major</i> , <i>ab alis sursum semiperfoliata</i> , <i>laciniata</i> , <i>crasso folio</i>	Cupani (1697, p. 41)
	<i>Jacobaea Africana frutescens</i> , <i>folio longo et glauco</i>	Ray (1704, p. 174)
	<i>Jacobaea Sicula Chrysanthemi facie</i>	Boccone (1674, p. 66, t. 36)
	<i>Jacobaea chrysanthemi creticifolio glauco</i> ³	Tournefort (1700, p. 486)
	<i>Jacobaea tenuissime laciniata</i> , <i>Bupththalmi flore</i>	Tournefort (1700, p. 486)
	<i>Jacobaea Chrysanthemi facie</i>	Boccone herbarium (P) in Bonnet (1883), Cupani (1696, p. 102), Cupani (1807, t. 162)
<i>S. chrysanthemifolius</i> Poir.	<i>Senecio minor altilis</i> , <i>umbellatus</i> , <i>stoebes foliis</i>	Cupani (1713, f. 105), Cupani (1807, t. 158)
	<i>Jacobaea minor stoebes foliis</i> , <i>umbellata</i>	Cupani (1807, t. 158)
	<i>Jacobaea Etnica</i> , <i>Chrysanthemi segetum lobatum folio</i>	Cupani (1694, p. 39)

- ¹ Tita (1713, p. 95) cites *Jacobaea Aetnica glauco folio cornuo cervi divisura* as a synonym of *Jacobaea sicula glauco folio* with reference to Tournefort (1700, p. 486). No such name appears in Tournefort, the closest being *Jacobaea sicula glasti folio*. However, Tita's description does not fit typical *Senecio aethnensis*, and is closer to the *aethnensis*-extreme of *S. incisus*. Tita (1713, p. 95) also cites *Jacobaea Aetnea glauco folio scisso* from the *Hortus Catholicus*, which falls within the morphological range of *S. incisus*.
- ² References to Cupani (1713, 1807) refer to the copies in the Library of the Linnean Society of London, except where otherwise stated. The publishing history of Cupani's *Panphyton* is complex, and no complete single copy exists (Priolo, 1996). References to the *Panphyton* in Gussone (1843) refer to the most complete copy of the work, which is located in the *Biblioteca Central della Regione Siciliana* in Palermo.
- ³ Specimens 5317 and 5317₂ in the Sherard herbarium (OXF) bearing this name fall in the morphological range of United Kingdom *Senecio squalidus*.
- ⁴ Tab. 421, f. 7 in Plukenet (1705), which bears this name, falls in the morphological range of United Kingdom *Senecio squalidus*.
- ⁵ Mt. Cenisio is on the Italian/French Border, although since *Senecio aethnensis* is considered to be endemic to Sicily the implication that the specimen came from Mt. Cenisio may be in error.
- ⁶ Tornabene (1890, p. 518) equates these polynomials with *Senecio gallicus* Chaix.
- ⁷ Gussone (1843) gives the name *Jacobaea sicula*, *Chrysanthemi cretici folio* for this illustration and places it in the range of *Senecio chrysanthemifolius*, although this polynomial does not appear in Barrelier (1714).
- ⁸ Vaillant (1720, p. 297) cites two additional polynomials, *Jacobaea Aetnensis, folia minus secto, glauco* and *Jacobaea Aetnensis, Coronopifolio raddis florum fistulosis*, which appear to match *Senecio aethnensis* and *S. squalidus* respectively. However, no specimens bearing these polynomials have been located.

London) existed or c) that the destroyed records contained no significant information pertaining to *S. squalidus*. A search of the archives of the University of Oxford and Magdalen College (owners of the Oxford Botanic Garden site) has revealed no information of relevance to the history of *S. squalidus*.

HERBARIUM MATERIAL

Jacob Bobart the Younger (1641–1719), was the youngest son of Jacob Bobart the Elder (1599–1680), and succeeded his father as *Horti Praefectus* in Oxford, and on the death of Robert Morison lectured as botany professor in the University, although he does not appear to have been officially appointed to the latter position (Vines & Druce 1914). Bobart is most widely known for his completion of the third part of *Plantarum Historiae Universalis Oxoniensis* (Morison 1699), following Morison's death. Bobart left a herbarium (*Hortus Siccus*), which comprises approximately 2,000 undated specimens collected mainly from the Botanic Garden (Clokier 1964). However, a search of the whole of the *Hortus Siccus* has failed to locate the specimen of *Senecio squalidus* cited by Druce in 1927. Furthermore, no specimens corresponding to the polynomial names of *S. squalidus* are cited by Bobart in the table of contents at the start of the *Hortus Siccus* and no material appears to be missing from the collection.

Druce (1927b) may have confused the *Hortus Siccus* and the Morisonian herbarium. The latter comprises approximately 5,000 sheets collected together, primarily by Bobart, for the preparation of third part of Morison's *magnum opus* (Vines & Druce 1914). There is a single sheet of sterile, scrappy material in this collection labelled "*Jacobaea Sicula Chrysanthemi facie* Boccone" in Bobart's hand, and doubtfully identified as *Senecio squalidus* by Vines & Druce (1914, p. 88). Clokier (1964) has argued that where Bobart cites a single author it is difficult to tell whether the author sent the specimen or not, although she states that Boccone sent specimens to Bobart, including "seeds" of *S. squalidus* (Clokier 1964, p. 134). The Morisonian specimen appears to be morphologically very similar to specimens in the Sherardian herbarium (labelled "*Jacobaea Chrysanthemi* Boc. Ic." [Francesco Cupani's hand], "Entr." [John Ray's hand, indicating that this specimen was seen during the preparation of Ray (1704)] and "5323" [William Baxter's hand], right side of a mixed sheet), the Du Bois herbarium (labelled "*Jacobaea Sicula Chrysanthemi facie* Boccone Ray Hist. Vol. 1 p. 286. From Mr Jacob Bobart of Oxford" [Du Bois' hand]) and the Duchess of Beaufort's herbarium (Sloane herbarium, BM, HS 140, f. 58, top of page; labelled "*Jacobaea Sicula Chrysanthemi facie* Boccone v. pag. 109" [Duchess of Beaufort's amanuensis; Dandy (1958)]). All of these specimens fit the description of *S. chrysanthemifolius*.

Bobart collected material gathered in, or assumed to be from, the Oxford Botanic Garden and sent it to prominent botanists of the early 18th Century, including William Sherard (OXF), Sir Arthur Rawdon (Sloane herbarium, HS 301, BM) and Charles Du Bois (OXF). In addition, he sent plants and seeds to the gardens of Mary Somerset, Duchess of Beaufort (1630?–1714) at Badminton, Gloucestershire, which he visited in 1693 (Dandy 1958), and to Chelsea.

Five specimens in the Du Bois herbarium are annotated as *Senecio squalidus* by Druce, but only one (labelled "*Jacobaea Sicula Chrysanthemi facie* Boccone Ray Hist. Vol. 1 p. 286. From Mr Jacob Bobart of Oxford") is cited by Druce (1927a) in his account of the British plants in this collection. A second specimen labelled "*Jacobaea Sicula Chrysanthemi facie* Bocc. Plant. Rar. *exsementi* D. Dubois [William Stonestreet's hand]. From Mr Stonestreet [Du Bois' hand]", appears to have been raised by Rev. William Stonestreet (d. 1716) from seeds sent by Charles Du Bois. A specimen from the Du Bois herbarium labelled "*Jacobaea aetnea glauco folio* [Bobart's hand]. Ragwort from Mount Etna with hoary leaves. From Mr Jacob Bobart of Oxford [Du Bois' hand]" was used by Druce (1927b) to indicate that *S. squalidus* was growing in the Botanic Garden pre-1690. However, there is nothing on the sheet to indicate the date of collection. Druce (1927a) stated that the earliest specimens in the Du Bois herbarium were made in 1690, although Clokier (1964) states that the sheets in the Du Bois herbarium are dated from 1698 to 1724 (an annotation in the OXF copy of Clokier places the earliest date as 1697). The polynomial name does not appear in Ray (1686, 1688, 1704), Plukenet (1696, 1700, 1705) or Cupani (1696, 1697, 1713), although one sheet (Sherard 5310) in the Sherardian herbarium (OXF) does bear this name. This sheet is morphologically distinct from the sheet in the Du Bois herbarium, and corresponds to the *S. aethnensis* end of the morphological range of *S. incisus*. In addition, the Sherard sheet bears the polynomial names *Jacobaea nebrodensis*, *fruticosa*, *oblongo folio*, *infernè ac supernè candido*,

sinuato (Cupani 1696, p. 102), *Jacobaea Montana major, ab alis sursum semiperfoliata, laciniata, crasso folio* (Cupani 1697, p. 41) and *Jacobaea Africana frutescens, folio longo et glauco* (Ray 1704, p. 174). Furthermore, this sheet also includes the phrase “*ex semina a P. Cupani misso, succravit in Horto Badminton*” [Sherard’s hand], indicating that this material was collected from the Duchess of Beaufort’s Garden from “seed” collected by Cupani (identical material is found in the Duchess of Beaufort’s herbarium, Sloane herbarium, **BM**, HS 135, f. 72, top of page). The morphological dissimilarity between the specimens in the Sherard and Du Bois collections raises the possibility that Bobart collected material from the Badminton material, and that the “seed” was of hybrid origin. Two specimens in the Du Bois herbarium come from the Duchess of Beaufort’s garden (“*Jacobaea folio glauco Aetnea*, Cupani. From the Dutchess of Beauforts Garden at Badminton” [Du Bois’ hand] and “*Jacobaea* in Cupani. One of Dr Sherards Badminton Specimens” [Du Bois’ hand]). These three morphologically diverse specimens, collected from the Badminton Garden, correspond to the range of variation found in *S. incisus*. Thus, there were plants morphologically similar to *S. squalidus* and *S. chrysanthemifolius* growing at Badminton.

William Sherard (1658–1728) was one of the most outstanding botanists of his day, and maintained friendships with most major botanists of the late 17th and early 18th Centuries, including Bobart, Tournefort, Ray and Sloane (Clokier 1964). For 18 months, between 1700 and 1702, he was engaged as a tutor to the grandson of the Dowager Duchess of Beaufort at Badminton, before being engaged as Consul to Smyrna in present-day Turkey (Jackson 1874). During his period at Badminton, Sherard introduced at least 1,500 plants (Turner 1835, p. 33). Sherard’s herbarium, described by Smith as “perhaps, except that of Linnaeus, the most ample, authentic, and valuable botanical record in the world” (cited in Dandy 1958, p. 202), comprises over 14,000 sheets, the majority of which are still identified by pre-Linnaean Latin polynomials. Four additional sheets in the Sherard collection fall within the morphological range of *Senecio squalidus*, although there is no indication of where these specimens were collected. All of these sheets have been labelled or annotated by Dillenius, although Sherard 5317₂ also bears one of Sherard’s original labels.

LITERATURE

Robert Morison (1620–1683), Professor of Botany in Oxford, fought the Royalist cause during the Civil War and fled to France. Following the restoration of Charles II he was made senior King’s Physician, King’s Botanist and superintendent of all the royal gardens. Morison is most widely known for his system of classification and the work *Plantarum Historiae Universalis Oxoniensis* that was to have appeared in three parts. However, only Part 2 appeared during his lifetime (Morison 1680), Part 3 was completed by Bobart (Morison 1699) and Part 1 remains unfinished. However, Morison’s reputation has been marred by the disagreements he had with John Ray (Raven 1942) and his own refusal to acknowledge earlier botanists in the formulation of his classification system (Boulger 1909, Vines 1913).

Druce (1927b) cited Morison (1699) as evidence that *Senecio squalidus* was growing in the Oxford Botanic Garden pre-1699 based on the observation that the plant over-winters as a perennial. The same over-wintering observation was made by Ray (1686, p. 286): “*Perpetua est planta, hyménque faciliè sustinens, ad Catanam & Tauromenium frequens*”. Clokier (1964, p. 54) repeats this assertion stating “Bobart undoubtedly grew it in the Garden and says of it that it easily stands the winter”. However, there is strong evidence that Morison’s description, and the associated plate, were copied from Boccone (1674), whilst that of Ray (1686) was modified from the same author. Furthermore, there is no dated herbarium specimen, collected in the Oxford Botanic Gardens, from this period in the **OXF** or **BM** collections. These data, taken together, indicate that *S. squalidus* was not necessarily growing in Oxford pre-1699.

Both Morison (1699) and Ray (1686) cite work by the Sicilian botanist Paulo Boccone (1633–1703/4) published in 1674. Comparison of the description of *Jacobaea Sicula Chrysanthemi facie* in Boccone (1674, pp. 66–67) and that in Morison (1699, p. 109, No. 15) show that they are identical except for the insertion of the phrase “*Hujus datur varietas humilior, Schol. Bot. Per.*” in Morison (1699). This phrase is a reference to W.S.A. (1689), in which *Jacobaea Sicula Chrysanthemi facie* is listed as growing in the Paris Botanic Garden in 1687–1688, along with another plant described as *Jacobaea Sicula Chrysanthemi faci humilior*. W.S.A. (1689) is usually attributed wrongly to an unknown botanist, Simon Wharton Anglus. However, most 18th Century

and modern botanists consider W.S.A. to refer to William Sherard (Clokier 1964, Jackson 1874). The description in Ray (1686) is a modified version of Boccone (1674), with no additional information that indicates Ray saw the living plant.

Comparison of the illustration in Boccone (1674, Tab. 36) with that in Morison (1699, Sect. 7, Tab. 12) shows that the latter is a poorer, stylised, reversed copy of the former. At least one other description and illustration in Morison is copied from Boccone; *Jacobaea multifida umbellata annua* (*Senecio delphinifolius* Vahl) in Morison (Section 7, Tab. 12) is copied from Boccone (Tab. 51). Numerous examples exist of the Boccone's text being copied exactly in Morison; e.g., *Pastinaca Oenanthes folio* [*Daucus carota* L. subsp. *drepanensis* (Arcang.) Heywood], *Jacobaea pumila Gallica* (*Senecio gallicus* Vill.) and *Lithospermum umbellatum latifolium* [*Lithospermum rosmarinifolia* (Ten.) I. M. Johnston]. With reference to Morison (1680), both Pulteney (1790, p. 310) and Vines & Druce (1914, p. xliii) state that many of the illustrations were copied from other authors.

Paulo Boccone, botanist to the Grand Duke of Tuscany and Professor of Botany at Padua, visited England and, on 7 May 1673, attended a meeting of the Royal Society (Birch 1757, p. 87). Robert Morison edited Boccone (1674), after Boccone requested Charles Hatton, one of Morison's patrons, to send the manuscript to him (Henrey 1975). However, Morison found the final seven of the 52 plates to be very inaccurate and had them redrawn from dried material at Charles Hatton's expense (Morison's dedication in Boccone 1674).

Clokier (1964) states Boccone sent *Senecio squalidus* "seed" material to Bobart in Oxford, although the source of her information is unclear. If Boccone were the source of plants grown in Oxford then it would appear that the initial introduction was *S. chrysanthemifolius*. Boccone's herbarium was studied by Bonnet (1883), and material described as *Jacobaea Sicula Chrysanthemi facie*, and associated with Tab. 36 in Boccone (1674), was identified as *S. chrysanthemifolius*, the binomial that has been attached to the polynomial by all subsequent authors (e.g. Bivona-Bernardi 1807; de Candolle 1837). Furthermore, all materials in the Sherard, Du Bois and Sloane herbaria identified by this polynomial are *S. chrysanthemifolius*. In addition, Boccone (1674) stated that *Jacobaea Sicula Chrysanthemi facie* occurred frequently between Catania and Tauromina (<300 m asl). This would support the conclusion that the material referred to is *S. chrysanthemifolius*, since, according to Crisp (1972), *S. chrysanthemifolius* occurs to approximately 1000 m asl and *S. aethnensis* from approximately 1600–2600 m asl, with the hybrid swarm between the two species occurring at 1300 ± 300 m asl on the slopes of Mt Etna.

The greatest diversity of Sicilian *Senecio* species in cultivation at the end of the 17th Century was growing in the *Hortus Catholicus*, the garden that Guiseppe del Bosca, Principe della Cattolica, established at Misilmeri, Palermo, in 1692, under the direction of Francisco Cupani (1657–1711), a Sicilian physician, and pupil of Boccone (Cupani 1696, 1697, 1713, 1807). Of the 28 pre-Linnaean polynomials applied to *S. aethnensis*, *S. chrysanthemifolius* and *S. squalidus*, 19 are first found in works by Cupani and the plants bearing these polynomials were in cultivation at Misilmeri. In contrast, the most frequent name among other European botanists was Boccone's *Jacobaea Sicula Chrysanthemi facie*. Cupani was a correspondent of Sherard (Sherard Collection, SH121–SH137, letters dated between 1696 and 1702), and "seeds" were sent to him at Badminton (specimens in the Sherardian, Du Bois and Sloane herbaria). These documents, together with the diversity of material in cultivation at Badminton, suggest that Cupani was the source of the original material grown in the United Kingdom, later described as *S. squalidus* by Linnaeus (1753).

CONCLUSIONS

Literature citations by English authors of the late 17th century refer to *Senecio chrysanthemifolius* [as *Jacobaea Sicula Chrysanthemi facie*; Morison 1699, Ray 1686], although there is no evidence that the plant was growing in United Kingdom during this period. Furthermore, the specimen of *Jacobaea Sicula Chrysanthemi facie* in the Morisonian herbarium appears to be a duplicate of a specimen in the Sherardian herbarium. In contrast, there is evidence that *S. chrysanthemifolius* was growing in the Paris Botanic Garden between 1686 and 1688 (Wharton 1689), and it is only in the works of Cupani (1696, 1697, 1713, 1807) that plants morphologically similar to United Kingdom

S. squalidus are described, many of which were growing in the garden at Misilmeri, Sicily. Specimens in both OXF and the Sloane herbarium (BM) indicate that material morphologically similar to United Kingdom *S. squalidus* was growing at Badminton in the early 18th Century and that at least some of the material was raised from seed supplied by Cupani, most probably via Sherard. Thus, it appears likely that Cupani was the original source of material introduced to Badminton. In addition, evidence from the Sloane herbarium indicates that the Duchess was also growing *S. chrysanthemifolius* in her garden. Until the death of the Duchess of Beaufort in 1714, Bobart appears to have had regular contact with the Badminton garden (Bobart 1699, Dandy 1958), which would be a more likely source of *S. squalidus* in Oxford than via Boccone, as proposed by Clokie (1964). However, introductions that involve Tournefort at the Botanic Garden in Paris or Boccone cannot be ruled out. If Cupani was the source of *S. squalidus* introduced to the United Kingdom, the identity of the original introduction is likely to remain a source of speculation since numerous morphological forms of *S. aethnensis*, *S. chrysanthemifolius* and *S. squalidus* were being grown in the *Hortus Catholicus*. Furthermore, since material matching both *S. squalidus* and *S. chrysanthemifolius* was growing in the Badminton Garden, the precise identity of the material introduced to the Oxford Botanic Garden is likely to remain a mystery, although Abbott *et al.* (2000) provide evidence that the material that colonised the United Kingdom is of hybrid origin between *S. aethnensis* and *S. chrysanthemifolius*.

Druce (1927b, p. 241) states that at "... Badminton, on the garden walls, I noticed it [*Senecio squalidus*] in 1909, but there it may have been unintentionally introduced from Oxford by Bobart, who about 1700 planted many shrubs and plants for the Duchess of Beaufort". In the light of the evidence provided in the present paper, this is a perceptive observation, except that the gardens at Badminton are likely to have been the source of the plants grown by Bobart in Oxford.

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NOTES

1. The phrase 'Oxford Botanic Garden' will be used throughout this paper as a synonym of the 'Oxford Physic Garden', except in the case of quotations.
2. The earliest dated herbarium specimen of *Senecio squalidus* (P. Gisbourne s.n.) was collected in Oxford in 1792 (CGE) and labelled '*Senecio muralis* Curt.', a name not found in the International Plant Name Index.
3. One specimen in the Sherard herbarium (OXF) is labelled '45 *Senecio squalidus*' in Sibthorp's hand. This is a specimen of *Senecio erucifolius* L., which in terms of superficial leaf morphology appears similar to *S. chrysanthemifolius*. Hermia Clokie annotated this specimen as '?from Hort Oxon.'. If this specimen represents Sibthorp's concept of *S. squalidus* it may explain why he did not recognise the material growing on the walls of Oxford in 1794 as *S. squalidus*. However, Sibthorp does describe *S. erucifolius* in *Flora Oxoniensis* (p. 253). In a manuscript catalogue of the plants in Oxford Botanic Garden, dated 1780, by Humphrey Sibthorp, John Sibthorp's father, no mention is made of *S. squalidus* (MS Sherard 213, Plant Sciences Library).
4. There is no mention of *Senecio squalidus* in a manuscript catalogue of the Oxford Botanic Garden prepared by Jacob Bobart in c. 1666 (MS Sherard 30, Plant Sciences Library), and similarly *S. squalidus* is not mentioned in a manuscript list of plants seen in the Duke of Beaufort's Garden at Badminton on 30 September 1699 (MS Sherard 36, Plant Sciences Library).
5. Specimen Sherard 5323 appears to have been sent to Sherard by Francisco Cupani. Part of this material may have been sent to Bobart, and is now included in the Morisonian herbarium, since it is known that Sherard sent much material to Bobart (Sherard Collection, SH105, dated 18 June 1703). Furthermore, this specimen must have been collected before 1704, since it has been annotated by Ray.
6. There is a second specimen in the Duchess of Beaufort's herbarium (HS 134, f.21, top of page) bearing this name. However, it is not possible to confirm the identity of the material since it is a sterile specimen of rosette leaves. This specimen is dated 'Chelsea 1714', although Dandy (1958, p. 211) states that the volumes of the Duchess' herbarium were prepared after her death (7 January 1714) and that the collection appears to have continued after this time.
7. The reference refers to Ray (1686). It is unclear if this citation implies that the specimen was added to the Du Bois herbarium before the publication of Morison (1699). Furthermore, there is nothing to indicate that the specimen was collected in Oxford, other than Jacob Bobart supplying the material to Du Bois. Clokie (1964) emphasises that it is often difficult to tell from where Bobart obtained his specimens. The leaf morphology of this specimen is similar to that of the specimen found under the same polynomial in the Morisonian herbarium. The reference to Ray (1686) may have been used by Druce (1927b) to support his conclusion that material in the Du Bois herbarium was collected pre-1690.
8. Letter from Sherard to Richardson dated 1 March 1701; '... on account of the noble gardens her Grace, my Lady Duchesse, has; and truly in a few years they will out-do any yet in Europe; being furnish'd with all conveniences imaginable, and a good stock of plants, to which I have added above fifteen hundred, and shall daily procure more from my correspondents abroad'. Sherard makes no mention of *Senecio squalidus* in a manuscript list of plants he saw in the garden at Badminton in 1700 (MS Sherard 174, f.10v–f. 11v, Plant Sciences Library).

9. A search of Cupani's *Hortus Siccus*, located in the herbarium of the Department of Botany, University of Catania (<http://www.dipbot.unict.it/Erbario/cupani/index.html>), failed to reveal any specimens that could be referred to as *Senecio aethnensis*, *S. chrysanthemifolius* or *S. squalidus*.
10. Cupani is also thought to have been the Sicilian source of the first United Kingdom introduction of *Lathyrus odoratus* L. (Fabaceae) to the Reverend Robert Uvedale's garden at Enfield in 1699 (Unwin 1952).

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***Lycopodiella inundata* in British plant communities and reasons for its decline**

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ABSTRACT

We investigated the community context of *Lycopodiella inundata* (Lycopodiaceae) in ten representative sites in England and Scotland. Vegetation classification (TWINSPAN), detrended correspondence analysis and indicator species analysis were used to derive community types and to reveal the phytosociological position of this scarce and threatened species. In the study sites *L. inundata* mostly occurs on very acidic, oligotrophic, moist to wet soils in fully exposed situations in wet heaths and along lake margins. The classification resulted in four vegetation units: a *Drosera intermedia*–*Sphagnum tenellum* community in England, and three community types in Scotland, viz. a *Drosera anglica*–*Myrica gale* community, an *Eleocharis multicaulis*–*Narthecium ossifragum* community and a *Hydrocotyle vulgaris*–*Leontodon autumnalis* community. The ecological differences between the communities in England and Scotland were mostly related to soil reaction, and the English sites were probably the most acidic. *L. inundata* seems to tolerate a wide range of soil pH and levels of soil moisture, whereas it seems to be intolerant to shading or eutrophication. Eutrophication may be partly responsible for the species' general decline across Europe. The scope for future conservation of this species is discussed.

KEYWORDS: classification, indicator analysis, lake margin, niche width, ordination, wet heath.

INTRODUCTION

Lycopodiella inundata (L) Holub, the Marsh Clubmoss, is a homosporous perennial pteridophyte within the *Lycopodiaceae* (Holub 1964). It is a small, bright green, creeping, moss-like plant producing 2–3 cm tall cones with weakly differentiated sporophylls in the autumn. The species has an amphi-atlantic distribution, occurring in Japan, North America, central and northern Europe, but it is absent from the central parts of Russia (Hultén & Fries 1986). In England it is mainly found on wet heaths (Rhynchosporion), often on bare peaty or occasionally sandy soils. It favours areas which are inundated in the winter and spring, kept open by occasional disturbance (Tansley 1953; Rodwell 1991). The species has also been found as a pioneer in disused sand and gravel pits (Petch 1980; Pickering & Wigston 1990), whilst in Scotland it mostly grows in the inundation zone along the edges of oligotrophic lakes on organic silt (Stewart *et al.* 2000).

Lycopodiella inundata is a stress tolerator according to the Grime strategy system, as indicated by its low biomass and low potential growth rate, little vertical growth, and rapid reproduction in autumn (Hodgson *et al.* 1999). The species often occurs as a pioneer and may easily be excluded if succession proceeds, as evidenced in Norfolk (Petch 1980). *L. inundata* is therefore only found where the vegetation is recently cleared or is constantly kept open. In England human disturbance such as foot paths, tracks and abandoned quarries seem to be necessary to maintain suitable habitats, which may indicate a lack of fully natural habitats for the species. It is possible that the

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species has never been a part of the natural flora in southern England, but invaded at the same time as heathlands spread, as Wiinstedt (1953) suggested for *L. inundata* in Denmark. One of the natural habitats for *L. inundata* is probably more like the one encountered around lochs in Scotland, where a fluctuating water level and ice movements in the winter maintain an open vegetation. The margins around salt marshes in Massachusetts, USA, are also reported to provide the essential disturbance and acidity for the occurrence of *L. inundata* (Wherry 1920).

It seems that human destruction of wetlands, in combination with eutrophication and changed management, have caused the decline of *L. inundata* in most of Europe (Denmark, Pihl *et al.* 2000). *L. inundata* is associated with the Habitat Action Plans for lowland heathland and purple moor grass and rush pastures and is included in the Annex V of the Habitats Directive (1992). In Britain, *L. inundata* has disappeared mainly from the central and northern English localities, probably due to the loss of habitat through drainage, lack of grazing and pollution (Stewart *et al.* 2000). It is considered "nationally scarce" and is identified as a priority species under the U.K. government's Biodiversity Action Plan. Conservation of *L. inundata* is, however, difficult since little is known about its ecology, including potential reasons for decline and response to environmental change (Stewart *et al.* 2000).

The aim of the present study is 1) to classify the vegetation associated with *L. inundata* in Britain, 2) to describe the habitats of *L. inundata* by ordination and indicator analysis, and 3) to discuss the present and future status of *L. inundata* in Britain. We especially want to address the question whether it is possible to plan conservation actions for a species like *L. inundata*, which relies in certain instances on recurring disturbances, which for other reasons may not be desirable.

METHODS

STUDY AREA

In England five representative sites (Table 1, Figure 1) of *L. inundata* were selected in Surrey and Hampshire. The sites represent most of the types of habitats where *L. inundata* is known to occur in England (Stewart *et al.* 2000). In all of the study sites the soil was firm with a rather open vegetation. Water levels were high enough to keep the area moist in summer and wet or flooded in winter and spring. The bare ground was often covered by mats of the purple alga, *Zygonium ericetorum*, which forms a crusty cover during dry weather and keeps the soil moist underneath. *L. inundata* is often the first coloniser of patches of bare soil, as for example on Chobham Common where it was growing on the edges of small holes left after peat digging. A similar case was observed on Elstead Common where it seemed to be spreading down a new footpath crossing the original track.

In Scotland sites along five different lakes (lochs/lochans) were studied (Table 1, Figure 1). Despite grazing in the Scottish Highlands, the main disturbance factor in the study habitats were water table fluctuations and moving ice at the shoreline, especially since the vegetation of the study habitats was sparse and much less palatable to livestock and deer than the surrounding heath vegetation.

DATA COLLECTION

Patches of vegetation with *L. inundata* were sampled according to the Braun-Blanquet method (Dierschke 1994), using 4–15 quadrats each of 4 m² and placed systematically to cover the variation within the area. The percentage cover of each species of vascular plant and bryophyte was estimated by eye and assumed reliable to the nearest five percent. One percent was the lowest possible score. The survey was undertaken in June and July 2000. The percentage cover values were transformed into the Domin scale to make the data comparable with the British National Vegetation Classification (NVC) (Rodwell 1991). In addition, the per cent cover of bare soil was recorded.

VEGETATION CLASSIFICATION

Clustering of the entire community dataset was performed with the programme TWINSpan (Hill 1979). The cut levels 0, 2, 5, 10 and 20 were used, and no quadrats or species were omitted. Three levels of divisions were chosen, otherwise the default options were applied. Clusters resulting from

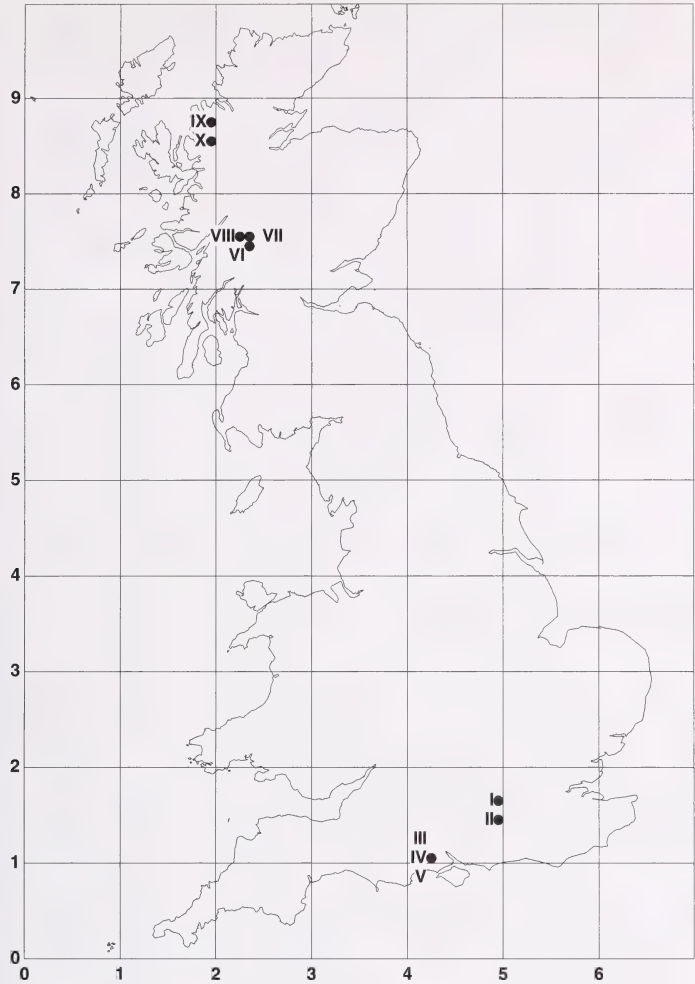


FIGURE 1: Map of the ten locations surveyed for habitats with *L. inundata* (Roman numbers correspond to sites described in Table 1).

TABLE 1. SITES SURVEYED IN BRITAIN

Site no.	No. of quadrats	Site name	County	National grid ref.
ENGLAND				
I	9	Chobham Common	Surrey	SU965655
II	15	Elstead Common	Surrey	SU900400
III	5	Station Road Holmsley, New Forest	Hampshire	SU231009
IV	10	Holmsley ridge, New Forest	Hampshire	SU217011
V	4	Duckhole Bottom, New Forest	Hampshire	SU253019
SCOTLAND				
VI	10	Lochan na h-Achlaise	Main Argyll	NN312480
VII	10	Loch Ba	Main Argyll	NN320520
VIII	10	Dubh Lochan	Main Argyll	NN274537
IX	11	Loch Maree Islands	West Ross	NG9172
X	6	Loch Bharranch	West Ross	NG979576

TABLE 2. SYNOPTIC TABLE OF THE FOUR DESCRIBED COMMUNITIES

Community	ENGLAND	Scotland	SCOTLAND	
	1		Loch Maree	Loch Maree
Number of quadrats	42	2	3	4
Number of species	38	37	6	4
		48	27	18
<i>Agrostis stolonifera</i>		5(1)		
<i>Betula pubescens</i> (s)	41(1)			
<i>Breutelia chrysocoma</i>		14(1)		
<i>Calluna vulgaris</i>	95(1-10)	86(1-12)	67(1-5)	75(1)
<i>Campylopus atrovirens</i>		22(1)	17(1)	
<i>Campylopus introflexus</i>	19(1-5)			
<i>Carex cf. viridula</i>	5(1)			
<i>Carex echinata</i>		46(1)	67(1-5)	
<i>Carex nigra</i>		76(1-10)	67(1-5)	100(20-25)
<i>Carex panicea</i>	21(1)	81(1)	100(1-10)	100(5-10)
<i>Carex viridula</i> ssp. <i>oedocarpa</i>		70(1-5)	100(1-10)	100(5-10)
<i>Dicranella palustris</i>		5(1)		
<i>Drosera anglica</i>		86(1-5)	50(1)	
<i>Drosera intermedia</i>	86(1)			
<i>Drosera rotundifolia</i>	64(1)	76(1)	100(1)	100(1)
<i>Drosera</i> × <i>obovata</i>		27(1)	17(1)	
<i>Eleocharis multicaulis</i>	19(1-5)	11(1)	100(1-20)	100(1-5)
<i>Equisetum fluvatile</i>		5(1)		
<i>Erica tetralix</i>	100(1-15)	65(1-5)	33(1-5)	
<i>Eriophorum angustifolium</i>	31(1)	51(1)	50(1)	
<i>Festuca ovina</i>	2(1)	3(5)	100(1-5)	100(15-25)
<i>Hydrocotyle vulgaris</i>			33(1)	100(1)
<i>Juncus acutiflorus</i>	19(1)	46(1-5)	33(1)	
<i>Juncus bulbosus</i>	52(1)	100(1)	83(1)	
<i>Juncus conglomeratus</i>		16(1)		
<i>Juncus effusus</i>	12(1)			
<i>Juncus squarrosus</i>	43(1-5)	49(1-25)		
<i>Jungermannia</i> sp.	2(1)	11(1)		
<i>Leontodon autumnalis</i>				100(1)
<i>Littorella uniflora</i>				25(1)
<i>Lobelia dortmanna</i>		22(1)	17(1)	100(1)
<i>Lycopodiella inundata</i>	76(1)	97(1)	100(1)	100(1-5)
<i>Molinia caerulea</i>	100(1-25)	100(1-25)	100(5-15)	100(1-5)
<i>Myrica gale</i>		59(1-10)		
<i>Nardus stricta</i>		68(1-10)		50(1)
<i>Narthecium ossifragum</i>	19(1-10)	76(1-5)	100(1)	
<i>Pedicularis sylvatica</i>	19(1)	19(1)	33(1)	
<i>Pellia epiphylla</i>		38(1)		
<i>Pinguicula vulgaris</i>		51(1)	33(1)	
<i>Pinus sylvestris</i>	57(1)	3(1)	50(1)	75(1)
<i>Pleurozia purpurea</i>		11(1)		
<i>Polygala serpyllifolia</i>		27(1)		
<i>Polytrichum commune</i>	2(1)	11(1)		
<i>Potentilla erecta</i>	10(1)	51(1)		
<i>Racomitrium lanuginosum</i>		19(1)		
<i>Ranunculus flammula</i>		65(1)	33(1)	100(1)
<i>Rhynchospora alba</i>	24(1)	3(1)	50(1)	
<i>Rhynchospora fusca</i>	12(1)			
<i>Salix cf. cinerea</i>	7(1)			
<i>Salix repens</i>	7(1)			
<i>Sphagnum compactum</i>	62(1-60)	100(1-30)	100(1-5)	
<i>Sphagnum papillosum</i>	2(1)	35(1-5)		
<i>Sphagnum tenellum</i>	60(1-34)			
<i>Succisa pratensis</i>		46(1)		25(1)
<i>Trichophorum cespitosum</i>	62(1-20)	35(1-5)	100(1-5)	50(1)

1, *Drosera intermedia*-*Sphagnum tenellum* community; 2, *Drosera anglica*-*Myrica gale* community; 3, *Eleocharis multicaulis*-*Narthecium ossifragum* community; and 4, *Hydrocotyle vulgaris*-*Leontodon autumnalis* community. Frequency (%) of species in quadrats is shown together with the percentage cover range in brackets, when the frequency is above 5% in any one community. (s) denotes seedling.

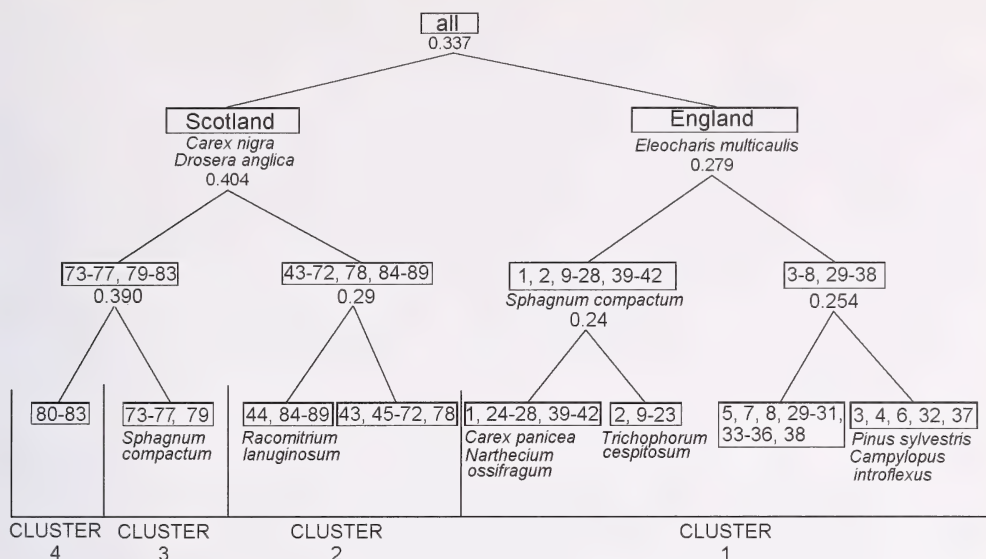


FIGURE 2: TWINSpan dendrogram for the whole data set. Eigenvalues, quadrat numbers and indicator species are given.

divisions with eigenvalues higher than 0.3 are treated as final clusters, which, however, do not necessarily constitute communities. The resulting vegetation units are named informally as communities after the most characteristic species.

In order to compare our results with the British National Vegetation Classification (NVC) (Rodwell 1991) the Domin-transformed cover values at each site were compared with the NVC data using the computer program MATCH (Malloch 1997). The similarity coefficients of the quadrat data for each site were compared with the descriptions in Rodwell (1991).

INDIRECT GRADIENT ANALYSIS

The floristic variation within the English and Scottish subsets of data, as well as the entire data set, were assessed with the computer program CANOCO, version 4.0 (ter Braak & Smilauer 1998). We used detrended correspondence analysis (DCA) with standard options to extract the primary ordination axes. The correlation of sample scores on the four axes with percentage bare soil and Ellenberg's indicator values were tested with Pearson correlation coefficient assuming a linear relationship.

Because the sites and quadrats were selected in places where *L. inundata* is known to occur, this species is certainly over-represented within the dataset. However, making the species "passive" did not change the result of the analysis and no down weighing was done in the results presented.

INDICATOR SPECIES ANALYSIS

The only environmental variable obtained in the field was percent bare soil, and the method of "bio-indication" is thus used to give an indication of the general habitat quality. The species indicator system of central Europe (Ellenberg *et al.* 1991), that has been calibrated to British conditions (Hill *et al.* 1999, 2000) was used to derive average bio-indicator scores for each quadrat. The extension of the Ellenberg indicator values to geographical areas outside central Europe has previously been successful, both in comparison of vegetation clusters and in connection with ordination (Diekmann & Lawesson 1999; Lawesson & Mark 2000).

For each quadrat a weighted average of the Ellenberg indicator values of each species for light (L), soil moisture (F), soil reaction (pH) (R), and nitrogen (N) was calculated with species cover as weights (Diekmann 1995). Note that the N-value probably indicates general soil fertility rather than availability of nitrogen. The median indicator value was used for each variable to characterise the habitats of *L. inundata* in the described communities and in England and Scotland, respectively. Differences were tested with the non-parametric Mann-Whitney test.

RESULTS

VEGETATION CLASSIFICATION

The entire dataset contained 89 quadrats from 10 sites with a total of 69 plant species. The TWINSPLAN analysis resulted in four final clusters (Figure 2). The first division of the dataset separated the Scottish from the English quadrats. All quadrats from England were placed in one vegetation unit as the subsequent divisions had low eigenvalues. The Scottish quadrats were more heterogeneous and split up into three final clusters. In general, the Scottish quadrats contained more species (51 compared to 39 from England); some of the most common species included *Ranunculus flammula*, *Succisa pratensis*, *Lobelia dortmanna*, *Carex echinata*, *Drosera* × *obovata* and *Pellia epiphylla*. The quadrats from Loch Maree Islands were all different from the remaining Scottish quadrats and were further divided into two clusters, although containing only a few quadrats. The synoptic table list the species with a frequency >5% in at least one of the four final clusters or communities (Table 2).

1. *DROSERA INTERMEDIA*–*SPHAGNUM TENELLUM* COMMUNITY

This community was observed in the south of England and, besides *Lycopodiella*, it was characterised by the presence of *Rhynchospora alba*, *R. fusca*, *Campylopus introflexus* and *Drosera rotundifolia*. It was found in wet heath intermediate between wet hollows and the drier plateau, and had the (significantly) lowest indicator value for soil reaction and also a very low N-value, indicating that this habitat was strongly acidic and nutrient poor (Table 3).

2. *DROSERA ANGLICA*–*MYRICA GALE* COMMUNITY

This community was characterised by the presence of *Breutelia chrysocoma*, *Juncus conglomeratus*, *Pellia epiphylla*, *Pleurozia purpurea* and *Polygala serpyllifolia*. It was the most species-rich community studied, and occurred around lakes in sheltered areas allowing deposition of a thin layer of organic silt. The littoral zone was between 0.3 and 3 m wide or completely absent depending on the slope between the surrounding heath and the lake. Soil reaction was the only indicator value differing significantly from all the other communities, and with a median Ellenberg value of 3.00 the habitat of this community was mostly found on acidic soils.

3. *ELEOCHARIS MULTICAULIS*–*NARTHECIUM OSSIFRAGUM* COMMUNITY

Here a high frequency of *Eleocharis multicaulis*, *Carex viridula* ssp. *oedocarpa* and *C. panicea* was characteristic. Compared to the closely related *Drosera anglica*–*Myrica gale* community, fewer species were found, but this may partly be due to the low number of quadrats. The habitat was a sheltered inundation zone around lakes, as described for the previous community. This community was found on a (significantly) slightly more neutral substrate than the two previous, and the soil had the same low nutrient status as the *Drosera intermedia*–*Sphagnum tenellum* community.

TABLE 3. MEDIAN OF WEIGHTED AVERAGES OF ELLENBERG'S INDICATOR VALUES FOR THE FOUR COMMUNITIES, THE ENGLISH AND SCOTTISH SUBSETS AND THE ENTIRE DATASET

Vegetation unit	Ecological indicator variables				
	L	F	R	N	% BS
1	7.6	7.9	2.5	1.6	60
2	7.4	8.0	3.0	1.9	60
3	7.6	8.1	3.4	1.6	45
4	7.4	7.3	3.9	1.9	30
England	7.6	7.8	2.5	1.6	60
Scotland	7.4	8.0	3.1	1.9	50
total data set	7.5	7.9	2.8	1.7	55
Total range	7.1–8.0	7.0–8.7	2.0–4.0	1.2–2.1	5–95

The ecological variables are: light (L), soil moisture (F), soil reaction (R), soil fertility (N) and percent bare soil (BS).

TABLE 4. PEARSON CORRELATION COEFFICIENTS BETWEEN DCA AXES AND ELLENBERG'S INDICATOR VALUES AND PERCENTAGE BARE SOIL (% BS) AS EXPLANATORY VARIABLES

Data set	Variable	DCA axis 1		DCA axis 2		DCA axis 3		DCA axis 4	
Entire	Light	-0.190	n.s.	-0.823	***	-0.823	***	0.041	n.s.
	Moisture	-0.057	n.s.	0.577	***	-0.456	***	-0.054	n.s.
	Reaction	0.857	***	0.37	***	0.043	n.s.	0.032	n.s.
	Fertility	0.425	***	-0.124	n.s.	0.739	***	0.113	n.s.
	%BS	0.017	n.s.	-0.505	***	0.036	n.s.	-0.226	*
England	Light	0.773	***	-0.403	**	0.195	n.s.	-0.025	n.s.
	Moisture	0.691	***	0.025	n.s.	0.258	n.s.	-0.546	***
	Reaction	0.171	n.s.	0.399	**	0.415	**	-0.643	***
	Fertility	-0.738	***	0.441	**	0.005	n.s.	-0.153	n.s.
	%BS	-0.713	***	0.262	n.s.	0.433	**	-0.016	n.s.
Scotland	Light	0.342	*	0.746	***	-0.328	*	0.28	n.s.
	Moisture	-0.194	n.s.	0.727	***	0.035	n.s.	0.265	n.s.
	Reaction	0.714	***	-0.072	n.s.	-0.23	n.s.	-0.224	n.s.
	Fertility	-0.318	*	-0.635	***	-0.124	n.s.	-0.511	***
	%BS	-0.222	n.s.	0.169	n.s.	-0.253	n.s.	0.136	n.s.

Significance levels given as *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$; ns $P > 0.05$. The highest value for each axis and dataset is in bold type.

4. HYDROCOTYLE VULGARIS–LEONTODON AUTUMNALIS COMMUNITY

Littorella uniflora and a high abundance of *Carex nigra* were characteristic of this community, which was found only on the Loch Maree Islands. Here it occurred on soil several centimetres deep and inundated from winter to spring. In July *L. inundata* was found about 3 m from the shore line, growing well above water-level. The impression of the vegetation was more like a grassy sward and, in addition to the species mentioned in Table 2, the rare *Deschampsia setacea* was also growing here (P. Lusby, pers. comm.). The quadrats representing this community had (significantly) the lowest indicator value for moisture (F) and the highest for soil reaction (R) (Table 3). This suggests that the soil was drier and less acidic than in any of the other communities.

ORDINATION AND CORRELATION

The first axis extracted by DCA showed that a unimodal model described the species response curves well since the length of the axis is 3.4 SD. As the quadrats from England and Scotland occurred at opposite ends of the first axis it confirms that there were major differences in species composition between the two countries. The amount of variation explained by axes 2, 3 and 4 (Eigenvalues 0.24–0.22) was substantially lower than the first (EV=0.55), and the lengths of axes 2, 3 and 4 were also rather short (2–2.5 SD). These axes described collectively the pattern within England and Scotland, respectively, and separate analyses were therefore carried out for these regions, while only axis 1 was meaningful for the entire dataset. Correlation analysis revealed that Ellenberg's indicator value for reaction was responsible for most of the variation in species composition between the English and the Scottish quadrats (Table 4), but the value for nitrogen also contributed significantly to the underlying gradient of axis 1.

The DCA analysis for the English data produced overall a lower level of significance with lower eigenvalues (0.40–0.06) and shorter axes. It was difficult to see a pattern in the distribution of the quadrats in the output, and this suggests that all quadrats should be classified into one vegetation unit. Ordination of the Scottish dataset produced a first axis that explained about half of the variation in species composition (EV=0.54). The length of axis 1 was 2.9 SD and it mainly described the separation between quadrats 80–83 and the rest. The underlying gradient for this axis correlated best with the indicator value for soil reaction but light and soil fertility also contributed significantly (Table 4). The succeeding axes reflected gradients in the vegetation that had little significance since the eigenvalues were very low (EV=0.13–0.05).

The Ellenberg indicator values for soil reaction and soil fertility were the only variables with a significant ($P < 0.001$) difference between England and Scotland (Table 3). The weighted averages were also slightly different for light, but there were no significant difference in percentage bare soil cover or soil moisture between England and Scotland.

DISCUSSION

HABITAT CONDITIONS OF *LYCOPODIELLA INUNDATA*

This study shows that the habitats of *L. inundata* are clearly different between England and Scotland in some respects, but for other variables no difference between the two countries could be detected. In terms of soil reaction the English habitats are probably more acidic whereas the substratum in the Scottish habitats, surprisingly, could be close to neutral according to the indicator value of the species present. Soil reaction has been measured to be about pH 4.5 in a *L. inundata* population in England (Pickering & Wigston 1990). For the remaining three indicator values and percentage bare soil there were no significant differences between the two countries, and the habitats can be characterised as exposed sites with constantly moist, very infertile soil, with about 50% of bare soil. Pickering & Wigston (1990) found an increase in total nitrogen content in the soil immediately around *L. inundata* compared to the surroundings, and they suggested a causal relationship between *L. inundata* and *Drosera rotundifolia*, the latter supplying nitrogen leaking from its insectivorous activity. From the present survey such a relationship was not obvious, as *L. inundata* was just as frequently found without *Drosera* plants in its immediate vicinity. The species presumably survives the infertile site conditions by having a slow growth rate and perhaps in association with mycorrhiza.

COMMUNITY TYPES WITH *LYCOPODIELLA INUNDATA*

The NVC communities with highest similarity to the vegetation of the ten locations of this study are listed in Table 5. The *Drosera intermedia*–*Sphagnum tenellum* community resembles the *Erica tetralix*–*Sphagnum compactum* wet heath (M16). This is a community of the British lowlands and it is found on shallow, seasonally inundated peat too dry or too freely drained for the development of Sphagnetalia vegetation and too wet for Calluno–Ulicetalia heaths (Rodwell 1991). *L. inundata* is only mentioned in connection with the *Rhynchospora alba*–*Drosera intermedia* sub-community, but according to the present study the species is also found in the drier typical sub-community. The *Drosera intermedia*–*Sphagnum tenellum* community also resembles the *Sphagnum tenellum*–*Rhynchospora alba* of continental NW-Europe and Scandinavia (Dierßen 1982), where *L. inundata* is characteristic of the wetter parts. It thus seems that this is a favoured vegetation for *L. inundata* throughout its European range.

For the Scottish quadrats the concordance with NVC units is ambiguous (see below). Different quadrats with the same similarity coefficients for different NVC units occurred at the same locality and, referring to the NVC community descriptions, both M16a and M17a are very unlikely to correspond to any of the recorded quadrats (Rodwell 1991). The *Scirpus cespitosus*–*Erica tetralix* wet heath, *Carex panicea* sub-community (M15a) is the best match to both the *Drosera anglica*–*Myrica gale* community and the *Eleocharis multicaulis*–*Narthecium ossifragum* community.

For the quadrats from Loch Maree the similarity coefficient is particularly low and the MATCH output for the site reveals a separation of the quadrats into two groups. The first group is a mixture of mire communities similar to M15a, whereas quadrats 73 and 79–83 best match the *Hypericum elodes*–*Potamogeton polygonifolius* soakway (M29). This community is characteristic of shallow pools in peats and peaty mineral soil with periodic inundation. Neither *Hypericum elodes* nor *Potamogeton polygonifolius* were seen during the survey, but many of the associated species mentioned in the description were found. The community is stated to occur on the beginning of a transition to truly aquatic vegetation in lakes, so it is likely that the *Hydrocotyle vulgaris*–*Leontodon autumnalis* community is at least related to this NVC community.

According to the continuum concept, a low similarity is to be expected for matching sampled vegetation stands with previous community descriptions (Økland 1990; Wilson & Chiarucci 2000). This theory views the vegetation community as an artificial unit, since species are believed to react to environmental heterogeneity on all scales creating a continuous gradient in vegetation

TABLE 5. RESULTS OF COMPARING THE STUDY QUADRATS FROM THE TEN LOCATIONS WITH THE NVC SYSTEM

Site no.	Best matching NVC community	Community code	Similarity coefficient (%)
I	<i>Erica tetralix</i> – <i>Sphagnum compactum</i> wet heath, typical sub-community	M16a	58.6
II	<i>Erica tetralix</i> – <i>Sphagnum compactum</i> wet heath, typical sub-community	M16a	63.6
III	<i>Erica tetralix</i> – <i>Sphagnum compactum</i> wet heath, typical sub-community	M16a	45.5
IV	<i>Erica tetralix</i> – <i>Sphagnum compactum</i> wet heath, <i>Rhynchospora alba</i> – <i>Drosera intermedia</i> sub-community	M16c	59.0
V	<i>Erica tetralix</i> – <i>Sphagnum compactum</i> wet heath, <i>Rhynchospora alba</i> – <i>Drosera intermedia</i> sub-community	M16c	63.0
VI	<i>Scirpus cespitosus</i> – <i>Erica tetralix</i> wet heath, <i>Carex panicea</i> sub-community	M15a	53.4
VII	<i>Erica tetralix</i> – <i>Sphagnum compactum</i> wet heath, typical sub-community	M16a	54.5
VIII	<i>Scirpus cespitosus</i> – <i>Erica tetralix</i> wet heath, <i>Carex panicea</i> sub-community	M15a	53.3
IX	<i>Scirpus cespitosus</i> – <i>Erica tetralix</i> wet heath, <i>Carex panicea</i> sub-community	M15a	44.9
X	<i>Scirpus cespitosus</i> – <i>Eriophorum vaginatum</i> blanket mire, <i>Drosera rotundifolia</i> – <i>Sphagnum</i> spp. sub-community	M17a	52.6

types. Using relevés to classify vegetation will thus always be a more-or-less inaccurate procedure depending on the degree of homogeneity of a particular stand of vegetation. Poor similarity between the Scottish quadrats and the NVC may thus be due to under-representation of Scottish sites in the NVC survey, where either a new community has been missed or some of the variation within the M15 is not covered.

ECOLOGY OF *LYCOPODIELLA INUNDATA*

Since all the sampled localities contain *L. inundata*, the range of indicator values for light, moisture, reaction and fertility can be used to model the niche of *L. inundata* in Britain. The estimated range for light and nitrogen was very narrow implying that *L. inundata* is intolerant of shading and occurs on very infertile soils. This corresponds well with the species being a poor competitor for light and a stress tolerator, in this case stress by lack of nutrients and high soil moisture. Regarding soil moisture and soil reaction the range is a little wider. From observations on the habitats in Britain it seems that they are all under water in winter and spring, but only moist in summer and a wide moisture amplitude is thus experienced every year. However, species often have differing ecological requirements across their range, and in Scandinavia *L. inundata* also grows in places which range from moist to dry during the year and which are protected by a cover of litter and mosses during winter (Øllgaard & Tind 1993).

Despite the described type of habitat being fairly common in Britain, *L. inundata* is decreasing. Øllgaard (1985) proposes a highly efficient spore dispersal for *L. inundata* and it seems that it is the establishing phase that is critical for the colonisation of new areas. Gametophyte development is reported from Denmark, where maturity was reached within a couple of years, and germination from dormant spores is reported in Britain (Stewart *et al.* 2000), though vegetative spread is considered most important in already established populations. We thus believe that certain micro-environmental factors are limiting the establishment of *L. inundata*, but more research is needed in order to determine exactly which factors. From this study light and soil fertility are the best candidates, but measurements at a smaller scale are needed to verify this. Pollutants in rain water have been suggested to have a negative effect on *L. inundata* (Stewart *et al.* 2000) and the deposition of nutrients over Europe is resulting in dramatic changes in heathland vegetation (Bobbink 1998; Berendse *et al.* 1993).

Lycopodiella inundata is the subject of conservation initiatives in Britain and Europe such as protection of habitat, management and restoration (Stewart *et al.* 2000). We would like to question the efficiency of these measures, as in our view it is doubtful whether a relatively ephemeral species such as *L. inundata* can be protected in this way. The overall factor important for the occurrence of this species is suitability of habitats. But as most heathland is semi-natural and

drastic management is needed to continuously provide suitable habitat for *L. inundata* here, we suggest that focus is instead placed on protection of the natural habitat, which seems to be the margins of oligotrophic lakes. Management of heathland for *L. inundata* is for many reasons undesirable and could eventually destroy the natural habitat for other protected organisms.

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Life cycle, ecology and distribution of *Schoenoplectus triqueter* (L.) Palla (Cyperaceae), Triangular Club-rush, in Britain and Ireland

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ABSTRACT

Schoenoplectus triqueter, Triangular Club-rush, is a rare plant which is declining in England. It is a rhizomatous perennial which rarely produces seed in the wild in Britain and Ireland but does so readily in cultivation and in Europe (and probably elsewhere). In Britain and Ireland it is restricted to the upper parts of tidal rivers where there are weakly brackish to fresh water conditions and large fluctuations in water level, but it occurs in a variety of wetlands and fresh water ecosystems elsewhere in the world. It has been recorded from four rivers in England (it was once locally abundant in at least three of these), but by 1995 was reduced to one or two plants on the Tamar. In Ireland it has been recorded in three rivers and, although gone from one river, still has a large and apparently stable population on the Shannon. The decline in England is probably due to destruction of habitats, spread of *Phragmites* and failure to recolonise after disturbance. It is probably not under threat world-wide.

KEYWORDS: biodiversity, conservation, reproduction, *Scirpus triqueter*.

INTRODUCTION

Schoenoplectus triqueter (L.) Palla (*Scirpus triqueter* L.), Triangular Club-rush, is a rare plant which is declining in Britain. It has been recorded from the rivers Arun, Medway, Tamar and Thames in England (and was once locally abundant in at least the latter three), but has recently become reduced to one or two plants on the Tamar. In Ireland it occurs along about 10 km of the River Shannon near Limerick and on the nearby River Maigue, where it is probably stable in both, and it was also recorded once on the River Cashen, North Kerry. In this paper, we draw together information about the life cycle, ecology and distribution of *S. triqueter* in Britain and Ireland which may help with the conservation of this critically endangered species which is on the priority biodiversity species list (UK Biodiversity Group 1998; Wigginton 1999).

Schoenoplectus triqueter is a distinct species, unlikely to be confused with any other species in Britain and Ireland except *S. pungens* (Vahl) Palla (*S. americanus* auct.) which has glumes with acute (not obtuse) lateral lobes (Lousley 1931). It is, however, more readily confused with its hybrids with *S. lacustris* (L.) Palla (= *S. × carinatus* (Sm.) Palla) and *S. tabernaemontani* (C. Gmelin) Palla (= *S. × kuekenthalianus* (Junge) D. H. Kent) which can have a markedly trigonous stem but differ in having at least some parts terete. Some inexperienced botanists have mis-named *Bolboschoenus maritimus* (L.) Palla as *S. triqueter*.

The hybrids are also declining, but are not dealt with in this paper. The genetics of the few remaining plants are currently being studied at the Royal Botanic Garden, Kew (M. Fay, pers. comm., 1999). Hybrids with *S. tabernaemontani* have been reported from all of the British sites and hybrids with *S. lacustris* from the River Tamar (one unconfirmed record) and the River Thames. No hybrids have been reported from Ireland. Hybrids have been reported widely elsewhere in the world (e.g. Lightcap & Schuyler 1984; Lousley 1931; Vanhecke 1986), and may form hybrid swarms (Bakker 1968).

Schoenoplectus triqueter is a long-lived, perennial helophyte. The plant spreads by rhizomes under the mud surface and often forms large clonal stands (e.g. Praeger 1900, 1934; Lousley 1931). Plants may fragment when rhizomes decay, separating parts of the clone. It is also possible that small, vegetative fragments may be able to establish themselves if eroded away from parent clumps and washed up in suitable places (e.g. Lousley 1931).

Aerial stems begin growth in late spring and die back in late autumn. Flowering may begin in early July and continues until the autumn (into October in cultivation in mild autumns). The inflorescences are composed of many heads, each of which is protogynous (the stigmas being exerted before the anthers dehisce). Although it usually flowers profusely, it very rarely sets seed in the wild in Britain and Ireland; in contrast, it produces abundant seed in Europe and the tropics, and in cultivation.

About 140 British and 20 Irish herbarium sheets from Britain and Ireland have been examined for seeds. The specimens were collected in various months and over many years, and most sheets have more than one specimen. It is remarkable that only three sheets (2%) have specimens with seeds: one collected from near Kew by R. Meinertzhagen (1878–1967), undated (**BM**), another from the same locality by W. McIvor in August 1846 (**DBN**) and the third from the River Cashen, Kerry, 1905, R. W. Scully (**DBN**). There is also one sheet with seedlings grown from seed by B. T. Lowne in **K** (no. 91–462) but there is no indication of the origin of the seed. Syme (1870) noted "Nut (which I have never seen to ripen in the British plant) about $\frac{1}{10}$ inch long, less rounded ...". Jackson & Domin (1909) noted, when discussing identification of hybrids, "the character of the nuts we do not mention as nearly all the spikelets of *S. triqueter* and *S. carinatus* were found to be barren". R. A. Stevens failed to find seed in 1994 and 1995 from the plant on the Tamar (pers. comm., 1996).

In contrast, abundant seed has been set in material from both the Tamar and Shannon in cultivation in fresh water/mud. Cuttings transplanted from the Tamar to the Royal Botanic Gardens, Wakehurst Place, West Sussex in 1994 have set seed, and self-sown seedlings have been observed (J. Terry, pers. comm. 1996). Cultivated material from the Shannon (ex D. A. Webb and University of Reading) set seed in North London in 1999 (J. Alder, pers. comm., 1999). Material of both clones set seed in 1999 in Cardiff, on both the hot sunny south-facing side of the house and also the shaded north side (material in **NMW**).

Similarly, most herbarium sheets examined from Europe have seed (52 fertile, 34 not fertile, = 60% fertile). Figure 1 shows the location of herbarium sheets with and without seed. A significant proportion of the European specimens which lack seed are immature plants collected early in the season.

Experiments are required to ascertain the causes of the lack of seed set in wild plants in Britain and Ireland. Clones apparently sterile in the wild are fertile in cultivation, and are also self-compatible (cf. seed produced in isolated clones at Wakehurst and North London above). Many wild plants occur in situations where they are regularly submerged by tides which might affect stigma or pollen function, but although numerous herbarium specimens are covered in fine mud, many are not. Initial thoughts by the first author were that the failure to set seed was due to climatic limitations (cf. Preston & Croft 1997; Stewart 1999) but the observations in cultivation noted above now also suggest other possibilities including physiological effects due to brackish growth conditions or fluctuating water levels.

Seeds are likely to be dispersed by water and by waterfowl (many of the sites are rivers or large wetlands of importance for birds). There is no information on seed dormancy in Britain. Watanaba & Miyahara (1989) studied seed dormancy of some lowland *Scirpus* weeds buried in paddy soil in Asia, including *S. triqueter*. They found that dormancy of seeds incubated at 5 or 15°C in the dark was broken after 2–3 months, with a maximum percentage germination of 91%.

S. triqueter is variable across its world-wide range in size, development of the uppermost stem leaf, number and size of inflorescences, development of peduncles and shape of glumes. Within Britain and Ireland, cultivation experiments have shown that a clone from the Shannon is about two-thirds the height of a clone from the Tamar (ex Wakehurst Place) when grown in the same conditions, indicating that there is some genetic variation in Britain and Ireland (specimens in **NMW**). Similarly, plants from several places in Europe and Asia (e.g. Japan) look different to plants from Britain, but are recognisable as this species.



FIGURE 1. Location of herbarium specimens of *Scirpus triquetus* with seed (●) and without seed (○), compiled from specimens in BM, BRISTM, BTN, CGE, DBN, K, L, NMW, OXF, P, RNG and TCD. Only two of the 90 specimens examined from the River Thames had seed.

There are no published chromosome counts for material from Britain and Ireland. Clapham *et al.* (1987) give a chromosome number of $2n=40$ but do not indicate the origin. Otzen (1962) reported a chromosome number of $2n=42$ from Holland. Bir *et al.* (1993) reported a chromosome number of $n=21$ for material from Punjab State, India, and noted that the chromosomes were diffuse. Hoshino *et al.* (1993) reported $2n=42$ and $2n=41$ from material from China.

HABITATS

In Britain and Ireland, *S. triquetus* is usually regarded as a species of brackish mud in estuaries and tidal rivers, and rarely in "marshes". It also occurs in these habitats elsewhere around the world, but overall is probably more common in freshwater lakes, rivers, ox-bows, ponds, ditches, muddy depressions, rice fields and other wetlands.

WATER AND SEDIMENT

In Britain and Ireland it grows in places where it may become partly or completely submerged due to tides. Along the Thames it used to grow at least partly submerged for the greater part of the day (Lousley 1931). Many herbarium specimens have fine mud, and sometimes flotsam debris, on the stems and inflorescences. Observations at its historic and extant sites suggest the water fluctuation is likely to have been in the order of 3–6 m, but it is difficult to be certain due to canalisation and embankment of the rivers. Similarly, in the Netherlands it is a pioneer plant of sand and mud flats

in the freshwater tidal area (Mennema *et al.* 1985); elsewhere in the world it grows in the tidal parts of estuaries. An important effect of the fluctuating water levels may be to reduce competition from other species.

Outside Britain and Ireland it may also grow in places where the water levels fluctuate little or only seasonally, and it is usually not completely submerged. For instance, in Germany it may grow in ditches, lakes, ponds and rivers (Hegi 1980), and in China it is a weed of rice fields (Yuan *et al.* 1991).

In Britain and Ireland, the associated species and hydrology suggest that it occurs in water which is weakly saline to fresh. Although there is no doubt that it does tolerate at least weakly saline conditions it is not found in any strongly saline situations. Stewart (1999) noted that it may be favoured by freshwater seepage around the roots, and recent surveys along the Shannon have confirmed that populations were most likely to be found where fresh water seeped onto brackish mud. Praeger (1934) also recorded it as growing "small and starved in running fresh water" above the head of the tide above Limerick, away from brackish influences. In Korea, the long-term salinity gradients appear to be primarily responsible for controlling its distribution in the Nagdong River, South Korea (Chung & Choi 1983). In the River Donets at Kharkov, Ukraine, its seasonal development in the hydroflora was connected with disturbance and pollution (Dogadina *et al.* 1979).

The upper parts of estuaries typically have fine, deep, soft mud which is likely to be nutrient-rich and weakly saline. Hegi (1980) and Ellenberg (1988) also regard it as a species of nutrient-rich mud in central Europe.

On the Tamar, plants occur where there are slight irregularities in the banks which may provide some protection from river flow; detailed observations are required. A bank on which it grew became subject to erosion in the 1990s, and by 1995 the one remaining *S. triqueter* clump had become under-cut and slumped down the bank into the river (FitzGerald *et al.* 1997). Similarly, observations on the hybrid clumps in the Medway in 1996 suggested that the river was changing course and under-cutting the plants, and that these were unable to grow quickly enough to re-establish on the newly exposed mud or the stony river bed.

VEGETATION

In Britain and Ireland, it is typically found on the outer edge of the swamp communities as a pioneer species forming relatively pure, single species stands. There are few records of associated species (there is no information on it in *British Plant Communities*; Rodwell 1991–2000). On the Tamar in 1989 it had no immediate associates, but *Agrostis stolonifera* L., *Oenanthe crocata* L. and *Phragmites australis* (Cav.) Trin. ex Steud. occurred within 1 m. W. B. Turrill noted that it grew in the Thames at Kew with *Schoenoplectus tabernaemontani* and *Bolboschoenus maritimus* (K), as also did the hybrids observed on the Medway in 1996 (T. C. G. Rich & E. G. Philp, pers. obs.). Praeger (1934) noted that it was associated with *Typha angustifolia* L., *Phragmites communis*, *Schoenoplectus tabernaemontani*, *Bolboschoenus maritimus*, *Cochlearia anglica* L., *Rorippa sylvestris* (L.) Besser and *Eleocharis uniglumis* (Link.) Schult. along the Shannon, and the legend of the photograph of it at Limerick notes it with *Schoenoplectus tabernaemontani*, *Alisma plantago-aquatica* L., *Apium nodiflorum* (L.) Lag., *Persicaria maculosa* Gray, *Groenlandia densa* (L.) Fourr., *Chara* sp. and green algae. At Tervoe, Co. Limerick in 1988 it was growing with *Alisma plantago-aquatica* on otherwise bare mud (pers. obs.). Mrs S. C. P. Reynolds has recorded it with *Schoenoplectus tabernaemontani*, *Bolboschoenus maritimus*, *Persicaria amphibia* (L.) Gray, *Apium nodiflorum* and *Callitriche* sp. at Ballinacurra Creek, Co. Limerick and with *Aster tripolium* L. and *Rumex crispus* L. subsp. *uliginosus* (Le Gall) Akeroyd at Ferry Bridge, River Maigue, Co. Limerick (pers. comm., 2000; Reynolds 1997a, b). White & Doyle (1982) placed it in the *Scirpetum triquetri et maritimi* in Ireland. The associated species are all typical of wetlands with fluctuating water tables. It does not appear to tolerate competition from robust swamp species such as *Phragmites* or *Typha*.

In central Europe it is regarded as a member of the *Bolboschoenion maritimi* (Brackish-water reedbeds and related communities) of the *Phragmiteteta* (Reed and Tall Sedge swamps), characterised by species such as *Bolboschoenus maritimus*, *Schoenoplectus* × *carinatus*, *S. pungens*, *S. tabernaemontani* and *S. triqueter* (Ellenberg 1988). It also occurs in *Phragmites* beds (Hegi 1980).



FIGURE 2. Distribution of *Scirpus triqueter* in Britain and Ireland. (●)1990 onwards. (○) pre-1990. (×) error.

HERBIVORY

There have been no detailed investigations of herbivory in Britain, but it may be eaten by swans and other wildfowl as it is elsewhere in the world. Observations suggest that ducks and geese graze heads at high tide on the Shannon (E. Meskall, pers. comm., 1994). Doornbos *et al.* (1986) report that the roots and rhizomes are the most important food source for wildfowl (mainly for swans) in the Nakdong Estuary, Korea, with approximately a quarter of its total production being eaten.

DISTRIBUTION

Data have been compiled from herbaria (**BM, BRISTM, BTN, CGE, DBN, K, L, LANC, NMW, OXF, RNG** and **TCD**), the literature (especially county floras), the Biological Records Centre, Monks Wood (BRC), and from correspondence with botanists and conservation officers. Details of all the records traced have been deposited at the BRC, and with the B.S.B.I. Threatened Plants Database. The records are mapped in Figure 2, and the history of each site is set out below.

RIVER TAMAR (V.C. 2 EAST CORNWALL AND V.C. 3 SOUTH DEVON)

This site was first discovered in July 1857 by C. Prentice, "most copiously on a mud bank for about a mile, or rather less, on the Calstock side of the Tamar [Cornwall] beyond Calstock, just opposite the rocks of Morwellham, on the opposite side of the river" (Prentice 1872). Prentice was surprised it had not been seen before as it was freely visible from boats on the river and the area had been visited by many notable botanists. He wondered if the plants had been washed away since he first saw it, but Briggs (1875) noted it was still present "in considerable quantity in two spots near Calstock, the higher being about ¼ mile above the village".

Botanists have sporadically visited the site since, but less so than the Devon side (see below). It was last recorded on the Cornish side of the river opposite Gawton Mine in August 1958 by Mrs I. G. Nicholson on SX451689 when four small clumps were seen on the river mud submerged at high tide (BRC record card; this is the origin of the record in Margetts & David 1980 and of three of the four records in French *et al.* 1999).

It seems to have been much rarer on the Devon side of the river when first found by T. R. A. Briggs in 1875 in three localities, Gawton, Tuckermarsh Quay and between Gawton and the Beer-Calstock Ferry (Briggs 1875, 1880). Again it has been irregularly recorded since then to the present day, but has declined. In 1985, surveys by M. E. Bradshaw revealed six patches covering 6 m², but in 1989 and 1994 only four patches remained covering a total of c. 2 m² (unpublished survey data by R. FitzGerald, R. Sparshott and R. Walton). In 1995 only one clump was known to survive, which was beginning to slump into the river (R. A. Stevens, pers. comm.). Stevens took cuttings in 1994 and 1995 which now form the basis of a conservation programme, including reintroductions. A full survey by boat in 1997, however, found two clumps about 20 m apart in the site where there had been four in 1994; there was no obvious reason for the loss (FitzGerald *et al.* 1997). Another site at Tuckermarsh Quay where two plants had been observed by T. Lording in 1994 (photographs in NMW) and one by D. Holyoak in 1995 was also found to have gone due to the bank slumping into the river (FitzGerald *et al.* 1997). Its survival is clearly very precarious.

The majority of the decline may be due to spread of *Phragmites* into its habitat (FitzGerald *et al.* 1997). Historic photographs from the period when it was abundant show that the river banks were open with low marshy vegetation, and no over-hanging trees or fringing *Phragmites* as they have today. The open banks were probably maintained for the river towpath and by grazing (Paige 1984 makes the tantalising but unsupported observation that "industry and river traffic destroyed the reed beds"). The cessation of towing, restriction of grazing animals and the water eutrophication caused by agriculture may have all contributed to the spread of *Phragmites*, which now forms a tall dense zone along much of both sides of the river. Unlike the other sites (see below) river engineering has not caused decline at this site.

RIVER ARUN (V.C. 13 WEST SUSSEX)

It was first recorded on the banks of the Arun near Amberley on 28 July 1832 by J. A. Power (**BM**, **K**), and by G. C. Druce in July 1918 "near Arundel", which we take to be the same locality (**OXF**). It was also reported at Stoke by G. J. Davies, in what was probably a separate locality to the south (Wolley-Dod 1937). Wolley-Dod (1937) reported that it was "still there, but much rarer than the hybrid", although, as in many cases in his flora, it is difficult to be certain that he had seen it recently. It was last collected in June 1967 by S. Hooper from Houghton Bridge (**K**). No plants have been seen by the Sussex Botanical Recording Society on several more recent visits, but a search by boat would be worthwhile.

The populations are reputed to have disappeared following canalisation and "improvements" to the banks of the river, but the river has not been investigated in sufficient detail to be certain.

RIVER MEDWAY (V.C. 15 EAST KENT AND V.C. 16 WEST KENT)

It was first found "in plenty" on the right bank of the Medway between Aylesford and Forstal in July 1894 by A. H. Wolley-Dod (**BM**; Hanbury & Marshall 1899). Marshall immediately visited the site and also saw it on the left bank both above and below Aylesford Bridge, and remarked that it was strange that it had been so long over-looked as there was a great deal of it at intervals for about a mile (**BM**, **BRISTM**, Hanbury & Marshall 1899).

It appears to have been only irregularly recorded afterwards. Lousley (1931) reported it had gone from the Medway by 1930, though hybrids were still present at Aylesford Bridge, but he subsequently re-found it at Forstal in 1934 (**RNG**). The most recent record traced is September

1938, N. D. Simpson (BRC record card). It is thought to have disappeared after the river walls were constructed and a new cut straightened the river. The late C. West told E. G. Philp that as a young man in the 1930s he remembered seeing *S. triqueter* by the Medway at Aylesford before the works were carried out, but afterwards only found it along by the Friary (pers. comm., 2000).

In 1987 a search by boat from Rochester to Aylesford was initiated by E. G. Philp with J. Bevan and R. FitzGerald. It was initially thought to have been refound at Burham Marsh (Philp 1988), but some doubts were expressed at the time and re-examination of the clumps in 1996 by E. G. Philp and T. C. G. Rich showed them to be *S. × kuekenthalianus* (Rich 1996) (material taken into cultivation at Royal Botanic Gardens, Wakehurst Place). Further searches on foot upstream to Allington Lock by E. G. Philp have been unsuccessful (pers. comm. 2000).

RIVER THAMES (V.C. 16 WEST KENT, V.C. 17 SURREY AND V.C. 21 MIDDLESEX)

The earliest record traced for Britain and Ireland is a manuscript annotation by William How for near the Horse Ferry at Westminster, c. 1650–1656 (Kent 1975). It was subsequently recorded from over 17 km of the River Thames between Richmond and Greenwich, and the London records are too numerous to present in detail. There are records in v.c. 16 West Kent between Greenwich and Woolwich (Cooper 1836; reported as extinct by Hanbury & Marshall 1899), in v.c. 17 Surrey from Lambeth (E. Forster, undated), Battersea (1832–1857), Wandsworth (1842–1856), Putney (1832–1932), Barnes (1891–1931), Mortlake (1836–1941), Kew–Mortlake (1880–1930), Kew (1832–1946) and Richmond (c. 1930–1931), and from v.c. 21 Middlesex from the Isle of Dogs (c. 1700), Limehouse (c. 1700), Chelsea (pre-1771), London (1670–1836), Westminster (c. 1650–1700), Fulham–Hammersmith (pre-1869) and Brentford (pre-1887).

The London records show a generally progressive loss upstream, and from the Middlesex side before the Surrey side, presumably related to the intensity of development along the Thames. Lousley (1931) noted “at one time the plant occurred on both banks of the Thames between Limehouse and Kew ... the embankments of the Thames have now destroyed it in all localities except around Mortlake and Kew where it still occurs in fair quantity”. Later he recorded “The one near Kew Bridge survived until about 1946 when a major reconstruction of the river-wall destroyed the last remaining patch of estuarine mud on which the plant grew” (Lousley 1976).

There is a specimen from a marsh at Gravesend, August 1840 in CGE (rejected as possibly misidentified by Preston & Croft 1997; the identification has now been confirmed); it has not been reported again from this site.

RIVER CASHEN (V.C. H2, NORTH KERRY)

The history of this site is documented in detail in the correspondence and maps held with the specimen in DBN, and in Praeger (1935, 1946).

In July 1905, R. W. Scully was investigating the distribution of *Eleocharis parvula* (Roem. and Schult.) Link ex Bluff, Nees & Schau. along the west bank of the tidal portion of the River Cashen and, being aware of the recent discovery of *S. triqueter* in the Shannon (see below), but not knowing what it looked like, collected *Schoenoplectus* inflorescences. Most were *S. tabernaemontani*, but the identity of one head was not ascertained until suggested to be *S. triqueter* by Miss M. C. Knowles in 1929 and subsequently confirmed by J. E. Lousley. Lousley also remarked that it was “off” the type and that he had not seen anything quite like it (similarly, T.C.G.R. agrees it is unlike other material seen from Britain and Ireland, and is exceptional in being fully fertile). Scully was sure the inflorescence had been collected between Dysert Church and the River Brick (c. Q9033). Despite being crippled by arthritis, he joined R. L. Praeger in an unsuccessful attempt to refind it on 16 July 1931. Praeger searched unsuccessfully again for three days in 1932, concentrating on both sides of the tidal part of the river.

This record has not been accepted by a number of authors (e.g. Perring & Walters 1962; Scannell & Synnott 1987; Preston & Croft 1997) and some doubts about it remain (Praeger 1935, 1946). However, its occurrence in the nearby Shannon estuary where the main population occurs (see below), its distinct morphology, and Scully’s certainty about the origin of the specimen suggest that it is acceptable. Searches on the river by boat in 1994 by R. FitzGerald with Wildlife Service staff were unsuccessful; the river had recently been embanked and there was no suitable habitat for either the *Eleocharis* or *Schoenoplectus*. In light of what is now known about fruiting, another search of fresh water rather than brackish habitats in the areas indicated by Scully might be rewarding.

RIVER SHANNON (V.C. H8 LIMERICK AND V.C. 9 CLARE)

It was first found new to Ireland by R. D. O'Brien in August 1900, and boat surveys showed it to occur in abundance on foreshores on both sides of the Shannon from Limerick city downstream to Tervoe Lower Light on the Limerick shore and to Coonagh Light on the Clare shore (Praeger 1900). One clump was also present in Cratloe Creek (later reported as "sparingly" by Praeger 1909). It also occurred sparingly above the town as far as the old canal entrance 1 mile ENE of the city, growing "small and starved in running fresh water" (Praeger 1934). Many botanists have seen it at the site in Limerick pictured in Praeger (1934).

Surveys by boat by R. FitzGerald and Wildlife Service staff in 1994 showed that the plant was found more or less in the same areas as when it was discovered. It was found in about 14 locations, most only accessible by boat, and some with substantial populations. On the Clare bank it was found downstream to, and in, Cratloe Creek. Several large patches were seen at the end of a small side creek at Tervoe in 1988 by N. Taylor and T. C. G. Rich, and in 1989 by G. M. Kay and T. C. G. Rich, but by 1992 the road had been blocked off, the area appeared to have building development, and we were unable to gain access. A number of the creeks and riverside sections of the Shannon both upstream and downstream of Limerick have been searched with a number of botanists including Mrs S. Reynolds and Miss C. Brady (v.c. Recorders for H8 Limerick and H9 Clare respectively) but without finding any new sites.

RIVER MAIGUE (V.C. H8 LIMERICK)

Several patches on estuarine mud were first found on the River Maigue at Ferry Bridge on 6 September 1996 by Mrs S. Reynolds (Reynolds 1997a, b) and are still present. Although this river drains into the Shannon Estuary, this is probably sufficiently distinct (c. 7 km) to be a separate site.

ERRONEOUS RECORDS

No evidence supporting Druce's (1932) record for v.c. 14 East Sussex has been traced. A record for Ballerden, Surrey (CGE), which cannot be traced (J. E. Smith, pers. comm.) is assumed to be a mistranscription of Battersea. There are (probably) erroneous records for v.c. 27 East Norfolk from Acle Dam (Trimmer 1866, rejected by Nicholson 1914) and v.c. 55 Leicestershire from Market Bosworth Park (Kirby 1850, rejected by Horward & Noel 1933).

WORLD DISTRIBUTION

It is a very widespread species which is locally abundant in the tropics and becomes rarer further north (map in Hultén 1958). It is recorded from west, central and southern Europe through western, central and eastern Asia to Japan and the Philippines, and in north Africa (recorded once on the Suez canal only) and South Africa. It is so prolific in some areas that control with herbicides is required (Yuan *et al.* 1991). It occurs from sea level in many parts of the world to an altitude of at least 2400 m in Kashmir (cf. Sharma 1979).

It was introduced to the Columbia River system, North America where it hybridised with *S. tabernaemontani* (Lightcap & Schuyler 1984).

DISCUSSION

Our current interpretation of the occurrence of *S. triqueter* in Britain and Ireland is that it is a relict species which is slowly declining due to the rate of loss of habitat being higher than the rate of recolonization. It presumably became established in Britain and Ireland earlier in the interglacial when the climate was warmer and other conditions were more suitable. A tantalising, tentative record of seeds of *S. × carinatus* from late-glacial beds at Waltham Cross (Godwin 1975) hints that *S. triqueter* could have occurred more widely in freshwater habitats. It may be less able to compete in freshwater habitats in northern areas due to the cooler climate, and be thereby restricted to the upper parts of tidal rivers, a sub-optimal habitat, where competition with other clonal swamp species is reduced by the severity of the habitat (e.g. brackish water with fluctuating levels and strong currents). It does not reproduce by seed or does so only rarely and now maintains itself vegetatively. Consequently, slow random events associated with natural changes in river dynamics, and more recently rapid changes brought about by river engineering, have resulted in

destruction of its habitats and fragmentation of the populations at a pace at which vegetative growth and recolonization cannot compensate for the losses. Hence it is now on the verge of extinction in England.

The three main causes of the decline in Britain appear to be direct loss of habitat due to construction of embankments (cf. Lousley 1976, etc.), growth of *Phragmites*, and failure to recolonise after indirect changes in the river flow patterns resulting from river engineering, canalisation, etc., which cause erosion of the river banks and the subsequent loss of colonies. Increased flow rates resulting from extensive drainage of the catchments may also contribute to changing water flows. Increased sedimentation rates due to high sediment runoff from ploughed fields may also have changed deposition and erosion patterns. There is no direct evidence that water pollution, wash from boat traffic, collection by botanists or hybridisation has caused decline.

The dangerous and inaccessible habitat, and it being a dull-flowered, unspectacular species have probably contributed to the lack of conservation. Surveys by boat are essential to assess the populations fully since sites may be inaccessible from the land, as found during the Shannon surveys in 1994. Significant action on the species in Britain began only in 1994 when R. A. Stevens of Plymouth City Council became concerned about the few remaining Tamar plants, which seemed to be declining further, and sent a cutting to Royal Botanic Gardens, Wakehurst Place for safe keeping. Independently, in June 1995 Eric Philp became concerned about the "second" British site on the Medway, but when he and T. C. G. Rich tried to bring material into cultivation it was found that the plants previously reported as *S. triqueter* were hybrid (cf. Philp 1988), and that *S. triqueter* was extinct in the Medway. In 1996, there was also concern for the safety of the plants at Limerick which were threatened by some of the early proposals for the Limerick Main Drainage Scheme.

The decline in the species in Britain had been noted by the conservation agencies (cf. Perring & Farrell 1977) but little was done to prevent it. Although it is protected under Schedule 8 of the Wildlife and Countryside Act 1981 in England and the River Tamar is a Site of Special Scientific Interest/Special Area for Conservation, the legislation provides no protection against the physical changes in its habitats which are now the biggest threats. In Ireland it is protected under the Flora (Protection) Order, 1999.

The longer term future for the species in Britain may now be brighter. A species action plan prepared by R. A. Stevens in 1996 has now been updated by a full national action plan (UK Biodiversity Group 1998). As part of a collaborative project between English Nature, Plymouth City Council and the Environment Agency cuttings have now been planted out in five places on the Tamar to reinforce the last population, some of which are growing well (FitzGerald *et al.* 1997); full details will be published elsewhere. Seed from the Tamar plants is held in the Millennium Seedbank, and live material from the Tamar and Shannon are being cultivated at Wakehurst Place, at Reading University and by a number of botanists.

World-wide, the species does not seem to be under any special threat, though it may be so in individual countries where it is rare. Estuarine barrage and land reclamation projects (e.g. Mennema *et al.* 1985; Doornbos *et al.* 1986) undoubtedly threaten local populations.

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***Bromus interruptus* (Hack.) Druce (Poaceae) - an extinct English endemic**

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ABSTRACT

Bromus interruptus, Interrupted Brome, is a grass endemic to England but which is extinct in the wild. The aim of this paper is to raise awareness of its records and ecology in the hope that it can be refound. It is related to *B. hordeaceus*, but differs in its contracted inflorescence (which makes it easy to pick out in the field), longer glumes and bifid paleas. The 169 historical records traced show it has been recorded in at least 106 sites in 73 hectads in v.cc. 6–9, 11–29, 32–34, 37, 53 and 63. It was last seen in Cambridgeshire in 1972. It is an annual in cultivation which produces abundant seed. It has mainly been recorded from fields, especially those sown with sainfoin, but also in a range of other situations. It was abundant and persistent in at least some of its localities. Plants should be looked for on disturbed edges of arable and hay fields and roadsides in its original localities and elsewhere in May–July onwards.

KEYWORDS: biodiversity, Gramineae, re-introduction, Interrupted Brome.

INTRODUCTION

Of the 21 non-critical species extinct in the British Isles, only *Bromus interruptus* (Hack.) Druce, Interrupted Brome, is endemic (Rich 2001). Fortunately, it has survived in cultivation, and as such is a high priority for re-introduction to restore a lost part of England's biodiversity.

The history of *Bromus interruptus* has been described by Druce (1897), Perring (1962), Donald (1980) and Lyte & Cope (1999). It was noticed by G. C. Druce in 1888 in considerable quantity in a fallow field in Berkshire and specimens were distributed through the Botanical Exchange Club as a possible new variety, though specimens had previously been collected in Cambridgeshire in 1849 and named as *Bromus pseudo-velutinus* Barnard ex Watson (this name is illegitimate; Druce 1904a, b). One specimen was sent to the expert Prof. E. Hackel, who accepted it as a new taxon and described it as a variety of *B. hordeaceus* L. (*B. mollis* L. var. *interrupta* Hack.) in Druce (1889). After further studies, Druce raised it to species status (Druce 1895). By the 1930s it had been found quite widely in England, often associated with sainfoin crops and hay meadows, and may have been passed around with seed from farm to farm. However, following the introduction of seed cleaning techniques it appears to have declined, and Druce (1932) described it as a diminishing species. By the 1960s it was virtually extinct; Perring (1962) listed the six records made since 1936, and suggested that it should be searched for again at known sites. It was subsequently rediscovered in one of its former sites on a field margin at Pampisford in Cambridgeshire in 1962 (Perring & Sell 1963), and material was taken into cultivation at Cambridge Botanic Garden. It continued to reappear on its field margin and conservation work was carried out on the site during 1965–1968. It was last seen in 1972 by C. Shaw and D. A. Wells. Later that year a four metre strip along the edge of the field was mown and the cuttings removed, and it was then scarified during the winter (G. Crompton, D. A. Wells *in litt.* at Biological Records Centre (B.R.C.)), but no plants reappeared. Further management attempts to resurrect the species in 1978 also failed.

In 1973 it was discovered that the seed held at Cambridge was no longer viable, and the species was thought to be extinct. Miraculously, seed had survived in cultivation; at a B.S.B.I. conference in Manchester in April 1979, P. M. Smith dramatically produced some plants which had been grown from seed he had originally collected from Pampisford on 23 July 1963 (Smith 1980; Donald 1980). Plants were subsequently again bulked up at the Cambridge Botanic Garden and have been widely distributed since. Seed also appears to have survived in cultivation since at least 1954 via Prof. Gailin at N.I.A.B. in France (D. E. Coombe, pers. comm., 1995).

In 1995, T.C.G.R. began collating data on this species and researching its ecology with P. G. Angold with a view to re-introducing it to the wild. The first step was to resurvey the historical sites in case it had survived unnoticed, but funding was not forthcoming from the three sources tried. To date only a few sites have been revisited (e.g. Rich 1999), and as it is now unlikely that we will be able to search the old localities, the aim of this paper is to present the information we have collated about *B. interruptus* to stimulate its rediscovery and to provide information for a re-introduction programme.

TAXONOMY AND IDENTIFICATION

Bromus interruptus is a distinct, little variable species, and grows true from seed. It is closely related to *B. hordeaceus* and is probably derived from it, perhaps by mutation, and it has been suggested to be an ecotypic subspecies selected in crops (Smith 1972, 1981; Ainouche & Bayer 1997; Oja 1998). Smith (1972) investigated seed protein serology and found *B. interruptus* shared the protein spectrum of *B. hordeaceus* almost completely; he later reported 75–80% similarity in serological and electrophoretic analyses of seed proteins (Smith 1980). Ainouche & Bayer (1997) found only one base-pair difference between internal transcribed spacer regions of nuclear ribosomal DNA of *B. interruptus* and *B. hordeaceus*. Oja (1998) found very close affinities in isozymes between *B. interruptus* and *B. hordeaceus*, the latter differing in being more polymorphic though more samples were studied.

L. M. Spalton has kindly proved an updated description as follows:

Culm to 100 cm. Panicle to 8 cm, erect, narrow, dense with many spikelets, often shortly interrupted below. Spikelets c. 10–12.5 mm long, elliptical, quickly divaricating to obdeltoid; often some in groups of three. Glumes conspicuously long, the lower lanceolate, the upper ovate, more than 2/3 as long as the lemma. Lemmas c. 7.4–8.5 mm, papery with prominent veins when dry, pubescent. Paleas bifid, reduced to two, frequently unequal, long hyaline strips c. 0.4 mm wide (development can be variable). Anthers to 1.5 mm.

Bromus interruptus is readily recognisable in the field, and differs from other annual brome grasses in having a contracted inflorescence, broader deltoid spikelets, long glumes and the bifid palea. The inflorescence is often described as 'interrupted' (hence its name) but only a few larger plants tend to have the lower cluster of spikelets separated, and in many specimens the outline is more-or-less continuous. Likely *B. interruptus* plants are most easily picked out from the contracted inflorescence, and then confirmation can be sought from examination of the palea. Paleas are most easily seen in fresh material, and are bifid from the start (note that paleas may become bifid in *B. hordeaceus* as they age). In ripe spikelets the palea may be wrapped around the back of the seed, and sometimes in *B. hordeaceus* the palea becomes fused to the seed making it difficult to observe without a microscope and careful dissection of the florets. A photograph and an illustration showing these features are given in Figures 1 and 2; another illustration by G. M. S. Easy is given in Donald (1980), where the inflorescence is shown more lax than is our experience.

A chromosome number of $2n=28$ (tetraploid) has been reported by Maude (1939), Smith (1973) and Dempsey *et al.* (1994). *Bromus hordeaceus* is also tetraploid with $2n=28$ (Smith 1973). No hybrids have been reported.



FIGURE 1. Photograph of *Bromus interruptus* by J. E. Lousley; herbarium specimen in **RNG** (courtesy of S. L. Jury).

DISTRIBUTION IN THE BRITISH ISLES

Data have been compiled from the literature, herbaria (confirmed material from **BEL**, **BIRM**, **BM**, **BRISTM**, **CGE**, **DBN**, **E**, **K**, **L**, **LTR**, **NMW**, **OXF**, **RNG**, and **SLBI**, other records included from **HCMS**, **LIV**, **NWH**, **SDN**), B.R.C. and correspondence with botanists. Determinations by G. C. Druce, C. E. Hubbard, P. M. Smith, L. Spalton, P. J. O. Trist and T. G. Tutin have been accepted directly, with other material determined by T.C.G.R. Full details are held in the Threatened Plants Database and are available from A.J.L. on request.

We have given best approximate 1 km squares for many records to help locate sites, though it should be noted many of these are best guesses, and should not be taken to indicate the exact original locations. We have also grouped together records from the same locality, though in some cases we know these represent more than one site. Different sources for the same record often hold different information, which we have endeavoured to summarise into one form.

V.C. 6. NORTH SOMERSET

Failand, field of sown fodder/in a grass field, June 1913, J. W. White (**BM**, **BRISTM**, **CGE**).

Field near ... I have only found this grass in fields sown for fodder, and with sainfoin, 16 June 1913, C. I. Sandwith (**L**). ST5271.

V.C. 7. NORTH WILTSHIRE

Aldbourne, 1929, E. S. M. Todd (**OXF**, **SDN**; Grose 1957). SU2376.

Allington, 1891, E. J. Tatum (Preston 1892). SU2039.

Colerne, wall top/old wall, 28 May 1903, E. S. Marshall (**BM**, **CGE**, **E**, **NMW**, **OXF**; Marshall 1904). ST8171.

V.C. 8. SOUTH WILTSHIRE

Bratton, sown grass field above/field at foot of chalk down near, 30 May 1903, E. S. Marshall (**BM, DBN, NMW**; Marshall 1904, Grose 1957). ST9152.
Salisbury, 1919, H. J. Goddard (**OXF**). SU1430.

V.C. 9. DORSET

Edmondsham, 1/2 – 3/4 mile from Verwood Station, 9 June 1902, E. F. Linton (**BM, DBN, OXF**). SU0710.

V.C. 11. NORTH HAMPSHIRE

Cross Mill, Winchester, 10 June 1910, G. C. Druce (**OXF**). SU4727.

Winchester, grass field near the Downs ...sown with *Lolium*, 30 May 1898, A. B. Jackson (**BM, OXF**; Townsend 1904). SU42.

Farley Chamberlayne, undated, G. C. Druce (Rayner 1929). SU4026.

Totton, 1906, probably collected by J. F. Rayner or H. G. Sadler (**HCMS**; Rayner 1929; Brewis *et al.* 1996). SU3513.

V.C. 12. SOUTH HAMPSHIRE

Andover, 1908, A. Wedgwood (Wedgwood 1945). SU3645.

Buryfields, Odiham, 19 June 1894, C. E. Palmer (**OXF**). It grows scattered in patches in the clover fields about here, its heads towering far above all other grasses. In abundance, 23 June 1902, C. E. Palmer (**BEL, BM, BRISTM, DBN, E, K, NMW, OXF, SLBI**; Rayner 1929). SU7450.

Ecchinswell, cultivated field near, 1906, A. B. Jackson (**BM**). SU5059.

North Warnborough [West Warnborough], near Odiham, by roadside, July 1911, G. C. Druce (**OXF**; Rayner 1929). SU7350.

Sydmonton, 1906, H. G. Sadler (**HCMS**; Brewis *et al.* 1996). SU4857.

Watership Down, chalk pit, 5 June 1906, A. B. Jackson (**OXF**). SU4957.

V.C. 13. WEST SUSSEX

Haslingbourne [Haslingford], old chalk pit, 30 June 1913, A. G. Gregor (**K**). SU9820.

V.C. 14. EAST SUSSEX

Glynde, with sainfoin, 23 June 1931, K. Pickard (**OXF**; Wolley-Dod 1937). TQ4508.

Woodingdean [Woodendean], near Brighton, amongst sainfoin, abundant, 9 June 1904, T. Hilton (**BM, E, SLBI**; Wolley-Dod 1937). North of Rottingdean, undated, E. Ellman (Wolley-Dod 1937). TQ3605.

V.C. 15. EAST KENT

Preston, 1890, G. Dowker (**CGE**). TR2360.

Snodland, cultivated field, 2 June 1923, I. M. Roper (**BM, BRISTM, K, NMW, OXF, SLBI**). TQ7061.

Whitstable, June 1897, E. Ellman (**OXF**). TR1066.

V.C. 16. WEST KENT

Kelsey Park, Beckenham, 23 May 1942, W. Howell (**K**). TQ3769.

Between Shinglewell and Cobham, in sainfoin field, 19 May 1912, C. E. Britton (**BM, K**). TQ6768.

Dartford Hospital, plentiful in sainfoin near, 21 May 1893, A. H. Wolley-Dod (**BIRM, BM, DBN, NMW, OXF, SLBI**; NB some collections are *B. hordeaceus*; Hanbury & Marshall 1901).

Chalky field of sainfoin, June 1893, A. H. Wolley-Dod (**BM**). TQ5374.

Eltham, near, 1894, A. H. Wolley-Dod (Hanbury & Marshall 1899). TQ4274.

Halling, 23 May 1893, F. J. Hanbury (**BM**). TQ7064.

Hayes, gravel pit, 1 June 1906, possibly collected by W. H. Griffin (**SLBI**). TQ4066.

Keston, near, June 1921, J. A. Pratt (**SLBI**). TQ4164.

Lads Farm, Upper Halling, sainfoin field near, 14 June 1936, J. P. M. Brenan and J. E. Lousley (**K**). Clover ley, 14 June 1936, J. E. Lousley (**RNG**). TQ6836.

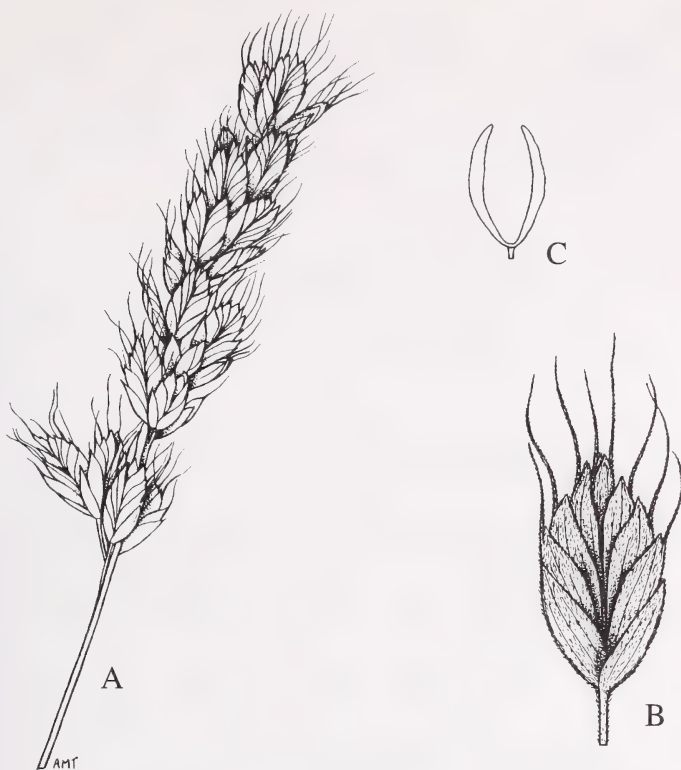


FIGURE 2. *Bromus interruptus* (del. A. Townsend). A. Inflorescence ($\times 1$); note contracted inflorescence (rarely some pedicels are slightly more lax), and spikelets are often in groups of three. B. Spikelet ($\times 3$), showing ovate shape when ripe. C. Palea ($\times 3$); this is usually reduced to simple membranous tissue.

V.C. 17. SURREY

Bank of River Thames at Mortlake, July 1879, G. Nicholson (**BIRM, BM, OXF, SLBI**). TQ2076. Selsdon, Sanderstead, in fields, 4 June 1899, J. Fraser (**K**). TQ3562.

Tot Hill, Headley, in heavy soil overlying chalk. Abundant in derelict field, 15 June 1930, C. I. Meikle (nee Dickinson) (**K, NMW**). Sainfoin field near, 17 July 1931, I. A. Williams (**K, OXF, SLBI**). June 1932, A. H. Carter (**BM**). June 1932, E. Nelmes (**K**). In chalky field opposite High Ashurst, 3 and 4 June and 2 July 1932, 4 June 1932, J. E. Lousley (**BIRM, BM, CGE, K, LTR, NMW, RNG, SLBI**). 12 June 1932, J. E. Lousley (**RNG**). In derelict hay field, very abundant near remains of old haystack, on heavy soil overlying chalk, 15 June 1932, C. E. Hubbard, C. V. B. Marquand and H. K. Airy Shaw (**BM, CGE, E, K, LTR, SLBI**). 27 June 1932, R. B. Ullman (**SLBI**). Fallow field, 1 or 11 July 1932, E. C. Wallace (**E, LTR, RNG**). Abundant in neglected arable land, 2 July 1932, J. E. Lousley (**NMW, RNG, SLBI**). Headley Lane, June 1933, E. Vachell and E. Knowling (**NMW**). Cultivated land, 3 June 1933, E. C. Wallace (**RNG**). Near larch plantation on the hill, 11 July 1936, N. D. Simpson (**BM**). TQ2054.

V.C. 18/19. ESSEX

Appeared in sainfoin crop, "common mess ?" Hasler and Clapham, Essex, undated, no collector (**K**). Further details not traced.

V.C. 18. SOUTH ESSEX

Ongar, roadside north of Moreton, 2 July 1932, A. H. Carter (**BM**). TL5306.

V.C. 19. NORTH ESSEX

Great Dunmow, in sainfoin, undated, A. R. Clapham (**K**). TL6221.

Hadstock, side of field near, 19 June 1926, H. Gilbert-Carter (**CGE**). TL5544.

V.C. 20. HERTFORDSHIRE

Asbury, May 1904, G. C. Druce, Dr Ashby and D. P. Stanfield (**OXF**). Not traced.

Haley Hill, near, July 1909, G. C. Druce and A. Trower (**OXF**). TL3728

Odsey, June 1849, A. M. Barnard (**BM**, **CGE**, **K**). TL2938.

V.C. 21. MIDDLESEX

Acton, c. 1900–1910, A. Loydell (**SLBI**). TQ2080.

Birchfield, Southall, May 1903, A. B. Jackson (**OXF**). TQ1280.

Uxbridge, near, in rough cornfield among rye, etc./in an arable field, July 1898, G. C. Druce (**BIRM**, **BM**, **NMW**, **OXF**, **SLBI**). On waste, 19 September 1907, A. Loydell (**BM**). TQ0584.

Yiewsley, 28 May 1912, J. E. Cooper (**BM**). TQ0680.

V.C. 22. BERKSHIRE

Aston Tirrold, chalky field between Unhill [Druce wrote Unwell] Wood [SU5682] and Blewburton Camp [SU5486], field was fallow following a crop of barley the previous year, July 1888, G. C. Druce (**BIRM**, **OXF**). SU5584.

Moulsford, in an arable field near, undated, G. C. Druce (Druce 1897). SU5983.

Park Place, Henley, on the Upper Chalk in a sainfoin crop, July 1894, G. Stanton and F. Tufnail (**BM**; Druce 1897). SU7782.

Streatley, among seeds near, undated, G. C. Druce (Druce 1897). SU5980.

Upton, near, June and August 1895, July 1896 and 31 May 1898, G. C. Druce (**BEL**, **BM**, **CGE**, **NMW**, **OXF**, **SLBI**). SU5186.

Windsor, near, undated, J. G. Everett (Druce 1918). SU9676.

V.C. 23. OXFORDSHIRE

Barton, in clover field, June 1906, G. C. Druce, Lord Bridport and A. W. Hill (**OXF**). SP5507.

Benson, near, June 1907, W. C. Barton (**BM**). SU6191.

Britwell Salome, June 1901, G. C. Druce (**BM**, **CGE**, **NMW**, **OXF**). SU6793.

Elsfield, 1894, G. C. Druce (**BM**). sown in large quantities with a form of *Bromus commutatus* and flourishing amazingly in spite of the intensive drought in a dry sandy field on the Coralline Oolite, 27 and 30 May 1895, L. V. Lester-Garland (**BEL**, **BIRM**, **BM**, **CGE**, **E**, **K**, **NMW**, **SLBI**; Druce 1897). July 1895, G. C. Druce (**OXF**). SP5410.

Eynsham, July 1915, G. C. Druce (**BRISTM**). June 1916, J. White (**BM**). June 1916, G. C. Druce (**BM**, **NMW**, **OXF**). SP4309.

Fowy, 1889, Anon. (**BM**). Not traced.

Between Goring and Gatehampton, in a clover field, June 1888, G. C. Druce (**OXF**, **RNG** - 1885 date at latter assumed an error). June 1889, G. C. Druce (**BM**). June 1915, F. J. Smith (**OXF**). SU6080.

Henley-on-Thames, among sainfoin, 16 June 1903, E. Armitage (**BM**). SU7682.

Taynton, June 1931, G. C. Druce and J. F. G. Chapple (**OXF**). SP2313.

V.C. 24. BUCKINGHAMSHIRE

Bailey Hill [Bailey Wood], with *B. secalinus* and *B. hordeaceus* in a field with sainfoin between Denham and Denham Marsh, June and July 1898, G. C. Druce (**BM**, **OXF**; Druce 1926). TQ0486.

Lane End, undated, G. C. Druce (Druce 1926). SU8091.

Prestwood, undated, G. C. Druce (Druce 1926). SP8700.

Princes Risborough, July 1895, July 1898, June 1900, August 1900, June 1904, July 1904, June 1913, G. C. Druce (**BM**). In the greatest abundance in a sainfoin field near ..., when I gathered over a hundred specimens in the area of a few yards, July 1898, G. C. Druce (**BM**, **CGE**, **DBN**, **E**, **LTR**, **RNG**). SP8003.

Rush Green, near, 13 June 1905, J. Roffey (**BM**). TQ0285.

West Wycombe, fields above, June 1903 (+1902?). G. C. Druce (**BM**, **E**, **OXF**; Druce 1926). SU8294.

Tring, very fine near, undated (Druce 1926). SP91.

V.C. 25. EAST SUFFOLK

Lowestoft, 'F. Tufnail tells me he saw it rather plentifully near Lowestoft in Suffolk' (Druce 1897). TM59.

Saxmundham, abundant in sainfoin fields near, June 1911, G. C. Druce and C. E. Moss (Druce 1911). TM3863.

Woodbridge, abundant in sainfoin fields near, June 1911, G. C. Druce and C. E. Moss (Druce 1911). TM2649.

V.C. 26. WEST SUFFOLK

Bury St Edmunds, in clover fields near, 27 May 1907, J. Rasor (**K**). TL8564.

Elmswell, clover field beside the railway, May 1908, J. Rasor (**BM, OXF**). TL9964.

Great Walsingham, roadside, 28 May 1916 and 4 June 1916, G. C. Brown (**BM, CGE, LIV, LTR, NMW, OXF**). TL9043.

Hadleigh, abundant in sainfoin fields near, June 1911, G. C. Druce and C. E. Moss (**BEL, NMW, OXF, SLBI**; Druce 1911). TM0242.

Lakenheath, 6 June 1928, T. J. Foggitt (**BM**). TL7182.

Mildenhall, roadside, 12 or 26 June 1916, W. C. Barton (**BM, K, NWH, OXF**). Roadside, 12 June 1916, C. E. Britton (**CGE, K, NMW**). 1957, E. Q. Bitton (Simpson 1982). TL6974.

Risby/Risby Pools Heath, field near, 7 June 1908, H. and J. Groves (**BM**). 8 July 1928, R. W. Butcher (**CGE**). TL7966.

Tuddenham, 'This must be pretty plentiful about Tuddenham for Cross first sent me a few heads and at my request had no difficulty in twice sending me large roots of it. S. H. Bickham' 20 June 1900, W. J. Cross (**NWH**). 3 July 1900, W. J. Cross (**CGE**). Sandy waste, 26 June 1901, W. J. Cross (**CGE**). In fallow S.E. of, 6 June 1933, J. E. Lousley (**RNG**). TL7371.

V.C. 27. EAST NORFOLK

Great Yarmouth, undated but pre-1905, F. Townsend (**SLBI**). TG5207.

Sprowston, 12 June 1882, E. F. Linton (**LIV**). TG2511.

V.C. 28. WEST NORFOLK

Anmer, sainfoin field, 16 June 1946, E. L. Swann (**L**). In sainfoin fields, scattered plants, 4 August 1946, C. E. Hubbard (**K**). TF7429.

Great Massingham, sainfoin field near, 1 July 1946, R. P. Libbey (**LTR**). TF7922.

Rockland All Saints, sainfoin field, 20 May 1916, F. W. Robinson (**BM**). Sainfoin field, in abundance, 25 May 1916, F. W. Robinson (**BM, K, NMW, OXF**). TL9996.

Thetford, chalky field side, 24 June 1882, E. F. Linton (**BM, SLBI**; Nicholson 1914). TL8586.

West Newton, in field of sainfoin, 25 May 1946, E. L. Swann (**K, LTR**; Petch & Swann 1968). TF7027.

Watton, 12 July 1915, F. W. Robinson (**LIV**); possibly unreliable as Robinson often confused herbarium labels; this is where Robinson lived and may not be where the plant was found. TF9200.

V.C. 29. CAMBRIDGESHIRE

Cambridge, 18 June 1857, C. C. Babington (**CGE**). TL4458.

Carlton Grange, sainfoin field, June 1932, T. G. Tutin (**CGE, LTR**). TL6453.

Dullingham, field near Dullingham Station, May 1904, E. J. Allard (**K**). Sainfoin and clover fields ... in quantity and growing with *B. mollis*, *B. sterilis* and *B. commutatus*, 29 May 1904/in sainfoin fields, very abundant and quite distinct, even at a distance, June and July 1904 and 2 July 1904, A. J. Hosking (**BEL, BM, BRISTM, CGE, DBN, E, K, LTR, NMW, SLBI**). TL6257.

Abington. Between Hildersham and Abington, Lucerne field, 6 June 1953, R. E. Parker (**BEL**). Little Abington, arable field near, 8 June 1953, R. E. Parker (**BM, CGE, E, K, LTR, NMW, RNG**). Meadow by field near Great Abington, 15 June 1953, P. D. Sell (**CGE, LTR**). Cornfield, chalk soil, 18 June 1957, C. C. Townsend (**K**). TL5349.

Pampisford, field S.W. of Brent Ditch, 11 June 1943, W. H. Mills (**CGE**). Abundant in a sainfoin field in the SW angle of the crossing of the disused old railway and the Granta, about one third of a mile north of Pampisford Station. (The farmer, who distinguished between it, *B. commutatus* and *B. sterilis*, keeps his own sainfoin seed and complains he cannot get rid of the

weeds. It doubtless occurs each year in his sainfoin). 1952, J. E. Raven (card index). Bourn Bridge, Pampisford, 17 July 1952, D. E. Coombe. Near Pampisford, 23 May 1953, J. E. Lousley (**LTR, RNG**). An agriculturally poor semi-permanent ley grassland with much *Bromus mollis*. *B. interruptus* was scattered over about 100 yards towards the middle of the field; several hundred plants were noticed. There was also one very luxurious plant in the rough field (abandoned arable?) immediately next to the A11, 14 June 1962, F. H. Perring, S. M. Walters, C. T. Prime and J. G. Faulkner (**CGE**). Abundant in hay fields, Pampisford/persistent in the sown fields near Pampisford, 22 June 1962, J. E. Lousley (**BM, CGE, K, RNG, SLBI**). On a post and wire fence line in field of old pasture, 25 June 1963, P. J. O. Faulkner (**CGE**). Some 25 seeds collected from beside a fence in a cut hay field where a number of plants were growing, together with *B. hordeaceus* and *B. commutatus*, 23 July 1963, P. M. Smith. Some 62 spikes this year, 28 June 1966, F. H. Perring and S. R. Payne. Sainfoin crop, immediately south of W.-E. track, on east a field of broad beans and on west a field of Hop Trefoil. I saw five plants altogether scattered over the field, each plant with many stems. One of the plants is very conspicuous as it grows right by the east side of another track way crossing the field of sainfoin diagonally from N.W. to S.E., June 1968, J. R. Palmer. Only two plants in each plot where turf had been removed, 20 June 1968, F. H. Perring. (A 1971 record attributed to R. J. Pankhurst was of a report of failure to find it; pers. comm., 2001). Present, August 1972, C. Shaw and D. A. Wells (Cambridgeshire Wildlife Trust files, pers. comm. N. Millar 2001; English Nature files). (Unattributed sources are pers. comm. G. Crompton 2001). TL5047 to TL5149.

V.C. 30. BEDFORDSHIRE

Listed by Druce (1904a, 1932). No source traced.

V.C. 32. NORTHAMPTONSHIRE

Coppice Moor, September 1907 (1901?), G. C. Druce (**OXF**; Druce 1930). SP74? Precise location of Coppice Moor unknown.

Moor End, July 1908, G. C. Druce (**BM**). SP7544.

Rainsborough [Rainham Camp], 1 June 1907, J. Cryer (**E**). In a field at Rainham Camp, 6 June 1907, H. J. Riddelsdell (**BIRM, BM, CGE**). Clover field by Rainsborough Camp, 6 June 1907, H. N. Dixon (**BM**). SP5234.

Between Morehay and Walton, near Peterborough, in a field of sainfoin on the cornbrash, 1910, G. C. Druce (**OXF**; Druce 1930). TF1702.

V.C. 33. EAST GLOUCESTERSHIRE

Cirencester, undated, W. J. H. Greenwood (Riddelsdell *et al.* 1948). SP0202.

Cold Aston, in a field, cultivated subsequently, 1915, C. I. Sandwith (**OXF**). Sainfoin field near, 12 June 1918, C. I. Sandwith (**BM, L**; Riddelsdell *et al.* 1948). SP1219.

Northleach, undated, G. C. Druce (Riddelsdell *et al.* 1948). SP1114.

Rendcombe, 18 June 1920, W. J. H. Greenwood (**BM**; Riddelsdell *et al.* 1948). SP0209.

V.C. 34. WEST GLOUCESTERSHIRE

Avonmouth Docks, 1930, C. I. and N. Y. Sandwith (Sandwith 1933; Riddelsdell *et al.* 1948). ST5380.

Bristol, 1930, C. I. and N. Y. Sandwith (Sandwith & Sandwith 1931). ST57.

V.C. 37. WORCESTERSHIRE

Malvern Common, one plant by side of road across common, 28 June 1911, R. F. Towndrow (Towndrow 1911). SO7744.

V.C. 53. SOUTH LINCOLNSHIRE

Druce (1897) stated that Mr F. Tufnail has seen specimens from Lincolnshire, and later cited it as v.c. 53 (Druce 1904a, 1932). No specimens have been traced.

V.C. 63. SOUTH-WEST YORKSHIRE

Dewsbury district, wood waste, 1905, P. F. Lee (**BM**). SE22.

Ossett, manure heap, July 1909, P. F. Lee (**BM**). SE2820.



FIGURE 3. 10-km square distribution of *Bromus interruptus*.

DISTRIBUTION IN EUROPE

The UK Biodiversity Group (1998) stated that it was introduced to the Netherlands and was apparently well-established there. However, there are only two old records in the Rijksherbarium at Leiden (L) and the Dutch do not have any other records (R. van der Meijden, pers. comm., 1998). The details of the two records are:

Ermelo, langs de weg naar de Zuiderzee [clover field], July 1933, Jansen & Kruseman.

Amsterdam, langs de Coenhaven [docks], July 1934, Jansen & Wachter.

Druce (1897) was unable to find any material from the continent, and P. M. Smith has similarly seen no other material (pers. comm., 1999).

LIFE CYCLE

Bromus interruptus in cultivation is a strict winter- or spring-annual. Observations of plants in T.C.G.R.'s garden in Cardiff 1997–2001 show that germination occurs in both spring and autumn, with autumn germinating plants flowering first and producing more inflorescences. Some plants have also been observed germinating in early summer, but tend to be small and flower with only 1–3 spikelets. G. C. Druce cultivated it in his garden (OXF) but oddly described it as a biennial or sub-perennial (Druce 1897).

The main flowering period is from May to July (Table 1). If the weather is suitably warm and damp, further inflorescences may be produced later through to September. Anthers may be exerted or included; Hubbard (1984) notes that as with other annual bromes, pollination may take place in unopened florets if the anthers are enclosed by the lemma and palea at the hairy top of the grain. Abundant seed is set. As the inflorescences ripen they become somewhat top-heavy, and have a tendency to lodge in wind and rain. The spikelets often remain intact rather than dehisce, and plants often occur in small clumps from groups of germinating seeds as a consequence. There is some indication that seeds may be short-lived.

Specimens in cultivation in greenhouses and gardens are susceptible to mildew (D. E. Coombe, pers. comm., 1995, and T.C.G.R., pers. obs.). Material in cultivation in Cardiff in 1999 had a powdery mildew *Erysiphe graminis* DC. (det. A. Orange; NMW). Specimens may also be susceptible to aphid infestation in cultivation; aphids collected on plants cultivated in Cardiff were determined by J. Martin in 1998 as *Sitobion fragariae* (Walker), a generalist species of grasses.

ECOLOGY

The historical records have been analysed to try to characterise its habitat more precisely (Table 2). These indicate that the main habitat was fields, of which it was most frequently found in sainfoin. However, it also occurred in a range of other habitats. It often appeared in abundance and was relatively persistent in its localities, dependent on the nature of crops (e.g. Druce 1889). According to notes in J. E. Raven's card index about the site near Pampisford, Cambridgeshire 'the farmer, who keeps his own sainfoin seed ... complains he cannot get rid of the weeds. It doubtless occurs each year in his sainfoin'. It seems to have been distributed in sainfoin crops (e.g. Perring 1962) and it was found as an impurity in sainfoin seed by the Seed Testing Station (CGE), but its seeds are not specifically adapted for dispersal as a sainfoin mimic (Smith 1980). It may have been most frequent in sainfoin and clover due to the rotation length of the crops which suited its life cycle.

Smith (1980) noted that its distribution was largely one of a calcicole, which is based on the predominance of records from chalk and limestone areas. It also grows readily in more neutral soils (pers. obs.), and was recorded from sandy soils and clays. Druce (1932) gave its altitudinal range as 30–215 m and it has also been recorded near to sea level at Avonmouth Docks (Sandwith 1933).

Other than crop plants, there are only a few records of *B. commutatus* Schrad., *B. hordeaceus* L. and *Anisantha sterilis* (L.) Nevski specifically noted as occurring with it (e.g. Druce 1897; Perring 1962 and notes on herbarium specimens). D. E. Coombe also noted it with *Cirsium arvense* (L.) Scop. and *Sanguisorba minor* Scop. subsp. *muricata* (Grelli) Briq. near Abington (Perring 1962).

TABLE 1. NUMBER OF RECORDS FOR EACH MONTH FOR
BROMUS INTERRUPTUS IN ENGLAND

Month	Number of records (%)
May	21 (15%)
June	82 (60%)
July	30 (22%)
August	3 (2%)
September	2 (1%)

TABLE 2. NUMBER OF RECORDS FOR EACH HABITAT FOR *BROMUS INTERRUPTUS* IN ENGLAND

Habitat	Number of records
Fields - all records	55
(sainfoin)	24)
(clover)	8)
(hay/pasture)	8)
(fallow)	6)
(arable - corn etc.)	5)
(unspecified)	9)
Roadsides	4
Chalk or gravel pit	2
Waste ground/waste	6
Other (wall/riverbank/docks/manure heap)	4
Not noted	35
Total	106

Repeated records from the same habitat and site are not included.

DISCUSSION

We have traced 169 records, indicating it has been recorded from at least 106 sites in 73 hectads in v.cc. 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 37, 53 and 63. The records are mapped in Fig. 3.

Plants should be looked for on disturbed edges of fields and roadsides between May and July. As sainfoin is rarely grown these days, any such field should be checked carefully. Searches should not be restricted to the 1 km squares we have indicated, as these are simply to help locate records. The only sites probably not worth checking are those around Pampisford in Cambridgeshire where it was last seen; these have been searched on many occasions up to 1987 by G. Crompton and J. Green (pers. comm., 2001). Its clustered heads are distinctive, and C. E. Palmer noted they 'towered above all other grasses' (c.f. above). T.C.G.R. will be happy to check identification of any specimens.

Given its association with clover and sainfoin fields and a decline matching that of a number of other casuals, the pattern is more indicative of an alien than a native species. However, Druce (1897) noted it did not occur with other casuals in sainfoin fields, and it has not been found elsewhere in the world (cf. above), and must therefore be accepted as an endemic.

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***Valerianella eriocarpa* Desv. in Dorset, and a reassessment of its status as a presumed introduction in Britain**

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ABSTRACT

Valerianella eriocarpa has usually been considered an introduction in Britain. Although long known from one semi-natural site on the Dorset (v.c. 9) coast, recent fieldwork has disclosed many new similar sites in Dorset, and also in the Isle of Wight (v.c. 10), all on limestone or hard chalk. In these sites *V. eriocarpa* is part of the annual, early-flowering cliff-verge communities and it is concluded that it is probably a native species there.

KEYWORDS: Hairy-fruited Cornsalad, rare species, distribution, maritime species, persistence.

INTRODUCTION

Valerianella is a genus comprising about 50 species of annual plants. Europe has about 22 species, all found in disturbed ground or in dry open habitats, many of them principally as weeds of cultivated ground. *V. eriocarpa*, like most of the species, is an early-flowering annual, probably a winter annual, and is part of a relatively ill-defined complex of species with *V. microcarpa* and, in some authorities, *V. muricata*. Neither of these occur in Britain, where *V. eriocarpa*, *V. dentata*, *V. rimosa*, *V. carinata* and *V. locusta* are the only species recorded. *V. dentata* and *V. rimosa* are almost confined to arable fields, whereas the last two are widespread weeds of many habitats.

V. eriocarpa is found around the Mediterranean from Turkey to Spain, and in North Africa. In *Flora Europaea* (Tutin *et al.* 1976) the section on *Valerianella* is prefaced by “it is impossible to determine the northern limit of many species ...”. The national floras describe the habitat as “dry and arid places” (Coste 1937) and “infesting the cultivation of cereals”, uncultivated land and garigue (Pignatti 1982). There is no evidence here of anything other than a species which likes open ground.

In some of the late Victorian floras *V. eriocarpa* was listed as a variety of *V. dentata* (var. *mixta*), or confused with that variety, but since then all British national and regional floras have treated it as a separate species and as an alien, except Stace (1999), who may have been influenced by the account in Wigginton (1999). The only other contrary view was that of the Rev. E. S. Marshall who wrote (Marshall 1908), that it “may be truly wild in the Portland station being a native of West France”.

The purpose of this article is to show that recent research into the habitat of *V. eriocarpa* in Dorset produces evidence which indicates a need to reassess its status in Britain. *V. eriocarpa* has traditionally been described in Britain as a plant of waste places, or as an arable weed, despite the fact that almost the earliest record and the most long-standing site is from the limestone scree of Church Ope Cove, on Portland, in Dorset (v.c. 9). Although it has been recorded from other parts

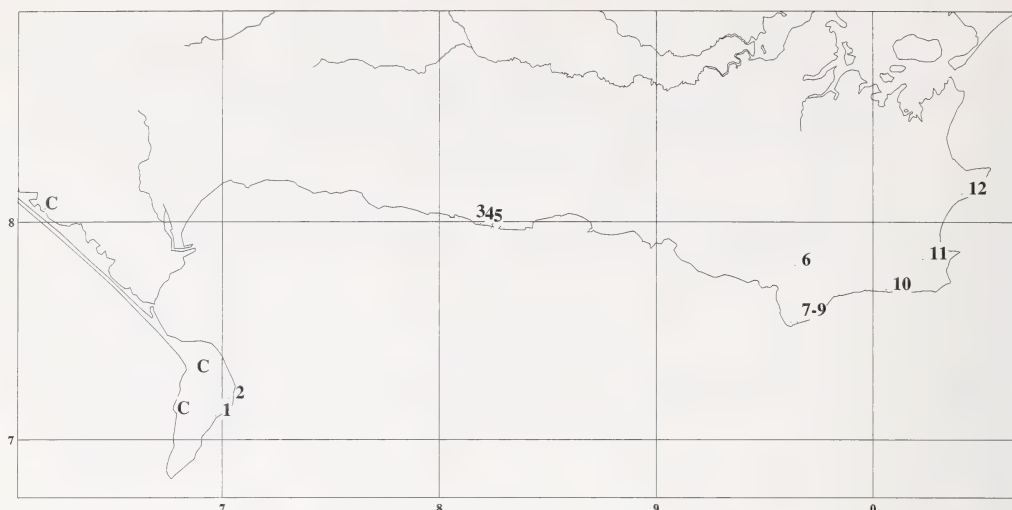


FIGURE 1. Distribution of *Valerianella eriocarpa* along the Dorset coast. The numbers refer to the sites referred to in Descriptions of the Dorset sites. C = casual records.

of Dorset in the last hundred years, it was not until detailed coastal survey work was undertaken in the last few years that we, with colleagues, began to find colonies in relatively similar situations all along the coast of central and east Dorset. Twelve seemingly natural sites are now known along the 50 km of coast from Portland to Ballard Down, north of Swanage (Figure 1). Some 30 km of that coast is seemingly unsuitable, comprising calcareous clays, soft chalk or urban development, but the twelve sites are scattered over the remaining stretches of limestone and hard chalk. *V. eriocarpa* is found typically in a summer-parched community on the edges of cliffs, or on rocky slopes facing the sea. There are a great number of plants over a wide area at Church Ope Cove, but relatively small areas of large numbers of plants at the other sites, which are widely separated from one another.

HISTORY OF THE DORSET SITES

Valerianella eriocarpa was first recorded in Dorset in 1874, when J. C. Mansel-Pleydell collected it from the churchyard wall in Church Ope Cove (Mansel-Pleydell 1895).

Table 1 gives the subsequent history; some of the repetitive collections for the Church Ope area have been omitted, but all other Dorset records are included.

The Portland site at the Lighthouse has not been refound. It is not known whether the 1955 and 1960 sites in the Fleet are the same as the 1993 site, which is on the roof of a wartime blockhouse and has been treated here as a casual, as is the site at Blacknor, Portland, refound in 2000.

HABITATS

Quadrats (2m × 2m, or in places 4m × 1m) were recorded for all of the known Dorset sites that were considered native during April, May and June 1999. Quadrats were selected at random but to include as much short vegetation as possible, but most of the sites are so small that selection was an automatic exercise.

In Dorset *V. eriocarpa* occurs in open vegetation on thin calcareous soils overlying Jurassic (Portland and Purbeck) limestones, or more rarely Upper cretaceous. The majority of sites occur in either open calcareous grassland or parched maritime grassland. Communities are assigned here to NVC communities (Rodwell 1992, 2000).

TABLE 1. HISTORY OF VALERIANELLA ERIOCARPA IN DORSET

Date	Location	Recorder	Source
1874	Church Ope – churchyard wall	J.C. Mansel-Pleydell	Mansel-Pleydell (1895)
1878 and later	Rather frequent in cultivated ground between the Prison and Church Ope		Bowles Barrett (1912)
1881	Blacknor (west coast of Portland)		Bowles Barrett (1912)
1883	Cliffs 200 yards south of Portland Prison		Hb. Bowles Barrett
1885	West Portland, cornfields	J. W. White	BRIST
1908	By the lighthouse, Portland	H. J. Riddlesdell	Druce (1908)
1924	Church Ope	A. W. Graveson	BDK
1928	Church Ope	J. E. Lousley	RNG
1935	Lulworth (exact site not known)	L. B. Hall	BM
1951	The Grove (Portland Prison)	W. A. Cocks	Hb. W. A. Cocks
1955	The Fleet (site not known)	W. A. Cocks	Hb. W. A. Cocks
1960	The Fleet (site not known)	R. D. Good	Good (1961)
1983	St Aldhelm's Head	A. J. Byfield	Field record at D.E.R.C.
1993	Shepherd's Dinner, Portland	R. FitzGerald	Field record at D.E.R.C.
1993	West of Moonfleet Hotel, Fleet	S. M. Eden	Field record at D.E.R.C.
1996	Dungy Head, west of Lulworth	H. J. M. Bowen	Field record at D.E.R.C.
1997	Portland Heights	B.S.B.I. AGM	Field record at D.E.R.C.
1997	Hill Bottom, Worth Matravers	B. Edwards	Field record at D.E.R.C.
1997	Emmett's Hill	B. Edwards	Field record at D.E.R.C.
1997	Above Blacker's Hole, west of Durlston	B. Edwards & D. Pearman	Field record at D.E.R.C.
1997	Townsend, Swanage	B. Edwards	Field record at D.E.R.C.
1998	Lulworth Cove	D. Pearman	Field record at D.E.R.C.
1998	Ballard Down	E. A. Pratt	Field record at D.E.R.C.
2000	Blacknor, Portland	H. J. M. Bowen	Field record at D.E.R.C.

i). Calcareous grassland. (Table 2)

The sites at Blacker's Hole, Ballard Down and Hill Bottom are all in short, open *Brachypodium pinnatum* dominated grasslands, referable to the *Avenula pratensis*-*Thymus praecox* sub-community of the *Brachypodium pinnatum* grassland, CG4a. The sward also supports *Festuca ovina*, *F. rubra*, *Dactylis glomerata* and *Koeleria macrantha*. Herbs include typical calcicoles such as *Sanguisorba minor*, *Thymus polytrichus* and *Pilosella officinarum*. Within these grasslands *V. eriocarpa* occupies pockets of bare soil along with other small annuals including *Aphanes arvensis*, *Erophila verna*, *Ranunculus parviflorus* and *Veronica arvensis*. At Townsend it is found in a rather different community on the south-facing slope of an old spoil heap. The grassland here is referable to the *Koeleria macrantha* sub-community of the *Festuca ovina*-*Hieracium pilosella*-*Thymus* spp. grassland CG7a. *Festuca ovina* dominates the sward, with *Koeleria macrantha* locally prominent. *V. eriocarpa* again exploits pockets of bare soil, along with other annuals including *Arenaria serpyllifolia*, *Erophila verna* and the nationally scarce *Cerastium pumilum*.

ii). Maritime grassland. (Table 2)

The sites at Shepherd's Dinner, Dungy Head, Stair Hole, Lulworth Cove and St Aldhelm's Head are all within open maritime grassland on cliff edges. Two main communities are involved. The first is the *Arenaria serpyllifolia* sub-community of *Armeria maritima*-*Cerastium diffusum* maritime therophyte community, MC5d. Here *Festuca rubra* and *Dactylis glomerata* form scattered clumps in an open sward. The small annual grasses *Catapodium maritimum* and *Bromus hordeaceus* ssp. *feronii* are locally abundant on bare soil. Herbs include rosette-forming perennials such as *Daucus carota*, *Plantago coronopus*, *P. lanceolata* and *Salvia verbenaca*, plus *Sedum acre* and *S. album*, which are particularly prominent in the Lulworth sites. Bare soil is exploited by annuals, particularly *Arenaria serpyllifolia*, *Cerastium diffusum* and *V. eriocarpa*. At Shepherd's Dinner, on the east side of Portland, *V. eriocarpa* is found in similar very open vegetation on the cliff top. This vegetation supports frequent *Daucus carota*, and is probably referable to the *Bromus hordeaceus* ssp. *feronii* sub-community of the *Festuca rubra*-*Daucus carota* grassland, MC11a.

TABLE 2. PLANT COMMUNITIES SUPPORTING *VALERIANELLA ERIOCARPA* IN DORSET

Species	Calcareous grassland	Maritime grassland	Other
<i>Valerianella eriocarpa</i>	V	V	V
<i>Plantago lanceolata</i>	V	V	V
<i>Bellis perennis</i>	V	II	IV
<i>Dactylis glomerata</i>	IV	V	V
<i>Galium mollugo</i>	IV	IV	III
<i>Koeleria macrantha</i>	IV	II	III
<i>Medicago lupulina</i>	IV	I	III
<i>Scorpiurium circinatum</i> (moss)	I	I	I
<i>Brachypodium pinnatum</i>	V	II	
<i>Thymus polytrichus</i>	V	I	
<i>Festuca rubra</i>		V	III
<i>Ranunculus bulbosus</i>	IV		III
<i>Daucus carota</i>		IV	III
<i>Erophila verna</i>	III		III
<i>Hippocrepis comosa</i>	III	II	
<i>Leontodon saxatilis</i>	II		III
<i>Aphanes arvensis</i>	II		IV
<i>Taraxacum</i> agg.		II	III
<i>Arenaria serpyllifolia</i>	I	IV	
<i>Festuca ovina</i>	V		
<i>Sanguisorba minor</i>	V		
<i>Veronica arvensis</i>	IV		
<i>Lotus corniculatus</i>	III		
<i>Sonchus oleraceus</i>	II		
<i>Ranunculus parviflorus</i>	II		
<i>Carex flacca</i>	II		
<i>Senecio jacobaea</i>	II		
<i>Catapodium rigidum</i>	II		
<i>Briza media</i>	II		
<i>Helictotrichon pratense</i>	II		
<i>Cerastium fontanum</i>	II		
<i>Bromus hordeaceus</i> subsp. <i>ferronii</i>		V	
<i>Catapodium maritimum</i>		V	
<i>Sedum album</i>		III	
<i>Beta vulgaris</i> subsp. <i>maritima</i>		II	
<i>Sedum acre</i>		II	
<i>Collema tenax</i> (lichen)		II	
<i>Armeria maritima</i>		II	
<i>Cerastium diffusum</i>		II	
<i>Plantago coronopus</i>		II	
<i>Ononis repens</i>		II	
<i>Salvia verbenaca</i>		II	
<i>Cochlearia danica</i>		II	
<i>Euphorbia portlandica</i>		II	
<i>Sonchus oleraceus</i>		II	
<i>Linum bienne</i>		II	
<i>Teucrium scorodonia</i>		II	
<i>Echium vulgare</i>		II	
<i>Rumex acetosa</i>			IV
<i>Sonchus oleraceus</i>			IV
<i>Trifolium scabrum</i>			IV
<i>Pilosella officinarum</i>			III
<i>Geranium rotundifolium</i>			III
<i>Myosotis ramosissima</i>			III
<i>Torilis nodosa</i>			III
<i>Achillea millefolium</i>			III

iii). Other communities. (Table 2)

Four quadrats were taken in habitats which are not easily referable to any described NVC community. At Church Ope Cove two quadrats were taken in very open habitat next to the steps down to the cove and on old spoil heaps. This vegetation supports many annuals, alongside *V. eriocarpa*, which are characteristic of the communities described above. These include *Erophila verna*, *Trifolium scabrum*, *Aphanes arvensis*, *Erodium cicutarium* and *Saxifraga tridactylites*. There are also ruderal species present such as *Dactylis glomerata*, *Poa annua*, *P. trivialis*, *Smyrnium olusatrum*, *Cardamine hirsuta* and *Geranium rotundifolium*. However, it must be stressed that this pioneer vegetation has developed on old spoil heaps which are subject to summer parching, and receive a lot of recreational pressure. One quadrat was taken at Emmett's Hill, and one to the east of St Aldhelm's Head, where *V. eriocarpa* is found in rather atypical, but species-rich, vegetation. It occurs in pockets of bare soil along with annuals such as *Erophila verna*, *Arenaria serpyllifolia*, *Aphanes arvensis*, *Sherardia arvensis* and *Veronica arvensis*. Other species typical of somewhat parched grassland also occur including *Stellaria pallida*, *Trifolium scabrum*, *T. subterraneum* and *Sedum acre*. The surrounding turf is closed and dominated by *Festuca rubra*. The vegetation here has elements of calcareous, maritime and mesotrophic grasslands.

All the sites surveyed share the following important factors:

- they support open communities with pockets of bare soil.
- they are subjected to summer parching.
- they support many early flowering annual species.

DESCRIPTIONS OF THE DORSET SITES

A short description of each site is included here to complement the habitat data. As with all annuals, numbers fluctuate widely from year to year. The full details of the quadrats are available at Dorset Environmental Records Centre.

1. Church Ope Cove, Portland, SY697711

Quadrats 11 and 12 03/04/1999 No NVC community 1000–5000 plants
This cove lies below the summit plateau on the east side of Portland. Rufus Castle and a group of 17th century houses, including Portland Museum, overlook the cove, and stand on unquarried Portland Stone. The ruined parish church of Portland lies adjacent to the south on unquarried but slumped limestone and clays. There are no other sheer cliffs surrounding the cove, as there are to the north and south, but all the rest of the area is a mixture of quarry spoil, with steps and walls as further evidence of human influence. *V. eriocarpa* is frequent over much of the site seawards of the steps down, but there is much low scrub of *Hedera helix*, *Rubus fruticosus* and *Ligustrum vulgare* which limits bare ground to areas around the paths, the south side of low spoil heaps and by the sea. Quarrying ceased here around 1920. Many other annuals occur here, including one of Dorset's few remaining sites for *V. dentata*.

2. Shepherd's Dinner, Portland, SY703719

Quadrat 10 03/04/1999 NVC MC 11a 100–500 plants
This site is on broken rocks and scree just below the summit plateau at the top of sheer cliffs. The site is open and exposed, and little different from the areas in the intervening 800 m or so from Church Ope Cove to the south, but no other colonies have been found.

3. Dungy Head, W of Lulworth Cove, SY819799

Quadrat 7 03/04/1999 NVC MC 5d >1000 plants
A large colony on the very edge of a limestone cliff, the nearest hard rock to Portland, 18 km to the south west. Landward of the site is a large area of *Brachypodium pinnatum* grassland (possibly overlaying Kimmeridge clays), leading to steep chalk downland. No grazing takes place, and bare patches only exist on the very edge of the cliffs. A very minor footpath is behind the site, which only covers about 4 m².

Quadrat 6 03/04/1999 NVC MC 5d 500–1000 plants
A series of small colonies to the west of Stair Hole, in the same setting as the previous site. Much of the area is rather long ungrazed *Brachypodium pinnatum*, but *V. eriocarpa* occurs in many of the areas which are kept open by exposure or by rabbits. A minor track leads to the site.

Quadrat 5 03/04/1999 NVC MC 5d <500 plants
A small patch almost at the mouth of the cove, on the seaward side of a track with the sea to the south and a slope to the cove to the north. There is much suitable habitat here, but no other *V. eriocarpa* was seen.

Quadrat 2 18/04/1999 NVC CG 4a 15 and 200 plants
Two patches in bare places in a large expanse of limestone grassland on a steep southeast facing slope. The site is distant from any footpath, but below flat fields which are now *Lolium* leys. This site is just over 1 km from the sea (and the only one out of sight of it).

Quadrat 14 18/04/1999 No NVC community <50 plants
A few plants in several patches on a south-facing slope in closed limestone turf well above a
footpath, and well below arable fields above the site to the north. The site is almost 500 m east of
the sea.

Quadrats 8 and 9 18/04/1999 NVC MC 5d >5000 plants
Scattered colonies on spoil heaps on the floor of a small quarry just below the cliff-top plateau and
on the stony, bare cliff-edge beyond. The whole site here is very bare and open.

Quadrat 13 18/04/1999 No NVC community >2000 plants
An atypical site, with many (at least 20 patches) plants of *V. eriocarpa* in a fairly open, calcareous permanent grassland, sloping down to the cliff path. *Cirsium acaule* and *Sanguisorba minor* are frequent here, but so are *Medicago polymorpha* and *Stellaria pallida*. Just to the east of this sward was a small quarry scrape, now infilled, where *V. eriocarpa* was frequent. Above this field, and separated from it by a small broken wall, is extensive arable, with *Adonis annua* and *Petroselinum segetum*, but no *Valerianella*.

Quadrat 1 26/04/1999 NVC CG 4a >1000 plants
At least ten patches on steep rocky slopes, just below the wall on the edge of summit plateau, and above the slumped ground leading down to the low cliffs. The colonies are spread over 500 m, with a very few plants (E. Pratt, pers. comm.) also on the north side of the wall, in flat fields that were formerly arable. A footpath runs just above these steep slopes which, although they support annuals such as *Torilis nodosa* and *Gentianella anglica*, are very herb-rich indeed, with plants such as *Ophrys sphegodes*, *Polygala calcarea* and *Salvia verbenaca*.

Quadrat 4 18/04/1999 NVC CG 7a 1000–2000 plants
Townsend is a grassland site which has developed over old limestone quarry workings. Although there is plenty of suitable open short habitat, *V. eriocarpa* occurs in one species-rich site only. The whole area is open to public access, is horse-grazed and heavily used.

Quadrat 3 25/05/1999 NVC CG 4a <50 plants
This is the only site in Dorset on the Chalk, but the rock here is the Lower Chalk, and is very hard.
There are two small patches at the bottom of a slope in a large area of unimproved grassland.
Arable fields lie below.

HISTORY OF THE OTHER BRITISH SITES

V. eriocarpa has been recorded since the mid 19th century in Britain, the first record being either from Dovedale, Derbys. (Watson 1837) or from "the side of the road between New Pool and the Hanley Turnpike Gate below Malvern Wells, Worcs." (Lees 1843). Amphlett and Rea (1909) say that "this first (Worcs.) record should be treated with caution; more probably it is in its right position under *V. dentata*, var b. *mixta*". We have our doubts over the Derbyshire record too.

Since that date it has been recorded in at least 27 vice-counties, but all have been only ephemeral, other than the Cornish and Isle of Wight sites described below. Of the fifty or so non-Dorset records traced, just over 60% are pre-1950 and only six post-1970. There is a current impression in Britain, perpetuated by the first author (in Wigginton, 1999) that the former ephemeral sites were principally arable. This is completely erroneous. Approximately 75% of those sites, where details are given, comprised waste ground, quarries and gardens. Some of the records are not supported by herbarium specimens and may be misidentifications, especially for *V. dentata*. Bowles Barrett (1912) describes sites for *V. eriocarpa* on Portland, including cultivated ground, but does not mention cornfields, whereas he describes *V. rimosa* and *V. dentata* as "not infrequent ... in cornfields".

The Cornish sites deserve more attention. There have been a number of casual sites (many listed in Davey (1909)), but two areas with a longer history: at Phillack, near Hayle, where it has been known since 1927, and in the Constantine-Harlyn area near Padstow, where it was known from 1965 to at least 1989. FitzGerald (1990) writes that "in Cornwall it utilises a more man-influenced (than at the Dorset sites) but ecologically similar niche, growing in small open earth pockets and ledges on stone hedges. A site near Phillack surveyed in 1989 showed that these hedge plants can seed down into arable ground below, but do maintain a seedbank out of the way of intensive management up on the refugia of the hedge".

Even more interesting are these sites on the Isle of Wight:

1. Culver Cliff SZ6285. Discovered 1985, although rumoured that it was found in 1971, *V. eriocarpa* is still present in two small areas of calcareous clifftop grassland, particularly in turf heavily grazed by rabbits. Populations are up to 1000–2000 plants in good years, and frequent associates are *Bromus hordeaceus*, *Cerastium pumilum*, *Erodium cicutarium*, *Plantago coronopus*, *Poa bulbosa*, *Ranunculus parviflorus* and *Sherardia arvensis*.
2. Afton Down SZ3685. Discovered in 1999, on an anthill between the road and the cliff edge, with *Bromus hordeaceus*, *Carex flacca*, *Daucus carota* and *Plantago lanceolata*.
3. Carisbrooke Castle SZ4887. Recorded here from 1912 to 1931, and rediscovered in 2000, on a steep south-east facing chalk bank on bare terracettes produced by sheep grazing. Associates here include *Arenaria serpyllifolia*, *Catapodium rigidum*, *Festuca ovina* and *Rhinanthus minor*.

DISCUSSION

The Dorset sites, apart from that in the Fleet, are all on limestone or the Upper Chalk. The only other limestone on the southern English coast is around Torbay, where we have made a specific and unsuccessful search. Other limestones in southern Britain occur at Brean Down in Somerset and in the Gower: perhaps these should be investigated too.

V. eriocarpa occurs in communities in Dorset that are almost entirely comprised of natives. It does often occur by paths, but we suggest that this is because paths supply the short vegetation and open ground needed for low annuals, rather than solely being a vehicle for dispersal of seeds. It looks native in these Dorset sites and, though it is patchily distributed, and is absent from many suitable stretches of coast, it is no more disjunct than many of its associated rare species such as *Cerastium pumilum*, *Medicago polymorpha*, *Stellaria pallida* and *Trifolium scabrum*. The only alien that occurred in any quadrat was *Centranthus ruber*, although if a non-British botanist were visiting Dorset for the first time he or she might well consider that that species looked native too!

Many of the associates or near neighbours of *V. eriocarpa* fall into the Mediterranean-Atlantic floristic element (Preston & Hill 1997). These include *Beta vulgaris*, *Catapodium maritimum*, *Crithmum maritimum*, *Inula crithmoides*, *Linum bienne*, *Parapholis incurva*, *Polypodium cambricum* and *Rubia peregrina*. Indeed, Fig. 29 in Preston & Hill's paper shows that Portland has one of the larger concentrations of species in this element in Britain.

There is an interesting further point to be made here. Among the other Mediterranean-Atlantic species found along the Dorset coast are *Oenanthe pimpinelloides*, very frequent on the clays, *Gaudinia fragilis*, also frequent on some of the coastal clays, and whose status as a British native is being re-examined (Leach & Pearman in prep.), and *Gastridium ventricosum*. This last is another species that was thought, for many years, to be an arable colonist, and county Floras hardly made mention of the sites that we now call native: that is, open habitats on calcareous rocks or clays (Trist 1986). Now that this native habitat is known, it has been discovered at many sites in Somerset, and at least six along the Dorset coast. One of these is very near the *Valerianella* site on the Fleet, two are on the calcareous clays east of Weymouth, one on the limestone of Durlston and one on Ballard Down, the last two adjacent to *Valerianella* sites. The presence of all these Mediterranean-Atlantic species, as natives or presumed natives, seems relevant.

The Dorset coast is well known for the occurrence of Mediterranean species. Bowen (2000) postulates that up to 16 vascular plant species, none of them maritime, are restricted to the coastal fringe, and that most of these are plants which are more at home in southern Europe. Portland in particular, and the Dorset limestone coast in general, has a very distinguished collection of Mediterranean thermophiles which also include:

Mediterranean-Atlantic bryophytes (from Hill & Preston 1998)

<i>Bryum canariense</i>	<i>Bryum torquescens</i>	<i>Cephaloziella baumgartneri</i>
<i>Eurhynchium meridionale</i>	<i>Gymnostomum viridulum</i>	<i>Leiocolea turbinata</i>
<i>Microbryum rectum</i>	<i>Scleropodium tourettii</i>	<i>Scorpiurum circinnatum</i>
<i>Southbya nigrella</i>	<i>Tortella nitida</i>	<i>Tortula marginata</i>
<i>Tortula viridifolia</i>		

Lepidoptera (from Emmet & Heath 1991)

- Cynaeda dentalis* ([D. & S.]) (a pyralid moth)
- Leucochlaeana oditis* (Hb.) (Beautiful Gothic)
- Idaea degeneraria* (Hb.) (Portland Ribbon Wave)

Some of these are restricted to Dorset; two of the Lepidoptera have old records from Torbay. Most of these species are widespread in southern Europe, and are mostly in a much broader niche there than in England. It may be that species behave differently at the edge of their range; there is no doubt that Portland and the south Dorset coast would be the nearest that this country comes to providing the microhabitats necessary for these Mediterranean species to survive this far north.

CONCLUSION

The habitat information listed above indicates that *V. eriocarpa* is a member of native annual, early-flowering cliff-edge communities in Dorset. The European distribution implies that it is a Mediterranean-Atlantic species, and many of its associates in Dorset are Mediterranean-Atlantic species. Taken together there seems a strong case for deducing native rather than introduced status for these coastal sites in Dorset and, possibly, in the Isle of Wight.

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Parentage of an unknown member of the *Sorbus latifolia* (Lam.) Pers. group (Rosaceae)

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ABSTRACT

Comparative morphology, AFLP fingerprinting and *trnL-F* region sequencing were used to investigate the origin of an unknown member of the *Sorbus latifolia* group with weakly lobed leaves and large fruits, discovered at Naas near the River Severn, Gloucestershire. Samples of the unknown hybrid, the three putative parents *S. aria*, *S. rupicola* and *S. torminalis*, and from *S. × vagensis*, the primary diploid hybrid between *S. aria* and *S. torminalis*, were analysed. Morphological analysis of leaf characters showed that the unknown hybrid fell between *S. aria* and *S. torminalis*. Genetic fingerprints were obtained using AFLP, and two primer combinations gave 109 bands, 84 of which were polymorphic. Both hybrids showed additivity between *S. torminalis* and *S. aria*/*S. rupicola*. *Sorbus torminalis* was one parent of both hybrids. The presence of twelve unique bands in *S. rupicola* (compared to only three bands in *S. aria*) indicate that *S. aria* is probably the other parent in both hybrids. Sequences for the *trnL-F* region of plastid DNA indicate that *S. torminalis* was the female parent of both hybrids. As the two hybrids thus appear to result from hybridisation between the same parents and the hybridisation took place in the same direction, we include the unknown hybrid within *S. × vagensis*.

KEYWORDS: AFLP, *Sorbus aria*, *S. rupicola*, *S. torminalis*, *S. × vagensis*, *trnL-F* region sequencing, Whitebeams.

INTRODUCTION

In the British Isles, the *Sorbus latifolia* (Lam.) Pers. (Broad-leaved Whitebeam) aggregate contains six taxa which are generally thought to have arisen by hybridisation between *S. torminalis* (L.) Crantz (Wild Service-tree) and members of the *S. aria* (L.) Crantz aggregate (Common Whitebeam) (Sell 1989).

On 8 September 1996, M. Kitchen, C. Kitchen and N. J. Wray found an unknown member of the *S. latifolia* group on remote, inaccessible cliffs of the River Severn at Naas in West Gloucester (v.c. 34). About 13 distinct plants, ranging in size from small suckers/saplings to moderate-sized trees, were present in an area of steep, eroding cliff in an area of about 30 m × 10 m, mixed with *S. torminalis*, and about 50 m from *S. rupicola*. The plants were morphologically uniform, and fruiting sparsely. They occurred on Old Red Sandstone rocks above the River Severn, 2–10 m above the mean tide line. This wood is very rich in woody species, and supports *Acer campestre*, *A. pseudoplatanus*, *Corylus avellana*, *Crataegus monogyna*, *Fagus sylvatica*, *Fraxinus excelsior*, *Ilex aquifolium*, *Ligustrum vulgare*, *Prunus domestica*, *P. spinosa*, *Pyrus communis*, *Quercus petraea*, *Q. robur*, *Rosa canina* s.s. and *R. arvensis*, and is W8 *Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* woodland (Rodwell 1991). These plants were probably first found by the late S. H. Bishop in 1982 (**BRISTM**).

As the unknown *Sorbus* was growing with *S. torminalis* and *S. rupicola* in the supposed absence of *S. aria*, it was suggested to be the hybrid between them (Kitchen & Kitchen 1997, 2000). On 18 September 1999, M. and C. Kitchen showed T. Rich the trees, which differed markedly in leaf morphology from other members of the *S. latifolia* group (cf. illustrations in Rich & Jermy 1998) and did not clearly match the descriptions in Warburg (1962) or Sell (1989). The leaves were nearly simple to weakly lobed, and the fruits were 12–14 mm long $\times$ 10–13 mm wide, brownish-orange with numerous small lenticels, and had well-formed seeds to 4.5 mm long. The weakly lobed leaves and large fruits might be characters expected if *S. rupicola* was the simple-leaved parent, and thus the suggested parentage looked plausible. However, the discovery of *Sorbus aria* (L.) Crantz nearby during the 1999 visit suggested that it might be the simple-leaved parent, as its primary diploid hybrid with *S. torminalis* ($=S. \times vagensis$ Wilmott) is widespread in the nearby Wye Valley.

If the parentage of the unknown hybrid could be confirmed as *S. rupicola* $\times$ *S. torminalis*, this would be of significant interest as previous reports of this hybrid refer to other taxa which are now treated as distinct species, and these plants might therefore also merit specific rank. The widely-cited records for *S. rupicola* $\times$ *S. torminalis* from v.c. 41 Glamorgan (Cefn Coed) and v.c. 42 Brecon (Dan-y-Craig) (Druce 1917; Ley 1901; Marshall 1916; Richards 1975; Stace 1997) refer to *S. leyana* Wilmott (which is not of this parentage; Lemche 1999) and both sites are actually in v.c. 42 Brecon. Wilmott (1934) suggested that *S. subcuneata* Wilmott had arisen from *S. rupicola* and *S. torminalis* (or possibly what is now known as *S. devoniensis*), and Sell (1989) also regarded this as possible parentage. Alternatively, if the simple-leaved parent was *S. aria*, then the Naas taxon could be included in *S. \times vagensis*. It was therefore decided to investigate the identity of the trees in more detail.

The taxa were investigated using comparative morphology and a combination of amplified fragment length polymorphism (AFLPTM) fingerprinting and DNA sequencing. Only limited sampling for DNA analysis was carried out as the methods were also being used as a trial to see if they could be applied to the genus as a whole, extending the work of Lemche (1999).

AFLP is a highly reproducible method of obtaining genetic fingerprints from small amounts of DNA consisting of DNA fragments of different sizes (number of base pairs) which are then visualised as bands on a gel (Vos *et al.* 1995). It has been used in studies within and between populations (e.g. Qamaruz-Zaman *et al.* 1998; Fay *et al.* 1999, 2000) and for investigation of the origin of taxa of hybrid origin (e.g. Beismann *et al.* 1997; Fay 1998).

Plastid and mitochondrial DNA are normally inherited maternally (e.g. Corriveau & Coleman 1988) and sequencing loci from the plastid genome can therefore provide information about the maternal parent in hybrids. The mode of plastid inheritance is not known in *Sorbus*, but Corriveau & Coleman (1988) showed it to be maternal rather than biparental in *Pyracantha* and *Rosa*, and this is therefore the likely scenario in *Sorbus*. Many plastid regions can be sequenced using universal primers, and for this project we chose to use the *trnL-F* region (the *trnL* intron and the *trnL-F* intergenic spacer; Taberlet *et al.* 1991) as it has been widely used at Kew and elsewhere and has been shown to be a relatively straightforward locus to sequence.

It might also be possible to indicate the parentage cytologically as *S. aria* and *S. torminalis* are diploid ($2n=34$) and *S. rupicola* tetraploid ($2n=68$); a *S. torminalis* hybrid with the latter might thus be expected to be triploid. One root cutting was taken but failed to establish.

METHODS

MORPHOLOGY

Leaf morphology was measured on fresh material from Naas Cliff and the Wye Valley, and from existing dried specimens in NMW from the Gloucestershire/Herefordshire/Monmouthshire/Brecon/Somerset area. Thirty leaves from lateral rosettes in well-lit situations were selected for *S. torminalis*, *S. rupicola*, *S. \times vagensis* and the unknown hybrid. Sixty leaves of *S. aria* were selected as it is more variable. The length (excluding petiole) and width of each leaf were measured, and the number of pairs of veins counted. The length:width ratio was then calculated and plotted against the number of veins as averages for the taxa. This graphical method has been found to be useful for distinguishing between *S. aria* (broad leaves with many veins) and *S. rupicola* (narrow leaves with few veins) elsewhere (Rich, unpublished), and might also therefore indicate which is the parent of the hybrid.

TABLE 1. COLLECTION INFORMATION FOR PLANT MATERIAL USED IN THE DNA ANALYSIS

Species/hybrid	Locality	NMW accession no.	Kew DNA Bank No.
<i>Sorbus aria</i>	River Severn, Naas, v.c. 34	V.2000.009.103	10321
<i>Sorbus aria</i>	Coldwell Rocks, v.c. 34	V.2000.009.104	10322
<i>Sorbus aria</i>	Lords Wood, v.c. 36	V.2000.009.105	10323
<i>Sorbus rupicola</i>	River Severn, Naas, v.c. 34	V.2000.009.106	10319
<i>Sorbus rupicola</i>	Coldwell Rocks, v.c. 34	V.2000.009.107	10320
<i>Sorbus torminalis</i>	River Severn, Naas, v.c. 34	V.2000.009.108	10324
<i>Sorbus torminalis</i>	River Severn, Naas, v.c. 34	V.2000.009.109	10325
<i>Sorbus torminalis</i>	Coldwell Rocks, v.c. 34	V.2000.009.110	10326
<i>Sorbus</i> × <i>vagensis</i>	Coldwell Rocks, v.c. 34	V.2000.009.111	10327
<i>Sorbus</i> × <i>vagensis</i>	Lords Wood, v.c. 36	V.2000.009.112	10328
<i>Sorbus</i> hybrid	River Severn, Naas, v.c. 34	V.2000.009.113	10317
<i>Sorbus</i> hybrid	River Severn, Naas, v.c. 34	V.2000.009.114	10318

DNA EXTRACTION

Collections of leaves were made from *S. aria*, *S. rupicola*, *S. torminalis*, *S. × vagensis* and the unknown hybrid from Naas Cliff and Coldwell Rocks, Gloucestershire, and Lords Wood, Doward, Herefordshire on 30 June 2000 by T. Rich. Two leaves from each tree were torn into narrow strips and put straight into desiccant silica gel in which they were kept until processed (Chase & Hills 1991). Voucher specimens were collected at the same time for NMW and K. The 12 samples included in the DNA analysis are listed in Table 1 with their origin, cross-referenced with the NMW accession numbers and the Kew DNA bank numbers.

DNA was extracted from approximately 0.2 g of dried material using a modified 2×CTAB (cetyltrimethyl-ammonium bromide) procedure (Doyle & Doyle 1987), purified and quantified using a spectrophotometer.

AFLP FINGERPRINTING

AFLPs were performed according to the AFLP Plant Mapping Protocol of PE Applied Biosystems Inc. (ABI). For each specimen, 0.5 µg of DNA was digested using the restriction enzymes MseI and EcoRI. Standard adaptors (PE Applied Biosystems) were ligated to the genomic digests. Twenty-four unique primer combinations were screened for their ability to amplify scoreable bands, from which two were selected for this study. Amplification reactions were separated on a 5% polyacrylamide gel using an ABI 377 automated sequencer. Genescan 2.1 and Genotyper 2.0 were used to analyse bands. Bands were scored as either present (1) or absent (0) for all individuals and exported as a binary matrix which was analysed using the UPGMA (Unweighted Pair-Group Method using Arithmetic Averages) algorithm in the software package PAUP version 4.0d64 for Macintosh (Swofford 1998) and by principle co-ordinates analysis (PCOA) in the R Package for Multivariate Analysis version 4.0 (Casgrain & Legendre 1999) using Jaccard's coefficient (Jaccard 1908).

trnL-F REGION SEQUENCING

Amplification of the *trnL-F* region from total DNA was carried out using the primers c and f of Taberlet *et al.* (1991). Modified dideoxy cycle sequencing with dye terminators run on an ABI 377 automated sequencer were used to sequence the purified amplification products directly. Both strands were sequenced for 75–100% of the *trnL-F* region, again with the c and f primers. Internal primers were not required. *Sorbus domestica* was used as an outgroup for comparative purposes.

RESULTS

MORPHOLOGY

Illustrations of typical sun leaves from lateral rosettes from Naas Cliff are shown in Figure 1 with material from other sources in the region to show the variation. The Naas Cliff plants show similarities to *S. × vagensis*, but the leaves are generally only weakly lobed.

The plot of leaf characters shows that morphologically the unknown hybrid fell close to *S. × vagensis* and between *S. aria* and *S. torminalis*, not between *S. rupicola* and *S. torminalis* (Figure 2).

AFLP FINGERPRINTING

Two primer combinations, B10 (MseI-CAC and EcoRI-ACT) and G21 (MseI-CTA and EcoRI-AGG), were selected for use in this study on the basis of the lack of background "noise" and the presence of variation between the taxa being studied. Specimen traces showing the general high degree of similarity are shown in Figure 3.

The binary matrix consisted of 109 characters, 45 being bands with primer combination B10 and 64 being bands with G21. Of these, 25 were found in all individuals. Thirty of the 84 polymorphic bands came from B10 and 54 from G21. The data are summarised in Table 2. Apart from the non-variable bands, the commonest types of band were those found in *S. torminalis* + *S. × vagensis* + the unknown hybrid, those found in *S. aria* + *S. rupicola* + *S. × vagensis* + the unknown hybrid, and those unique to *S. rupicola*. Other classes were relatively infrequent. No bands were found that were shared between *S. rupicola* and *S. × vagensis* and/or the unknown hybrid which were not also found in *S. aria* or *S. torminalis*.

In both UPGMA (Figure 4) and PCOA (Figure 5), all species and hybrids were distinguishable. *Sorbus aria* and *S. rupicola* fell close to each other, *S. torminalis* was the most distant from this species pair, and *S. × vagensis* and the unknown hybrid fell in intermediate positions.

The three individuals of *S. aria* had 49, 52 and 53 bands (average 51). The two individuals of *S. rupicola* each had 67 bands, and each had one unique band. Given the high degree of similarity between the two individuals, it is possible that these two bands are homologous, i.e. they represent alleles of the same locus, but it would require studies of how the bands segregate to confirm this.

TABLE 2. DISTRIBUTION OF BANDS AND THEIR RELATIVE FREQUENCIES.
T, PRESENT IN *SORBUS TORMINALIS*. V, PRESENT IN *S. × VAGENSIS*. K, PRESENT IN
UNKNOWN HYBRID. A, PRESENT IN *S. ARIA*. R, PRESENT IN *S. RUPICOLA*

Type of band	Number	Percentage
T+V+K+A+R	25	23
T+V+K	20	18
V+K+A+R	18	17
R	12	11
T+V	6	6
K+A+R	6	6
T+V+K+R	5	5
T	5	5
A	3	3
T+K	3	3
T+V+A+R	1	1
K	1	1
V+K+A	1	1
K+A	1	1
T+A	1	1
V+A+R	1	1

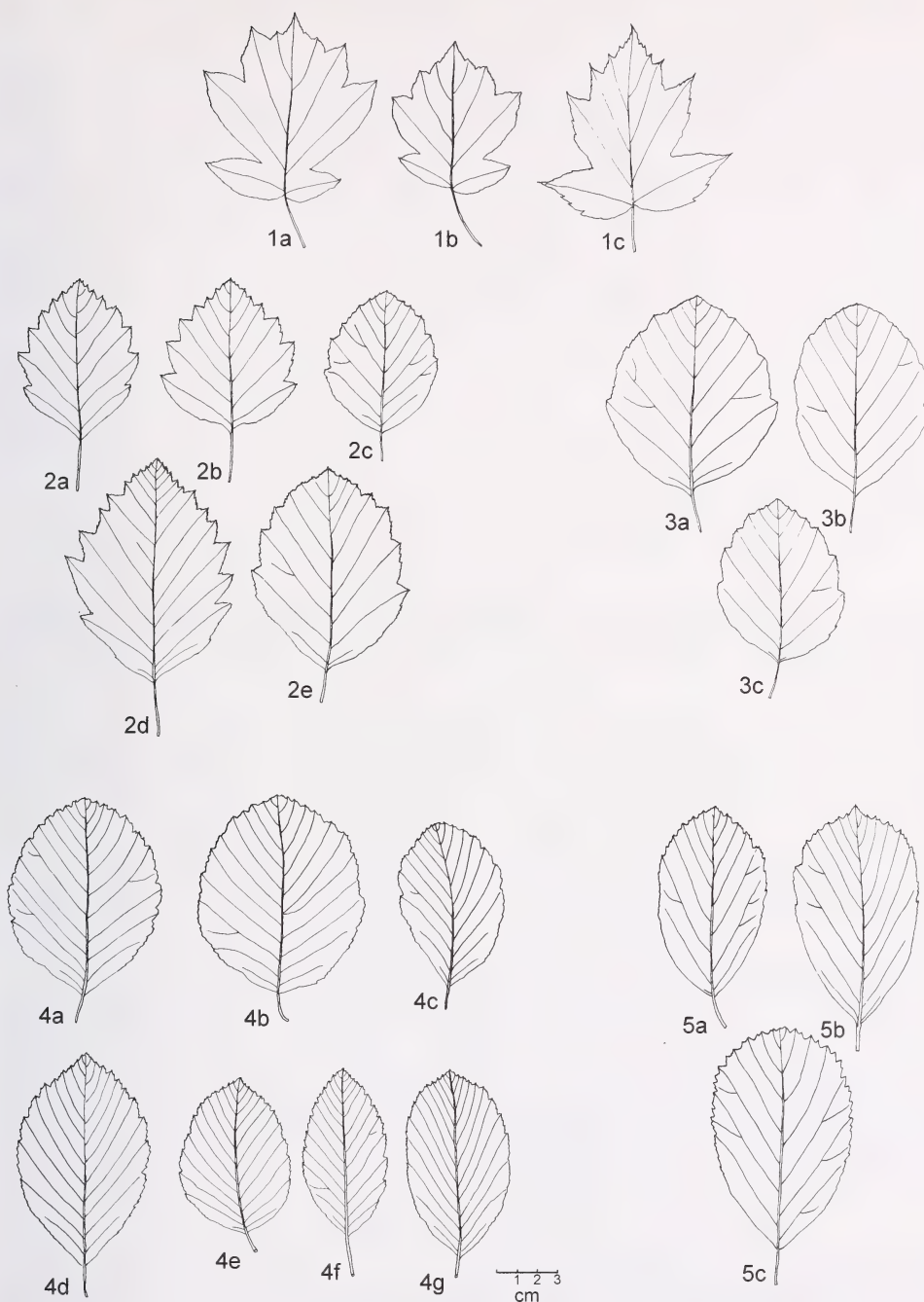


FIGURE 1. Silhouettes of *Sorbus* taxa studied in morphological analysis. 1. *S. torminalis*. a, b, Naas Cliff, Gloucestershire. c, Coldwell Rocks, Gloucestershire. 2. *S. x vagensis*. a, Coldwell Rocks. b, c, Symonds Yat, Gloucestershire. d, Cheddar Wood, Somerset. e, Wyndcliff, Monmouthshire. 3a–c. Unknown *Sorbus* hybrid, Naas Cliff. 4. *S. aria*. a, b, Naas Cliff. c, d, Coldwell Rocks, e–g, Avon Gorge, Gloucestershire. 5. *S. rupicola*. a, b, Naas Cliff. c, Coldwell Rocks.

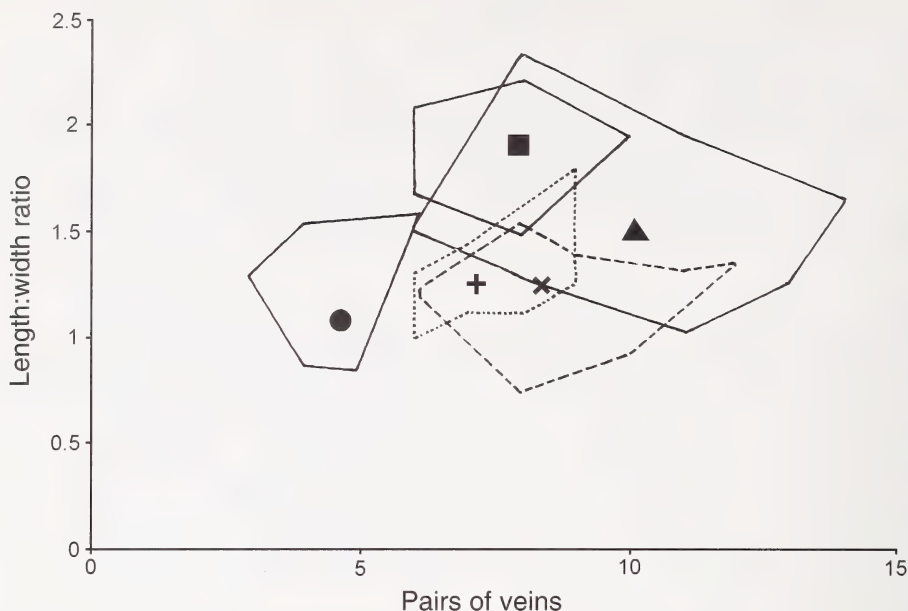


FIGURE 2. Number of veins against leaf length:width ratio for *Sorbus* taxa from NMW collections. Plots show polygons covering all the variation with the means at the approximate centres. ▲ = *S. aria* (n=60). ■ = *S. rupicola* (n=30). ● = *S. torminalis* (n=30). × and --- = *S. × vagensis* (n=30). + and ···· = Unknown hybrid (n=30).

The three exemplars of *S. torminalis* had 58, 58 and 61 bands (average 59). The *S. × vagensis* samples had 73 and 74 bands and they differed from each other in the presence or absence of five bands. The two exemplars of the unknown hybrid fell slightly separate from *S. × vagensis* in both analyses. They had 77 and 79 bands (average 78), and they differed overall by two bands.

In the PCOA, the first three co-ordinates accounted for 61, 14 and 9% (total 84%) respectively, of the variation, and thus the signal in the data is strong, with all other co-ordinates only accounting for 16% of the variation. Figure 5 shows co-ordinate 1 plotted against co-ordinate 2. The result of plotting co-ordinate 1 against co-ordinate 3 was very similar, and therefore is not presented.

trnL-F REGION SEQUENCING

The aligned *trnL-F* sequences gave a matrix of 618 characters. Of these, 608 were constant, and 617 were constant in all taxa apart from *S. domestica*. The remaining sequences were of two types. *Sorbus torminalis*, *S. × vagensis* and the unknown hybrid had identical sequences of the 'torminalis' type, and *S. aria* and *S. rupicola* had identical sequences of the 'aria' type. In addition to differing from each other by a single substitution (G in 'aria' and T in 'torminalis' at base 406 in the aligned matrix), the 'aria' type also had a single base insertion relative to the 'torminalis' type (an A at base 405).

DISCUSSION

The morphology and AFLP fingerprinting indicate that the likely parentage of the unknown Naas Cliff hybrid is *S. aria* × *S. torminalis*, rather than *S. rupicola* × *S. torminalis*.

In addition to falling separately from the species in the AFLP analyses, *S. × vagensis* and the unknown hybrid also showed clear additivity between the genotypes of *S. aria* and *S. torminalis*, with both apparently having received 18 bands from *S. aria* and 20 bands from *S. torminalis*. On the basis of the sampling here, *S. torminalis* is confirmed as one parent of both *S. × vagensis* and the unknown hybrid. The evidence for *S. aria* as the other parent is not so clear, and what evidence

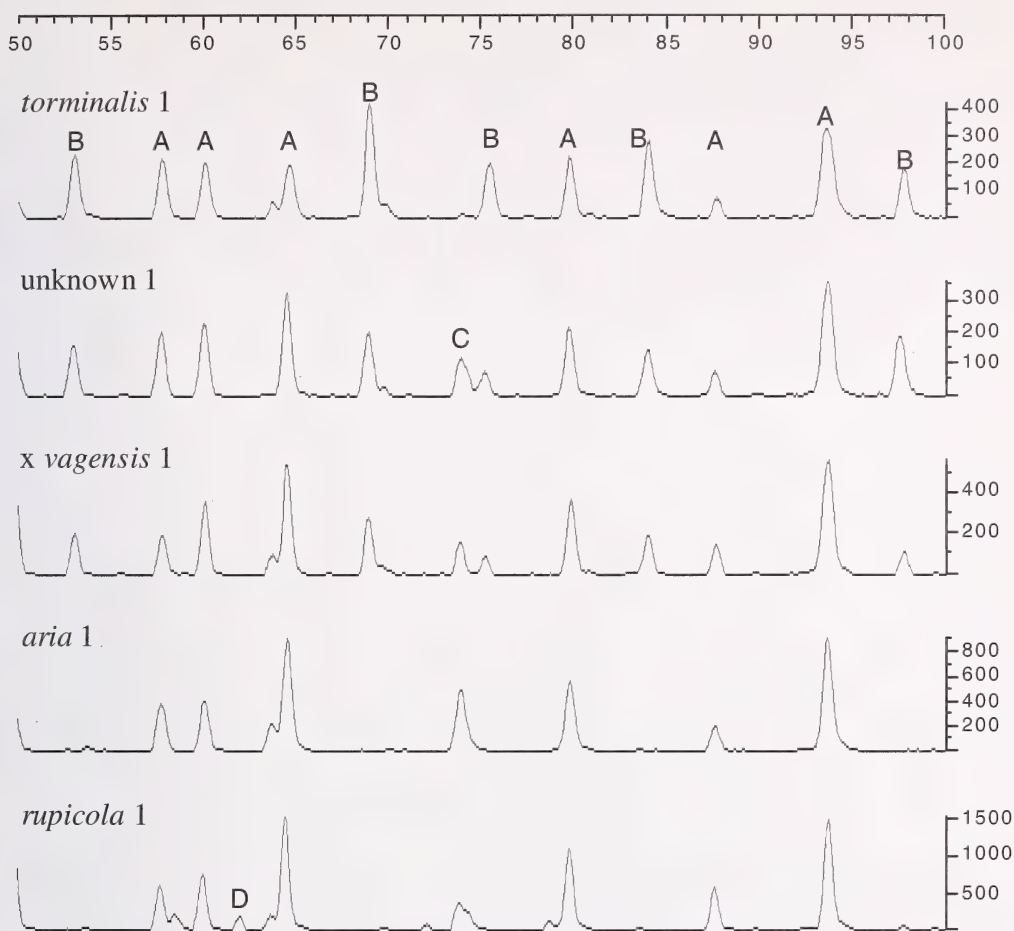


FIGURE 3. Specimen trace for samples of *Sorbus* taxa, showing a general high degree of similarity. Examples of different types of band are indicated by different letters. A = universal bands. B = bands present in *S. torminalis* + hybrids. C = bands present in *S. aria*/*S. rupicola* + hybrids. D = bands only present in *S. rupicola*. Numbers at the top of the figure indicate the sizes of the fragments in base pairs and numbers at the side indicate the strength of peaks in arbitrary units of fluorescence.

there is excludes *S. rupicola* rather than proving *S. aria* to be the other parent. *S. rupicola* has twelve unique bands (compared to three in *S. aria* and five in *S. torminalis*), and no bands are shared by *S. rupicola* and either *S. × vagensis* or the unknown hybrid which are not also present in either *S. aria* or *S. torminalis*. There is thus strong evidence to exclude *S. rupicola* as a parent in both cases, and both *S. × vagensis* and the unknown hybrid appear to be the result of hybridisation between *S. aria* and *S. torminalis*. As would be expected of hybrids, *S. × vagensis* and the unknown hybrid both have more bands than either parent as a result of additivity.

The sequence analysis showed that both *S. × vagensis* and the unknown hybrid share the plastid type of *S. torminalis*. Thus *S. torminalis* was apparently the female parent in both cases. As both *S. × vagensis* and the unknown hybrid appear to have the same two parental species and the hybridisation took place in the same direction, we include the unknown Naas hybrid in *S. × vagensis*. Hybridisation has thus occurred independently at Naas and Coldwell Rocks, and the morphological variation observed in *S. × vagensis* (cf. Sell 1989, and Figures 1 and 2) may thus be partly explained in terms of multiple hybridisation events. What is surprising, given the large geographical overlap in range exhibited by the parents in Britain, is the apparent limitation in the

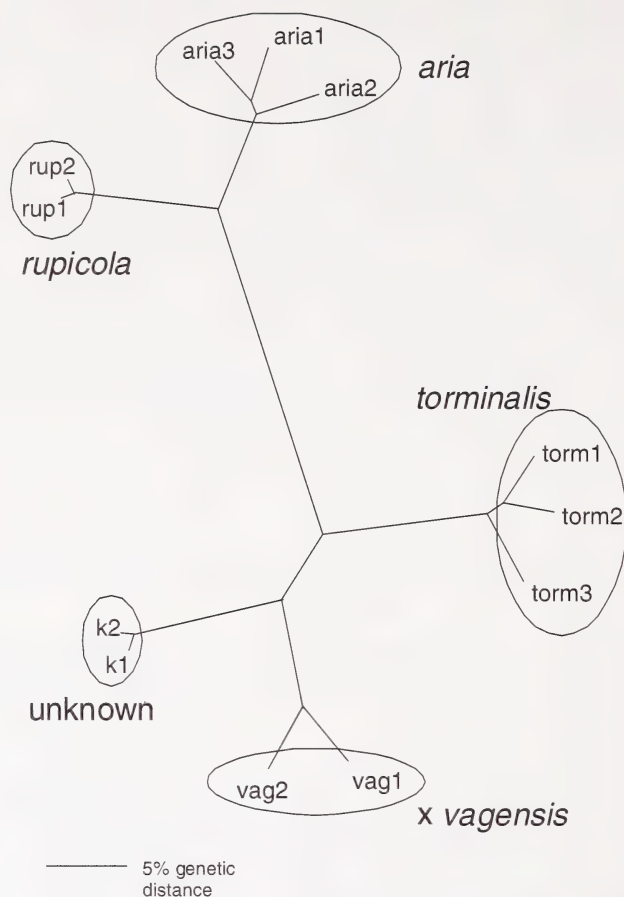


FIGURE 4. UPGMA dendrogram showing relationships of *Sorbus* taxa whose DNA was studied.

occurrence of *S. × vagensis* to the region around the Severn Estuary. Sell (1989) explains this in terms of ecological separation, the Severn Estuary/Wye valley area being one of the few places where the parents grow close together.

The DNA methods were found to be useful tools for analysing the species and hybrids in the group, and show great potential for further work. The high number of bands shared between *S. aria* and *S. rupicola* (51 out of a possible 53) and the higher number of bands present in *S. rupicola* suggest that *S. rupicola* may also be of ancient allopolyploid hybrid origin, with *S. aria* s.s. as one parent and another member of *S. aria* s.l. as the other. Further sampling of both taxa and of other members of the *S. aria* group would be required before a conclusive answer as to its parentage can be obtained.

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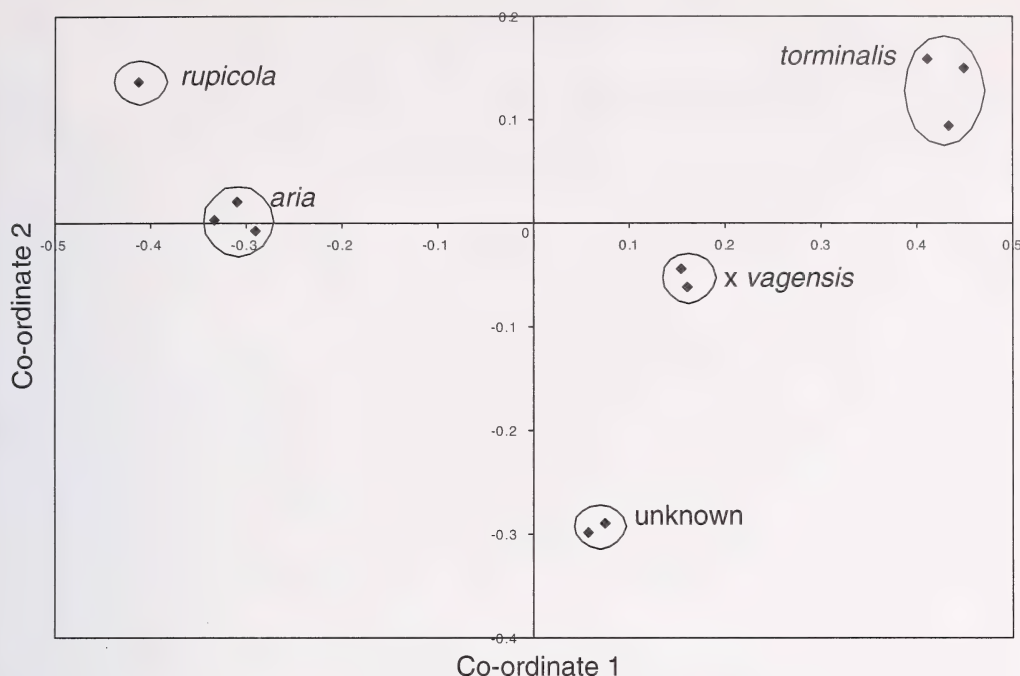


FIGURE 5. Plot of the first and second axes from a PCO analysis of *Sorbus* taxa whose DNA was studied. The two samples of *S. rupicola* have identical co-ordinates.

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Conservation of Britain's biodiversity: *Hieracium asteridiophyllum* and *H. cillense* (Asteraceae)

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ABSTRACT

Hieracium cillense and *H. asteridiophyllum* are very rare endemic Welsh hawkweeds confined to limestone cliffs in and around Craig y Cilau National Nature Reserve, Llangattock, Brecon (v.c. 42). In June 2000 surveys were carried out of their entire populations to assess their requirements for conservation. 659 plants of *H. cillense* were found; 396 plants in the N.N.R., and 263 in a new extension of the population to the east. 512 plants of *H. asteridiophyllum* were found; 296 plants in the N.N.R., and 216 mostly in a new extension of the population to the east. Compared with population sizes in the N.N.R. in 1975, more plants of *H. cillense* were found and fewer of *H. asteridiophyllum*; the differences are probably due to the problems of recording. Both species are 'Critically Endangered' under the I.U.C.N. criteria, but they are probably not at significant risk. Seed has been deposited in the Millennium Seed Bank and plants are being cultivated at the National Botanic Garden of Wales.

KEYWORDS: distribution, ecology, endemic, hawkweed, population size.

INTRODUCTION

Hieracium cillense Pugsll., Craig y Cilau Hawkweed, and *H. asteridiophyllum* P. D. Sell & C. West, Llangattock Hawkweed, are very rare, endemic hawkweeds, as far as is known confined to the area around Craig y Cilau National Nature Reserve, Llangattock in the Brecon Beacons (v.c. 42). Craig y Cilau is one of the most outstanding botanical sites in Wales, the scenic limestone cliffs supporting many rare plants and animals as well as superb geological and geomorphological features. It is perhaps best known for its five rare endemic *Sorbus* species, but it is equally important for *Hieracium*, of which at least 15 have been recorded.

Hieracium cillense and *H. asteridiophyllum* are unusual amongst hawkweeds in Britain in that there is already some information available on their population sizes. In 1975, P. D. Sell and L. Farrell carried out surveys on Craig y Cilau N.N.R. and reported 253 plants of *H. cillense* and 458 plants of *H. asteridiophyllum* (rare species forms held by the Countryside Council for Wales). Both species are now listed with 77 other rare hawkweeds in the *Vascular Plant Red Data Book* (Wigginton 1999), but there is no recent information on their population sizes. A joint project was therefore set up between the National Museum & Gallery, Cardiff and C.C.W. to establish their current status and determine their needs for conservation. The data are summarised in this paper; full details can be found in Rich (2001a, 2001b).

About 400 species of *Hieracium* are recognised in Britain, most of which are apomictic (i.e. reproduce asexually) and triploid or tetraploid. *H. cillense* was first described as a distinct variety in 1905 by the Reverend Augustin Ley, and was later raised to a species by Pugsley (1941). It is a distinct plant which is almost instantly recognisable in the field by the leaves which are covered in dense, fine, stellate hairs on both sides which give them a greyish-green hue. Sell & West (1968) noted that it is similar to the widespread European species *H. lasiophyllum* Koch, from which it may have been derived.

H. asteridiophyllum was also first collected by Ley, but was only named as a distinct species in 1955 after much confusion (Sell & West 1955, Sell 1987). It is very similar to the more widespread species *H. pellucidum*, from which it can be distinguished by having pilose hairs on the phyllaries in addition to the glandular ones. From the other hawkweeds in the Craig y Cilau area, these two species can be picked out by the clustered, smaller, deeper yellow heads with black glands on the phyllaries (this yellow/black contrast is quite distinctive), dark styles and a basal rosette of dark green, ovate leaves.

TABLE 1. POPULATION COUNTS OF *HIERACIUM ASTERIDIOPHYLLUM* AND *H. CILLENSE* FOR APPROXIMATELY THE SAME AREAS OF CRAIG Y CILAU N.N.R. BY P. D. SELL & L. FARRELL IN 1975 AND BY T. RICH IN 2000

	<i>H. cillense</i>		<i>H. asteridiophyllum</i>	
	1975	2000	1975	2000
Craig y Cilau, main Cliff	0	2	338	110
Llangattock Quarries, Agen Allwedd cliffs	0	19	0	9
Llangattock Quarries, cliffs east of Agen Allwedd	46	54	46	0
Top cliff below Waun Rudd west	0	0	4	17
Top cliff below Waun Rudd east	195	319	68	65
Chwar Mawr (all cliffs)	12	2	1	95
Total for N.N.R.	253	396	458	296
Quarry above Mayberry Cottage (outside N.N.R.)	-	0	-	8
Quarries west of Waun ddu (outside N.N.R.)	-	0	-	3
Darren Cilau-Ogof Darren Cilau (outside N.N.R.)	-	263	-	205
Total		659		512

DISTRIBUTION AND POPULATION SIZES

Historical information in the literature and on herbarium sheets at **BM**, **BRISTM**, **CGE**, **LIV** and **NMW** was abstracted. Information from the *Hieracium* database was provided by D. McCosh. The records traced are listed in Appendices 1 and 2, which indicate that both species are confined to the Craig y Cilau area (also known historically as Craig Cille). Sell (1987) indicated that *H. asteridiophyllum* was restricted to one section of cliff c. 1.5 km long, but the type specimen had been reported further east at Darren Cilau.

Field surveys were carried out on 7, 16, 20 and 28 June 2000. The first day was mainly spent with familiarisation of the Craig y Cilau hawkweeds, another day was spent collecting ecological information, and two days were spent estimating the population sizes. One further day was spent surveying nearby sites which had possible habitat, but no new populations were found.

Plants were generally surveyed by walking under the cliffs and looking up, sometimes using binoculars. No rock climbing was attempted, with the exception of some scrambles up the safer sections. All accessible cliffs were covered except those above Darren Cilau quarries which were considered too dangerous (eight dead sheep were counted at the foot of the cliffs over 2 km). It was possible to walk along two levels of the main Craig y Cilau upper cliffs using sheep paths, the upper one of which is very narrow and scary. Cliffs with broken rocky bases were much harder to get close to and survey properly than those with massive bases. In general, it was only possible to count plants on the lowest third of the larger cliffs, and there is no doubt that the population sizes are under-estimates, possibly by 50% or more.

H. cillense was most abundant on the top cliffs below Waun Rudd and in the eastern end of Darren Cilau quarry, with a few smaller populations elsewhere, with a total of 659 plants (Figure 1). *H. asteridiophyllum* was more widespread, with most plants on the main lower Craig y Cilau cliff and at the west end of Darren Cilau quarry, with a total of 512 plants (Figure 2). It was pleasing to discover extensions of the known ranges of both species to the east of the N.N.R., though they are clearly parts of the same populations. Figure 3 shows an updated national distribution map, which is the same for both species.

Population counts for sub-sites within the N.N.R. are summarised in Table 1 and compared with the 1975 Sell and Farrell counts for approximately the same areas. Sell and Farrell essentially recorded in the same way; they scrambled along the ledges and used binoculars and included vegetative rosettes, but they only spent one very hot day surveying and counted both *Sorbus* and *Hieracium* at the same time. L. Farrell did most of the counting (pers. comm., 2000).

The counts for the same areas in 1975 and 2000 show some discrepancies (Table 1). For equivalent areas searched, I usually recorded more *H. cillense* plants than Sell & Farrell, but the counts were more variable for *H. asteridiophyllum*. I found both more widely. As Sell & Farrell

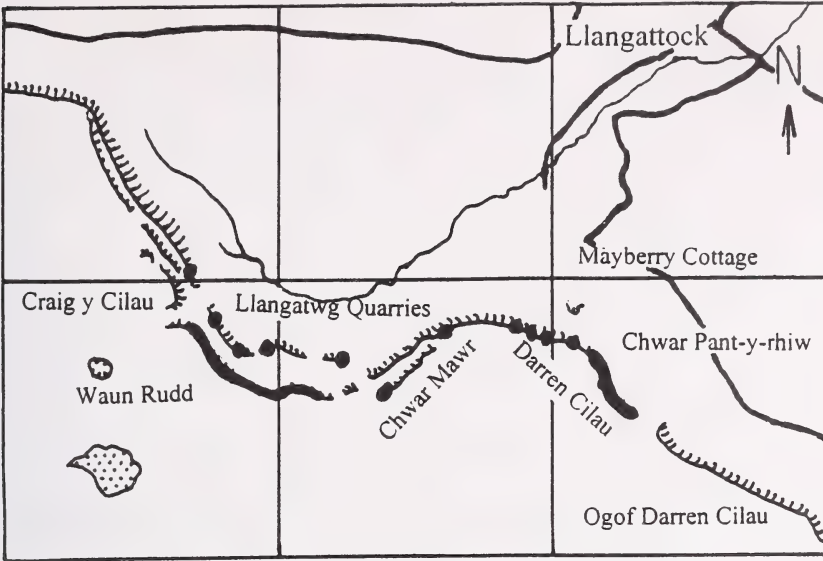


FIGURE 1. Distribution of *Hieracium cillense* around Craig y Cilau.

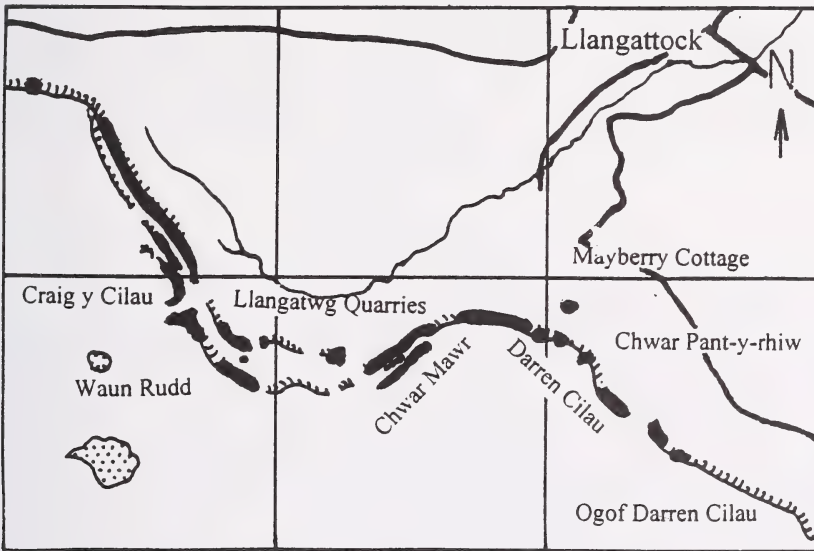


FIGURE 2. Distribution of *Hieracium asteridiophyllum* around Craig y Cilau.

only spent one day recording, and probably covered fewer crags, I would have expected to have recorded more plants of both species if the populations had remained the same size. The undoubted greater expertise of P. D. Sell should not have played a significant role in recording differences for *H. cillense* which is readily identifiable, but may have done so for *H. asteridiophyllum*. Surveys were carried out at the same time of year. The differences in numbers of plants are probably largely due to differences in recording, but may also include some population changes.

ECOLOGY

Both species have very similar life cycles, but there are a few differences in ecology. They are both perennials which are probably quite long-lived. The leaves of both species are largely clustered in basal rosettes, which is typical of hawkweeds that grow in rocky places. Their main flowering periods are from early June to early July, with most seed being shed by the end of the July (*H. cillense* usually coming into flower a little later than *H. asteridiophyllum*). Both are probably obligate apomicts like the other *Hieracium* species, and produce seed asexually. The seeds have a small pappus and are wind-dispersed.

Both occurred on natural rocks and on quarry faces, usually on steep or nearly vertical rocks. Plants were mostly rooted directly into rock crevices with no apparent soil, on shallow, narrow ledges, or into shallow brown rendzinas over shattered rocky outcrops. The pH of the soil ranged from 7.1 to 7.5 (measured with a pHep2 Hanna pocket-sized pH meter in a 50:50 mixture with distilled water). *H. cillense* was most abundant on the Upper Limestone Shales in the N.N.R., and on the Carboniferous Limestone at Darren Cilau quarry. *H. asteridiophyllum* was most abundant on Carboniferous Limestone.

H. cillense was most abundant on the open crags, and rarely occurred in significantly shaded situations. *H. asteridiophyllum* occurred in both open and partly shaded situations, and was one of the most common hawkweed species on the main cliff in partly shaded situations. These differences in shade tolerance and substrate may account for the different distributions on crags within the N.N.R. as many of the lower cliffs and those at the east end have patches of woodland and scrub with *Fagus*, *Fraxinus*, *Sorbus* spp., etc.

Both species usually occurred in as scattered plants in open vegetation with low cover, but sometimes also occurs in more closed grassy vegetation on some of the less steeply sloping outcrops. In terms of the National Vegetation Classification (Rodwell *et al.* 1991–2000), the vegetation on the ledges and rock faces is the OV39 *Asplenium trichomanes* - *Asplenium rutamuraria* community, that on the grassy outcrops CG10 *Festuca ovina* - *Agrostis capillaris* - *Thymus praecox* grassland, and that on the wooded cliffs W9 *Fraxinus excelsior* - *Sorbus aucuparia* - *Mercurialis perennis* woodland. Both were often associated with the two other common Craig y Cilau hawkweeds, *H. cyathis* (Ley) W. R. Linton and *H. subbritannicum* (Ley) Sell & West, and more rarely with *H. dicella* Sell & West.

CONSERVATION

Both species qualify as 'Critically Endangered' under the 1994 IUCN criteria (area of occupancy <10 km²). They are both included in the *Vascular Plant Red Data Book* (Wigginton 1999), but are not protected under Schedule 8 of the Wildlife and Countryside Act 1981. The site is within the Brecon Beacons National Park, and most of the populations of both species occur on the National Nature Reserve. These designations give a significant degree of protection to the sites and as most plants occur on relatively inaccessible rocks they are scarcely under any significant threat. Climbing at Darren Cilau is restricted and stipulates no clearance of vegetation.

Seeds of both species were collected in July 2000 and sent to the Millennium Seed Bank at the Royal Botanic Gardens, Wakehurst Place for long-term storage. Material of both species is also being cultivated at the National Botanic Garden of Wales.

Both species are palatable, and thus largely confined to cliffs inaccessible to sheep; reduction of sheep stocking levels might allow spread into places where they are currently grazed out. The cliff habitats are essentially unmanaged, and the only potential management in the future might be very localised control growth of scrub or trees.

It is recommended that the populations should be surveyed every 25 years. Given the difficulties of counting plants, caution should be applied to interpreting changes in population size. For *H. cillense*, there should be cause for concern if the population counted in the N.N.R. drops below 200 plants, or the total population drops below 400 plants; for *H. asteridiophyllum*, the figures are 200 plants and 300 plants respectively.

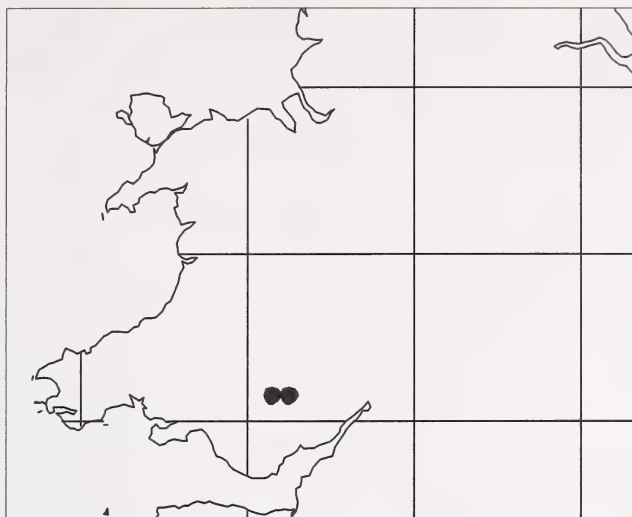


FIGURE 3. National distributions of *Hieracium cillense* and *H. asteridiophyllum* (the same for both species).

ACKNOWLEDGMENTS

This work was jointly funded by Countryside Council for Wales and National Museum & Gallery, Cardiff as part of a collaborative project into conservation and ecology of critical species.

I would like to thank Andy Jones, Richard Preece and Graham Motley of C.C.W. for their help, David McCosh for records from the B.S.B.I. *Hieracium* database, Peter Sell and Lynne Farrell for information about the 1975 survey, and the Keepers of the herbaria for access to specimens and libraries. The map was plotted using DMAPW by Alan Morton.

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(Accepted June 2001)

APPENDIX 1. HERBARIUM AND LITERATURE RECORDS OF *HIERACIUM CILLENSE*

Date	Collector	Site	Source and notes
14/6/1897	A. Ley	Craig Cille	BM, CGE , det. Sell & West; Set of British Hieracia no. 139 in part
14/6/1900	A. Ley	Craig Cille	BM, CGE, LIV, NMW det. Sell & West; Set of British Hieracia no. 139 in part
9/6/1903	A. Ley	Craig Cille	CGE , det. Sell & West
2/6/1904	H. J. Riddelsdell	Craig Cille	BM , det. McCosh
15/6/1904	A. Ley	Craig Cille	BRISTM, LIV , det. Sell & West
6/7/1923	H. J. Riddelsdell	Craig Cille	NMW , det. C. E. A. Andrews
29/6/1927	A. E. Wade	Craig y Cilau	NMW , det. Sell & West
3/7/1935	H. W. Pugsley	Craig Cille	BM , det. West
1952	C. West	Darren Cilau	CGE (holotype; Sell & West 1955)
22/6/1953	P. D. Sell	Dan-y-Darren (Craig Cille), limestone cliffs	CGE , det. Sell
22/7/1955	B. A. Miles	Craig Cille, SO191157	CGE , det. Sell & West
14/6/1964	U. K. Duncan	Craig y Cilau, west of Llangattock quarries	CGE , det. Sell
8/6/1972	P. D. Sell	Dan-y-Darren near Llangattock, limestone cliffs, SO186163	CGE , det. Sell
5/7/1974	P. D. Sell	Dan-y-Darren, Craig y Cilau, cliff face, SO186161	CGE , det. Sell
22/6/1975	P. D. Sell	Craig y Cilau, frequent in central area, SO188159	CGE , det. Sell
30/6/1975	P. D. Sell & L. Farrell	Craig y Cilau NNR, 458 plants, from SO181166 to SO190156	C.C.W. Rare Species Form and Sell (1987)

APPENDIX 2. HERBARIUM AND LITERATURE RECORDS OF *H. ASTERIDIOPHYLLUM*

Date	Collector	Site	Source and notes
12/6/1893	(A. Ley)	Craig Cille, limestone rocks	BM Ley (1909)
4/6/1895	A. Ley	Craig Cille, limestone rocks	NMW
5/6/1899	A. Ley	Craig Cille, centre of crag at base below cave	CGE
9/6/1903	W. R. Linton	Craig Cille	LIV
11/6/1903	H. J. Riddelsdell	Craig Cille	BM
6/1904	H. J. Riddelsdell	Craig Cille	BM, CGE
5/6/1904	A. Ley	Craig Cille, central portion	BM (holotype, cf. Pugsley 1948), CGE
3/7/1908	A. Ley	Craig Cille, central part of cliff	BM, CGE, NMW
6/7/1923	M. A. Wedgwood	Craig Cille	BM
1925	J. E. Roffey	Craig y Cilau	Pugsley (1948)
9/6/1927	H. A. Hyde & A. E. Wade	Craig y Cilau	NMW
3/7/1935	C. I. & N. Y. Sandwith	Craig Cille	BRISTM
7/1952	C. West & J. W. Cardew (?)	Craig Cille	CGE
5/6/1954	J. E. Raven	Craig Cille	CGE
22/7/1955	B. A. Miles	Craig Cille	CGE
27/7/1957	J. E. Raven	Craig Cille	herb. D. McCosh
22/6/1975	P. D. Sell	Craig y Cilau, frequent in rock crevices in central area	CGE
23/6/1975	P. D. Sell	Craig y Cilau, central area	CGE
30/6/1975	P. D. Sell & L. Farrell	Craig y Cilau N.N.R.; 253 plants	C.C.W. Rare Species Form
1980	M. Porter	Craig y Cilau	Ellis (1983)

Notes

A NEW BRAMBLE OF NORTHUMBRIA AND THE SCOTTISH BORDERS

Rubus newtonii Ballantyne, **sp. nov.**

Turio alte arcuatus, faciebus sulcatis obtusangulus, brunneus, pilis simplicibus stellatisque sparsis vel numerosis vestitus, glandulis sessilibus multis et interdum stipitatis raris instructus; aculei 6–18 in 5 centimetrorum longitudine, ad angulos plerumque limitati, nonnunquam geminati, turionis diametro vel breviores vel aequales vel paulo longiores, declinati vel curvati, raro patentes, e basi compressa purpurea vel flavescenti tenues, aut omnino flavescentes.

Folium foliolis 3(–4) magnitudine subaequalibus, non contiguis, aliquantum coriaceis, supra viridibus, nitentibus, magis minusve glabris, infra pallide viridibus, rare pubescentibus; foliolium terminale 4–7(–8) cm, plerumque obovatum sed variabiliter subrotundum vel ellipticum, apice (1–1.5 mm) acuminatocuspidato, basi emarginata, regulariter serratum marginibus planis, dentium principalium paucis recurvatis, petiolulo lamina 3–4plo breviora praeditum; foliola lateralia nonnunquam latere inferiore lobata, petiolulis brevibus (2–8 mm) patentibus vel ascendentibus praedita; foliolorum basium petioluli, quando adsunt, 1–3 mm; petiolus brunneus, pilis simplicibus stellatisque numerosis vel densis brevibus vel mediocribus vestitus, glandulis sessilibus nonnullis instructus, aculeis (7–)9–11(–13) curvatis 1–3 mm armatus, folioluli terminalis petiolulo laminaeque longitudine subaequalis vel paulo longior.

Ramus florens infra foliis ternatis, supra folio uno (vel duobus) simplice, interdum satis grandi, instructus, non ad apicem foliosus; inflorescentia interdum pyramidalis vel supra subracemosa, vertice angusto plerumque rotundato, pedunculis subaequalibus suberectis vel ascendentibus, ramulis axillaribus superis magis minusve congestis, floribus 1–3 praeditis, medianis multifloris, pedunculis foliis suis brevioribus vel longitudine aequalibus, infimis longis, interdum paniculis secundariis effectis.

Rachis flexuosa, pilis simplicibus stellatisque numerosis vel densis patentibus brevibus vel mediocribus vestita, glandulis sessilibus subsessilibusque numerosis raroque stipitatis paucis instructa, aculeis satis numerosis, tenuibus, plerumque purpurascens, basi lata, acumene flavescenti (3–6 mm), declinatis vel curvatis, armata; pedicelli sicut rachis vestiti et armati.

Flores ad 2.5 cm diametro; sepala viridibrunnea, pallidimarginata, pilis simplicibus stellatisque densis vestita, glandulis stipitatis aciculisque sparsis instructa, apice brevi vel mediocri, interdum curvata, laxa reflexa vel patentia. Petala 8–15 × 5–9 mm, rosea, obovata vel elliptica, aliquantum sinuata, ciliata, magis minusve contigua, leniter concava; stamina stylos excedentia, filamentis subroseo antheraque pilosa praedita; styli luteovirides; carpella juvenia pilis longis sparsis vestita; receptaculum hirsutum; fructus elongatus. Floret Julio et Augusto.

Stem high arching, bluntly angled with furrowed sides, brown with sparse to numerous simple and tufted hairs and many sessile glands and sometimes an occasional stalked gland; *prickles* 6–18 per 5 cm, mostly confined to the angles, sometimes in pairs, from shorter than to more than equalling the stem diameter, slanting to curved, seldom patent, slender from a compressed purplish to yellowish base or yellowish throughout. *Leaf* with 3(–4) leaflets of approximately equal size, not contiguous, somewhat coriaceous, shining green above and more or less glabrous, pale green and thinly pubescent beneath; *terminal leaflet* 4–7(–8) cm, mostly obovate but varying from almost round to elliptic, with an acuminate-cuspidate apex (1–1.5 cm) and weakly cordate base, regularly serrate with flat margins, a few main teeth recurved, the petiolule one quarter to one third as long as the lamina; lateral leaflets not infrequently lobed on the lower side with short patent to ascending petiolules 2–8 mm; petiolules of basal leaflets, when present, 1–3 mm; petiole brown, with numerous to dense short to medium simple and tufted hairs, some sessile glands and (7–)9–11 (–13) curved prickles 1–3 mm, about equalling or slightly longer than the petiolule and lamina of the terminal leaflet. *Flowering branch* with ternate leaves below and 1(–2) simple sometimes quite large leaves above, not leafy to the apex; *inflorescence* sometimes pyramidal or subracemose above with a narrow usually rounded top with subequal peduncles which are suberect or ascending, the upper more or less congested and 1–3 flowered, the middle many-flowered with

peduncles shorter or as long as their leaves, the lowest long and sometimes developed as secondary panicles. *Rachis* flexuous, with numerous to dense patent, short to medium, simple and tufted hairs, numerous sessile and sub-sessile glands, and occasionally a few stalked glands and fairly numerous usually purplish broad-based slender prickles with yellowish points 3–6 mm, most declining or curved; pedicels clothed and armed like the rachis. *Flowers* to 2.5 cm in diameter; sepals greenish-brown, pale-bordered with dense simple and tufted hairs and occasional stalked glands and acicles, with a short to medium point, sometimes curved, loosely reflexed to patent. Petals 8–15 × 5–9 mm, rose-pink, obovate to elliptic, somewhat sinuate, ciliate, more or less contiguous, slightly concave; stamens exceeding styles, filaments pinkish, anthers pilose; styles yellowish-green; young carpels with occasional long hairs; receptacle hairy; fruit thimble-shaped. Flowering in July and August.

HOLOTYPE: roadside bank Craster, v.c. 68, NU207198, 5 September 1996, A. Newton (E). Isotype in BM.

This member of ser. *Sylvatici* (P. J. Mueller) Focke is named in honour of Alan Newton, whose work over the past half-century has done so much to advance the study of *Rubus* L. in Britain and Ireland. He has been familiar with this species himself ever since encountering it in 1971 in the far north-east corner of England, where its distinctiveness owing to its having the primocane leaves almost invariably ternate led him to give it the working name of “*R. trifolius*”. Although by no means the sole British *Rubus* exhibiting this character, it is the only predominantly eglandular one with this character that has a sufficiently wide distribution for it to be likely to be encountered. At the same time, care needs to be taken in the field to avoid confusing it with a not infrequent companion, *R. drejeri* Jensen ex Lange, which also often has ternate primocane leaves as well as pink petals and hairy anthers, but always with at least a few stalked glands on the stem and usually many on the rachis.

Specimens exist in herbaria as far back as 1855 (near Stannington, D. Oliver, CGE, v.c. 67), but there is persuasive evidence that this was the “*R. leucostachys*” mentioned by Johnston (1853), the description of which tallies with *R. newtonii* in important details. These rule out equation with Johnston’s “*R. mucronatus*”, the other possible candidate. Johnston’s specimen was collected at Twizell House, Warenford, south-west of Lucker, v.c. 68, the residence of his fellow naturalist and High Sheriff of the county, P. J. Selby, and *R. newtonii* occurs thereabouts in quantity today.

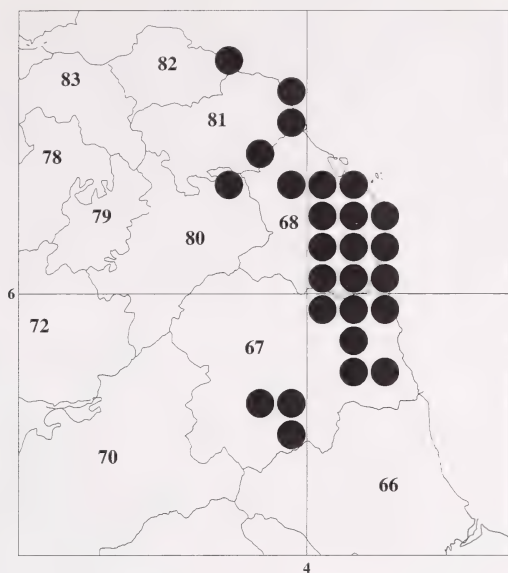
Fieldwork by the writer since 1984, particularly in 2000, has established that the species is present in at least 21 hectads in South and North Northumberland, v.c.c. 67 and 68, mainly to the east of the NU/NZ dividing grid line, from the neighbourhood of Fenwick south to Stannington. It is at its most plentiful in NU02, 12 and 22 in v.c. 68. It grows chiefly in or fronting the hedges of minor roads, especially those with a broad verge, on the margin of former moorland, often associated with honeysuckle, *Lonicera periclymenum* L., with populations of up to 50 × 3–4 m in extent in places. The bramble is scarce in and south of the Tyne corridor, but a good stand in the vicinity of Slaley Hall, v.c. 67, suggests that the distribution may extend southwards into Co. Durham, v.c. 66, as well. To the north, entering Scotland, *R. newtonii* is scattered throughout Berwickshire, v.c. 81, edges into East Lothian, v.c. 82 in the vicinity of Oldhamstocks and on the coast, and follows the River Tweed into Roxburghshire, v.c. 80, south-east of Kelso in the Softlaw area. The species thus occurs in at least five vice-counties and in almost certainly more than the 26 recorded hectads, thereby amply qualifying for taxonomic recognition.

REPRESENTATIVE EXSICCATAE:

v.c. 67, S. Northumberland: Near Stannington, c. NZ2080, August 1855, D. Oliver, (CGE). Langley Lead Mines, NY86, September 1865, J. G. Baker (CGE). Acklington Station (W. of), NU2101, 25 July 2000, GHB (GHB). Stobswood, W. of Widdrington Station, NZ2394, 25 July 2000, GHB (GHB).

v.c. 68, N. Northumberland: [Long]Framlington, NU1301, 1865, J. G. Baker (BM). Skinlaws Toll, NT95, October 1877, A. Brotherston (CGE). Alnwick-Eglingham, NU11, 4 September 1897, F. A. Rogers (BM). Fowberry, NU0228, August 1971, A. Newton (AN). Ford, NT9538, August 1971, A. Newton (AN). Chillingham, NU0525, August 1971, A. Newton (AN). Rothbury, NU0501, 7 July 2000, GHB (GHB). Yeaverling, NT9030, 24 August 2000, GHB (GHB).

v.c. 80, Roxburghshire: Softlaw East Mains Plantation, S.E. of Kelso, NT756311, 19 July 2001, GHB (GHB).

Distribution of *Rubus newtonii* by 10-km squares

v.c. 81, Berwickshire: Aytonwood House area, NT9161, 22 September 1984 and 15 July 2000, GHB (GHB).

v.c. 82, East Lothian: N. of Oldhamstocks, NT7372, 11 August 1986 and 15 July 2000, GHB (GHB).

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A NEW NAME IN THE BRITISH FLORA: *PERSICARIA* × *FENNICA* (REIERSEN) STACE

In July 1981 Dr and Mrs John Dony collected a puzzling large, leafy, branched knotweed growing on a grassy bank near a road at New Mill, near Holmfirth, c. 5 miles south of Huddersfield, West Yorkshire (v.c. 63). Specimens were sent to Ann Conolly, who similarly had not seen the likes of it previously. Her investigations showed clearly that it belonged to a group of species that includes *Persicaria alpina* (All.) H. Gross, *P. weyrichii* (F. Schmidt ex Maxim.) Ronse Decr., *P. mollis* (D. Don) H. Gross and *P. campanulata* (Hook. f.) Ronse Decr., and which is often segregated into the genus *Aconogonon* (Meisn.) Rchb. (Conolly 1983). The plant is mentioned in Stace (1997) at the end of the entry for *P. alpina*, but is not covered in Wilmore (2000) and no other wild localities are known in the British Isles. Similar plants are, however, much commoner in Scandinavia as garden escapes: 15 localities in Denmark; 12 in Norway; 2 in Sweden; and over 100 in Finland (Reiersen 2000).

Reiersen (in Jonsell 1999) concluded that the Scandinavian plants are probably garden hybrids between *P. alpina* and *P. weyrichii*, two species which have very different distributions overall but which are possibly sympatric in parts of eastern Asia. Reiersen (2000) reported that the Danish plants differ from the Finnish and Norwegian plants in having well-developed anthers with apparently good pollen, longer and narrower perianth-tubes, and more hairy leaves and upper parts of stems. Plants from Yorkshire and some garden material from Cambridge and Kent were sent in 1990 to Reiersen, who confirmed that they belong to the same taxon as the Scandinavian plants. He claimed that the Yorkshire plant resembles the Finnish/Norwegian plants and the garden material resembles the Danish ones. However, in contradiction to this, the Cambridge cultivated material appears to have fertile pollen but the Kentish garden material has sterile pollen (Reiersen's own annotations on the specimens), and the Yorkshire plant does set some good seed (A. P. Conolly, pers. comm., 2001).

The evidence for splitting *Aconogonon* (and *Bistorta* (L.) Adans. among others) from *Persicaria* is rather equivocal. On a practical level the distinction between *Aconogonon* and *Persicaria* is obscured because one other 'large, leafy, branched species', *P. wallichii* Greuter & Burdet (*Polygonum polystachyum* Wall. ex Meisn.), morphologically resembles an *Aconogonon* but is in its technical details (style length, stigma and pollen form, seed shape) a *Persicaria* (Hong 1993). This species does not occur in Scandinavia, but using Reiersen's generic key it would wrongly key out to *Aconogonon*. For this purely practical reason I prefer not to split off *Aconogonon*, at least until generic and sectional limits are better understood in this group, so the hybrid plant needs recombining under *Persicaria*:

Persicaria* × *fennica* (Reiersen) Stace, **comb. nov.*

Basionym: *Aconogonon* × *fennicum* Reiersen, *Nordic J. Bot.* 19: 386 (1999).

ACKNOWLEDGMENT

I am grateful to Ann Conolly for advice on several points.

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THE RE-APPEARANCE OF *LOBELIA URENS* L. FROM SOIL SEED BANK AT A SITE IN SOUTH DEVON

Lobelia urens L. (Heath Lobelia) is a rare plant recorded from 19 British localities before 1970, all but one in the southern coastal counties of England. From 1987 onwards it could only be found on six of these sites with population levels fluctuating dramatically depending on management (Dinsdale 1999). It has been known from Andrew's Wood (Stanton Moor) in South Devon, now a Devon Wildlife Trust Reserve, since 1889 (Martin & Fraser 1939) whilst the unimproved fields to its south and east remained its main stronghold until the 1950s (Archibold 1971).

On 8 July 1995, C. J. Smith and I visited Andrew's Wood and we noticed some "purple patches" amongst the vegetation in a field, then in set-aside, adjacent to the wood on its south eastern edge.

TABLE 1. SPECIES ASSOCIATED WITH *LOBELIA URENS* IN A SET-ASIDE FIELD ADJACENT TO ANDREW'S WOOD, SOUTH DEVON IN JULY 1995

<i>Agrostis capillaris</i>	<i>Agrostis stolonifera</i> *	<i>Anagallis tenella</i> *
<i>Centaureum erythraea</i> *	<i>Cerastium fontanum</i>	<i>Cirsium arvense</i>
<i>Cirsium palustre</i>	<i>Crepis capillaris</i>	<i>Galium uliginosum</i>
<i>Holcus lanatus</i> *	<i>Hypericum tetrapterum</i> *	<i>Hypochaeris radicata</i> *
<i>Juncus effusus</i> *	<i>Lolium perenne</i>	<i>Lotus pedunculatus</i> *
<i>Lysimachia nemorum</i> *	<i>Potentilla erecta</i> *	<i>Pulicaria dysenterica</i> *
<i>Ranunculus acris</i> *	<i>Ranunculus flammula</i> *	<i>Ranunculus repens</i> *
<i>Senecio aquatilis</i>	<i>Sonchus asper</i>	<i>Taraxacum officinale</i> *
<i>Trifolium dubium</i>	<i>Trifolium pratensis</i>	<i>Trifolium repens</i> *
<i>Veronica serpyllifolia</i>		

Species associated with *L. urens* at its traditional sites are marked with an asterisk.

These patches proved to be *L. urens*. There were thousands of plants forming drifts here and there across the field. *Holcus lanatus*, *Agrostis stolonifera* and *A. capillaris* dominated the vegetation of the field. Other than some large patches of *Lotus pedunculatus*, *Lobelia urens* was by far the commonest forb present. All species recorded are shown in Table 1.

It seems unlikely that the plants in the field arose recently by way of seed rain from the large population now growing in clearings in Andrew's Wood. This population, which has varied between 2000 and 13,000 plants annually between 1975 and 2000 (G. Waterhouse, pers. comm. 2000), is isolated from the field by a considerable barrier of woodland. Dispersal is said to be limited to a "short distance" (Brightmore 1968).

It is more likely that the population in the field re-established from soil seed bank. This view is supported by evidence from another South Devon site, Yarner Wood, where plants of *L. urens* re-appeared following disturbance after a period of 40 years (Dinsdale *et al.* 1997). Additionally, many of the species established in the set-aside field, marked with an asterisk in Table 1, are known associates of *L. urens* where it grows typically in M25 and W23 communities (Dinsdale *et al.* 1997; Dinsdale 1999) of the National Vegetation Classification (Rodwell 1991). It is, perhaps, less clear why *L. urens* was able to persist in the seed bank, germinate and establish in such large numbers when associated species of forbs were so uncommon. Indeed, with the exception of *Centaurea erythraea* and *Pulicaria dysenterica*, all these species can have long term persistent soil seed banks (Thompson *et al.* 1997) as can many of the absent associates. The most likely explanation is that, in its characteristic habitats, *L. urens* relies on disturbance to regenerate. In Brittany for instance, Brightmore (1968), quoting C. D. Pigott, suggests that a ruderal response is normal. The small seed size and the large numbers of seeds produced, perhaps 15000 by a mature plant (Brightmore 1968), is more typical of the seed bank of an arable weed (Harper 1977) than a permanent grassland species. Perhaps, after nearly 40 years of agricultural improvement, the soil seed banks of the permanent semi-natural grassland species have simply become exhausted through decay and senescence. Alternatively, the conditions for seed germination and seedling establishment of these species may have been less than optimal.

Enquiries regarding the history of this field suggest (G. Waterhouse, pers. comm., 2000) it remained unimproved as late as 1960 when it was said to be overgrown with gorse and rushes and virtually impassable. The neighbouring field to the south was known as Lobelia Close and was said to be blue with *L. urens* in the 1930s. At some time during the 1960s the fields were under-drained with clay tiles, ploughed and reseeded to agriculturally improved grassland. Grazing with cattle continued throughout the 1970s, 1980s and early 1990s.

When C. J. Smith and I visited the field in 1995 the field was set-aside and had, presumably, been ploughed and cropped at least once. We visited the site again in 1999 when there was a crop of flax, but no sign of any *L. urens*. However, in 2000, two large patches comprising an estimated 2000 plants of *L. urens* re-appeared in a wide fallow margin on the edge of a flax crop (G. Waterhouse, pers. comm., 2000).

The importance of disturbance and the presence of a persistent seed bank for the maintenance of populations of this species has already been stressed by both Archibold (1971) and Dinsdale *et al.* (1997). This evidence supports that view and also indicates the possibility of the reclamation of

such sites even after many years of agricultural improvement. The seed bank is less likely to have become impoverished where a site becomes overgrown or where it is managed as permanent grassland, whereas continuous arable cropping is likely to exhaust the seed bank more rapidly. Investigation of the soil seed bank of former sites by taking a few soil cores and allowing any seeds to germinate would be a relatively simple procedure to confirm its presence prior to attempting large-scale intervention.

Devon Wildlife Trust made an unsuccessful bid to purchase these fields when they came up for sale again during 2000. On 4 August 2001 the field was visited during a B.S.B.I. meeting. The field was set-aside again and *L. urens* was locally abundant (R. Barrett, pers. comm., 2001). All the traditionally associated species recorded in 1995 were also present together with another 15 known associates. It is now hoped that the field will be managed within a Country Stewardship Agreement.

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Book Reviews

Domestication of Plants in the Old World. 3rd edition. D. Zohary and M. Hopf. Pp. 316. Oxford University Press, 2000. Pbk £22.95. ISBN 0-19-850356-3.

The evolution of agriculture was perhaps the most significant step in the evolution of human civilization. It created the basis of settled living, trade and, for better or worse, the accumulation of capital. Although we have a significant gene-pool of wild crop relatives in Britain and Ireland, especially of hedgerow fruits, so many of our crop plants reached northern Europe by diffusion from the 'cradle of agriculture' in the Middle East. Here is a fascinating account of that process, showing the origin and spread of cultivated crops in S.W. and C. Asia, the Nile Valley and Europe over the last 10,000 years. This third edition of Zohary and Hopf's book has been much updated and expanded, although a chapter on wild-collected fruits such as beech-mast and haws in the first (1988, see review in *Watsonia* 17: 504, 1989) and second edition (1993) has been dropped. The authors wisely suggest that this topic deserves its own book.

They provide an authoritative synthesis of one of the most important fields of contemporary botany. The text is packed with information and laid out clearly as a convenient reference and an absorbing read. Based on an interdisciplinary synthesis of archaeology, genetics and cytotaxonomy, chapters are devoted to cereals (especially the breadwheats), pulses (including some of the less obvious vetches), oils and fibres, tree fruits and nuts, leaf and root vegetables, condiments and dyes. All the major crops are included, and plenty of minor ones such as saffron and madder. Rice and sorghum, which probably arrived in Hellenic times from Asia and Africa respectively, are included too, although buckwheat (*Fagopyrum esculentum*), which arrived from C. and N. Asia in the medieval period, is not. Each species account has an introductory section, including variation and genetics, followed by information on its wild ancestry and on Neolithic and Bronze Age archaeological evidence, ending with a most useful recapitulation.

A chapter on representative archaeological sites, mostly in the Middle East, Levant and Europe, which lists facies of crop remains, includes three sites in Britain and one in Ireland. There are 45 black-and-white illustrations and 25 maps to augment the text, and the book ends with an extensive 45-page bibliography. This book deserves a wide readership but will be especially valuable to those studying Mediterranean and S.W. Asian floras.

J. R. AKEROYD

The Changing Flora of Glasgow. J. H. Dickson, P. Macpherson, and K. Watson. Pp. xii + 402. Edinburgh University Press, 2000. £30.00. ISBN 0-7486-1397-8.

This is a remarkable flora by three much respected botanists with contributions by three other distinguished authors and colour photography by T. N. Tait. It is, in a sense, the scientific sequel to Dickson's *Wild Plants of Glasgow*, 1991, which was a selective report on the Flora of Glasgow survey aimed at the general reader (review - *Watsonia* 19: 155, 1992).

It represents a meticulous study of a restricted area, 'The Rectangle', comprising 3.6 hectads which includes urban Glasgow and an almost equal area of green belt. This area has been selected to include the area of the City of Glasgow District Council, but is bounded by Ordnance Survey grid lines. It corresponds fairly closely with the area surveyed in detail by Thomas Hopkirk in 1813 when he recorded 670 flowering plants and 32 ferns. The fate of Hopkirk's plant localities and those of many other botanists over the years have been fully researched and this, together with some archaeobotanical evidence, is the basis of the book's title.

Introductory sections not only cover the area's geology and climate but also include a splendid chapter 'Spreading of the City: Medieval Times to the Late Twentieth Century'. This is superbly illustrated by maps, paintings and photographs, including an amazingly apposite map of 1795, almost contemporary with Hopkirk, which details the area just before the great environmental changes of the 19th century. A further chapter considers pollution. Later in the book, it is fascinating to learn of the effects of air pollution on the distribution of *Asplenium* spp. on walls.

After the species accounts there are some further chapters in which the pen of Professor Jim Dickson is particularly evident, and some of the material is common to *Wild Plants of Glasgow*. These examine invasions, extinctions, current distribution patterns and conservation. The approach

adopted is to take particular examples and to examine these in some depth, but in a highly readable style that provocatively leads to the exclusive use of English names. Rayed Groundsel (a taxon unfairly excluded from Atlas 2000) is hailed as an example of an extreme urbanophile together with such garden weeds as Lesser Swine's-cress (sic). The less obvious urbanophobes include Changing Forget-me-not and Ground Ivy. There are amazing stories describing the abundance of Broad-leaved Helleborine and the occurrence of Stag's-horn Clubmoss in a cemetery. Then there are the thousands of plants of Round-leaved Sundew found in an abandoned railway siding. The invasions of incomers are traced right through from the late-glacial period, with a fascinating insight into the medieval period through the medicinal plants found in archaeological digs, including the spice Mace, imported all the way from Indonesia. The later invasions along railways and roads are also demonstrated. Since 1998 Dickson has been a champion of the now fashionable concept of archaeophytes and neophytes for plants first recorded before or after the end of Medieval times, taken as AD 1500, and he develops the concept here. The section on conservation suggests valuable input by Keith Watson and all the authors are to be congratulated on the prominence placed on the future of the *Potamogeton* hybrids, especially Bennett's Pondweed. Between these chapters are interspersed 16 pages of fine and relevant colour plates by Norman Tate, a mixture of close-ups and habitat studies including a striking portrayal of the Necropolis.

The species accounts demonstrate first the heroic fieldwork by about 100 members of the Glasgow Natural History Society with the massive assistance and close supervision of the authors. The accounts are meticulous but, in consequence, somewhat difficult to read through. There is much detail of localities and recorders together with tetrad maps. These have a background delineating the urban area, the Clyde and, if you can spot it, the canal. Maps are presented for all except the rarest and ubiquitous species. 'Bladder Campion (*Silene vulgaris* ssp. *vulgaris*)' is, we learn, 'Native and/or accidental in twenty-seven, mainly diagonal, strongly urban tetrads'. This style indicates Dr Peter Macpherson's absorption with plant status, a concept he has carried through with persistence, even in cases where the outcome is indeterminate. We also learn that the principal habitats of Bladder Campion have changed from 'meadows and pastures' in 1813 to roadsides and railways in the 1990s, a neat illustration of a most widespread trend. The localities of hairy and pinkish-flowered varieties of this species are noted. The preface advises us that about 1,500 species are listed but, despite a computer database, there are no statistics to support this. Nevertheless, the total alone indicates the extensive coverage of aliens. From where else in Britain can one find a detailed distribution map of *Agrostis scabra*? This species, we are told, has been persistently present in Glasgow for at least 25 years and is spreading to waste ground sites. Planted aliens are wholly excluded resulting in a treatment of trees that is perverse to a degree. It can also be confusing to find a species listed as a former native solely on the evidence of late-glacial fossils.

The lack of statistics is particularly evident in the treatment of the 100 or so extinctions. Although the reasons for the extinctions are well analysed, it is really no surprise that Corncockle, Herb Paris, Field Gentian and the Bladderworts have disappeared. What is as remarkable is the untabulated number of equally unlikely species that have survived against the odds. Do we not need to know how this pattern of extinctions compares with the wider countryside around, and Lanarkshire in particular? Perhaps the forthcoming Flora of that vice-county will tell us? To test the value of the Glasgow data set, I have carried out an exercise to compare the extinctions of native species with those of a similar sized rural area in Berwickshire and am fascinated to find a close correspondence. It seems that, in relation to extinctions at hectad level, urbanisation may have no more drastic effect on our flora than intensive arable farming. However, the Glasgow data used in this comparison includes the data from its green belt and an interesting study could be made by comparing statistically, at tetrad and hectad level, the relative distributions of the native species in the urban parts of 'The Rectangle' with those in the green belt.

M. E. BRAITHWAITE

The Origin, Expansion, and Demise of Plant Species. D. A. Levin. Pp. 230. Oxford University Press, 2000. Hbk £49.50. ISBN 0-19-512728-5; Pbk £24.95. ISBN 0-19-512729-3.

Precisely as the title indicates, this book deals with the lives of plant species. The subject is treated in four stages, corresponding to a species' origin, expansion, differentiation and extinction. Throughout, it weaves together the wide variety of ecological and evolutionary phenomena and

processes that are involved and, as a result, it encompasses an extraordinarily broad scope but yet still manages to stay focused on the issue at hand. I was very much reminded of Dr Who's tardis: although the volume contains only 180 pages of text, which for a text book is relatively slim, it is deceptively large between the covers. Perhaps most impressive is the wealth of examples and case studies drawn from an extensive survey of the literature; based on observations, experiments and theory, they illuminate extremely well the various points being made. In this respect I was also reminded of Briggs & Walters' *Plant variation and evolution*, to which Levin's book, in some ways, could be considered a companion volume. One other thing to say about the examples and case studies is that, refreshingly, they are derived not just from North American situations but also from European and British ones as well (not to mention Africa and Asia). Indeed, B.S.B.I. members will recognise very many of the species names; it is always easier to appreciate or understand the significance of an example when one has a mental image or experience of the plant concerned.

The book is intended for "botanists, evolutionary biologists, and conservation biologists, as well as all broadly curious students of the biological sciences". The word 'professional' has been omitted here but, although the book is quite technical in some places, any amateur B.S.B.I. members who would regard themselves as belonging to any of the categories listed above should get a copy of this book and read it: they will undoubtedly learn something of interest. Conservationists will find the section on the decline and fall of species especially worthwhile. In short, this is an excellent book and I recommend it highly.

R. J. GORNALL

Wild Orchids of Sussex. D. Lang. Pp. 144, with 102 colour photographs, a number of b&w photographs, charts, maps and drawings. Pomegranate Press, Lewes, Sussex 2001. Pbk £14.95. ISBN 0-9533493-3-0.

With the sustained and intense level of interest in wild orchids, recent publications in the field have reached new heights, in the quality of their scholarship and production alike. In the context of such distinguished forebears, both in the local and international fields, it would be hard to imagine that a new local county orchid flora could find a significant place. It is vastly to the author's credit that he has achieved that aim, with a combination of scholarship, wit and above all with a collection of stunning photographs.

The book has sections or chapters covering orchid habitats in Sussex, structure of orchid flowers, germination and growth, reproduction, classification, hybridisation, and mapping: all fairly routine stuff, but which have to be covered, and are dealt with competently by the author. My only reservation in this regard is that the author might have considered including some indication of the time period covered by the solid circles or open circles on the maps. He touches briefly (perhaps slightly too briefly) on current and ongoing research into the taxonomy and nomenclature of many of our orchid species, based on the extensive DNA work of several authorities. Having referred to this aspect, the author decides to stay with traditional nomenclature. Whilst (as one of the slightly older school myself) I have considerable sympathy for the rationale of this decision, it might perhaps have been a good idea to include the revised nomenclature in the section headings for each species. It is a minor criticism. For me, however, one of the highlights of the 'peripheral' sections is the wonderfully interesting and entertaining chapter entitled, somewhat eccentrically, 'Sussex Botanologia'. This is a review of the illustrious botanists, past and present, who have graced the county with their lives or work.

The 'meat' of the book is, of course, the 33 sections on the individual orchids, written in a very readable narrative style, which I personally prefer to the pseudo-scientific laconic 'notes' which have begun to creep in in recent years. These sections are beautifully illustrated with the author's own photographs. It would be churlish to suggest that some indication as to whether or not the photographs were taken in Sussex or elsewhere might be welcome. In the majority of cases, each species is illustrated with a full plant shot and a flower-head close-up (although in one or two cases these are perhaps a little too similar in scale and magnification), and a number of subspecies, varieties and variants are also illustrated. The quality of the photography is outstanding, and it is worth noting here that the quality of reproduction in the printing process is also excellent: as far as I can see, the colour balance is more or less perfect. As I know only too well, that is no mean achievement, unless the author himself has been intimately involved with the proof stages of the colour process.

Whilst one could perhaps quibble with the slightly optimistic total of 33 orchid species for the county (after all, the Red Helleborine, *Cephalanthera rubra*, remains to be confirmed in the county, and the Lesser Twayblade, *Listera cordata*, if it ever existed in the county, was probably only imported and quickly disappeared again), there is no doubt that Sussex is a county of vast botanical riches, often in the past somewhat overshadowed by the more celebrated rarities to be found in neighbouring counties; this book goes a long way towards redressing that balance. From the riches of the Brighton Downs (Early Spider Orchid, *Ophrys sphegodes*, significant among them) to the more mundane but no less delightful Marsh- and Spotted-orchids (*Dactylorhiza* spp.) populations of the Ashdown Forest, and the newly-colonising populations of several orchid species on the roadside verges of the county, this is a vivid account of the orchid flora of one of the richest orchid counties in the British Isles. I commend this new work to committed enthusiast and newcomer alike, as a valuable addition to the considerable body of literature on this absorbing subject.

M. N. JENKINSON

The Flora of the Bristol Region. I. P. Green, R. J. Higgins, C. Kitchen and M. A. R. Kitchen, edited by S. L. Myles. Pp. vi + 276. Pisces Publications, Newbury, 2000. Hbk £27.50. ISBN 1-874357-18-8.

This is the fourth published Flora centred on the city of Bristol and the first to map the wild plants of the area. The area covered, the short-lived and recently abandoned county of Avon, is similar to that in its predecessor, J. W. White's monumental Bristol Flora (1912). Although not covering Watsonian vice-counties 6 and 34 completely, there appears to be no gap nor overlap with recent publications on Gloucestershire (1986), Wiltshire (1993) and Somerset (1997).

This atlas Flora deals "almost exclusively with records made since 1983". The lack of historical continuity with White's Flora is a disappointment, but then, as White wrote, finality in field botany is fortunately unattainable. 1,600 vascular plants are mapped over 1,500 1 km squares or their distribution is described if a map would have little value. The field work was a collaborative undertaking and began as a job creation scheme. Around 1997 a decision was evidently made to complete the project. Species accounts, mainly by Ian Green, one of the authors of the recently completed Somerset Flora, were drafted from the maps and from field experience, and the introductory text was shared out as described in the acknowledgements. Thus the Flora is the work of a committee and the editor and publisher deserve credit for a neatly laid out and attractively presented book.

The dustcover bears an idealised view of the Avon Gorge, the showpiece of the regional Flora, looking south towards Brunel's famous suspension bridge. Whilst perfectly capturing the spirit of the place, it misplaces *Veronica spicata* and surely swaps *Leucanthemum vulgare* for *Matricaria recutita*. There are eight pages of colour photographs of plants and habitats - revealing two of the authors in the field. Charming pencil or line illustrations by Brin Edwards include a perfect Bristol Rock-cress, locations such as Inglestone Common, and a collection of the tools of a botanist's trade.

The introductory material starts with a brief account of the geography, geology and climate of the region. Comprehensive accounts of the major habitats and sites of interest follow. Homage is paid by Professor Willis and others to a century of botanists, though, surprisingly, White and his contemporaries are mostly omitted. Schoolmasters, solicitors, accountants, tax collectors, doctors and dentists and even a retailer of bathroom units meet here with professional botanists as they did in the field, largely ignorant and careless of each other's weekday chores. This reviewer's doctoral thesis on the Avon Gorge has some further information, references and unpublished portraits. The bibliography is a single page, as quirky as any botanist's bookshelf, though additional references are given in the accounts of individual botanists. There are separate appendices of natives and casuals not recorded during the current survey. Unfortunately, they give only the plant name and the date last recorded, so cannot be easily followed up and investigated, thus denying readers that encouragement to out-do the authors which White recognised as adding "zest to the pursuit".

Since survey results were the main basis of inclusion of plants in the body of the work, additions to the flora should be relatively easily traced from the literature or in the field or herbarium.

Spiraea, for example, has six taxa and twelve localities recorded for Somerset but only three taxa (one dated 1983) and four localities in the Bristol list. Critical genera other than Rob Randall's *Rubus* are imperfectly dealt with and nothing is said of the "new species" of *Sorbus* claimed in *BSBI News* 75 (April 1997). Only four *Euphrasia* species were noted during the survey. The species distribution accounts are mostly short summaries, as compared to the locality lists in the Somerset atlas, and unashamedly planted species like the monkey-puzzle tree opposite Bristol Zoo are given no less space than the rarities for which the area is famous. Aliens are not so well distinguished from natives in the main text as they are in the appendices.

The evenness or otherwise of coverage has attracted some critical comment. A map of the relative density of species recorded in each 1 km square is given, but without any legend. Square ST5071 between Nailsea and Long Ashton has no density spot and since both the Holly and the Ivy are not mapped therein (as well as several common wayside grasses and clovers), the suspicion is that there were no records incorporated from that square. Such incomplete or uneven coverage must inevitably devalue the record if, as seems possible, less common species are unevenly covered. Probably the reviewer was wrong to advocate the use of so small a recording unit. The Somerset Atlas has less than 1,000 tetrads and was completed in half the time.

Some typographical and technical errors have been noticed during review. White's initials are incorrectly quoted on the title page and Skene is mis-spelt in the bibliography. Brunel's pioneering transplant of *Scilla autumnalis* (pages 26–27) was in the early 1830s, during the construction of the piers, not in 1860, when the Clifton Suspension Bridge was being completed. H. S. Thompson's herbarium is surely still at Birmingham University, not Bristol Museum. *Koeleria vallesiana* (page 23) and its hybrid (page 29) are said to occur at Dolebury Warren, but the flora text and maps fail to confirm either.

Overall, this is a useful atlas flora in the modern style, graphic enough to draw the reviewer's thoughts out of Africa and to inform him of the wider distribution of some species and the persistence of some plants he found 20 years ago. Two generations after White, the writing of this book was overdue, but the authors have left space for a more traditional account of the floristic record and its discovery.

C. M. LOVATT

An annotated topographical checklist of the flowering plants, conifers, ferns & fern allies of the Burren Region. Compiled and edited by E. C. Nelson. Pp. vii +115. Privately published at Outwell, Norfolk. IR£11.00. ISBN 0-9524847-1-4. Spiral bound.

For some years *FCB* (Webb, D. A. & Scannell, M. J. P. (1983). *Flora of Connemara and the Burren*, Cambridge University Press) has been out of print and, despite the appearance of many books on the Burren, there is still a need for a new edition of this celebrated work. This Checklist endeavours partly to fill the gap. The area covered by the *Checklist* approximates to districts 1–3 of *FCB* but, for very pragmatic considerations, sadly omits the Aran Islands which are administratively in Co. Galway.

The *Checklist* is in quite conventional format and follows the Kent-Stace nomenclature and order with English names and Irish civil service translations. The font is small but readable, but the attempt to put a cover on a spiral bound book is less than satisfactory. Some salient points with regard to the identification of each species is given, too brief to help in the identification of most species and most certainly not productive for critical species such as the Dandelions. Up to 40 publications are referenced with, helpfully - for those who have access - the relevant pages number for *FCB* and *An Irish Flora* (Webb *et al.* 1996. Dundalk) for each species. A considerable effort has been made to bring the text up to date with recent findings. Opinions are expressed on the status of species that are scarce or perhaps extinct. Coincidentally, another publication on the Burren has come to hand (Scannell, M. J. P. and Jebb M. H. P. *Flora of Connemara and the Burren* – Records from 1984. *Glasra* 4: 7–45 (2000)). The latter (restricted) publication contains additional information together with a critical reassessment of some records published in the Checklist. When the B.S.B.I. Atlas appears, the ingredients should be ripe for a revised edition of the *Flora of Connemara and the Burren*.

D. NASH

Plants and Plant Lore in Ancient Greece. J. E. Raven. Edited by F. Raven, W. T. Stearn, N. Jardine & M. Frasca-Spada. Pp. xxvii + 106. Leopard's Head Press, Oxford, 2000. Hbk £25.00. ISBN 0-904920-40-2.

John Earle Raven (1914–1980) was, like his father Canon Charles E. Raven, a Cambridge scholar who was also an amateur botanist and leading member of the B.S.B.I. (see his obituary in *Watsonia* **13**: 244–246 (1981)). His detective work in 1948 on the dubious botanical records of Professor J. W. Heslop Harrison on Rum has recently become known to a wide audience through Karl Sabbagh's book *A Rum Affair*, reviewed in *Watsonia* **23**: 349 (2000) by Michael Braithwaite. This new book brings together in an attractive format John Raven's four J. H. Gray Lectures delivered in Cambridge in 1976 (previously published in *Annales Musei Goulandris* **8**: 129–180 in 1990 and providing the book's title), another lecture that he gave to the Alpine Garden Society of Oxford in 1971, related essays by Alice Lindsell, William Stearn, Nicholas Jardine and Peter Warren, talented flower paintings (by Alice Lindsell) and good colour photos (by John's widow, Faith). As John was my official Classics supervisor and informal botanical mentor when I was an undergraduate, I am delighted to review the book.

Faith Raven writes in the preface that the Rum exploit and the lectures "bring to botany the same qualities: of detection and deduction, of questioning of received wisdom – and of humour". "The first lecture," writes the late William Stearn in his introduction, "made evident 'with unholy glee' the unreliability of some identifications by Sir William Turner Thiselton-Dyer (1843–1928) of plants mentioned in classical Greek literature." He says that Raven treated him "harshly but not altogether fairly", but Nicholas Jardine suggests that "John's animus against Thiselton-Dyer and his ilk was motivated not just, as Stearn maintains, by their dogmatism, but also by their *method*" – "literary and philological" rather than "botanical or historical".

John Raven's characteristic style, accurate and logical, but complex and ornate, with numerous qualifications and asides, pervades these lectures, a *tour de force* which enthralled his Cambridge audience in 1976. Here too is that self-deprecation which will be familiar to anyone who knew John or has read *A Rum Affair* ("But if you care to invite me again, which after this evening is inconceivable, ..."). With exemplary scholarship he discusses the plants mentioned by the poets Homer (some 60 out of the Greek flora of about 4300, 32 of them either trees or shrubs), Sappho, Hesiod and Theocritus (his favourite), and the work of the two best-known ancient Greek botanists, the philosopher Theophrastus (c. 370–285 B.C.), who named 500 species, and Dioscorides, a Roman army doctor in Nero's reign. However, the most memorable passages are digressions describing his own searches for the three wild tulips of Crete – apparently to contrast his own enthusiasm for first-hand fieldwork with Theophrastus' chiefly home-based study – and his step-by-step detection of what he believed to be the very pool on Cos "into which the suddenly love-stricken nymphs dragged young Hylas" in Theocritus' Thirteenth Idyll! Like John's fieldwork and like his exposure of Heslop Harrison and Thiselton-Dyer, these reveal what most motivated him – "the enthusiasm of the hunt".

There is an intriguing subplot in this book, relating to the contributions of Miss Alice Lindsell – papers entitled 'A Note on Greek Crocus' (1937, previously unpublished, where she argues that "Sir William Thiselton-Dyer, like Homer, nodded ... over the crocus") and 'Was Theocritus a Botanist?' (published in 1937) and reproductions from "a marvellous book of pencil and wash portrayals of native Greek plants ... evidently done on the spot, and dated from 16th October 1930 to 18th May 1931". It seems that these came into John's hands from "Andrew Gow, Fellow and Tutor of Trinity College [John's first college] and the leading Theocritus scholar of his generation", usually "reserved and severe" but uncharacteristically impressed by Miss Lindsell's scholarship. John was impressed too and paid her generous tribute: sometimes, one feels, she outshines him at his own game!

P. H. OSWALD

The Sussex Rare Plant Register. Edited by M. Briggs. Pp. 126. Sussex Wildlife Trust, 2001. £10.00. ISBN 1-898388-16-4.

The full title of this spirobound volume is "The Sussex Rare Plant Register of Scarce and Threatened Vascular Plants, Charophytes, Bryophytes and Lichens"; it is edited with the assistance

of P. Harnes and A. Knapp, and published on behalf of the Sussex Botanical Record Society and the Sussex Biodiversity Record Centre. Furthermore, 18 authors have contributed to the species accounts, so it is truly a cooperative venture.

The categories are clearly set out in the introduction, and conform to our Society's guidelines, that is, plants that are Nationally Rare and Scarce, plus local rarities (three or less sites in a vice-county; in this work, in either vice-county). Other native species have been included where they are important in a Sussex context, or where they have greatly declined but are not yet in the above categories. Alien species are only included where they have been well established for more than 50 years.

The species accounts are a model for other writers. They are succinct, they give the feel of the situation, and the records, praise be, almost all have 6-figure grid references, date of last records (all post-1986) and initials of recorders. As always, it is the orchids that have slightly less details; I suppose we have to accept that they and the rare ferns are the last preserves of the collectors (and cranks), but for all the rest we must nail the shibboleth about secrecy. By and large we need to tell people where plants grow to protect them from mis-management. What a change, over only 30 years or so, from when it was the collectors who were the supposed bugbear!

A propos the above the only extra item I would have tried to include would have been a note of whether the site had any "protection" as a S.S.S.I., Wildlife Trust reserve or whatever.

So, all in all, I would heartily recommend this little volume and look forward to seeing more of its kind. I hope the data are available both for updating and for incorporating with our own Threatened Plants Database.

D. A. PEARMAN

Grazing Ecology and Forest History. F. W. M. Vera. Pp. 528. CABI Publishing, Wallingford, 2000. Hbk £55. ISBN 0-85199-442-3.

This is a LANDMARK BOOK. At last someone has dealt comprehensively with the thorny problem of what the vegetation of the "Wildwood" of temperate Europe, and to some extent of eastern North America, was really like.

As a result of pollen analysis studies, many interpretations have been made of the nature of this primaeval vegetation. Hitherto published interpretations have tended to imply that these forests, in Europe at least, were extremely dense and almost impenetrable, with little light able to reach the forest floor in summer, and with few or no large herbivores present. This has become the accepted story of the European temperate forests. However, there is another very different interpretation of the history of the nature of European temperate forests, namely that these forests were in fact pasture-woodlands with many glades and open areas, due to the dominance of large native herbivores including the European Bison, the Wild Ox or Aurochs, and the wild horse or Tarpan. There were also various species of deer.

Dr Vera has produced a splendid, scholarly book, and he is to be congratulated. He has produced a comprehensive and in-depth study, leading to a re-interpretation of previous studies by woodland ecologists. Vera's concept of the primaeval forest would have had far more light and biodiversity than the dense closed forest (without large herbivores), envisaged by most earlier ecologists. These concepts, as presented by Dr Vera, delighted me when I first read of them because, for some twenty years and more, I have been convinced by my own studies in the field that the primaeval forest, at least of western Europe, must have been quite open in places; in fact with numerous glades and lawns, much as in the New Forest in Hampshire today, where the original wild herbivores have been replaced by domestic stock. If the primaeval forest was uniformly dense, where else did all the numerous light-demanding species of plants and invertebrates evolve? Most of our forest wildlife is adapted to light as well as shelter. The greatest diversity in our British (and European) woodlands is found today along edges and rides. The denser parts of our managed forests have far less biodiversity. It is clearly evident that the richest floral displays in our woodlands are where there is a combination of adequate light and some shelter from wind, promoting higher humidity. This is not just true of the vascular plants, but also for many other groups of organisms. For example, most epiphytic bryophytes and lichens clearly need sufficient light as well as humidity to flourish and it is also in well lit but sheltered glades in woodland that the majority of forest birds and butterflies are found.

The vegetation of northern temperate forests must have been evolving for millions of years, ever since the long cooling of the Pliocene had gone far enough for temperate conditions to replace the former tropical climates and ecosystems, as indicated by the fossil records. Ecologists seem often to put too much emphasis on evidence from Interglacial and Devensian (Postglacial) changes, forgetting that these periods were quite short in terms of time for evolutionary changes, compared to the millions of years that the Pliocene era lasted. The Pliocene must surely have been the key period for the evolution of recent temperate ecosystems. The changes in flora would clearly have reacted with the fauna. Perhaps too often the role of large herbivores in the development of our forest vegetation has been under-emphasised: the large animals must have been a major driving force, interacting with the available flora by creating and maintaining open habitats.

It is no accident that dense, closed canopy high forests have a low biodiversity. The intense internal shading ensures this. Many believe, quite wrongly in my view, that grazing by large herbivores impoverished the flora and fauna of a wood. It certainly must reduce the biomass of the ground flora, but in an ungrazed forest this is very limited in species diversity anyway. I first raised these issues myself in the small book *Pasture-Woodlands in Lowland Britain* (Institute of Terrestrial Ecology; NERC 1986) with Paul Harding as co-author. At that time few woodland ecologists seemed to agree with us, so I was naturally delighted when Dr Vera produced in 2000 his magnificent and in-depth study of the history of temperate forests. One series of phenomena which convinced me of the truth of this concept of temperate forest history, was the observed behaviour of epiphytic lichens. It became clear to me years ago that well developed woodland lichen florae are closely correlated with open, rather park-like pastured woodland. For me, the implication is that during their long history such forests were almost certainly open rather than dense, otherwise their evolution would have been quite different.

Other writers, such as George Peterken, have suggested that in the North American temperate forest, particularly in the east, bison and other large herbivores were of no great importance in the dynamics of the forest. Peterken deduces from his studies that fire and storms were more important factors than the large herbivores. Vera's research has included study of earlier historical accounts, dating from the early 17th century. These seem to indicate that the forests were far more open at that time, and that bison were abundant.

I would reiterate that in my opinion this is an extremely important book for those interested in just how the vegetation of temperate Europe north of the Alps, evolved in the post-glacial Devensian period. There has been so much misinterpretation of this story for many years.

F. ROSE

The Cambridge Illustrated Glossary of Botanical Terms. M. Hickey and C. King. Pp. xii + 208. Cambridge University Press, Cambridge, 2000. Hbk £52.50. ISBN 0-521-79080-8; Pbk £18.95. ISBN 0-521-79401-3.

This volume, similar in format to the authors' *100 Families of Flowering Plants* (1981) and *Common Families of Flowering Plants* (1997), will be welcomed by users and admirers of these earlier works. After a brief introduction which includes a useful couple of pages on symbols, general and numerical prefixes, suffixes and taxonomic ranks, the work progresses to a 46-page glossary, followed by clear illustrations which elucidate what many of the terms in the glossary mean. The illustrations of 'features of certain plant families' are particularly useful, and help to remind the reader of terms which are peculiar to such groups as orchids and pteridophytes (lower plants are not included).

When reviewing glossaries it is inevitable that the reviewer will quibble about the meaning of some terms, and berate the authors for excluding other terms. My personal quibble is the definition of stolon as 'a lateral stem growing horizontally at ground level, rooting at the nodes and producing new plants from its buds ...'. If this is correct, what should one call the arching stems of *Rubus fruticosus*, which cannot be described as 'growing horizontally,' but for which I can neither find (nor want to find) another term. As far as the inclusion of terms goes, the Glossary is most likely to be consulted by people interested in plant morphology, looking up terms which they come across when using keys, or studying species descriptions. I can think of no important morphological term which has been omitted; if anything, the authors tend to be too inclusive. There is an uneasy boundary between the necessity of using precise terms to describe a feature,

and cluttering up one's work with unnecessary jargon. In my opinion a few of the terms in this book fall into the latter category. For example, do we need 'chiropterophilous' when we can use 'bat-pollinated'? However, while people continue to use jargon, the compilers of glossaries have a duty to include them.

I shall keep the work on my desk, where, no doubt, I will frequently consult it. I encourage others to do likewise.

A. R. VICKERY

Loch Lomondside: Gateway to the Western Highlands of Scotland. J. Mitchell. Pp. 232. Harper Collins (*New Naturalist*), 2001. Hbk £34.99. ISBN 00-220145-3. Pbk £19.99. ISBN 00-220146-1.

With Scotland poised to have its first National Park designated, after a very long gestation, this latest addition to the *New Naturalist* series is very well timed and serves as an invaluable reference source. Such an important book could have had no better author than John Mitchell, who has had a long and intimate relationship with the area, through both work and play. Working since 1966 for the former Nature Conservancy as Reserves Warden, the author has developed a comprehensive knowledge of the area, thoroughly researching the wealth of literature and contributing a number of articles of his own. The product is a compact distillation of all the factors that produce the dramatic landscape and natural heritage that greets the millions of visitors who enjoy the area every year.

The book is divided into three main parts: the first two, comprising the first half of the book, look at the physical geography and the impact of the various human groups on the landscape. The effects of climatic events such as great freezes and gales and the impact of devastating fires on the relict Scots Pine woodlands are discussed. Direct human actions have affected the loch water levels and surrounding forests and caused drastic agricultural changes. In addition the reader can learn about stag hunting, the last wolves and the curious wild white mountain bulls, and also learn about introductions such as the Capercaillie and the Red-necked Wallaby.

The latter half of the book is concerned with the natural heritage in chapters on the loch, lowlands, woodlands and mountains. Each chapter summarises the vegetation and botanical interests, describing common and rare species: detailed information is provided on the oak and yew woodlands and on famous botanical residents such as the Scottish Dock (*Rumex aquaticus*), Elongated Sedge (*Carex elongata*), Pillwort (*Pilularia globulifera*), Eight-stamened Waterwort (*Elatine hydropiper*) and Mudwort (*Limosella aquatica*); wider botanical interest includes bryophytes and lichens. The chapters, as would be expected from the author's all round knowledge, also provide fascinating accounts of the rich fauna.

The text is very well written and manages to communicate complex issues in a succinct and very readable manner. The text is supported by 120 black and white photographs with eight plates providing high quality colour. One criticism is the lack of a detailed map; any reader would be advised to have a good map to hand, to allow for orientation. There is a further reference section, although this might have been more useful if it had been linked to individual chapters or subject headings.

I found the book a fascinating read and, although not primarily a book about plants, any botanists with an interest in Scotland and the understanding of the complex issues influencing our natural inheritance will be well rewarded.

K. WATSON

Obituaries

WILLIAM THOMAS STEARN (1911–2001)

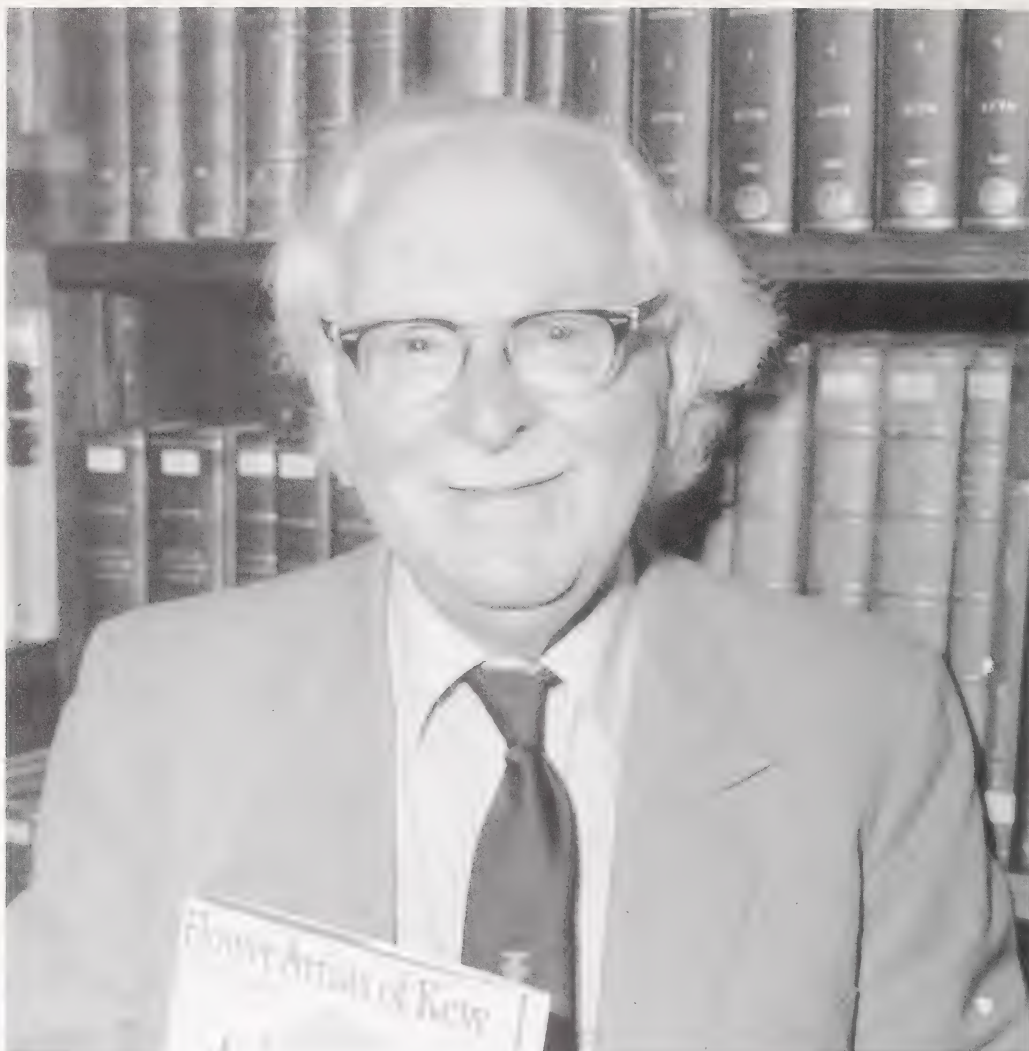
Professor William Stearn, who died 9th May 2001 aged 90, made all taxonomists indebted to him for his studies in the history of botany and its publications and, in particular, for the four editions of his *Botanical Latin* (1966–1992) and his 176-page Introduction to the Ray Society's edition of Linnaeus' *Species plantarum* (1957). He also produced valuable monographic work, notably on *Epimedium*, *Paenonia* and *Allium* (of which he was a world expert), and floristic treatments of e.g. Jamaica and Nepal. His contributions to horticultural taxonomy and the study of the literature of horticulture were likewise both numerous and learned; and in this regard his drafting of the original *International Code of Nomenclature for Cultivated Plants* (1953) must be mentioned. Stearn's horticultural interests led him into a study of botanical illustration, of which he also became a noted expert, resulting in the publication, with Wilfred Blunt, of *The Art of Botanical Illustration* (1950). Stearn's revised and enlarged edition (1994) of this book confirmed it as the standard work on the subject.

William Stearn was born in Cambridge and, after a period as an assistant in a Cambridge bookshop (when he began studying in his spare time), he became an assistant in the R.H.S. Lindley Library at the age of 22. He had already, four years previously, published the first of his many botanical papers – on a fungal disease of *Campanula*. After service during the Second World War in the RAF Medical Corps (being a Quaker, he was unwilling to bear arms), he returned to the Lindley Library, where a major task was his completion of the fourth and last volume of *The RHS Dictionary of Gardening*. The flow of his publications continued unabated and eventually totalled 470 – books, papers and contributions to composite works.

In 1952 he moved to the British Museum (Natural History), where he joined the staff of the Botany Department. Here he was in charge of Section 3 of the General Herbarium (the last third of the Dicotyledons in the Bentham & Hooker system) and worked officially on the long-established *Flora of Jamaica* and *An Enumeration of the Flowering Plants of Nepal*. Stearn nevertheless found time to complete (alone or in collaboration) articles and/or books on *Allium*, *Lilium*, *Paenonia* and *Anemone* and many other subjects, including the taxonomy of *Cannabis*. Despite this busy productive life, he always had time for fellow staff members – and others – who invoked his help. The answer to an apparently simple question often involved excursions in unexpected directions. My inquiry about the Latin for 'saddle', for instance, resulted in a lecturette on Roman cavalry. They used saddle cloths (*ephippium*, something placed on a horse, usually a saddle cloth), not saddles – which appeared much later and for which the word *sella* (seat, chair) was used.

William Stearn's retirement in 1976 did not have any apparent effect on the stream of works that issued from his pen. I use this word advisedly; all his careful, always unjoined writing was done with a fountain pen, much of it being typed by his wife, Ruth, who was a constant support to William in all his endeavours. Together they translated and edited Hellmut Baumann's *Greek Wild Flowers and Plant Lore in Ancient Greece* (1993), Greece and its flora having been subjects of long-standing interest to him. As a result of his experiences as a botanical courier on holiday cruises, he was concerned to bring to an end the practice of weed-killing the ancient sites in that country. He would have been gratified to learn that it has become much less common in recent years. After retirement he undertook the editorship of the *Annales Musei Goulandaris*, which he continued to edit until 1999, the year of publication of *John Lindley, 1799–1865*. This volume, celebrating the bicentenary of the birth of the famous botanist and secretary of the RHS, was edited by him; and his introductory biographical chapter was a major contribution to it. In his old age William returned to his first taxonomic love, the study of *Epimedium* (Berberidaceae), a revision of which was all but ready for press when he died.

Stearn's many honours included the CBE, the Gold Medal of the Linnean Society (he was the authority on Linnaeus, President of the Society, and its Botanical Curator for many years), the Victoria Medal of Honour of the R.H.S., the Asa Gray Award by the American Association of Plant Taxonomists and the Engler Medal of the International Association of Plant Taxonomists. In addition he received honorary degrees from the Universities of Leiden and Uppsala and was created Commander of the Star of the North by the Swedish Academy of Sciences for his work on Linnaeus.



Prof. W. T. Stearn, 1991. Photograph reproduced by kind permission of the Royal Botanic Gardens, Kew.

William Stearn had been a member of the B.S.B.I. since 1954. He was co-opted on to the Maps Committee in 1955 to help with the preparations for the original edition of the Atlas (1962), became a full member the following year, and continued as a committee member until 1968, the year after it changed into the Records Committee. For 40 years he was the B.S.B.I. Referee for *Allium*; with his world-wide experience of the genus, he will be very difficult to replace. His great knowledge of Botanical Latin was put at the Society's disposal when he gave the principal lecture at the meeting on this subject in Reading in February 1995. William was often to be seen at B.S.B.I. conferences; and he was always as ready to share his encyclopaedic knowledge with amateurs as with his professional colleagues. In so many ways he will be very much missed.

Much of the above information and more can be found in the extensive obituaries that appeared in *The Daily Telegraph* (10. v. 2001), *The Times* (11. v. 2001), *The Independent* (15. v. 2001), *The Guardian* (6. vi 2001, by Max Walters) and *The Garden* (July 2001). I am indebted to Mary Briggs for additional details.

N. K. B. ROBSON

BRIAN BROOKES
(1936–2000)

Brian Brookes, a BSBI member for 40 years, died at the early age of 64 in December 2000. After Beckenham and Penge Grammar School (where he was a pupil of Frank Brightman; like him he became a beekeeper as well as a botanist), Brian gained his botany degree and education diploma at King's College, London. He taught at Sloane Grammar School and before that at Forest Hill, London's famous Comprehensive School (he said, in later years, that no-one could claim that they were a real teacher unless they had regularly taken the Friday afternoon class of non-readers!).

With the late David Stanbury, Brian took his students on field courses to, amongst other places, the island of Handa off the coast of Sutherland and to Slapton Ley Field Centre. In 1965 he became Assistant Warden at Slapton; he was recommended for the post with the words "this man will identify all your plants for you - by the cotyledons - and he's waterproof!". He and I together wrote the paper on the flora of what is now the Slapton Ley National Nature Reserve. Brian was an excellent, enthusiastic and thorough field botanist and a most pleasant companion in the field; his good humour never flagged even as, for many weekends in succession, we fought our way through thicket and reedswamp in order to record every corner in detail. The Higher Ley was, in those days, so impenetrable that we were forced to explore it in a boat, using a very specialised rowing technique devised and operated by Brian, where the oars, instead of pulling on the water, were worked against the aerial stems of the dense *Phragmites* stands.

In 1967 he became Warden at Kindrogan Field Centre, where many B.S.B.I. members will remember him for his patient and inspirational teaching.

After 18 years at Kindrogan he ran field courses privately and developed a consultancy service, working principally on his own and almost exclusively in the Scottish Highlands.

Ten years ago, he and Joan bought the farm of Borelick, 54 acres of some of the poorest farmland in Highland Perthshire. The object was to provide a practical demonstration to show that it is possible to increase productivity through farming and forestry whilst, at the same time increasing the biodiversity of the wildlife. This led them to the need for hardy livestock and so to a special interest in Luing cattle. He thus had a first hand understanding of hill farming, woodland management and forestry and consequently was able to bridge the gap between biological science and practical management. This combination made him stand out amongst environmental consultants in the UK and led to the high regard in which he was held. He did a prodigious amount of habitat survey work, vegetation mapping and report writing.

Brian advised government agencies, serving on regional advisory committees of the Forestry Commission, and did much work for Scottish Natural Heritage. In these last years he surveyed some of the most remote areas of the Highlands, often living under canvas, miles from the nearest road. He gave advice to a great number of Scottish estates; in the last five years of his life he made five major vegetation surveys every year - 10,000 hectares per year, spent knee deep in the wettest of wet places in Britain. These were mostly full N.V.C. surveys, often in preparation for natural regeneration schemes and environmental assessments for woodland management. Always his interest was in the long-term view and he had no time for "quick buck" economic land uses or for merely sentimental preservation; his concern was for the whole ecosystem, not just a golden eagle.

Despite his heavy workload, he gave enormous amounts of his time to non-governmental agencies - including the Scottish Wildlife Trust since its inception 30 years ago. He served on many S.W.T. committees and management groups, in particular its Reserves Committee (he had become responsible for the Loch of the Lowes reserve before the ospreys arrived; he then had to cope with the consequences of their presence). More recently, he had chaired a S.W.T. committee looking at grazing management; he was able to provide advice on potential woodland schemes and their likely effect on hill grazing regimes.

He was a fine teacher and his enthusiasm inspired professionals and amateurs alike. His special skills were recognised when he was made an M.B.E. for his work at Kindrogan.

He wrote the British Naturalists' Association *Guide to Mountains and Moorlands* which contains a splendidly clear statement of his practical philosophies, illustrated with the most telling photographs, many his own - all just one more demonstration of his skill as a communicator.

A few weeks before the final return of his illness, his two small grandsons had stayed at Borelick; Brian would have been gratified that, on being told of his grandfather's death, the response of the six year old Daniel was great disappointment and annoyance that never again could his grandfather take him to find the small beasties in the Borelick Burn.

At Brian's Memorial Meeting, in the snows of Amulree, Perthshire, last February, a letter from Miroslav was read out. Miroslav, from the former Yugoslavia and in Britain with his diplomat father, had been a pupil at Sloane; he wrote to say how much, amid the horrors that had befallen his country, he had been sustained by contemplating the world of nature to which, as a schoolboy, he had been so ably introduced by Brian Brookes, his former schoolmaster.

Brian's ashes were scattered on Handa, the island whose vegetation he had mapped and monitored over 30 years; not inappropriately, there was such a wind blowing that perhaps some part of him got even as far as Iceland.

AILSAS BURNS

(taken, except for the first three and the last three paragraphs, from the obituary by Don Aldridge).

DEREK ARTHUR WELLS

(1930–2001)

Derek Wells died from cancer on 9 June 2001. He was born at Marlingford on the River Yare a few miles west of Norwich where an early interest in natural history was inspired by his teacher at the village school, Mrs Elizabeth Morgan, and by the local poacher. He was the first boy from the school ever to go to Norwich Grammar School. After National Service in Germany he went to King's College, Newcastle and graduated in Agriculture in 1954.

His first post was in the Grassland Division of the East of Scotland College of Agriculture in Edinburgh where he quickly developed an interest in grasses and skills in their identification: he was renowned for his ability to name species from their leaves in hay. During his time in Edinburgh he was an active member of the Natural History Society and became President in 1960. In 1966 he moved to Monks Wood Experimental Station of the then Nature Conservancy, near Huntingdon, to join the Conservation Research Section, led by Dr Eric Duffey and later renamed the Lowland Grassland Section. Here he worked alongside that other grassland Wells - Terry from whom he was humorously separated by Lynne Farrell in *BSBI News* (1981) as 'Wet Wells' (*Wells palustris*) 'found almost exclusively in wet meadows or neutral grasslands, therefore the wearing of wellingtons often a distinguishing characteristic' whereas Terry was 'Dry Wells' (*Wells campestris*) 'found on dry chalk grassland slopes'. After the Nature Conservancy was split up in 1973 Derek left Monks Wood to join Dr Derek Ratcliffe in the Chief Scientist's Team of the new Nature Conservancy Council as specialist adviser on grasslands, heaths and agriculture, first in Huntingdon and then, from 1984, in Peterborough. Before he retired as Senior Grassland Ecologist in 1990 he had added vascular plants to his responsibilities.

Derek had more the look and voice of a farmer than of a scientist and his ability to talk to farmers in their own language earned the trust of many who would otherwise have been suspicious of 'a man from the Ministry': his patience and understanding were vital attributes leading to the securing of sites such as Parsonage Down and North Meadow, Cricklade in Wiltshire as National Nature Reserves.

Derek Wells joined the B.S.B.I. in 1962. He was co-opted to the Records Committee in 1981 and elected a full member the following year. In 1981 he was appointed as B.S.B.I. Plant Recording Scheme organiser to liaise between plant recorders and the Biological Records Centre at Monks Wood and quickly set about preparing new procedures for assembling and storing records. He became more widely known to V.C. Recordors when he organised a conference for them in the Norfolk College of Agriculture in 1983. Here he introduced the scheme to survey the species with 3 or fewer records in each vice-county as an indication of the most threatened and rapidly declining species across Britain. A year later he became chairman of a sub-committee to draw up plans for a new recording project which resulted in the launch of the Monitoring Scheme on 1 January 1987. He was chairman of the Monitoring Scheme Steering Committee (with special

responsibility for liaison with the Nature Conservancy Council) which saw the project to its conclusion with the publication of the Monitoring Scheme Report (Rich & Woodruff 1990). Thereafter, until he retired from the Records Committee in 1992, Derek played a significant part in the organisation of Records' Conferences and in stimulating Records and other members to contribute to various recording projects.

In 1990 he became joint Recorder (with Gigi Crompton) for v.c. 29 Cambridgeshire, a position he kept and relished until his death. He set up the Cambridgeshire Flora Group to collect records by parishes as well as by tetrads. During his final illness he sent some 90,000 records for v.c. 29 to the Biological Records Centre for *Atlas 2000*.

Another major task he undertook was to finalise the definitive list of species in his v.c. for the B.S.B.I. Database (Leicester).

Derek was an excellent teacher, especially in the field, and during his retirement he was an inspiring leader in the Botany Group of the Cambridge University of the Third Age helping to organise some wonderful excursions for them to other parts of Britain.

He was an infrequent author, but with colleagues at Monks Wood he wrote *Grassland Ecology and Wildlife Management* (Duffey *et al.* 1974) and he later collaborated with Noel King to write an article on 'The Flora of Neutral Grasslands in Wiltshire' in *Supplement to the Flora of Wiltshire* (Stearn 1975) which recognised six types of neutral grassland in the county - amongst them the fritillary meadows on the Gloucestershire border which they described as: 'together with the *Carex humilis* chalk grasslands of south west Wiltshire, ... the twin botanical glories of the county'. He was also a major contributor to the section on lowland grassland in *A Nature Conservation Review* (Ratcliffe 1977) for which most of the surveying was done in collaboration with Karen Buckley, Lynne Farrell and Terry Wells. He made a number of contributions to symposium volumes and conference reports notably a paper on 'The protection of British rare plants on nature reserves' in *The Biological Aspects of Rare Plant Conservation* (Synge 1985). For nearly 30 years he made an annual pilgrimage to Bratoft Meadow, Lincolnshire where he joined Barrie Wilkinson to count the number of flowering spikes of green-winged orchid, *Orchis morio*. Results from the first 23 years were published in a paper of which he was one of the joint authors (Silvertown *et al.*).

Botanical friends who saw him only when he was 'in the field' may be surprised to learn of his other enthusiasms: he was passionate about the 'Canaries' (Norwich City Football Club), music, history, whist and table tennis. For many years he taught the young of St Ives to play the latter and even took teams to compete in St Ives' twin town in Germany.

I am most grateful to Mary Briggs, Gigi Crompton, Philip Oswald, Bridget Smith Terry Wells and Barrie Wilkinson for their invaluable help in preparing this tribute to my former friend and colleague at Monks Wood. We all remember him with gratitude and affection.

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F. .H. PERRING

EDWARD BENEDICT BANGERTER
(1911–2001)

Those who have been members of the B.S.B.I. for more than three decades will remember Ted Bangerter (also known to his many botanical friends as 'Bang'), and be aware of the outstanding service he gave to the Society over many years. This is because the post-retirement section of his long life was spent in the Antipodes, and British botany's loss was literally New Zealand's botanical gain.

He was born in London, in a family which had come from Switzerland a few generations earlier. He was educated at Holloway School, where he matriculated at the early age of fourteen and subsequently gained a scholarship to Cambridge. However, he had by then formed a lasting attachment to Queenie which exceeded his commitment to education and, despite the very strong opposition of his parents, they soon married. In those days husbands were expected to have some visible means of financial support for their wives, so further education, leading to a career as a doctor that his parents had planned, was precluded. Accordingly, he joined the staff of the Natural History Museum (then British Museum (Natural History)) in 1931, as an assistant in the British Herbarium of the Botany Department under the legendary A. J. Wilmott whose knowledge of the British flora was only equalled (at least in departmental mythology) by his king-sized personality. Bangerter used to tell colourful stories about Wilmott's taxonomic confrontations with other botanists – in particular his 'discussions' with Wolley-Dod (author of the flora of *Sussex* and a *Rosa* specialist) must have sounded like *Jurassic Park*! Learning his curatorial job was enlivened by a trip to the Outer Hebrides with his colleague Jim Crabbe from the Fern Section, to assist Wilmott and Maybud Campbell (another larger than life sized character, who as a notable amateur was also a devoted supporter of the Society). What a trip that must have been! As for all botanists of that vintage, the Second World War interrupted his career through service in the army, most of which was spent in India as a cryptographer in the Intelligence Corps. This was reflected in later life by his devotion to cryptic crossword puzzles, and colleagues will remember that he was never quite at ease if he had not completed the Telegraph puzzle before starting work in the morning.

Wilmott died in 1950 and was replaced at the Museum by Dr Alexander Melderis whose substantial frame belied his most kindly and benign personality. However, coming to this country from Latvia via Sweden, after a career very cruelly disrupted by the war in eastern Europe, Melderis had initially much to learn about Britain, its flora and the English language. At this time Bangerter played a crucial role in maintaining the continuity of the department's activities. He joined the Society two years before I first met him in 1951, when I was a museum vacation student and, like many others, had reason to be grateful for his fatherly support and extensive knowledge of the collections. When a year later I joined the Museum staff, his welcome and support eased my early days in the Botany Department. He was by now deeply involved in the work of both the B.S.B.I. and the London Natural History Society, in association with great amateurs of the time like Ted Lousley, John Dony and Duggie Kent. With the Botanical Section of the L.N.H.S., he was closely concerned with the comprehensive survey of Frensham Ponds. His service to that society was recognised by his election to council in 1953, as Chairman of the Botany Section in 1955 and as President in 1959. I understand that an L.N.H.S. obituary will appear in due course. His central position in the Museum enabled him to play an informal but valuable liaison role that oiled the working of both societies. He acted as B.S.B.I. postmaster, redirecting the mail sent to the Society's official address at the Museum to the appropriate officers. At that time a vast quantity of the Society's back numbers of publications was stored at the top of the Museum's East Tower, and many of his lunch hours were spent dealing with orders and posting the resultant packages. His formal involvement as an officer of the Society included four terms on Council and service on the Meetings, Publications, Development & Rules and Records Committees. He undertook the onerous duty of Hon. General Secretary 1964–67, at a time of change in the Society from the long term sterling service of Ted Lousley and John Dony to an evolving situation that has led to the Society as we know it today.

He had by then reached a position of some seniority in the somewhat stratified departmental hierarchy. The Keeper of the time had managed to justify an additional staff post of Senior Experimental Officer, to act as a general co-ordinator of the department, its central office and staff. Bangerter was successful in applying for this job, for which he was in many ways particularly well

fitted, not least because his equitable and warm personality ensured that he was respected and trusted by all members of the staff, from the youngest and most junior, to his most senior colleagues. Unfortunately, the job description demanded his removal from the British Section and resulted in his place of work being located in the General Herbarium, where he had relatively little interest in, and only passing knowledge of, the totality of the world's flowering plant flora. Of course he maintained a fatherly interest in the British Section, but the circumstances inevitably meant some diminution of the department's impetus and involvement with the British flora, while leaving him somewhat at a loose end. Happily an opportunity was presented through the initiation of the department's five-year Mull project, in which a detailed field study of all plant groups was made, and which resulted in the publication of *The Island of Mull, a survey of its flora and environment*, Ed. A. C. Jermy and J. A. Crabbe in 1978. He seized the chance this project offered and was closely involved in many aspects of the work. It is a special pleasure to recall his collaboration with me in the collation of all the field, herbarium and literature records for the flowering plants and ferns, and the writing of the published account, together with chapters on the history of botanizing in the area and plant distributional patterns.

He was by then nearing the age for retirement, and his colleagues were aware that his interest and concern for British plants was only exceeded by his role as a family man – with his wife, three sons and a daughter, augmented by numerous babies that his wife fostered over the years. Meanwhile two sons had emigrated with their own families to seek fresh opportunities in New Zealand and, after retirement, he and his wife decided to visit them on the other side of the world. They went by sea armed with an open six-month return ticket, but once there, the many attractions of New Zealand and the presence of half their family made them decide to emigrate permanently. The two remaining families in England were charged with packing up and dispatching their belongings. This was a sad blow to his many friends in the Museum, the B.S.B.I. and the L.N.H.S., and there is no doubt that had he remained in Britain, we should be further indebted for many other botanical services. However, once settled in New Zealand, he rapidly established himself in the new botanical milieu and was soon appointed as an associate of the Auckland Museum. The New Zealand flora is remarkable for the number of alien plants which have become established, and we understand that his expertise and familiarity with European weeds and aliens was particularly welcome. He only made short return visits to this country, but he maintained a correspondence with some of his old botanical friends and colleagues, which clearly showed his continuing interest in British botany and that he looked forward to the arrival of the Society's publications and news of old friends.

The B.S.B.I. formally indicated its appreciation of his services and contributions by electing him an Honorary Member in 1968, but to many senior citizens of the Society, the remembrance of his warm and generous personality, and the welcome that he gave to visitors in the department will remain the most significant memorial of his life in British botany.

I am grateful to Mr John Bangerter (eldest son) for information on his earlier days, to Keith Hyatt for the L.N.H.S. connections and to many Museum and B.S.B.I. friends for other recollections.

JOHN F. M. CANNON

Report

ANNUAL GENERAL MEETING, 5 MAY, 2001

The Annual General Meeting of the Society was held in the rooms of the Linnean Society, Burlington House, Piccadilly, London at noon. The President, Dr G. Halliday took the chair in the presence of 74 members.

Apologies for absence were read out and the minutes of the 2000 Annual General Meeting, published in *Watsonia* 23: 465–467 were approved as a correct record and signed by the President.

REPORT OF COUNCIL

This had been circulated to members and the President went through it commenting on the achievements of the Society during the past year, noting with especial pleasure that the enormous Atlas 2000 project was now in its closing stages and that publication was expected in spring 2002. He expressed his and the Society's great gratitude to all who had contributed. The Honorary Treasurer presented the financial part of the report; summary accounts had been circulated to all members and full sets of accounts had been available on request by post and were now available at the meeting. He stated that the new format of the accounts was in accordance with the requirements of the Charity Commissioners. He reported that the Society's accounts were in good order and that we had worked within our means; he urged that as many members as possible make use of the Gift Aid scheme which allows the Society to recover tax paid on subscriptions. The Membership Secretary reported that again this year there had been a slight decrease in membership. The Annual Report of the Council was adopted unanimously.

BSBI STRATEGY 2000

The President proposed that the Society adopt the Strategy as approved by Council and his proposal was carried by the acclamation of the meeting.

ELECTION OF PRESIDENT-ELECT

Mr R. D. Pryce was nominated by Council; his election was unanimous. Mr Pryce thanked the meeting for electing him and stated that he intended to serve the Society as President for 3 years.

ELECTION OF VICE-PRESIDENT

Dr A. J. Richards was nominated by Council.. His election was unanimous.

ELECTION OF HONORARY GENERAL SECRETARY

Miss A. Burns was nominated by Council; her election was unanimous. She was warmly thanked by the President for her work during the preceding year when she was Acting Honorary General Secretary

RE-ELECTION OF HONORARY TREASURER

Mr M. E. Braithwaite, nominated by Council, was re-elected unanimously. He was warmly thanked by the President for all his good work on behalf of the Society.

RE-APPOINTMENT OF EDITORS, INDEXERS AND REPRESENTATIVES OF COMMITTEES

The President, after warmly thanking the Editors, Indexers and Representatives of Committees for all their hard work, proposed their re-appointment; this was accepted unanimously.

ELECTION OF COUNCIL MEMBERS

In accordance with Rule 12, nominations had been received for Mr I. R. Bonner and Mr N. S. de Sausmarez. Profiles had been circulated and would be published. The election of these new Council Members was accepted unanimously.

ELECTION OF HONORARY MEMBERS

The President stated that the nominations for Honorary Membership this year were for Mr D. A. Pearman and Dr C. D. Preston; this was in recognition of their most outstanding contribution to the Society in the production of Atlas 2000. The President said that he intended to break with tradition and himself sponsor Mr Pearman; Mr A. O. Chater was the sponsor for Dr Preston. The sponsors' appreciations were given at the meeting and will be published in BSBI News. Both proposals for Honorary Membership were accepted with acclamation.

RE-ELECTION OF HONORARY INDEPENDENT EXAMINER

The President expressed the Society's gratitude to Mr J. H. Coats, CA, for his exemplary examination of the Society's accounts. His re-election was accepted unanimously.

There was no other business and the meeting closed at 12.45 p.m.

AILSA BURNS
HONORARY GENERAL SECRETARY

INSTRUCTIONS TO CONTRIBUTORS

Scope: Authors are invited to submit Papers and Notes concerning British and Irish vascular plants, their taxonomy, biosystematics, ecology, distribution and conservation, as well as topics of a more general or historical nature. Authors should consult the Hon. Receiving Editor for advice on suitability or any other matter relating to submission of manuscripts.

Papers and Notes must be submitted *in duplicate*, typewritten on one side of the paper, with wide margins and double-spaced throughout. Pages should be numbered. Submission of final edited copy on computer disc will be requested, but two hard copies of the text are acceptable if computer facilities are not available.

Format should follow that used in recent issues of *Watsonia*. Underline where italics are required. Names of periodicals should be given in full, and herbaria abbreviated as in *British and Irish herbaria* (Kent & Allen 1984). The Latin names and English names of plants should follow the *New Flora of the British Isles* (Stace 1997). Further details on format can be obtained from the Hon. Receiving Editor or by viewing the website at:
<http://www.rbge.org.uk/data/BSBI/Activities/watsonia.htm>

Tables, figure legends & appendices should be typed on separate sheets and attached at the end of the typescript.

Figures should be drawn in black ink or be laser-printed and identified in pencil on the back with their number and the author's name. They should be no more than three times final size, bearing in mind they will normally be reduced to occupy the full width of a page. Scale-bars are essential on plant illustrations and maps. Lettering should be of high quality and may be done in pencil and left to the printer. Black and white photographs can be accepted if they assist in the understanding of the article. If you are able to submit figures on disc please contact the Receiving Editor to check they are in a suitable format.

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Submission of manuscripts

Papers and Notes: Mr M. N. Sanford, c/o The Museum, High Street, Ipswich, Suffolk, IP1 3QH.

Books for Review: Mr D. A. Pearman, The Old Rectory, Frome St Quintin, Dorchester, Dorset DT2 0HF

Plant Records: the appropriate vice-county recorder, who should then send them to Dr C. D. Preston, Biological Records Centre, Monks Wood, Abbots Ripton, Huntingdon, PE17 2LS.

Obituaries: Mrs M. Briggs, 9 Arun Prospect, Pulborough, West Sussex, RH20 1AL.

Back issues of *Watsonia* are available from the official agents for BSBI Publications, Summerfield Books (John & Sue Atkins), Summerfield House, High Street, Brough, Kirkby Stephen, Cumbria CA17 4AX. Tel: 017683 41577. Fax: 017683 41687. E-mail: bsbipubs@beeb.net



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WATSONIA

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Editors: M. Briggs, R. G. Ellis, D. L. Kelly, D. R. McKean,
D. A. Pearman, M. N. Sanford, D. A. Simpson

Botanical Society of the British Isles

Applications for membership should be addressed to the Hon. General Secretary,
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Book Reviews, D. A. Pearman

Plant Records, R. G. Ellis

Obituaries, M. Briggs

*Receiving editor, to whom all MSS should be sent (see inside back cover).

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

Presidential Address, 2001

GEOFFREY HALLIDAY

THE BRITISH FLORA IN THE ARCTIC

I should like to preface a discussion of the flora with a few words about British botanists in the Arctic. It is necessarily few since British botanists, like romantics and artists, gourmets, hedonists and political Europhiles have long been seduced by the lure of the south, Goethe's land where the orange trees bloom. In the nineteenth century the only arctic territory in the former British Empire was northern Canada and thanks to largely Admiralty inspired initiatives there was a succession of expeditions seeking to find a vital safe route, the north-west passage, to the Indies. Besides the crew, the expeditions usually included a number of variously qualified scientific members and during the course of these expeditions botanical collections were brought back to Britain to be identified and, not infrequently, written up. Two famous botanists who had a part in this were Robert Brown and William Hooker. Neither were especially interested in the Arctic, or at least not sufficiently motivated to visit it, but both made important contributions in describing species: Hooker, chiefly during the period of his professorship at Glasgow University, prior to his southwards move to Kew. The most important collections processed by Brown were those made by Ross and Sabine on the former's 1818 expedition (Ross 1819) to Baffin Bay, during which they explored both the Greenland and Canadian shores, and one made by the members of Parry's expedition of 1819–1820, chiefly during their long overwintering on Melville Island. The collectors included Parry himself, Sabine, Edwards and Ross, all of whom had taxa, both genera and species, named after them by Brown in his botanical supplement to Parry's *Narrative* (1821). About the same time, Hooker published a similar appendix in Scoresby's *A Journal of a Voyage to the Northern Whale-fishery* (1822), an account of the first visit by Europeans to the coast of north-east Greenland. He listed 35 vascular plants, many of which were already familiar to him in Scotland. However, Hooker was mainly interested in the Canadian arctic flora and it was he who wrote up the botanical collections in Richardson's scientific appendices to Franklin's narrative (1823) of the first of his two amazing expeditions (1819–22, 1825–27), again in search of the elusive Passage. Richardson, a naturalist and surgeon, covered thousands of miles on both expeditions on foot and canoe, mostly in conditions of extreme hardship, around Great Bear Lake, down the Mackenzie and Coppermine Rivers, the coast between these rivers and for more than 500 miles eastwards. The extensive collections from these expeditions formed the basis of Hooker's subsequent *Flora boreali-Americana* (1829–40). The hazardous Passage was finally completed in the 1850s.

I can think of no other British botanist of note who took an interest in the Arctic other than Nicholas Polunin, sometime Curator of the Fielding Herbarium at Oxford and a man with wide-ranging interests. During the 1930s he spent a considerable amount of time carrying out floristic and ecological work in the Canadian Arctic, publishing a number of important papers under the auspices of the National Museum of Canada. He also made a number of visits to the west coast of Greenland. He is, however, best remembered for his *Circumpolar Arctic Flora* (1959), which is still the only Flora to cover the whole area although, of necessity at that time, it features an unduly wide species concept.

The importance of Brown and Hooker is demonstrated by the fact that 10% of the vascular plants in Svalbard were first named by them, and to these we can add Smith's *Alopecurus alpinus* and Polunin's *Festuca baffinensis*.

Before proceeding to consider the flora we need to remind ourselves of the limits of the Arctic and its subdivision (Fig.1). The southern limit is now generally taken to be the latitudinal tree-line and as is very evident from the map this follows a very different path in the western and eastern Arctic. In the Hudson Bay area it plunges south to 55° N (the latitude of Carlisle) whereas in Russia and Siberia it follows the Arctic Circle, more or less, for most of its length. Within the Arctic it is helpful to distinguish between the High Arctic and Low Arctic. The latter has an oceanic climate with a relatively small annual temperature range, a mean July temperature above 5° C and a moderate to high precipitation. Conversely the High Arctic has a wide temperature range, a mean July temperature below 5° C and low precipitation.



FIGURE 1. Delimitation of the Arctic and its division into Low Arctic (stippled) and High Arctic (between Low Arctic and the Pole) (from Freuchen & Salomonsen (1960)).

In the following discussion I shall be concentrating on east Greenland, partly because this is the area that I am most familiar with but also because it has the advantage of a continuous land surface taking us from the latitude of the Shetlands to within 700 km of the Pole.

It was a surprise to me to discover just how well the British flora is represented in the Arctic. Using his wide species concept Polunin (1954) estimated that native British species account for 32% of the total arctic vascular flora of 833 species. Table 1 shows the percentage representation in four sectors of the Arctic; the critical genera *Hieracium* and *Taraxacum* are excluded from these and subsequent calculations. Not surprisingly the percentage decreases westwards, and eastwards

TABLE 1. BRITISH SPECIES IN THE ARCTIC
(excluding Russia)

		Total
Alaskan Arctic Slope	26%	438
Canadian Arctic Archipelago	31%	318
Greenland	45%	452
Svalbard	40%	158
Total Arctic flora (Polunin 1954)	32%	833

also if the data for the Russian Arctic were readily available, but 26% for the Alaskan Arctic Slope, on the opposite side of the world, is, I think, quite impressive. The north American figures, likewise the Russian, would be appreciably higher but for the major role played by certain genera such as *Ranunculus*, *Draba*, *Astragalus*, *Oxytropis*, *Pedicularis*, *Antennaria*, *Artemisia* and *Puccinellia*, which have virtually no British arctic representatives. On the other hand, ericaceous shrubs are well represented, three quarters of the Alaskan species occurring in Britain; a third of Alaskan sedges are British and nearly half of the 47 Greenland species. The Alaskan Arctic Slope includes two British montane species which we never consider as arctic, namely *Potentilla fruticosa* and *Myosotis alpestris*, the national flower of Alaska. Both these species have a limited distribution in the Arctic from the Yukon to western Siberia.

If we look at the representation of Preston & Hill's (1997) British phytogeographical elements in the Greenland flora (Fig. 2) we find, as one would expect, that their Arctic-Montane and Boreal-Arctic-Montane species feature prominently but not overwhelmingly, accounting for 44% of the total British component. The Boreal-Temperate element even exceeds the Boreal-Montane and there is a not insubstantial tail of 12 Temperate zone species. However, these include two

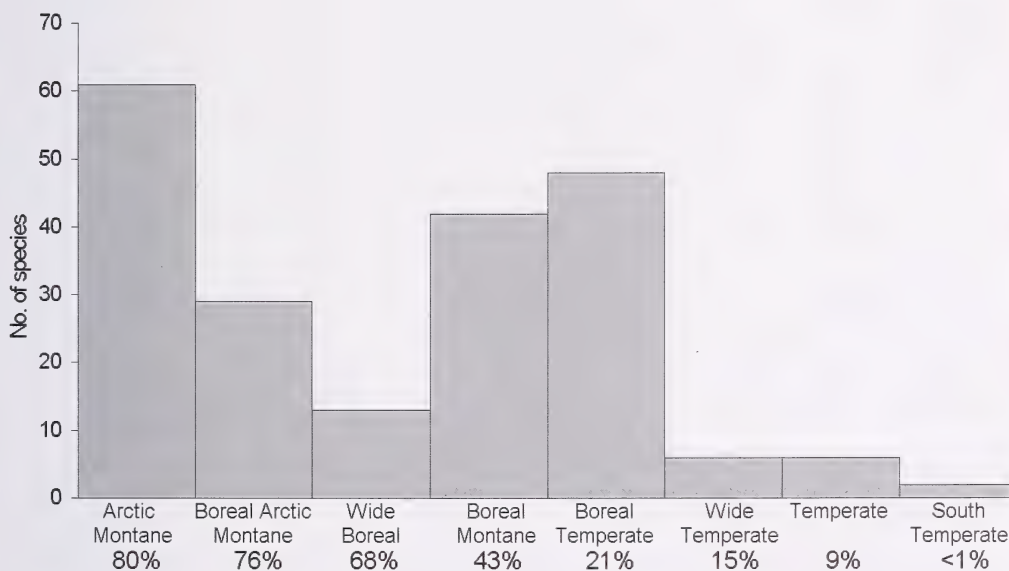


FIGURE 2. Number of species and percentage representation within each British phytogeographical element of British species occurring in Greenland.

Wide Temperate: *Agrostis stolonifera*, *Anthoxanthum odoratum*, *Eleocharis palustris*, *Juncus gerardii*, *Poa pratensis**

Temperate: *Eleocharis uniglumis*, *Juncus squarrosus*, *Myriophyllum spicatum*, *Polygala serpyllifolia*, *Rumex acetosella**

South Temperate: *Juncus ambiguus*, *Potentilla pusillus*

* aggregate species replaced, to varying extent, in the Arctic by northern segregates.

aggregate taxa, *Rumex acetosella* and *Poa pratensis*, both of which are increasingly replaced northwards by arctic segregates. In the case of *Poa pratensis* this is subsp. *alpigena*, a strongly stoloniferous plant with a narrow panicle. Interestingly, Hultén (1964), in his atlas of *The Circumpolar Plants*, shows it as occurring in the Scottish Highlands. I do not know the basis of this but it is a plant worth searching for.

The British Arctic-Montane and Boreal-Arctic-Montane species which occur in Greenland are shown in the Table 2a. It reads like E. S. Marshall's Highland shopping list, positively bristling with *Red Data Book* and *Scarce Plant* species. Notice again the large numbers of sedges. Although *Luzula arcuata* is absent from Greenland, I have included it since it is generally subsumed in the ubiquitous *L. confusa*. I have also included *Deschampsia alpina* as a species, since it is treated as such in all the Arctic Floras. The remaining species in Preston & Hill's two lists are shown in the Table 2b under their respective geographical ranges in the eastern Arctic. Note the appearance of our 'Alpine' species *Gentiana verna*, *Lloydia* and *Pinguicula alpina* in the Russian Arctic, together with *Myosotis alpestris*. Notice also the surprising absence of *Salix reticulata* from Iceland and Greenland although this willow is otherwise circumpolar. These two lists do not include three species in Preston & Hill's Arctic-Montane list: *Cochlearia pyrenaica*, *Minuartia recurva* and *M. sedoides*. These fail to reach the Arctic but were included on the grounds that they occur above the tree-line in the Boreal zone.

TABLE 2A. BRITISH ARCTIC-MONTANE* AND BOREAL-ARCTIC-MONTANE SPECIES OCCURRING IN GREENLAND

<i>Alchemilla alpina</i>	<i>Diphasiastrum alpinum</i>	<i>Oxyria digyna</i>
<i>A. glomerulans</i>	<i>Draba norvegica</i>	<i>Phyllodoce caerulea</i>
<i>Arabis alpina</i>	<i>Dryas octopetala</i>	<i>Persicaria vivipara</i>
<i>Arenaria ciliata</i>	<i>Empetrum nigrum</i>	<i>Phleum alpinum</i>
<i>Athyrium distentifolium</i>	<i>E. anagallidifolium</i>	<i>Poa alpina</i>
<i>Alopecurus borealis</i>	<i>Equisetum variegatum</i>	<i>P. glauca</i>
<i>Arctostaphylos alpinus</i>	<i>Erigeron borealis</i>	<i>Potentilla crantzii</i>
<i>Bartsia alpina</i>	<i>Euphrasia frigida</i>	<i>Sagina nivalis</i>
<i>Betula nana</i>	<i>Festuca vivipara</i>	<i>S. saginoides</i>
<i>Calamagrostis stricta</i>	<i>Gentiana nivalis</i>	<i>Salix herbacea</i>
<i>Carex atrata</i>	<i>Gnaphalium norvegicum</i>	<i>Saxifraga aizoides</i>
<i>C. atrofusca</i>	<i>G. supinum</i>	<i>S. cernua</i>
<i>C. bigelowii</i>	<i>Huperzia selago</i>	<i>S. cespitosa</i>
<i>C. capillaris</i>	<i>Juncus biglumis</i>	<i>S. hirculus</i>
<i>C. chordorrhiza</i>	<i>J. castaneus</i>	<i>S. nivalis</i>
<i>C. lachenalii</i>	<i>J. trifidus</i>	<i>S. oppositifolia</i>
<i>C. maritima</i>	<i>J. triglumis</i>	<i>S. rivularis</i>
<i>C. microglochin</i>	<i>Kobresia simpliciuscula</i>	<i>S. stellaris</i>
<i>C. norvegica</i>	<i>Koenigia islandica</i>	<i>Sedum rosea</i>
<i>C. rariflora</i>	<i>Lathyrus japonicus</i>	<i>S. villosum</i>
<i>C. rupestris</i>	<i>Leymus arenarius</i>	<i>Sibbaldia procumbens</i>
<i>C. saxatilis</i>	<i>Ligusticum scoticum</i>	<i>Silene acaulis</i>
<i>C. vaginata</i>	<i>Loiseleuria procumbens</i>	<i>Thalictrum alpinum</i>
<i>Cerastium alpinum</i>	<i>Luzula arcuata</i>	<i>Tofieldia pusilla</i>
<i>C. arcticum</i>	<i>L. spicata</i>	<i>Vaccinium uliginosum</i>
<i>C. cerastoides</i>	<i>Lychnis alpina</i>	<i>V. vitis-idaea</i>
<i>Cornus suecica</i>	<i>Lycopodium annotinum</i>	<i>Veronica alpina</i>
<i>Deschampsia alpina</i>	<i>Mertensia maritima</i>	<i>V. fruticans</i>
<i>Diapensia lapponica</i>	<i>Minuartia rubella</i>	<i>Woodia alpina</i>
<i>Draba incana</i>	<i>M. stricta</i>	<i>W. ilvensis</i>

* bold type

TABLE 2B. BRITISH ARCTIC-MONTANE* AND BOREAL-ARCTIC-MONTANE SPECIES ABSENT FROM GREENLAND BUT OCCURRING ELSEWHERE IN THE GREENLAND-RUSSIAN SECTOR OF THE ARCTIC

ICELAND	NORWAY, RUSSIA
<i>Euphrasia ostenfeldii</i>	<i>Allium schoenoprasum</i>
<i>Poa flexuosa</i>	<i>Artemisia norvegica</i>
ICELAND, NORWAY	<i>Carex aquatilis</i>
<i>Arenaria norvegica</i>	<i>Eriophorum vaginatum</i>
<i>Juncus balticus</i>	<i>Oxytropis campestris</i>
ICELAND, NORWAY, RUSSIA	<i>Salix arbuscula</i>
<i>Arabis petraea</i>	<i>S. lapponum</i>
<i>Carex dioica</i>	<i>S. myrsinites</i>
<i>Epilobium alsinifolium</i>	<i>S. phylicifolia</i>
<i>Salix lanata</i>	RUSSIA
NORWAY	<i>Astragalus alpinus</i>
<i>Euphrasia salisburgensis</i> s.l.	<i>Gentiana verna</i>
NORWAY, RUSSIA, SVALBARD	<i>Lloydia serotina</i>
<i>S. reticulata</i>	<i>Myosotis alpestris</i>
<i>Saussurea alpina</i>	<i>Pinguicula alpina</i>

* bold type

The progressive northern limits of certain British species up the east coast of Greenland, a range of 2670 km and 24° of latitude, are shown in Fig. 3. The boundary of the High and Low Arctic lies just south of Scoresby Sund at c. 70° N. It has to be remembered that there is very little ice-free land along some 350 km of inhospitable coast, the Blosseville Kyst, to the south of this. By contrast, immediately to the north is a series of fjord complexes which extend inland by up to 300 km and northwards to 77° N. These provide relatively benign conditions for many species, with mean summer temperatures actually rising locally in the interior above 5° C. These mean temperatures are shown in the figure for a number of mainly outer coastal stations.

Notice the presence in the extreme south of such common British upland species as *Drosera rotundifolia*, *Isoetes lacustris*, *Juncus squarrosus* and *Viola palustris*, as well as, surprisingly, *Achillea millefolium*. Further north, *Sedum acre* has its only Greenland station. *Juniperus communis*, *Alchemilla alpina*, *Sedum villosum* and *Armeria maritima* all fail to pass the Blosseville Kyst and reach the fjords. A cluster of warm springs at 69° 30' N and 50–60° C provides outlying stations and northern limits for *Epilobium palustre*, *Sagina saginoides*, *S. procumbens*, *Selaginella selaginoides* and *Subularia aquatica*, as well as the only Greenland localities for *Geum rivale* and *Ophioglossum azoricum*. The decrease in species proceeds apace in the fjord region, *Veronica fruticans* disappears before *V. alpina*, and the dwarf shrubs disappear in the order *Phyllodoce caerulea*, *Arctostaphylos alpinus*, *Betula nana*, *Empetrum nigrum*, *Salix herbacea* and, finally, *Vaccinium uliginosum*. Some of the species shown on this map have southern limits. The significance of some of these will be discussed later. There are also a number of species (Table 3) which occur in northernmost Greenland, the nearest land to the pole, and therefore have no northern limit; most occur throughout Greenland.

TABLE 3. BRITISH SPECIES OCCURRING IN NORTHERNMOST GREENLAND

<i>Alopecurus borealis</i>	<i>Juncus biglumis</i>	<i>Sagina nivalis</i>
<i>Carex maritima</i>	<i>J. triglumis</i>	<i>Saxifraga cernua</i>
<i>Cerastium arcticum</i>	<i>Minuartia rubella</i>	<i>S. cespitosa</i>
<i>Cystopteris fragilis</i>	<i>Oxyria digyna</i>	<i>S. nivalis</i>
<i>Equisetum arvense</i>	<i>Persicaria vivipara</i>	<i>S. oppositifolia</i>
<i>E. variegatum</i>	<i>Poa glauca</i>	<i>Silene acaulis</i>

All, apart from *Alopecurus borealis*, occur throughout Greenland and all are circumpolar with the exception of *Silene acaulis* which has a large gap in arctic Russia.

Arenaria ciliata, *Carex rupestris*, *C. saxatilis*, *Festuca vivipara*, *Hippuris vulgaris*, *Juncus castaneus*, *Kobresia simpliciuscula*, *Koenigia islandica*, *Vaccinium uliginosum*

Saxifraga aizoides

Carex bigelowii
Saxifraga hirculus

Salix herbacea

Empetrum hermaphroditum, *Euphrasia frigida*, *Honckenya peplodes*, *Minuartia stricta*, *Sedum rosea*, *Sibbaldia procumbens*

Luzula spicata
Betula nana, *Carex lachenalii*, *Poa alpina*, *Tofieldia pusilla*

Carex norvegica
Arctostaphylos alpinus, *Carex microglochum*, *Juncus trifidus*, *Potentilla crantzii*, *Sedum rosea*, *Sibbaldia procumbens*

Cerastium cerastoides, *Carex rariflora*, *Thalictrum alpinum*

Arabis alpina
Triglochin palustre, *Lychnis alpina*, *Pinguicula vulgaris*

Botrychium lunaria, *Phyllodoce caerulea*, *Veronica alpina*

Diphysastrum alpinum, *Hieracium alpinum*, *Veronica fruticans*, *Woodсия alpina*

Diapensia lapponica, *Epilobium anagallidifolium*
Alchemilla glomerulans, *Gnaphalium supinum*, *Limosella aquatica*, *Loiseleuria procumbens*, *Phleum alpinum*, *Pyrola minor*, *Woodсия ilvensis*

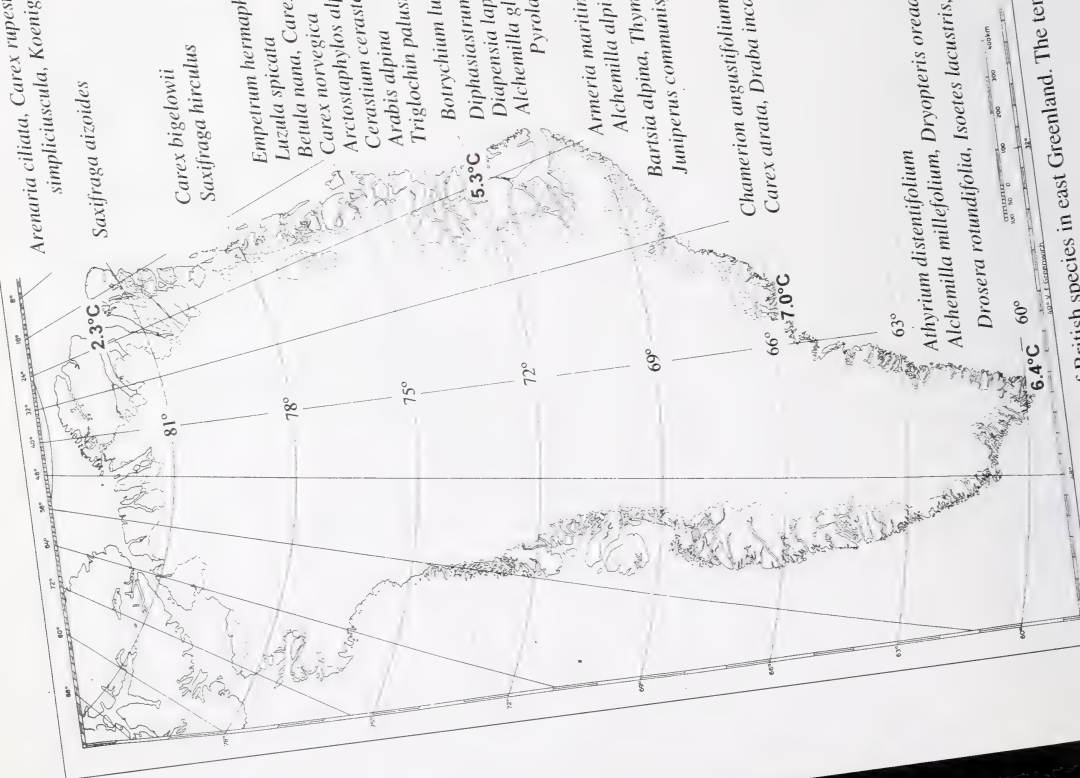
Armeria maritima
Alchemilla alpina, *Sedum villosum*, *Trichophorum cespitosum*

Bartsia alpina, *Thymus polytrichus*
Juniperus communis

Chamerion angustifolium, *Gnaphalium norvegicum*
Carex atrata, *Draba incana*, *Listera cordata*, *Sedum acre*, *Subularia aquatica*, *Viola palustris*

Athyrium distentifolium
Alchemilla millefolium, *Dryopteris oreades*, *Juncus squarrosus*, *Phegopteris connectilis*

Drosera rotundifolia, *Isoetes lacustris*, *Rhinanthus minor*



of British species in east Greenland. The temperatures are the July means of coastal stations.

A number of British arctic taxa are largely replaced northwards in the Arctic by related taxa (Table 4). About half of these pairs are diploid, or more or less so. *Huperzia selago* subsp. *arctica* and *Empetrum hermaphroditum* are the only northern taxa reported so far from Britain.

TABLE 4. BRITISH TAXA WHICH ARE REPLACED IN THE ARCTIC WHOLLY OR PARTLY BY RELATED SPECIES

a) with little or no difference in chromosome number

<i>Huperzia selago</i>	<i>Eriophorum angustifolium</i>
<i>H. selago</i> subsp. <i>arctica</i>	<i>E. triste</i>
<i>Lycopodium annotinum</i>	<i>Eriophorum vaginatum</i>
<i>L. pungens</i>	<i>E. spissum</i>
<i>Armeria maritima</i>	<i>Juncus balticus</i>
<i>A. scabra</i>	<i>J. arcticus</i>
<i>Erigeron borealis</i>	<i>Carex aquatilis</i>
<i>E. uniflorus</i>	<i>C. stans</i>
<i>Luzula arcuata</i>	
<i>L. confusa</i>	

b) with different ploidy

<i>Rumex tenuifolius</i> 2x	<i>Chrysosplenium alternifolium</i> 2x
<i>R. acetosella</i> s.s. 4x	<i>C. tetrandrum</i> 4x
<i>R. graminifolius</i> 6x	<i>Vaccinium uliginosum</i>
<i>Draba norvegica</i> 3x	subsp. <i>uliginosum</i> 4x
<i>D. glabella</i> 4x	subsp. <i>microphyllum</i> 2x
<i>Primula farinosa</i> 2x	<i>Empetrum nigrum</i> 2x
<i>P. scotica</i> 6x	<i>E. hermaphroditum</i> 4x
<i>P. stricta</i> 14x	<i>Campanula rotundifolia</i> 4x
<i>Saxifraga stellaris</i> 2x	<i>C. gieseckiana</i> 2x
<i>S. foliolosa</i> 4x	<i>Puccinellia maritima</i> 5x
<i>Saxifraga nivalis</i> 4x	<i>P. phryganodes</i> 2x
<i>S. tenuis</i> 2x	
<i>Saxifraga rivularis</i> 4x	
<i>S. hyperborea</i> 2x	

Probable allopolyploids

<i>Saxifraga aizoides</i>	×	<i>S. oppositifolia</i>	<i>Woodsia glabella</i>	×	<i>W. ilvensis</i>
2x		2x	2x		2x
		<i>S. nathorstii</i> 4x		<i>W. alpina</i> 4x	

It has long been known that the frequency of polyploids increases dramatically with latitude. In Iceland, for example, it reaches 55%, and in Svalbard 77%. It is also commoner in monocotyledons than in dicotyledons. The reasons for this have been argued at length. It has been suggested that polyploids, *per se*, are hardier. Others argue that the ebb and flow of the ice cover during the Pleistocene allowed scope for extensive mixing of floras with the potential for hybridisation and possible chromosome doubling to produce species with a wider ecological tolerance. Another suggestion is that monocotyledon families, such as Juncaceae, Cyperaceae and Poaceae, with their propensity for vegetative reproduction, were pre-adapted to take advantage of the newly-exposed, demanding habitats uncovered by the retreating ice.

However, it has to be said that the diploid-polyploid pairs listed here show almost as many instances of diploid northern and southern polyploid pairs as vice-versa. The only diploid-tetraploid pair to occur in Britain are the *Empetrum nigrum* subspecies, or species, although *Vaccinium uliginosum* subsp. *microphyllum* could perhaps turn up. The table also shows two examples of allopolyploid species believed to have originated by hybridisation involving arctic species and subsequent chromosome doubling.

While on the subject of hybridisation, I should like to mention *Cerastium* and *Dryas*. *Cerastium alpinum* is a low-Arctic species which appears to have undergone extensive hybridisation and introgression throughout the Arctic with related species, including *C. arcticum*, the high-Arctic *C. regelii*, *C. jenisejense* and *C. beeringianum*, in the process forming some very stable taxa, such as *C. arcticum* subsp. *vestitum*, the prevailing taxon over much of Greenland and Svalbard. *Dryas octopetala* occurs alone throughout most of the eastern Arctic and east Greenland, as does *D. integrifolia* in western Greenland and Canada. Hybrids probably occur wherever the two species overlap, namely in eastern Siberia, Alaska, the Rockies and Greenland. The complex pattern of hybridisation and introgression in Greenland is shown in Fig. 4.



FIGURE 4. Leaf variation in *Dryas* in Greenland demonstrating regional introgression between *D. octopetala* (equilateral triangles) and *D. integrifolia* (narrow triangles) (from Elkington (1965)).

I mentioned earlier that a number of British species in east Greenland are restricted to the high Arctic, mostly north of 70°. These include *Alopecurus borealis*, *Kobresia simpliciuscula*, *Minuartia stricta* and *Saxifraga hirculus*, all of which, as it happens, occur in and around upper Teesdale. It seems to me highly probable that the British populations of these species, together with those of the *Minuartia* and saxifrage in Iceland, differ significantly in their physiology from those luxuriating in the Arctic Riviera climate of the east Greenland fjord region. Physiological differences in populations of wide-ranging species are of course well known. Scandinavian populations of *Solidago virgaurea*, for example, from lowland woodlands have lower optimum light requirements and higher temperature optima than montane populations, and arctic populations of *Oxyria digyna* and *Thalictrum alpinum* have lower temperature optima than those from mountains to the south. Some evidence for this in the case of *Kobresia* is provided by T. W. Böcher's observation, frequently impressed on visiting botanists, that Greenland plants grown at Copenhagen could only be overwintered in the Arctic Greenhouse and not outdoors with the Teesdale plants.

Two examples of ecological behaviour in the Arctic which differ substantially from what we might expect are provided by *Lychnis alpina* and *Carex maritima*. The former occurs in Britain on serpentine in Clova and at one locality on pyritic rocks in the Lake District. It is often assumed that the plant has a requirement for heavy metals, although analyses have revealed little unusual about the soil at the Lake District site, other than a slightly higher than expected manganese level, and the plants are readily grown in ordinary soil. However, the plant is widespread in the Scandinavian mountains and over the southern half of Greenland on soils with or without a substantial heavy metal content. It seems likely that, as in *Minuartia verna*, heavy metal tolerant populations of *Lychnis* are readily selected for. The other example, *Carex maritima*, is exclusively maritime in Britain but in Iceland, Scandinavia and Greenland it occurs far inland and, in Greenland, at altitudes up to 1200 m.

British botanists visiting the Arctic are often surprised by the wider ecological range of familiar British basicolous species, examples include *Dryas octopetala*, *Saxifraga oppositifolia* and *Silene acaulis*. Exceptions include most plants of base-rich mires, such as *Carex atrofusca*, *C. microglochin*, *Juncus castaneus* and *Kobresia simpliciuscula*, which behave much as in Britain. It is worth noting that limestone exposures are rare in the southern half of Greenland but common in the north and in the western Canadian arctic archipelago where, because of the relatively arid climate, they present a distinctly hostile environment.

In any discussion of the arctic flora one subject guaranteed to raise the emotional temperature is the question of where the component species survived the Holocene ice ages, or, more particularly, the last one, the Weichsel. In Scandinavia the debate still continues with Gjaerevoll upholding the views of Nordhagen and the late Eilif Dahl that many species survived on ice-free refugia, nunataks, near their present sites. Dahl in particular was impressed by the very weak dispersal ability of many relict mountain populations and also by the very local occurrence of certain western Arctic species. However, the discovery of substantial and extensive sub-fossil remains to the south of the ice sheets, including Britain, demonstrates that invasion following the ice retreat was an alternative and more likely possibility. Furthermore, as Birks (1993) has shown, using a powerful correlation technique, there is a high correlation between the present day distribution and topographic, climatic and edaphic factors, but only a low correlation with ice-free areas. As he says, the subfossil evidence renders any nunatak hypothesis superfluous. These opposing arguments are essentially the same as those used by British periglacial survivalists, particularly in relation to Teesdale, and by Quaternary botanists, with their impressive lists of full and late-glacial plant remains.

However the situation regarding Greenland, and Svalbard, is radically different since there was no post-glacial land bridge to facilitate dispersal and, if the nunatak hypothesis is rejected, one is thrown back on long-distance dispersal by various agencies. Gelting, and later Böcher, favoured survival, and Nathorst and later Sørensen long-distance dispersal.

The last glaciation in Greenland is known to have lasted c. 130,000 years and to have finished relatively abruptly some 11,500 years ago. There is now strong geological evidence that some relatively extensive areas in east Greenland were ice-free during the whole of this glaciation (Funder 1979). Estimates from Europe of the drop in mean temperatures during this period suggest a figure of about 6° C. The summer temperatures shown in Fig. 3 suggest that the corresponding

TABLE 5. RECORDS OF TAXA FROM SITES IN THE EAST GREENLAND FJORD REGION UNGLACIATED DURING THE LAST ICE AGE

MACROFOSSILS FROM DEPOSITS 11,900 - 11,000 YEARS BP (Bennike *et al.* 1999)

<i>Carex</i> sp.	<i>Oxyria digyna</i>
<i>Cerastium</i> sp.	<i>Minuartia</i> sp.
<i>Draba</i> sp.	<i>Papaver radicatum</i>
<i>Eriophorum</i> sp.	<i>Poaceae</i>
<i>Juncus</i> sp.	<i>Potentilla</i> sp.
<i>Luzula</i> sp.	<i>Saxifraga oppositifolia</i>
<i>Melandrium apetalum</i>	
<i>Empetrum nigrum</i> 10,400	
<i>Saxifraga cespitosa</i> 10,400	
<i>Salix herbacea</i> (pollen) 10,000	
<i>Dryas</i> sp. (pollen) 10,000	

sea-level summer temperature in central east Greenland would therefore be close to zero. This would seem to preclude the vast bulk of the flora from the list of potential survivors. Table 5 shows a list of species with macrofossil remains from the period 11,900 to 11,000 BP and Table 6 of species found at the present day at over 2000 m on nunataks in south-east Greenland. 2000 m is equivalent to a drop in temperature of c. 12° C below that at sea-level, indicating that these plants probably survive a mean summer temperature of c. -6° C. Incidentally, studies of photosynthesis in *Ranunculus glacialis* and *Oxyria digyna* from the Tyrol showed that they still achieved net photosynthesis at this temperature. Furthermore, some 58 species are now known to occur at altitudes in excess of 1200m on nunataks in south-east Greenland. This is equivalent to a temperature decrease of at least 7° C, which would correspond to a mean summer sea-level temperature of c. -2° C. I think, therefore, we can assume that many of these species were capable of withstanding such temperatures at sea-level during the last glaciation, although of course they are likely to have been restricted to favourable south-facing microclimates. Some species may have survived since before the last ice-age, others may have invaded during the 130,000 years of the glaciation. I think, however, that one has to accept that the 'thermophilous' bulk of the flora has invaded Greenland subsequently, probably via Iceland (Bennike 1999). In this context I would remind you of the existence of *Ophioglossum azoricum* and *Geum rivale* around warm springs on the Blossville Kyst, on the migration route of barnacle geese from Iceland.

TABLE 6. SPECIES RECORDED ABOVE 2200 M ON A NUNATAK IN SOUTH-EAST GREENLAND

Species	Height
<i>Minuartia rubella</i>	2480 m
<i>Papaver radicatum</i>	2450 m
<i>Saxifraga cernua</i>	"
<i>S. oppositifolia</i>	2400 m
<i>S. cespitosa</i>	"
<i>Carex nardina</i>	2330 m
<i>Poa glauca</i>	"
<i>Phippsia algida</i>	"
<i>Antennaria canescens</i>	2300 m
<i>Cerastium arcticum</i>	"
<i>Draba nivalis</i>	"
<i>Oxyria digyna</i>	2280 m
<i>Silene acaulis</i>	2200 m
<i>Erigeron uniflorus</i>	"
<i>Luzula spicata</i>	"



FIGURE 5. Distribution of *Potentilla stipularis*.

Nevertheless there are certain high-arctic Greenland species which raise doubts, in my mind at least, about the uncritical acceptance of long distance dispersal. Outside the high Arctic *Alopecurus borealis* is known only from Britain. It seems a highly likely survivor. And what of *Kobresia simpliciuscula*, likewise absent from Iceland? Did this invade from Scandinavia or get blown over the inland ice from central west Greenland? What of *Saxifraga hirculus*? The strong probability that the southern and northern populations of these three species – possibly also of *Minuartia stricta* – are physiologically distinct, supports the idea that they have had a similar history during the last glaciation. Then there are the remarkable relict east Greenland populations of certain other non-British species. Prominent in discussion of periglacial survival is the small, creeping, yellow-flowered *Draba sibirica*. This occurs in a very limited, unglaciated area of east Greenland, but is otherwise known only from Siberia. Similarly, *Potentilla stipularis* is known from a few scattered sites in central east Greenland, far distant from its main range from the Urals to Alaska (Fig. 5). Must we really accept that these two species have succeeded in establishing

themselves by long-distance dispersal over 3000 km? There are also a very few relict populations in east Greenland of the Siberian - American *Dryopteris fragrans*, which also has an outlying site in northern Finland and others in the north Urals, and of the western arctic *Saxifraga tricuspidata*. I mentioned earlier the occurrence in Norway of certain western arctic species. One such is *Carex scirpoidea*, known from two localities in northern Norway, but otherwise restricted to North America and west and east Greenland. I find it difficult to credit such distributions to the vagaries and uncertainties of long-distance dispersal but the alternative is to accept that the list of possible periglacial survivors must be appreciably longer than previously thought.

In conclusion I hope I have said enough to convince you of the importance and significance of the British flora in the Arctic and I should like to think there are, in the audience, young spirits prepared to fan the flickering flame of British interest in the Arctic.

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A new hybrid horsetail, *Equisetum arvense* × *E. telmateia* (*E.* × *robertsii*) in Britain

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ABSTRACT

An extensive colony of *E.* × *robertsii* T. D. Dines **hybr. nov.** (*E. arvense* L. × *E. telmateia* Ehrh., Equisetaceae) was discovered on sand and boulder-clay cliffs at Traeth Lligwy on the N.E. coast of Anglesey (v.c. 52), close to a known colony of *E.* × *font-queri* Rothm. (*E. palustre* L. × *E. telmateia*). *E.* × *robertsii* is intermediate between its parents in all respects. The morphology, stem anatomy and stomatal characters of the hybrid and its parents are described and illustrated, and its habitat is also outlined. This hybrid has previously been reported from Suffolk, where its identity was never confirmed, and from the Czech Republic, where the record was apparently based on material of *E. arvense*. The distribution and ecology of other hybrids involving *E. arvense* and *E. telmateia* are discussed.

KEYWORDS: Morphology, anatomy, stomata, Anglesey.

INTRODUCTION

Britain and Ireland provide particularly rich hunting grounds for hybrids between the eight native and one alien species of *Equisetum* known from this area. Nine hybrid combinations have currently been recorded, with all nine species being involved to varying degrees.

The genus *Equisetum* is divided into two subgenera, *Hippochaetae* and *Equisetum*, and hybrids are only formed between species from the same subgenus (Hauke 1963 & 1978; Page & Barker 1985). Two hybrids are known between the three species (*E. variegatum* Schleich. ex F. Weber & D. Mohr, *E. hyemale* L. and *E. ramosissimum* Desf.) in subgenus *Hippochaetae*, and seven have been recorded between the six species in subgenus *Equisetum*.

All *Equisetum* hybrids, except *E.* × *litorale* Kühlew. ex Rupr. (*E. arvense* L. × *E. fluviatile* L.) and *E.* × *trachyodon* A. Braun (*E. hyemale* × *E. variegatum*), can be regarded as rare, and they usually exist in small, isolated populations. Given the morphological variability displayed by the species, hybrid horsetails can be difficult to identify, and all are probably under-recorded.

One species, *E. telmateia* Ehrh., has a particular propensity to hybridise. It is currently known to have formed hybrids with three of the most common species in Britain and Ireland (with *E. palustre* L. to give *E.* × *font-queri* Rothm., with *E. fluviatile* to give *E.* × *willmotii* C. N. Page and with *E. sylvaticum* L. to give *E.* × *bowmanii* C. N. Page). Missing from this list is the hybrid with the most frequent species in Britain, *E. arvense*. Although *E. arvense* and *E. telmateia* are abundant in suitable habitats across Britain and Ireland, the hybrid between them has remained elusive and undescribed.

In July 2000 we visited Traeth Lligwy (SH48) on Anglesey (v.c. 52) to examine the population of *E.* × *font-queri* that was discovered there in 1989 (Roberts 1990). At the south-eastern end of the bay, while making our way towards the *E.* × *font-queri* site, we passed an area of sand and boulder-clay cliffs and noticed plants of an *Equisetum* of unusual appearance. They were stout and well-branched, possessed pale green internodes, and many were decumbent with declined or

horizontal branches. Our initial impression was one of plants intermediate between *E. arvense* and *E. telmateia*. Specimens were collected and subsequent examination has confirmed the presence of the hybrid between these species.

We can trace only two earlier reports of hybrids between *E. arvense* × *E. telmateia*. The first is that of Dostal (1950), who collected putative plants of the hybrid from near Nový Jicín in Moravia (Czech Republic) in 1948. He provisionally named the hybrid *E. × dubium*, but no formal description was published and no herbarium specimens appear to exist. Moreover Hrouda (1988), in agreement with Novak (1971), considers the record to be a mistake, the plants in question being robust forms of *E. arvense*. The name *E. × dubium* (nom. nud.) is therefore placed in synonymy with *E. arvense*.

There are also references to *E. arvense* × *E. telmateia* from E. Suffolk (v.c. 25), where an old, established colony was recorded and determined by F.W. Simpson from a shady marsh at Foxhall (TM24) in 1974, and another from Belton (TG40) in 1977 (Simpson 1982). Unfortunately, no specimens exist of these plants (Simpson, pers. comm., 2000) and no formal description was published. There is no mention of the Suffolk populations in Stace (1975, 1997), Page & Barker (1985) or Page (1997).

The population described here is therefore the first confirmed and fully documented occurrence of this hybrid. It is given here a formal name, and specimens have been placed in **BM**, **E** and **NMW**. This discovery brings the number of confirmed *Equisetum* hybrids recorded for Britain to ten, and those involving *E. telmateia* to four.

TAXONOMIC DESCRIPTION

Equisetum × robertsii T. D. Dines, **hybr. nov.**

(*Equisetum arvense* L. × *E. telmateia* Ehrh.) (Fig. 1)

HOLOTYPE: Growing on wet sand and boulder-clay cliffs, Traeth Lligwy, Anglesey, v.c. 52, SH498871, 6th July 2000, T. D. Dines (**BM**).

An erect or decumbent herb, with rhizomes black or brown-black, glossy, 2–(2.2)–3 mm in diameter. Stem to 60 cm, terete, moderately thick, 2.5–(4)–5 mm in diameter; stem internodes green or pale green when young, whitish green or white when mature, always paler towards the base of the stem, minutely rough, with central hollow 0.25–0.5 of diameter of stem and 12–(20)–30, shallow, rounded ridges; stem sheaths 3–(4)–6 mm long (excluding teeth), appressed, dull greenish brown when young, brown or blackish when mature; sheath teeth numerous, about as many as the ridges, 3–(4)–5 mm long, appressed, with a single rib, slender, acute, occasionally with a fine, hairlike apex, uniformly brown, lacking a scarious margin or with a very narrow scarious margin at the base, two or three sometimes adhering laterally by their margins. Branches numerous, arranged in regular and numerous whorls, 9–(11)–14 per whorl, 60–(117)–190 mm long, distributed evenly around the stem or arranged bilaterally (particularly on decumbent stems), slightly ascendent when young, later ascendent to declined when stem erect but declined when stem decumbent, slender, 1.5–2 mm in diameter, green or yellow-green; first internode of branches equal in length to or slightly longer than stem sheath; branch sheaths appressed to branch, yellow-green, with teeth 2–3 mm long, with a green base and a narrowly triangular brown point; branch internodes with 4–6 flattened or slightly rounded ridges and an equal number of rounded furrows, the ridges sometimes slightly biangled where they enter the subtending sheath. Cones unknown, not seen and not to be expected on vegetative stems; spores unknown.

Herba erecta vel decumbens, rhizomatibus nigris vel brunneonigris, nitidis, 2–(2.2)–3 mm diametro, praedita. Caulis ad 60 cm, teres, modice crassus, 2.5–(4)–5 mm diametro; caulis internodia viridia vel subviridia ubi juvenilia, albiviridia vel alba ubi matura, caulis basin versus semper pallidiora, minute aspera, cavo centrali 0.25–0.5 diametri caulis metiente, porcis 12–(20)–30 non profundis rotundatis instructa; caulis vaginae 3–(4)–6 mm longae (dentibus exclusis), appressae, obscure viridibrunneae ubi juveniles, brunneae vel nigricantes ubi maturae; vaginae dentes numerosi, circiter tot quot porcae, 3–(4)–5 mm longi, appressi, costa singula praediti, graciles, acuti, apice tenui capilliformi aliquando muniti, uniformiter brunnei, marginem scariousum

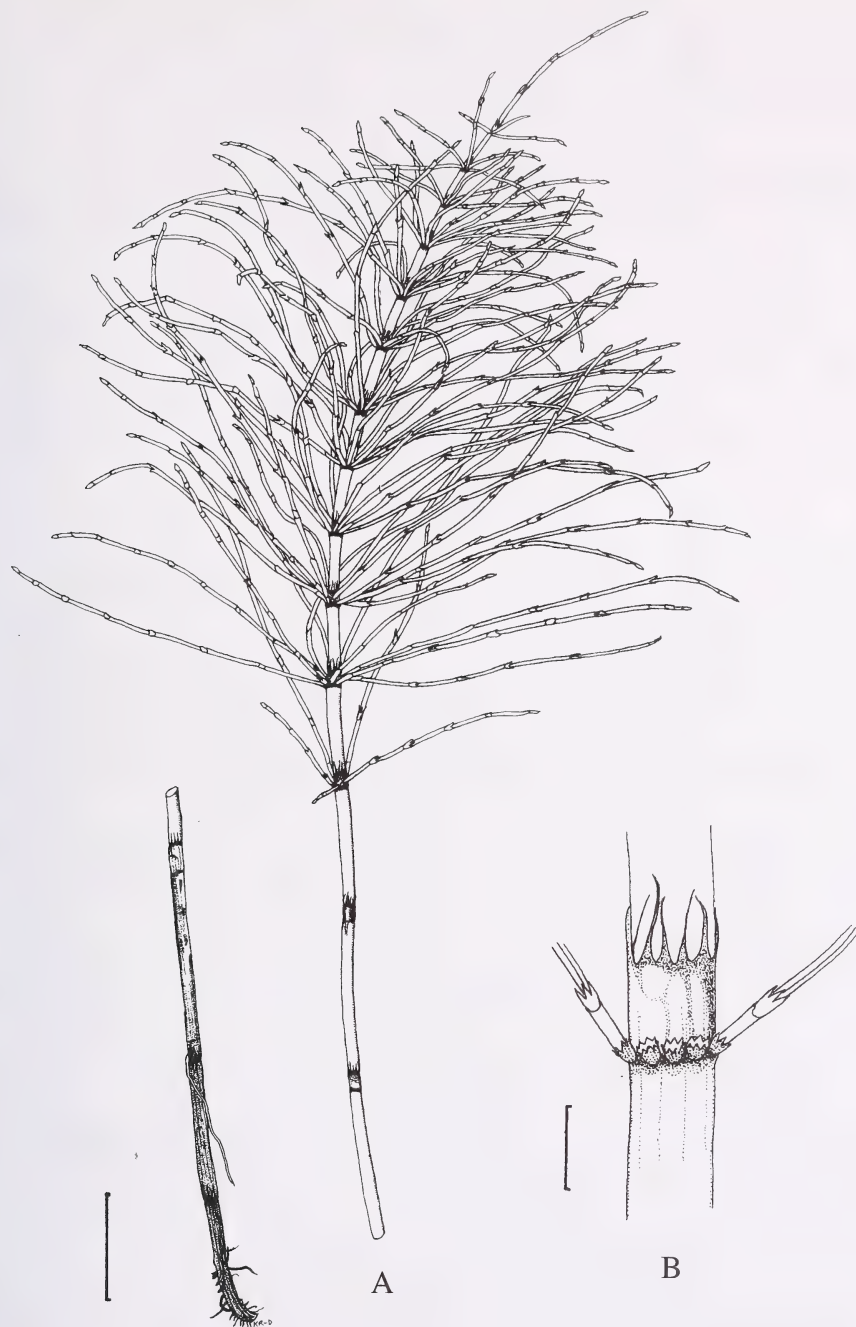


FIGURE 1. *Equisetum* $\times$ *robertsii* T. D. Dines. del. K. Rees-Davies.

A. Habit of whole plant growing upright; when growing from the cliff-face, the stem is decumbent and the branches are declined (scale bar = 5 cm); B. Detail of stem node, showing sheath, sheath-teeth, and mode of insertion of branches (scale bar = 4 mm).

carentes vel margine scarioso perangusto basi praediti, duo tresve lateraliter marginibus interdum adhaerentes. Rami numerosi, in verticillis regularibus numerosis dispositi, 9–(11)–14 in quoque verticillo, 60–(117)–190 mm longi, aequaliter circum caulem distributi vel bilateraliter ordinati (praecipue in ramis decumbentibus), ubi juveniles leniter ascendentes, postea ramo erecto ascendentes vel declinati sed ramo decumbente declinati, graciles, 1.5–2 mm diametro, virides vel flavovirentes; ramorum internodium primum caulis vaginam aequans vel paulo excedens; ramorum vaginae ad ramum appressae, flavovirentes, dentibus 2–3 mm longis praeditae, base viridi et apice brunneo anguste triangulari; ramorum internodia porcis 4–6 complanatis vel leniter rotundatis sulcisque totidem canaliculatis instructa, porcis aliquando leniter biangularibus ubi vaginam subtenentem intrant. Strobili ignoti, nec visi nec in ramis vegetativis exspectandi; sporae ignotae.

The hybrid is named in honour of R. H. Roberts for his outstanding contribution to our knowledge of the Anglesey flora and its conservation; his work, particularly with *Polypodium* and *Dactylorhiza*, has influenced many British and Irish botanists. He received the H. H. Bloomer Award of the Linnean Society in 1999. Dick also found and described the population of *E. × font-queri* at Traeth Lligwy (Roberts 1990). If an English name is required, Anglesey Horsetail may be appropriate, or Marchrawn Môn in Welsh.

MORPHOLOGICAL DESCRIPTION

Morphologically, most plants of *E. × robertsii* are reassuringly intermediate between the parent species. This is shown in Table 1, where various characters of the hybrid and its parents are compared. The hybrid itself is illustrated in Fig. 1.

Because typical plants of *E. arvense* and *E. telmateia* differ widely in appearance, plants of *E. × robertsii* are readily identified without resorting to detailed examination and measurement. They differ most markedly from *E. arvense* in having thicker stems with paler internodes, these contrasting markedly against the longer, darker stem sheath and sheath teeth. They also possess more branches per whorl, these branches being longer than *E. arvense* and tending to be curved downwards or horizontal if the stem is decumbent. The plants have the look of a robust, more yellow-green *E. arvense* with pale stem internodes and less erect branches.

E. arvense and *E. × robertsii* sometimes grow together, especially along the base of the cliff. In such situations, main stems are often decumbent and they can instantly be distinguished by observation of their branches; those of *E. arvense* are always ascendent while those of *E. × robertsii* are always curved downwards. When growing on top of one another, the effect of this contrast is most striking.

E. × robertsii differs markedly from *E. telmateia* in having shorter, more slender stems with greener internodes, especially when young; fewer and shorter branches, but these being slightly thicker than in normal *E. telmateia*; and in frequently being prostrate, a character we have never observed in *E. telmateia*. The shoots also lack the distinct 'bottle-brush' appearance of *E. telmateia*. The overall impression therefore, is of a depauperate, slender-stemmed and less branched *E. telmateia* with greener internodes.

E. arvense is a very variable species, however, and sometimes has thicker, paler stems than normal, giving plants that closely resemble this hybrid. If a more detailed examination is required to determine the identity of doubtful plants, the morphology of the branch internodes provides the best evidence. Very distinctive, knife-edge branch angles are diagnostic of *E. arvense* (Page 1997). In cross-section, they resemble a Maltese cross, usually having 4 ridges, although 3 or 5 are not uncommon. They also bear a shallow groove along the base of each ridge. These characters can be seen with the naked eye, and are clearly visible with a $\times 10$ lens. The branch internodes of *E. telmateia* are very different, being shallowly lobed into 4 or 5 angles. Each of these angles bears a groove along distinct ridges its apex, producing a double-ridge effect which is characteristic of this species (Page 1997). Furthermore, the edges of these ridges are armed with a row of minute teeth, giving it a saw-edged appearance, also unique to *E. telmateia*. These characters are readily observed with a $\times 10$ lens. In *E. × robertsii*, the internodes are intermediate between the parents. They have 4–6 that are usually rounded or flat-topped at their apex. They lack both the 'knife-

TABLE 1. MORPHOLOGICAL CHARACTERS OF *E. × ROBERTSII* AND ITS PARENTS

	<i>E. telmateia</i>	<i>E. × robertsii</i>	<i>E. arvense</i>
Shoot colour	Yellow-green.	Bright green or yellow-green.	Dull green.
Shoot apex	Flat-topped, squared off.	Tapering, usually with a flagellate tip.	Tapering, often with a flagellate tip.
Stem	Erect.	Decumbent to erect; if decumbent, branches horizontal to declined.	Decumbent to erect; if decumbent, branches ascendent.
Stem stomata	Absent.	Present, but not frequent.	Present, frequent.
Stem height	58–(86)–108 cm.	25–(45)–60 cm.	28–(41)–61 cm.
Stem diameter	5–(8)–9 mm.	2.5–(4)–5 mm.	2–(3)–4 mm.
Stem cavity diameter	2/3 or more.	1/4 to 1/2.	1/4 to 1/2.
Stem internode colour	White.	Green or pale green when young, whitish green or white when mature.	Green.
Stem surface	Smooth, 20–30 indistinct ridges.	Indistinctly ridged, 12–(20)–30 ridges.	Distinctly ridged, 6–(13)–18 ridges.
Stem sheath length	5–(7)–9 mm.	3–(4)–6 mm.	2–(4)–5 mm.
Stem sheath colour	White or very pale green.	Green when young, brown or blackish when mature.	Green.
Stem sheath teeth length	4–(6)–8 mm.	3–(4)–5 mm.	1–(2)–2.5 mm.
Stem sheath teeth colour	Brown.	Brown.	Green or green with brown tip.
Stem sheath teeth shape	Narrowly triangular, with finely pointed tip.	Triangular (not narrow or broad), some with short fine point.	Shortly triangular.
Stem sheath teeth margins	With a narrow basal scarious margin.	No scarious margin, or rarely with a very narrow basal margin.	No scarious margin.
Branch length	120–(153)–247 mm.	60–(117)–190 mm.	92–(132)–170 mm.
Length of first branch internode in relation to stem sheath	Much shorter.	Equal to or, usually, slightly longer.	Longer.
Number of branches per whorl	16–(22)–30.	9–(11)–14.	7–(9)–13.
Branch internodes	4–5 shallow, biangled ridges bearing saw-edged teeth.	4–6 distinct rounded or flat-topped ridges, sometimes slightly biangled basally, lacking both saw-edged teeth and groove at base.	3–5 very prominent knife-edge ridges, with groove along base between ridges.
Branch teeth length	2–(2.5)–3 mm.	2–(2.5)–3 mm.	1.7–(2)–2.2 mm.
Branch teeth	Green base with slender, brown point; adpressed.	Green base, narrowly triangular with brown point; adpressed.	Green, bluntly triangular; curving outwards.

Measurements given are based on samples of 20 from populations of all three taxa at Traeth Lligwy, Anglesey (v.c. 52). Where appropriate, averages are given in brackets along with the maximum and minimum range encountered.

edge' ridges and the groove along the ridge base found in *E. arvense*. The saw-edge teeth and double-ridge of *E. telmateia* are absent in the hybrid, although a trace of the double-ridge can sometimes be seen, especially where a branch internode enters its subtending sheath.

As mentioned previously, a large population of *E. × font-queri* (*E. telmateia* × *E. palustre*) also grows at Traeth Lligwy, approximately 400 metres away from *E. × robertsii*. *E. × font-queri* differs from *E. × robertsii* in being much larger (many plants being over 90 cm tall), being completely smooth to the touch, having longer branches and longer stem sheaths, the sheath teeth and branch teeth having a distinct scarious margin, and the first branch internode being much shorter than the sheath. These are all characters derived from the *E. palustre* parent. Also, *E. × font-queri* produces terminal cones on vegetative shoots, and these were numerous in the Lligwy population in July, a character again derived from *E. palustre*. *E. × robertsii* does not appear to produce cones; since both *E. arvense* and *E. telmateia* produce cones on achlorophyllous stems in early spring, the hybrid may have been expected to do the same, but no such cones could be found despite extensive searches between March and June 2001, and neither have cones been found on any vegetative shoots.

ANATOMICAL AND STOMATAL CHARACTERS

METHODS

Details of stem anatomy and the micromorphology of stomata are important in *Equisetum* identification, and material from Traeth Lligwy was therefore examined. For stem transverse sections, fresh material was sectioned by hand and stained with 0.01% toluidine blue in distilled water. For scanning electron microscopy (SEM) of stem stomata, fresh sections of stem 5 mm in length were fixed in 3% glutaraldehyde in 0.1 M phosphate buffer, dehydrated in an ethanol and acetone series, and critical-point dried using a Polaron CPD. Samples were then mounted on aluminium stubs with double-sided tape and sputter-coated with gold using a Polaron SEM coating unit. Specimens were examined on a Hitachi S-520 scanning electron microscope at 10 kV, and photographs taken using 50 ASA Ilford PAN-F film.

ANATOMICAL CHARACTERS

The arrangement of cell types within *Equisetum* stems is frequently used to identify different taxa, especially hybrids. Transverse sections of the stem internodes of *E. arvense*, *E. telmateia* and *E. × robertsii* are illustrated in Fig. 2.

The internal anatomy of *E. × robertsii* is clearly intermediate between that of its parents, although its overall appearance is closer to *E. arvense* than *E. telmateia*. The most important differences are in the arrangement of the green, chloroplast-bearing chlorenchyma tissue and the supportive and strengthening collenchyma tissue. In *E. telmateia*, chlorenchyma is absent (hence the white colour of the internodes), and the collenchyma forms a continuous ring around the whole stem, being located immediately under the epidermis. The collenchyma of *E. arvense* is distinctively arranged into discrete bundles at the apex of each ridge, and at the base of each furrow separating them. The chlorenchyma is arranged in a broad band around and beneath each bundle of ridge collenchyma. This almost continuous distribution of chlorenchyma gives the stem of *E. arvense* its more or less uniform green colour. In *E. × robertsii*, the collenchyma forms broader, shallower bundles beneath the ridges and in the valleys, and the chlorenchyma is confined to two discrete bundles on either side of the ridge collenchyma. When viewed externally, each furrow on the stem of *E. × robertsii* can be seen to possess a pair of narrow green lines, and this is explained by the distribution of chlorenchyma.

The central canal of *E. × robertsii* is more similar to *E. arvense*, and it is perhaps surprising that the hybrid has inherited so little of the characteristically large canal of *E. telmateia*; another *E. telmateia* hybrid, *E. × wilmottii* (Page 1995), does exhibit this feature. The vallicular canals (which are associated with the vascular tissue) of *E. × robertsii*, however, are intermediate between the parents, being smaller than those of *E. telmateia*, but larger than in *E. arvense*. The size and arrangement of the endodermis, the carinal canals, and the vascular tissue is similar in all three taxa.

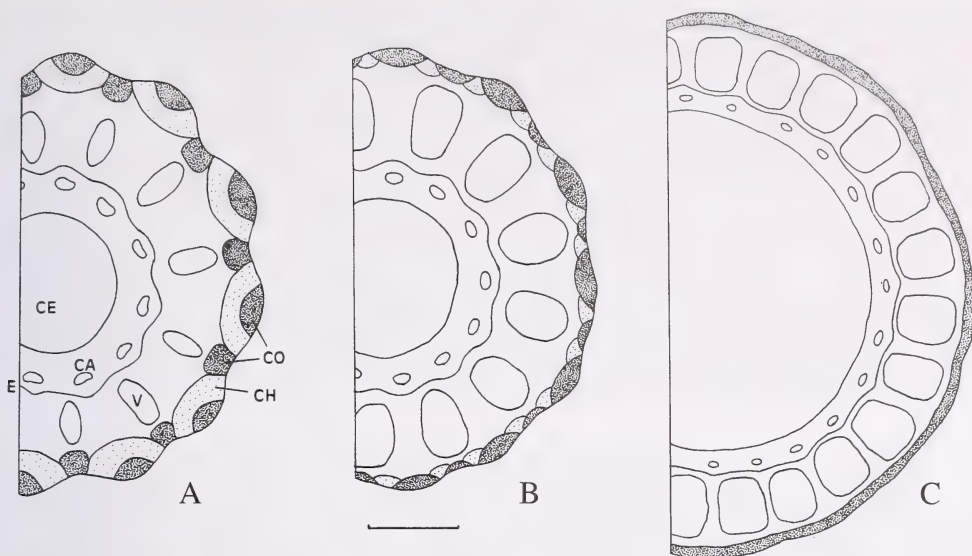


FIGURE 2. Transverse sections of stem internodes (all material from Treath Lligwy, Anglesey, v.c. 52). A. *Equisetum arvense*; B. *E. x robertsii*; C. *E. telmateia*. CO = collenchyma (shaded), CH = chlorenchyma (stippled), V = vallecular canal, E = endodermis, CA = carinal canal and vascular tissue, CE = central canal (scale bar = 0.9 mm, all section at same scale).

STOMATAL CHARACTERS

The micromorphology of stomata in *Equisetum* is highly diverse between species, and has been used as both an aid to identification and a basis for taxonomic classification (Hauke 1963, 1978; Page 1972). In *Equisetum*, true guard cells (which form part of the epidermis) are not present, although the paired cells that surround the stomatal aperture perform the same function. These cells are termed subsidiary cells (Hauke 1957), and are, for their most part, hidden beneath the surface epidermis. Only the periphery of each cell that actually borders the edge of the stomatal pore is visible. The visible part of the cells on either side of the pore are together termed the stomatal cell area (Page 1972). This area is highly variable in shape, and the cells themselves are richly ornamented with numerous hemispherical or globose bead-like projections from the cell surface, which are termed pilulae (Page 1972).

Two extremes in form can be recognised. In the first (Fig. 3, A and B), the stomatal cell area is nearly circular in outline and has a highly convex profile. The surface of the cells are sparsely covered in short, globose pilulae, and a ring of such pilulae delimit the outer edge of the stomatal cell area. Beyond this, there is also a trench-like depression. The stomatal pore itself is often open and clearly visible. In the second type (Fig 3, E and F), the stomatal cell area is highly elongated longitudinally, and low and flat in profile. The actual surface of the subsidiary cells is often invisible, being completely covered in drumstick or rod-shaped pilulae which are arranged in regular rows and point inwards towards the stomatal pore, usually intermeshing and obscuring the pore itself. The stomatal cell area therefore appears like an elongated sunken pore filled with opposing and interlocking rods. In this type, there is no trench-like border.

The first type of stomatal cell area is seen in *E. arvense* from Traeth Lligwy (Fig. 3, A and B), thus confirming the observations of Page (1972) and Hauke (1978) for this species. The second type is seen in *E. telmateia* and *E. palustre* (Page 1972; Hauke 1978), and in the hybrid between these species, *E. x font-queri* (Fig. 3, E and F). Because *E. arvense* possesses stomata of the first type, and *E. telmateia*, *E. palustre* and *E. x font-queri* of the second type, stomatal morphology is a useful tool for the technical confirmation of *E. x robertsii*. Stomata of this hybrid are illustrated in Fig. 3 (C and D), and are clearly intermediate between those of *E. arvense* and *E. x font-queri*

(which illustrates the *E. telmateia* and *E. palustre* type). They differ from *E. arvense* in being more elongate in outline and less convex in profile, and in having more frequent, longer pilulae. Also, the stomatal pore is closed and the edge of the stomatal cell area is less well defined. They differ from *E. × font-queri* in being much more rounded in outline and more convex in profile, having shorter, more globose pilulae (especially towards the outer edge of the cell), and in the edges of the cell area being more clearly defined. The stomata of *E. × robertsii* therefore confirm its hybrid parentage, and also clearly separate it from *E. × font-queri*.

CONFIRMATION OF THE HYBRID

Taking into account the morphological, anatomical and stomatal characters, it can be concluded with certainty that *E. arvense* and *E. telmateia* are the parents of *E. × robertsii*. The presence of abortive spores would provide further evidence, and these will be examined if such material becomes available, but the current evidence is so compelling that we do not feel these are needed to confirm the hybrid. Some hybrids, such as *E. × font-queri* and *E. × trachydodon* (Hauke 1978), are known to occasionally produce a small proportion of fertile spores, and these will also be looked for in *E. × robertsii*. Both *E. arvense* and *E. telmateia* have the same chromosome number, $2n = 216$ (Stace 1997).

Material from Traeth Lligwy has been examined by Mr P. Acock, Miss A. Paul and Dr C. N. Page, all of whom have agreed that it is the hybrid between *E. arvense* and *E. telmateia*. Dr Page has examined other putative British material which may be this hybrid, but reports that specimens from Anglesey are "... the most convincing, in that they appear to be the most exactly intermediate". His observations suggest that the hybrid is probably overlooked elsewhere and should be searched for more widely, especially where the parents grow together in disturbed, wet habitats.

HABITAT DESCRIPTION

The population of *E. × robertsii* at Traeth Lligwy grows on an area of sand and boulder-clay cliffs with a N.E. aspect. These deposits overly Carboniferous conglomerates and, in one place, Carboniferous limestone. At the S.E. end of the site, the cliffs reach a maximum height of approximately 16 m, and slope down to a sand, gravel and boulder beach, where the conglomerate and limestone is frequently exposed. There is a zone of erosion up to 2.5 m high at their base. Towards the N.W., the rocks are not exposed and the overlying clay and sand cliffs are lower, sloping down to a sandy beach.

Plants of *E. × robertsii* are found over an area of approximately 400 m² (200 m long by 20 m wide). Throughout the length of the site, they grow in a variety of substrates, including pure sand, well-drained, humus-rich sandy loam, and pure clay. The cliffs are damp, with obvious areas where seepage of fresh water occurs, and some sections are slumped. Plants of the hybrid occur from the top of the cliff down to the beach, onto which they extend in a few places. They rarely form a dense colony in any one area, but their strongly rhizomatous growth means that plants are loosely clumped in many areas on the cliffs. They are most frequent towards the base of the cliff, particularly in the otherwise unvegetated zone of erosion and on sections of slumped clay.

The sand and boulder clay are derived from a variety of sources (calcareous beach sand, local limestone and conglomerate rocks), and the soil is therefore very variable in pH, ranging from a highly calcareous 8.9 (at the base of the limestone cliff) to an acidic 5.1 (at the top of the sandy conglomerate cliff), the average of twelve samples being 8.1. Such high soil pHs may partly result from enrichment by salt-laden sea-spray. With such a range in pH, it is not surprising to find that a diverse list of 102 associated species have been recorded from the cliff, including both calcicole and calcifuge species, occasional halophytes and species typical of both rank and heavily rabbit-grazed coastal grassland. These taxa are listed in Appendix 1. Although most abundant on the eroded cliff base, where competition is minimal, *E. × robertsii* is not infrequent in the more densely vegetated areas higher up, and competes successfully in stands of *Cirsium arvense*, *Eupatorium cannabinum*, *Hedera helix*, *Heracleum sphondylium*, *Pteridium aquilinum*, *Rubus fruticosus* agg., *Ulex europaeus* and *Urtica dioica* that dominate this area.

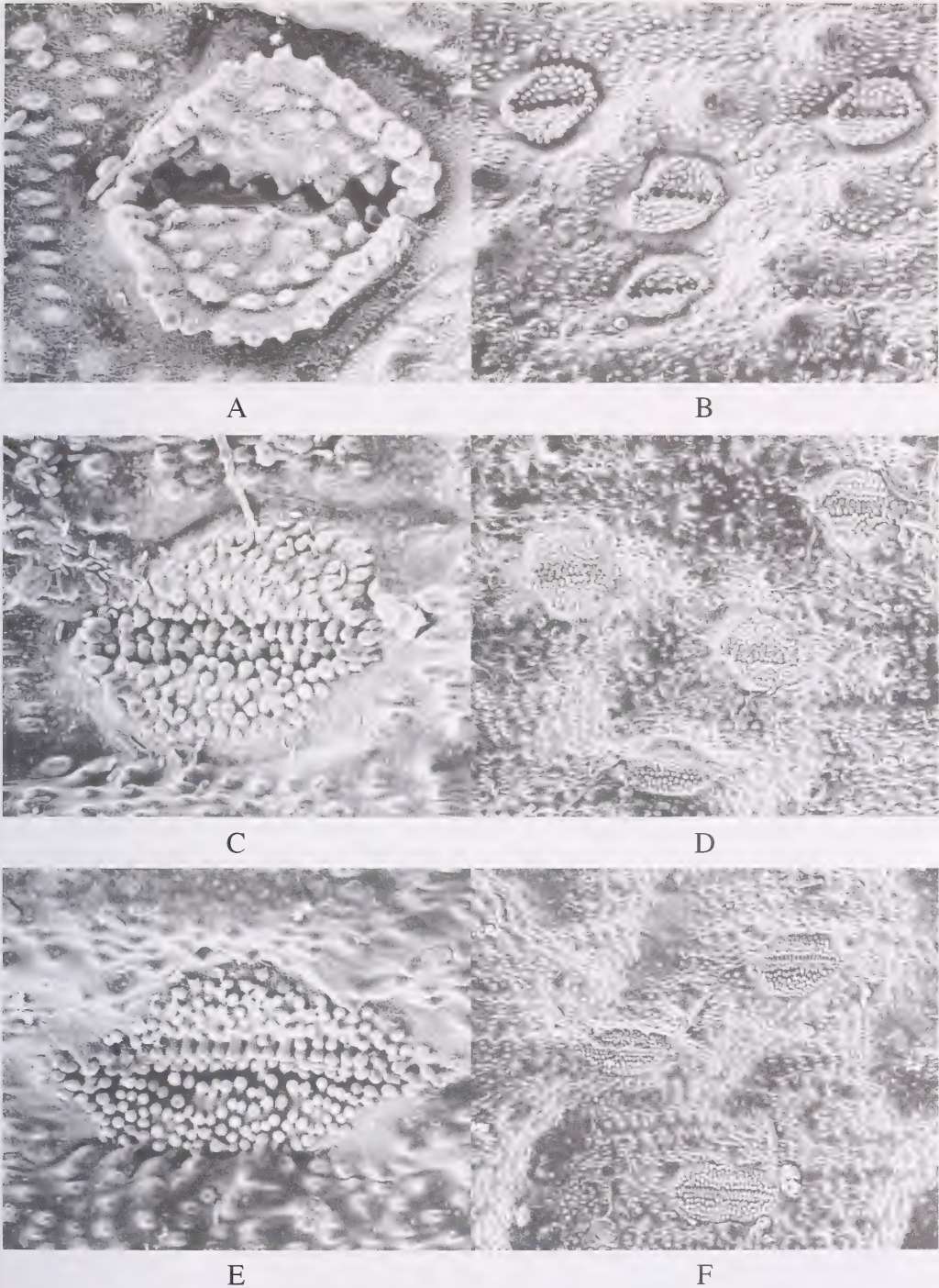


FIGURE 3. Photomicrographs of stem stomata (all material from Treath Lligwy, Anglesey, v.c. 52). A-B. *Equisetum arvense*; C-D. *E. x robertsii*; E-F. *E. x font-queri* (*E. telmateia* $\times$ *E. palustre*). A, C and E, individual stomata ($\times 2200$); B, D and F, stomatal groups ($\times 660$).

In contrast to *E. × robertsii*, *E. × font-queri* at Traeth Lligwy grows at the back of a small area of sand dunes (Roberts 1990). This site is more scrubby, being dominated by bushes of *Salix cinerea* subsp. *oleifolia* and *Rubus fruticosus* agg. It is also flatter and less open to erosion. The population of *E. × font-queri* is much smaller than that of *E. × robertsii*, but the plants are much more densely spaced within this area.

Throughout the entire extent of the *E. × robertsii* population, plants of the hybrid often grow in close proximity to *E. arvense*. Specimens of this species show considerable variation at Traeth Lligwy, ranging from weak, narrow-stemmed and sparsely-branched plants to very robust specimens with thick stems, dense branches, and even frequent secondary branching. The closest population of *E. telmateia* is on the top of the cliff at the eastern edge of the sand dune hybrid population (approximately 15 m from the nearest hybrid plants), where a typically dense colony grows interspersed with robust plants of *E. arvense*. Both parents therefore grow in very close proximity to the hybrid.

Although Traeth Lligwy is a popular and heavily used beach, the main cliffs on which *E. × robertsii* grows separate the beach from the Anglesey coastal footpath, and are too steep, overgrown and wet to be developed. Little threat is currently posed to the population, although plants on the lower cliffs to the N.W. may be at risk from trampling.

DISCUSSION

DISTRIBUTION AND ECOLOGY OF PARENTS

E. arvense has a Circumpolar Wide-boreal distribution (Preston & Hill 1997); it is found throughout much of central, western and northern Europe (Jalas & Souminen 1972). In contrast, *E. telmateia* has a European Southern-temperate distribution (Preston & Hill 1997), being most frequent in southern, western and central Europe, north to the British Isles. It is also present in western N. America (Jalas & Souminen 1972), although the taxon there is currently regarded as a separate subspecies, *E. telmateia* subsp. *braunii* (Milde) Hauke (Hauke 1978).

In Britain, *E. arvense* (like many Wide-boreal species) is extremely widespread, being absent only from upland areas in the most north-westerly parts. It is similarly widespread in Ireland, but not quite as frequent, being unrecorded from a number of 10-km squares throughout its range (Jermy *et al.* 1978). *E. telmateia* is a more restricted species, being absent from parts of south-west and eastern England, central Wales and much of Scotland. In Ireland, it is most frequent in the north and the south-east (Jermy *et al.* 1978).

Throughout its British and Irish range, *E. arvense* can be encountered in a very wide range of natural, semi-natural and man-made habitats (Page 1997). Its natural habitats include river banks, fixed dune-pastures, sea-cliffs and montane flushes. It has, however, become closely associated with human activity, and is now commonly found in cultivated ground, road-verges, paths, quarries, waste ground and railway embankments. It tolerates a wide range of soil pH and substrate, and its only requirement is for constantly moist or damp soil, at least around its potentially deep rhizomes, a feature common to all *Equisetum* species (Hauke 1978; Page 1997). *E. telmateia* is more exacting in its requirements, preferring calcareous substrates that are constantly wet. It is most frequently found along spring lines and open flushes on deep clay soils, and is particularly common on eroding sea and river cliffs, but is also found in marshes, and has also colonised roadside verges and railway embankments.

Given the ubiquitousness of *E. arvense* and the similarity in their habitat requirements, it is unusual to encounter *E. telmateia* in the absence of *E. arvense*. The most recent data available from the Biological Records Centre (Monks Wood) indicate that of the 10-km squares in which *E. telmateia* occurs there are only two in Britain and five in Ireland in which *E. arvense* is not also recorded. Although their presence in the same 10-km square does not necessarily mean that the species are actually growing together, *E. arvense* is able to grow well in the same habitats as *E. telmateia*, and it is likely that the species co-exist extremely frequently.

There is therefore a widespread sympatric occurrence of *E. arvense* and *E. telmateia* in Britain, Ireland and Europe, but their hybrid appears to be rare. This apparent anomaly is discussed below in the context of other *Equisetum* hybrids.

OCCURRENCE OF HYBRIDS IN *EQUISETUM*

The coincidence between hybrids and parents in *Equisetum* is very variable. Some hybrids occur in the apparent absence of both their parents, particularly where species of subgenus *Hippochaete* (*E. hyemale*, *E. variegatum* and *E. ramosissimum* Desf.) are involved. At its most extreme, this is illustrated by the presence in Ireland of *E. × moorei* Newman (*E. ramosissimum* × *E. hyemale*). *E. ramosissimum* is absent from Ireland and found only in Britain as an alien. It has been suggested that the presence of *E. × moorei* in Ireland could indicate the former presence of *E. ramosissimum* here as a native (Page & Barker 1985). The second most frequent *Equisetum* hybrid in our area, *E. × trachyodon* (*E. variegatum* × *E. hyemale*) is also commonly encountered in Britain and Ireland in the absence of both its parents (Page 1997).

Most species of subgenus *Equisetum* are more widespread in Britain and Ireland than those of subgenus *Hippochaete*, and one would therefore expect hybrids between these species to occur in the vicinity of their parents. This is certainly true. The two most common hybrids in the subgenus, *E. × litorale* (*E. fluviatile* × *E. arvense*) and *E. × dycei* C.N. Page (*E. fluviatile* × *E. palustre*) are usually closely associated with their parents (Page 1997), and this is also true of many of the rarer hybrids, for example *E. × mildeanum* Rothm. (*E. pratense* Ehrh. × *E. sylvaticum*), *E. × bowmanii* (*E. telmateia* × *E. sylvaticum*) and *E. × font-queri* (Page 1973 & 1988). An exception is *E. × willmotii* (*E. fluviatile* × *E. telmateia*), which is known from one site in Co. Cavan, Ireland, in the absence of both parents (Page 1995).

The frequency of a hybrid, however, is no reflection of parental frequency. This is shown by the hybrids *E. × robertsii*, *E. × font-queri*, *E. × willmotii* and, particularly, *E. × rothmaleri* C. N. Page (*E. arvense* × *E. palustre*), all of which are apparently rare despite the abundance of the parents in suitable habitat across Britain and Ireland. The first three of these, in particular, form robust hybrids which occur in large, probably long-lived colonies.

In attempting to reconcile these differences, Page & Barker (1985) suggest that several factors are involved in the formation of, and subsequent success of, particular hybrid combinations. These include the availability of a disturbed soil surface for gametophyte germination and subsequent colonisation of a bare area by the hybrid, the availability of a habitat intermediate between that required by the parents, the presence of an oceanic microclimate which promotes gametophyte growth and longevity, and, finally, the possibility of vegetative spread by rhizome or stem fragmentation.

All these requirements are met at Traeth Lligwy for the formation and successful growth of *E. × robertsii*. The slumping clay cliffs provide regular bare surfaces for hybrid formation and subsequent colonisation. It is not possible to say if the hybrid has arisen at Lligwy once or several times, although once is probably the more likely scenario. If it has arisen only once, the sheer size of the population indicates that it arose many years ago, and has been successfully spreading vegetatively for some time - although the possibility of fertile hybrid spores cannot be ruled out as there is evidence of the production of well-formed spores in both *E. × font-queri* and *E. × trachyodon* (Hauke 1978; Page & Barker 1985). Anglesey also has an oceanic climate, characterised by mild winter and cool summer temperatures, and relatively high rainfall of 90–100 cm per year (Roberts 1982).

E. × robertsii appears to be a successful plant at Traeth Lligwy; it forms a very large and probably very long-lived population, and competes well with vigorous tall herbs. Given this, and the abundance of its parents in suitable habitat across Europe, why is it apparently so rare elsewhere? One factor may lie in the taxonomic relationship between the parents. Page (1972) proposes a simple rule for the success (in terms of frequency) of hybrids, "In *Equisetum*, the least successful hybrids in the field are those which arise between pairs of species which are ecologically similar but taxonomically distant. The most successful regularly arise between parents which are ecologically diverse but taxonomically near".

Although there is much disagreement over the precise phylogenetic relationship between the various species in subgenus *Equisetum* (see Hauke 1978 for a comprehensive review), it is generally agreed that *E. telmateia* and *E. arvense* are taxonomically distant. Indeed, both Hauke (1978) and Page (1972) place them in separate sections within the subgenus. They are, however, similar in their ecological needs, although *E. telmateia* is more demanding in its habitat requirements. The rarity shown by *E. × robertsii* therefore supports Page's rule, and fits in with the other uncommon hybrids between ecologically similar but taxonomically distant species

(particularly *E. × willmotii* and *E. × bowmanii*). However, the size and vigour of the *E. × robertsii* population suggests that it is a successful hybrid that can compete well; the limiting factor appears to be the formation of the hybrid, which may be governed by either ecological or genetical factors. Page's rule suggests the latter may be the case, and this might also be supported by the presence of *E. × font-queri* at the same site - perhaps the gametophytes of *E. telmateia* at Treath Ligwy are particularly liable to hybridisation.

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APPENDIX 1. ASSOCIATED SPECIES

The following taxa have been recorded in the same area as *E. × robertsii* (r = rare, 1 or 2 plants seen; o = occasional, 3 to 7 plants seen; sd = in sand-dune areas only). Nomenclature follows Stace (1997).

Anthoxanthum odoratum, *Acer pseudoplatanus* (r), *Achillea millefolium*, *Agrimonia eupatoria* (o), *Agrostis capillaris*, *A. stolonifera*, *Arrhenatherum elatius*, *Athyrium filix-femina* (o), *Brachypodium sylvaticum*, *Bromus hordeaceus* subsp. *hordeaceus* (sd), *Carex arenaria* (sd), *C. caryophylla* (sd), *C. flacca*, *Centaureum erythraea* (sd), *Centaurea nigra* (sd), *Cerastium fontanum* (sd), *Chaerophyllum temulum* (o), *Chamerion angustifolium*, *Cirsium arvense*, *C. palustre*, *C. vulgare*, *Cochlearia officinalis*, *Crataegus monogyna*, *Crepis capillaris*, *Dactylis glomerata*, *Dactylorhiza fuchsii*, *D. purpurella* (sd), *Deschampsia cespitosa* subsp. *cespitosa*, *Dryopteris affinis* subsp. *affinis* (r), *D. dilatata*, *D. filix-mas*, *Elytrigia juncea* (sd), *Epilobium hirsutum* (sd), *E. montanum*, *Equisetum arvense*, *E. palustre* (sd), *Eupatorium cannabinum*, *Festuca rubra*, *Filipendula ulmaria*, *Fragaria vesca*, *Galium aparine*, *G. verum*, *Geranium robertianum*, *Glechoma hederacea*, *Hedera helix* subsp. *helix*, *Heracleum sphondylium*, *Holcus lanatus*, *Hypericum androsaemum* (o), *H. tetrapterum* (r), *Hypochaeris radicata*, *Juncus acutiflorus* (sd), *J. bulbosus* (sd), *J. inflexus* (sd), *Lathyrus pratensis*, *Leymus arenarius* (sd), *Lolium perenne* (sd), *Lonicera periclymenum*, *Lotus corniculatus*, *L. pedunculatus*, *Ononis repens*, *Phyllitis scolopendrium* (o), *Pimpinella saxifraga*, *Plantago lanceolata*, *P. maritima*, *Poa humilis*, *Potentilla anglica*, *P. anserina*, *P. erecta* subsp. *erecta*, *P. reptans*, *Primula vulgaris*, *Prunella vulgaris*, *Pteridium aquilinum*, *Pulicaria dysenterica* (sd), *Ranunculus acris*, *Rhinanthus minor*, *Rosa canina* agg., *R. pimpinellifolia*, *Rumex crispus* subsp. *littoreus* (sd), *Rubus fruticosus* agg., *Sagina procumbens*, *Salix cinerea* subsp. *oleifolia*, *S. repens* (r), *Sanguisorba minor* subsp. *minor*, *Sanicula europaea* (o), *Senecio jacobaea*, *Silene dioica*, *Solidago virgaurea*, *Sonchus oleraceus* (sd), *Tamus communis*, *Taraxacum* sp. (sd), *Torilis japonica*, *Trifolium dubium* (sd), *T. medium*, *T. pratense*, *T. repens*, *Tussilago farfara*, *Ulex europaeus*, *Urtica dioica*, *Veronica chamaedrys*, *Vicia cracca*, *Viola riviniana*.

A large population of *Plagiobothrys scouleri* (Boraginaceae) in north-east Scotland, and notes on occurrences elsewhere in Britain

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ABSTRACT

The alien *Plagiobothrys scouleri* (Hook. & Arn.) I. M. Johnst., White forget-me-not, was first observed in Britain in 1974, and has now been recorded in eight vice-counties. Several populations have been short-lived, but in Hampshire and North Aberdeenshire (v.cc 11 and 93) persistent large colonies exist in open habitats that regularly flood. Details are given about all British records, a common feature being occurrence in sown grass, which implies that *P. scouleri* is a seed impurity. Morphological variation between colonies is assessed. The North Aberdeenshire colony occupies a large dune slack at St. Fergus across which gas pipelines have been laid, and it is believed that restoration work led to *P. scouleri* being introduced; the plant is now abundant over the whole extent of the c. 5 ha “winter loch”. The sequence of events permitting spread at St. Fergus, and the plant communities in which *P. scouleri* occurs there, are described.

KEYWORDS: White forget-me-not, dune slack, alien, seed impurity.

INTRODUCTION

Plagiobothrys scouleri (Hook. & Arn.) I. M. Johnst. (Boraginaceae) is an introduced annual with small white flowers very similar to those of *Myosotis*. Clement & Foster (1994) describe it as a persistent grass-seed alien, locally abundant on silt and gravel at Setley and Beaulieu in S. Hampshire (v.c. 11), and also recorded in new-sown grass and other disturbed ground elsewhere in Britain. We have now found it in great abundance on silty sand within a large dune slack behind sand dunes at St. Fergus, North Aberdeenshire (National Grid ref: NK102542, v.c. 93), on the north-east coast of Scotland.

The plant was first seen with certainty in this locality in 1991. In that year, and subsequently in 1994 and 1999 (Gimingham & Lane 1994, 1999), botanical surveys of the site were carried out by P.L., as part of a monitoring programme of the restoration of the dune systems affected by gas pipeline landfalls, commissioned and funded by the St. Fergus Dunes Management Committee (now named the St. Fergus Coastal Environment Committee). The Dunes Management Committee

(DMC) evolved from an environmental liaison group set up in the early 1970s by the Geography, Zoology and Botany Departments of the University of Aberdeen. This group helped to establish the DMC which was constituted by the operators of the four North Sea Gas Terminals and Aberdeenshire Council, with Professor W. Ritchie as its Senior Ecological Advisor; the DMC has been serviced by the University of Aberdeen and its commercial company Aberdeen University Research & Industrial Services (AURIS).

In 1991 and 1994 the plant was treated simply as an unusual white-flowering form of *Myosotis ramosissima*, even though it was present in abundance in 1994. However, specimens were collected and dried, and after finding the plant again in quantity in 1999 its distinct nature was realised. It was then identified as *Plagiobothrys scouleri* by D.W. and subsequently confirmed by E.J.C. It is possible that the plant had been seen in earlier surveys by other workers who recorded several species of *Myosotis* in the area in 1977, 1980 and 1983, but the first year in which we can be certain of its presence is 1991.

MORPHOLOGY OF THE ST. FERGUS POPULATION

The plants are annual, with several to numerous ascending or sub-erect stems, as shown by silhouettes of a range of specimens (Fig. 1). Detailed drawings are provided in Fig. 2; this shows a typical plant and a dwarf variant that flowered early.

The stems are mostly 10–15 cm tall but occasionally reach 20 cm; they bear adpressed hairs. The leaves are linear, mostly 3–5 cm long and 2–3 mm wide, but on the tallest stems one or two lower leaves may attain 10 × 0.4 cm; the leaves are mainly alternate on the upper stems but are opposite at the three lowest stem nodes. The foliage is evenly clothed with short hairs spreading at about 45°. The flowers are borne in false racemes; these bear a few bracts chiefly below, and are tightly coiled at the top. The corollas are very small, c. 2–3 mm in diameter, and the calyces are divided to three-fifths or three-quarters their length, the sepals extending slightly beyond the petals. The flowers are white with a yellow eye at the top of the corolla tube and scarcely visible. Flowering occurs from June to early September. The four nutlets (length 1.4–1.9 mm) are dark olive-green or brown and rugose, with their abscission scar just slightly lateral of the base.

HABITAT OF THE ST. FERGUS COLONY

Plagiobothrys scouleri was very abundant in 1999, 2000 and 2001, in an open community in the St. Fergus slack. The substrate consists of a mixture of silt and fine-grained sand particles, but will be referred to as silty sand; it is mapped as the “sandy area” in Fig. 3.

The St. Fergus dune slack lies between the coastal fringing dune (which rises to about 12–16 m) and a more irregular line of old dunes to landward (Fig. 3) which abut onto a steep escarpment (an old low cliff line, rising to c. 18 m above sea level), beyond which the Terminal complex has been built on a flat plateau. The slack extends for approximately 1200 m and is about 120 m wide at its widest. Its surface lies about 2 m above sea level, and in winter most of the slack is flooded by fresh water, forming a “winter loch”. The duration of this flooding varies from year to year, but on average 75% of its area is continuously flooded for around 6 weeks, although the part in which *Plagiobothrys scouleri* is most abundant floods for a shorter period. A section of the south of the slack (Fig. 3) has its surface higher, is rarely flooded, and has a closed turf lacking *Plagiobothrys*.

Before 1974, when work on the first pipeline crossings began, a lush turf of *Agrostis stolonifera*, *Hydrocotyle vulgaris*, several *Carex* species including *C. maritima*, and other plants, occupied much of the exposed area of the winter loch once the standing water disappeared in spring. In 1974 and again in 1976 this turf was disrupted in places by the construction of two pipeline corridors through the dunes and across the dune slack in its central part (Fig. 3). In 1976 an area of slack which abutted the cutting was used for the temporary storage of excavated material including much sand and silt. Since then there has been a gradual decrease in the extent of the lush-turf community, with greater amounts of relatively unvegetated silty sand remaining after the winter inundations (Fig. 3). This has been tentatively linked to a lowering of the water table and a decrease in the extent and duration of winter flooding, particularly during the 1980s (Soulsby & Malcolm 1997). It is also possible that some sand has been deposited into the dune slack from the



FIGURE 1. Silhouettes of *Plagiobothrys scouleri* specimens collected at St. Fergus on (a) 14 June 2000 and (b) 5 August 1999.

main dune ridge, or has been spread from the pipeline corridors which after restoration had their surface level slightly higher than the surrounding slack. By 1991, quite a large extent of almost bare muddy sand was visible in summer, and this has been progressively colonised by the open plant community containing *Plagiobothrys scouleri* described below. By 1999, this habitat and its associated plant community occupied almost all the ground regularly flooded in winter.



FIGURE 2. Drawings of two plants of *Plagiobothrys scouleri* and selected plant parts. A – habit of typical plant, B – section of stem, C – cauline leaf, D – outside view of calyx lobe, E – plan view of flower at early stage with petals small, F – cross-section through calyx and corolla at anthesis, G – corolla opened-out, H – nutlet (adaxial, lateral and abaxial views, from left to right), Y – nutlet from small early-flowering variant, Z – small early-flowering variant.

THE PLAGIOBOTHRYS COMMUNITIES AT ST. FERGUS

Cover assessments recorded in 1999 for two sub-types of the slack community differentiated by degree of openness are given in Table 1. *Juncus bufonius* is generally dominant, reaching a cover of c. 30–50%. Other prominent species are *Callitriche stagnalis*, *Gnaphalium uliginosum*, *Sagina procumbens*, *Barbula convoluta*, *Bryum algovicum* and *Bryum argenteum* (Table 1). Locally, in hollows and old ditches dug c. 60 years ago, *Agrostis stolonifera* has substantial cover, quadrats from these areas being grouped as the less-open community (Table 1). *Plagiobothrys scouleri* has

TABLE 1. ASSOCIATES OF *PLAGIOBOTHRYS SCOULERI* IN OPEN COMMUNITIES AT THE ST. FERGUS DUNE SLACK

	Domin-scale assessment of cover in 1 m ² quadrats																
	Open community of silty-sand areas										Less-open community of hollows, ditches						
<i>Agrostis stolonifera</i>	2	2	3	3	1	/	1	2	2	3	6	5	6	2	1	3	5
<i>Barbula convoluta</i>	2		3	/	/	2	2	2	2	2	1	3		2	2	2	2
<i>Bellis perennis</i>											/				2		
<i>Bryum algovicum</i>	2		3	/	2	2	2	2	2	2	2	3	1	2	2	2	2
<i>Bryum argenteum</i>	2		3	/	2	2	2	2		2	2	3		/	2	2	2
<i>Bryum cf. bicolor</i>																2	
<i>Callitriche stagnalis</i>	2				2	2	2	3						2	3	3	2
<i>Capsella bursa-pastoris</i>				/													
<i>Cardamine pratensis</i>						/											
<i>Carex arenaria</i>				/								4					
<i>Cerastium fontanum</i>				1						+							
<i>Chenopodium rubrum</i>					2	/											
<i>Cirsium arvense</i>											+						/
<i>Cirsium vulgare</i>				+	+	/			+		+		+	+			
<i>Climacium dendroides</i>				/							2	2					
<i>Equisetum palustre</i>				+		/	2				/		+				1
<i>Festuca rubra</i>													/				
<i>Gnaphalium uliginosum</i>	3	3	3	3	4	2	3	3			3	3	3	2		3	4
<i>Juncus articulatus</i>				+													
<i>Juncus bufonius</i>	8	3	6	3	9	8	3	7	3	4		+	3	6	6	3	9
<i>Myosotis laxa</i>	3	1	3	3			+	+	+	/	1	1	2	+	3	3	1
<i>Myosotis scorpioides</i>										+							
<i>Odontites vernus</i>				/			+								/		
<i>Persicaria maculosa</i>	/			1					/					/			
<i>Plagiobothrys scouleri</i>	3	/	+	4	2	1	2	+	8	7	1	1	4	3	3	3	1
<i>Plantago major</i>	3	2	+	2	3	2	1	2	2	/	3	2	3	2	3	3	2
<i>Poa pratensis</i>	/			/	2	1	1		2	2			3	2	3	1	
<i>Potentilla anserina</i>	2	2	2	1	+	/	+	1	1	+	1	2	2	+	1	3	1
<i>Ranunculus repens</i>				1													
<i>Rhytidiadelphus squarrosus</i>				/													
<i>Riccia cavernosa</i>					2	2	3	1		3	/		1	2	3	3	2
<i>Rumex crispus</i>											/						
<i>Sagina procumbens</i>	3	3	3	4	2	2	3	3	3	3	3	7	3	2	3	3	4
<i>Senecio jacobea</i>		+	/	+		/	+		/		1					+	+
<i>Veronica anagallis-aquatica</i>	+	/	2	2	1	1	+	1	1	2	1	2	1	+		+	1
Bare ground	3	9	3	5	3	5	7	5	3	3	3		2	6	3	3	

DOMIN VALUES:

9 = cover >75%

5 = cover 10–25%

1 = scarce, cover small

8 = cover 50–75%

4 = cover 5–10%

+ = isolated single plant

7 = cover 33–50%

3 = scattered, cover small

/ = present near quadrat

6 = cover 25–33%

2 = very scattered, cover small

Nomenclature follows Stace (1991) for vascular plants, Smith (1978) for mosses and Paton (1999) for liverworts unless otherwise given in the text.

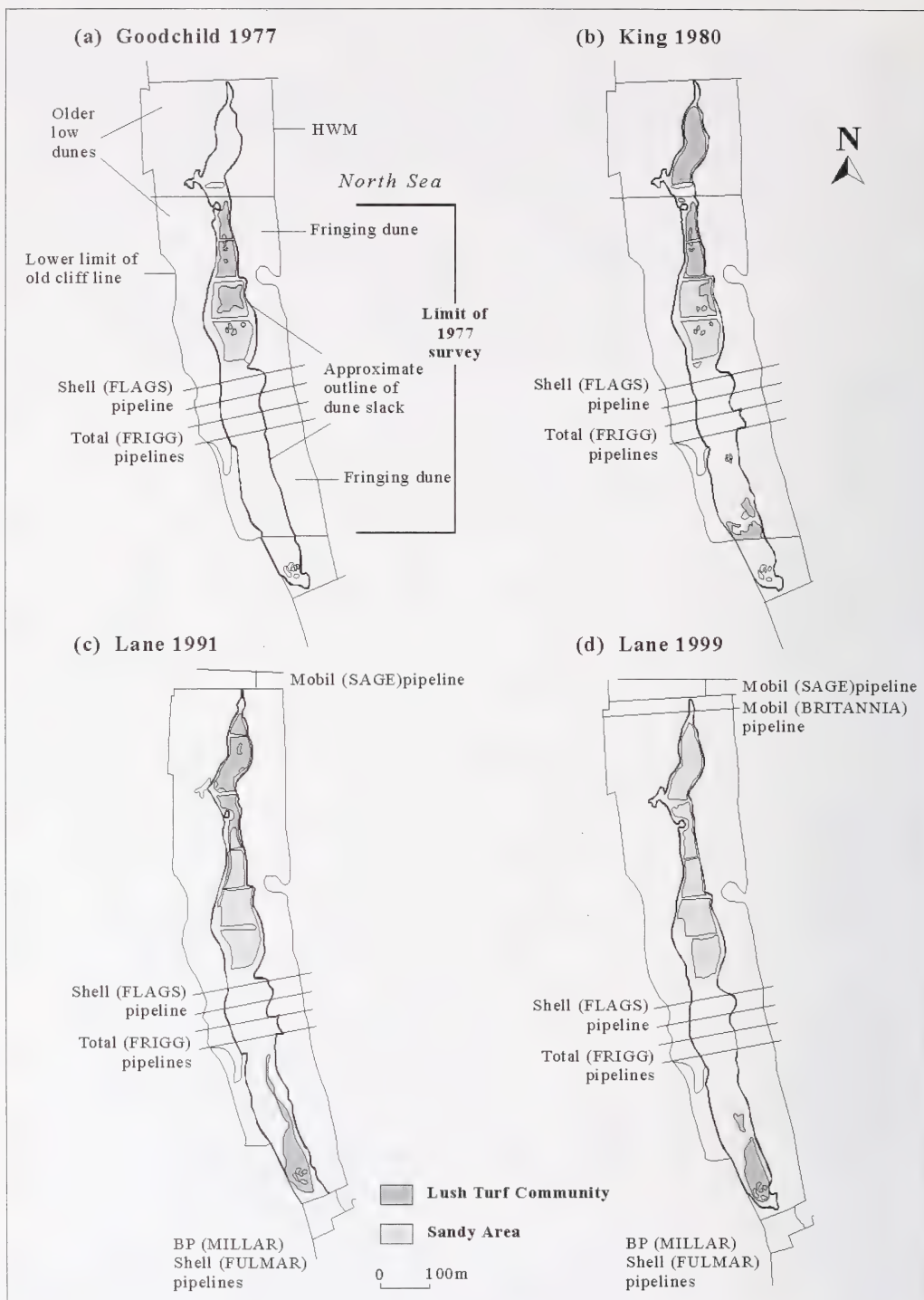


FIGURE 3. The St. Fergus dune slack colonised by *Plagiobothrys scouleri*, and changes in the distribution of "lush turf" and "sandy area" habitats from 1977 to 1999; unmarked areas within the outline of the slack carry several other habitat types.

an average cover of c. 15% in the two community sub-types, with small-scale variation (between 1 m² areas) and some large-scale variation across the slack: in two areas of c. 1 ha in the west central section of the slack it reached an average cover of c. 75% in 1999, 2000 and 2001. Both open communities are moderately rich in species, with altogether 35 plant species in the 18 1-m² quadrats recorded; numbers of species per m² ranged from 10 to 24 and averaged 16 (Table 1). An interesting characteristic species is *Riccia cavernosa*, which tends to form large patches and is in places very conspicuous. This liverwort was probably present in small amounts in the years before 1990, but was first noted in considerable abundance in 1991. It is now dominant in certain parts of the western (inland) margin of the winter-loch, where it forms large clusters in slight hollows, *Plagiobothrys scouleri* being relatively scarce there.

P. scouleri also occurs sparsely in almost closed vegetation at the margins of the slack and where the surface is slightly raised. The main species in these communities are *Agrostis stolonifera*, *Plantago major*, *Poa pratensis*, *Potentilla anserina* and *Veronica anagallis-aquatica*, indicating that they are related to the lush-turf community that formerly was extensive in the dune slack. In this vegetation, which becomes more closed as the season progresses, the individual plants of *Plagiobothrys* have a more erect form than the compact rosettes with half-prostrate stems usual in the open communities, and they flower more freely. The presence of some quite large individuals of *P. scouleri* in mid July 2000 in these situations suggests plants establish earlier in the year than in the lower parts of the slack that experience longer submergence.

It is evident that the population of *Plagiobothrys scouleri* has been extending over the past ten years from the two locations where it was originally abundant, and by 2000 there were plants throughout the whole open area of silty sand that floods each winter. In the past few years the centre of the basin has been progressively colonised, and towards the edges of the slack there have been in early summer conspicuous bands of densely packed seedlings, probably resulting from the grounding of floating seeds when the water level falls from its winter peak (Fig. 4).

Specimens from the St. Fergus slack collected at different stages of growth and illustrating the different growth forms are kept in **herb. D. Welch** and **ABD**, and more material is in **herb. E.J.C.**

SOURCE OF THE ST. FERGUS COLONY

It is generally held that *P. scouleri* has been introduced to British sites from western N. America with grass seed. It is likely, although we have no definite evidence, that it also came to St. Fergus with grass seed, because, after backfilling the pipeline trenches across the dunes and winter-loch, the corridors were reseeded with commercial grass seed mixtures. The two pipelines that cross the winter loch area were seeded in 1974 and 1976, immediately following their construction. Other pipelines at St. Fergus were constructed and sown in 1984 and 1990, but these pass just beyond the northern and southern ends of the winter loch and do not cross the loch itself (Fig. 3). It has not proved possible to obtain the lot numbers of any of the seed mixtures used on these occasions, but northwest America is a major source of imported grass seed and the inoculation could have occurred on one (or more) of these dates.

A second probable alien, *Chenopodium rubrum*, is present in the St. Fergus slack, this species only occurring as a casual in northern Scotland. It has, however, been observed in reseeded roadsides in Lanarkshire (v.c. 77) (Dickson, Macpherson & Watson 2000), and E.J.C. believes grass seed the likely source. *Chenopodium rubrum* has a wide world distribution and is common in western North America although considered an introduction (Williams 1969).

OTHER POPULATIONS RECORDED IN BRITAIN

Plagiobothrys scouleri has previously been recorded in the British Isles from 9 hectads in seven vice-counties, as detailed below, the first record dating from 1974 (v.c. 109). No Irish records have been located.

South Wiltshire (v.c. 8)

Salisbury, SU13, road-building site, found by Mrs F. D. Richards (Clement 1976).



FIGURE 4. A typical plant of *Plagiobothrys scouleri* at St. Fergus (above), and a group of plants including a linear band of seedlings produced presumably from the grounding of seeds at the edge of standing water (below).

South Hampshire (v.c. 11)

Setley, SZ3099. Locally abundant on silt and fine gravel in shallow flood hollows in levelled tip areas, found by A.L. Hale & E.S. Haines in 1982 (Anon. 1988; Brewis *et al.* 1996). Voucher specimen in **WCR**. In May 1985 J. Ounsted independently discovered this colony and estimated a population of about 10,000 plants. The site was also visited by E.J.C. *et al.* in September 1998: very numerous rosettes were observed, some flowering and fruiting, suggesting this population has summer and autumn germination when conditions are suitable.

Beaulieu airfield, SU3500. Bare mud and gravel in shallow flood hollow, recorded by R. P. Bowman in 1987 (Anon. 1988; Brewis *et al.* 1996). Voucher specimens in **BM & WCR**.

Lee-on-the-Solent, SZ5699. A single large and sprawling plant found by D. Allan and E.J.C. in reseeded grassland on a dry low cliff-top in July 1998; it did not reappear in 1999 (E.J.C.). Voucher piece in **herb. E.J.C.**

Berkshire (v.c. 22)

Windsor Great Park, private area near Norfolk Farm, seen by M. F. Gardner in July 1990 and June 1991 "in considerable numbers suggesting that seed had been successfully set the previous year" (Clement *et al.* 1993). Voucher specimens in **herb. E.J.C.**

Buckinghamshire (v.c. 24)

Several plants were observed in SP83 in sown grass in 1990, but have apparently not perpetuated themselves (R. Maycock, pers. comm.). *Downingia elegans* (Douglas ex Lindley) Torrey was also present in the swards, suggesting that the grass seed originated in western North America (Clement 1978; Briggs 1986; Clement & Foster 1994). *Crepis setosa* and *Rorippa palustris* ssp. *hispida* (Desv.) Jonsell were also recorded (R. Maycock, pers. comm.), the latter being probably a first record for the British Isles (and possibly Europe), this subspecies being native in much of North America.

Staffordshire (v.c. 39)

Cannock Chase, in an old quarry on very light sandy soil, found by G. M. Kay in July 1987; "a pathetic scrap", now in **herb. E.J.C.**, was gathered whilst in a dash during a B.S.B.I. field meeting. Several plants were seen in July 2001 on bare mud at two locations: SJ974192 ("Natterjack Toad scrape") and SJ975190 ("Old quarry") (Hawksford 2002), and specimens are deposited in **STO**.

Caithness (v.c. 109)

Thurso, ND1268. In abundance, observed on a single occasion in newly-sown grass on a roadside verge by the river bridge in June 1974 (Clement 1976; Macpherson & Macpherson 1977; Bullard *et al.* 1977). Specimens in **BM, E, herb. E.J.C.** and **herb. P. Macpherson**.

Shetland (v.c. 112)

Baltasound, HP 6009. Plants observed in reseeded ground outside a new building (Baltasound Leisure Centre) in July 1989 by R. C. Palmer (Walter Scott, pers. comm.). Specimens were checked by E.J.C. and are deposited in **OXF, E** and **SLBI**. The colony has not persisted (W. Scott, pers. comm.).

DISCUSSION

Allocating specific limits to the bewildering variation within the genus *Plagiobothrys* is somewhat arbitrary, and authors have differed widely in their treatments. The self-pollinating races are often apparently very distinct, but extensive searching usually reveals intermediates. In this paper we follow the practical, broad-species concept of Hitchcock *et al.* (1959), but do not uphold their var. *penicillatus* (Greene) Cronq.; this variety they said was separable "with some difficulty", its characters being smaller flowers (mostly 1–2 mm wide, cf. 2–4 mm) and a more prostrate habit. Nutlet characters such as hispidity and ornamentation, often used by C. V. Piper, E. L. Greene and others to define new species, can vary within populations, and are considered to be of little taxonomic significance. Further careful research on native North American populations may eventually reveal that more than one taxon is present in Britain.

British populations of *Plagiobothrys scouleri* are certainly not all uniform, although differences are often more obvious in fresh specimens than dried. The most extreme variant was the single plant at Lee-on-the-Solent. It totally lacked the fulvous coloration of the indumentum of the young inflorescence so prominent on the Thurso plants, and had minute flowers with the corolla tube just equalling the calyx (shrinking to much shorter when pressed), and the corolla only 1.5 mm in diameter with no yellow bosses at the mouth. The style was very difficult to find, being totally hidden between the four nutlets and reaching to only half their length. The procumbent much-branched growth and the narrow leaves (0.5 mm broad) gave the plant an appearance like *Polygonum aviculare*, and it was only found whilst searching on hands and knees for tiny grass-seed aliens. In contrast the Setley plants are almost garden-worthy ornamentals, with flowers uniformly about three times as large as at Lee-on-the-Solent yet also lacking ferruginous indumentum.

As a native, *P. scouleri* grows in moist, often poorly drained soils at low to moderate elevations, and ranges from N. California to British Columbia with easterly extensions as far as Manitoba and New Mexico. It is introduced in Alaska; outside N. America we can track down only a record from Sweden as an ephemeral (Karlsson 1997). There are suitable habitats in New Zealand, but no records yet. Closely related native taxa exist in Chile, but none seems to fall within our complex. One close ally, a native of both N. and S. America, is *P. fulvus* (Hook. & Arn.) I. M. Johnst. which has been provisionally claimed for Britain (Clement & Foster 1994). It differs subtly, basically by having the nutlet attachment scar near its middle, instead of almost basal as in *P. scouleri*.

Grass-seed mixtures are the most likely source of inoculum for the British *Plagiobothrys* colonies, but it is tempting to suggest for St. Fergus, because of its situation amongst extensive semi-natural habitats, that bird introduction has occurred. However no bird migrates from western N. America to Britain, whereas the repeated sowings of grass for the reinstatement of the gas pipeline trenches at St. Fergus gave plenty of opportunities for the establishment of the impurities that are known to occur in grass seed; impurities may be most common when legumes, e.g. clover, are included in mixes as nitrogen fixers. There is good evidence that British grass-seed mixtures often have an origin in NW America, since casual species such as *Downingia elegans* that are native in this region are regularly observed in new-sown grass; Clement & Foster (1994) give more examples of such species. *Agrostis exarata* Trin. is a further example for which secondary introduction is apparently impossible: it is not known established elsewhere in the world away from its home in NW America and extreme E. Asia (Ryves *et al.* 1996).

From its native distribution, *Plagiobothrys scouleri* is likely to persist in Britain only where winter water-bodies dry out to mud or silt during the growing season. The most typical associates are therefore likely to be annuals such as *Juncus bufonius* and *Gnaphalium uliginosum*, the latter having a striking similarity in habit. At Setley some colonies in shallow hollows have similar rings of plants resulting presumably from seeds stranded as water recedes, as described for St. Fergus; the perennial species *Mentha pulegium* also shows this. This plant is native in the New Forest, but occurs at Setley in a slightly different form, and has undoubtedly arrived from America where it is a serious weed. Similar introductions have occurred elsewhere in Britain, e.g. Kay (1996), far from native localities. Similarly, the Lee-on-the-Solent plant grew with *Parapholis incurva*, most probably another introduction even though native in S. Hants. Significantly, *P. incurva* did not reappear here during the next two years.

Dune slacks are an unusual habitat in having a major regular change in conditions between winter submergence and summer dryness. As dune slacks have quite small total extent in Britain and are not often affected by development and accompanying practices such as grass sowing, the number of colonisations by alien species like *Plagiobothrys scouleri* seems to have been small. But now with the colonies at St. Fergus and Setley well established, it is likely that secondary natural spread will proceed, brought about by wildfowl dispersing the seed *via* their muddy webbed feet to other water bodies at which there is summer drying-out. Fortunately, no rare native species seems likely to suffer as a consequence.

Finally, a reflection on the unexpected consequences of modern changes in life-style. The specific name of our plant commemorates John Scouler (1804–1871), a Scottish botanist who collected extensively in western North America: we are sure that he never dreamt that this plant would one day make a home for itself in his native Scotland.

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A comparison of the pollination ecology of *Arum maculatum* and *A. italicum* in England

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ABSTRACT

Britain is considered to have two native species of *Arum*; the common Lords & Ladies, *A. maculatum* L., and the Rare Lords and Ladies, *A. italicum* Miller subsp. *neglectum* F. Towns. Currently *A. italicum* subsp. *neglectum* occurs only as thinly scattered populations spread across southern England and the Channel Islands. This study investigates whether part of the reason for the rarity of *A. italicum* subsp. *neglectum* in Britain is because it has different pollinator requirements to that of its very common close relative, *A. maculatum*. Results indicate that although the inflorescence odour composition of the two species are different, they attract similar suites of insects. Most insects caught by the plants were female *Psychoda phalaenoides* L., but both *A. maculatum* and *A. italicum* subsp. *neglectum* also caught substantial numbers of females of another species of midge, *Smittia pratorum* Goetghebuer. Both *P. phalaenoides* and *S. pratorum* were found to carry *Arum* pollen between plants but *S. pratorum* generally carried much smaller pollen loads than *P. phalaenoides*. The main pollinator of *Arum italicum* subsp. *italicum* Miller was also found to be *P. phalaenoides*. In conclusion, as female *P. phalaenoides* are readily available throughout the flowering period of *A. maculatum* and *A. italicum*, pollinator limitation is unlikely to be a reason for the rarity of *A. italicum* subsp. *neglectum* in Britain.

KEYWORDS: *Arum italicum*, *Arum maculatum*, *Psychoda phalaenoides*, *Smittia pratorum*, pollination ecology, odour chemistry.

INTRODUCTION

Plant species of the genus *Arum* have evolved a fascinating range of pollination systems centred around a general theme of using an odour to lure pollinators into elaborate inflorescences and then often imprisoning them to increase their effectiveness as pollinators. Important details vary, such as the nature of the odour, and not all species appear to trap their pollinators (Boyce 1993). Britain is believed to have two native species of *Arum*: *A. italicum* and *A. maculatum* (Prime 1961; Stace 1991). In Britain *A. italicum* occurs as two sub-species, *A. italicum* subsp. *neglectum* and *A. italicum* subsp. *italicum*, but only *A. italicum* subsp. *neglectum* is considered as native (Boyce 1993). Its current distribution is confined to scattered and dwindling populations across southern England and the Channel Islands (Prime 1960). In contrast, *A. maculatum* occurs frequently throughout England and Wales. It has been suggested that the reason for this difference in distribution may be that *A. italicum* is more sensitive to freezing (Prime 1960; Chatters 1994) as it is at the northern limit of its range in Britain (Stewart & Pearman 1994). This study investigates whether there is also a difference in pollinator requirement.

The pollination ecology of *A. maculatum* has been the subject of a number of studies and these indicate that the most frequent insects captured are female owl midges of the species *Psychoda phalaenoides* (Prime 1960; Lack & Diaz 1991; Kite 1995). By contrast, there has been no detailed

study of the species of insect caught by *A. italicum* in Britain. There is some indication that the two species produce different floral odours (Kite *et al.* 1998). This study compares the pollination ecology of *A. maculatum*, *A. italicum* subsp. *neglectum* and *A. italicum* subsp. *italicum* in southern England. It aims to investigate the relationship between scent production, total insect capture and reproductive success. It also investigates which of the species captured are actually acting as pollinators.

METHODS

STUDY SITES

Five sites were used in this study (Table 1). Three of these sites, E-Meon (Hampshire), Arundel (W. Sussex) and Dancing Ledge (Dorset), contained sympatric populations of *A. maculatum* and *A. italicum* subsp. *neglectum*. A fourth site at Ridge (Dorset) contained a naturalised population of *A. italicum* subsp. *italicum*. *Arum maculatum* did not occur at this site and so comparisons were made with a nearby population of *A. maculatum* at Wareham (Dorset). Each site contained a population of at least 200 plants of each *Arum* species present. All sites other than Dancing Ledge were in deciduous woodland. The Dancing Ledge site consisted of a system of stone walls on exposed sea cliff grasslands where both species of *Arum* occurred mostly in the shelter of the walls or nearby scrub.

PSYCHODA AVAILABILITY

Although the flowering times of *A. maculatum* and *A. italicum* can overlap in Britain, peak flowering time for *A. maculatum* is usually from the last week of April to the first week of May while that for *A. italicum* is the last two weeks of May. The availability of *Psychoda* was monitored at each site from mid-April 2000 to mid-June 2000 to establish if *Arum* populations were experiencing differences in pollinator availability. To do this, ten 10 cm² sticky traps were positioned at random but at a height of 25 cm above the ground within each study site. Traps were constructed out of sheets of stiff yellow plastic fly traps and were functional even in wet weather. Trap points were visited each week through the study period to count the number of *Psychoda* caught and to set fresh traps. This method did not measure total *Psychoda* abundance, but provided an index with which to assess the relative abundance of *Psychoda* before, during and after the flowering period of each *Arum* species studied.

INFLORESCENCE ODOUR ANALYSIS

The spadix appendix odour of selected inflorescences of each species was collected in the field, with minimal disturbance to the plant, by the technique of headspace trapping. A plastic sleeve made from a forensic sample bag (Keygrowth Marketing) was attached to the end of an odour trap (100 mm long x 3 mm diameter; SGE Ltd) packed with 100 mg of 35/60 mesh Tenax TA (Jones Chromatography) and inserted over the spadix of an odorous inflorescence. Air was then drawn past the appendix and through the trap at a rate of 25 ml/min by means of a portable constant flow pump (DuPont Air Sampler Model P125A). The odour was collected during the female phase of inflorescence opening: that is from about 18:00 h, soon after spathe opening, to about 07:00 h the following morning.

TABLE 1. LOCATION OF STUDY SITES.

Study Site	Taxon Surveyed	Location and Grid Reference
E-Meon	<i>A. maculatum</i> & <i>A. italicum</i> subsp. <i>neglectum</i>	East Meon Church, Hampshire (GR468122)
Arundel	<i>A. maculatum</i> & <i>A. italicum</i> subsp. <i>neglectum</i>	Offham Hanger, near Arundel, W. Sussex (GR502108)
Dancing	<i>A. maculatum</i> & <i>A. italicum</i> subsp. <i>neglectum</i>	Dancing Ledge, near Langton Matravers, Dorset (GR399076)
Wareham	<i>A. maculatum</i>	Wareham, east part of town wall, Dorset (GR32087)
Ridge	<i>A. italicum</i> subsp. <i>italicum</i>	Ridge village, Dorset (GR393086)

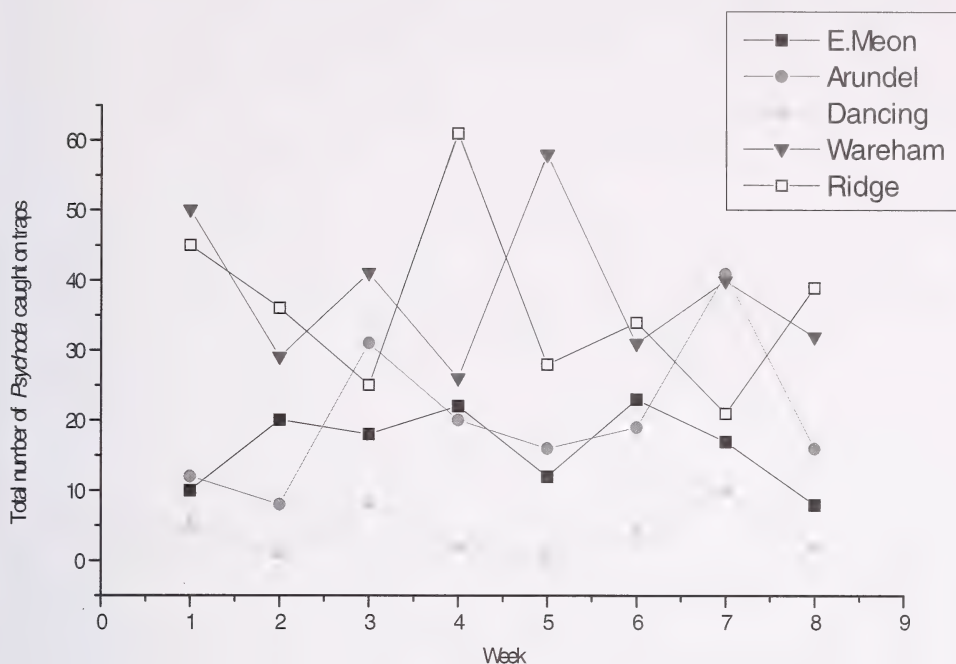


FIGURE 1. The total number of *Psychoda phalaenoides* caught per week on ten artificial traps in each study site. Week 1 started on the 14th of April 2000.

The compounds on the Tenax trap were analysed by thermal desorption-gas chromatography-mass spectrometry (TD-GC-MS: thermal desorption injector, SGE; GC, Perkin-Elmer Model 8500; MS, Finnigan-MAT Ion Trap Detector 800 series). The trap was inserted into the thermal desorption injector for 10 s where it was subjected to a flow of helium gas at 10 psi and 250°C. During desorption, the helium flow from the trap was directed onto a non-polar capillary column, the front end of which was looped through a polystyrene cup full of liquid nitrogen. The front end of the column was then removed from the liquid nitrogen and chromatography of the volatile compounds was carried out using an oven temperature programme of 40–260°C at 5°C/min. Electron ionisation (70 eV) mass spectra of the compounds eluting from the column were recorded by the ion trap detector (acquisition parameters: m/z range 38–400, automatic gain control set at m/z 38, scan rate 1/s) and the retention index of each component was determined by calibrating the retention time against a series of n-alkanes (Supelco UK Ltd) analysed in the same manner. Identifications were achieved in the first instance by comparison of the mass spectra and retention indices with those published by Adams (1995), obtained using the same column polarity and mass spectrometer. For components showing unsatisfactory matches, assignment was attempted by on-line searching of the NIST mass spectral database (Mikaya *et al.*, 1999). The identities of some components were confirmed against standards purchased from the Aldrich Library of Rare Chemicals. Peak areas were determined from the total ion chromatogram and expressed as a percentage of the summed peak areas of all the component peaks, ignoring those components (either Tenax artefacts or air pollutants) that were also present in a control sampling of air at the study site.

INSECT CAPTURE AND SEED SET

Insects were collected from 30 inflorescences of each *Arum* species at each site. Collections were made over three separate days during the main flowering phase of each population. Only one

TABLE 2. COMPOSITION OF THE APPENDIX ODOURS OF INDIVIDUAL INFLORESCENCES OF WILD-GROWING *A. ITALICUM* AND *A. MACULATUM* DETERMINED BY TENAX TRAPPING IN THE FIELD AND TD-GC-MS

No.	RI	Component Assigned	Relative amount, % (tr = <1%)									
			<i>A. italicum</i>			<i>A. italicum</i>					<i>A. mac.</i>	
			subsp. <i>italicum</i>			subsp. <i>neglectum</i>						
1	703	3-methyl-2-butanone ^c	2	1	1	tr	tr	2	5	11	-	-
2	745	pentan-1-ol ^c	4	2	3	-	-	-	-	-	-	-
3	759	3-methyl-2-pentanone ^c	2	tr	3	tr	tr	tr	tr	2	-	2
4	823	butyl acetate ^b	-	-	-	-	-	-	-	-	-	2
5	890	2-heptanone ^a	2	1	1	2	tr	4	2	2	2	5
6	898	3,7-dimethyl-1-octene ^a	6	12	9	16	29	21	28	38	-	-
7	922	2,6-dimethyl-1,7-octadiene ^c	3	5	2	4	2	4	2	3	-	-
8	939	3,7-dimethyl-1,6-octadiene (β -citronellene) ^a	51	50	37	21	23	28	13	22	-	-
9	967	3,7-dimethyl-2-octene*	-	-	-	26	23	21	12	9	-	-
10	1004	<i>trans</i> -2,6-dimethyl-2,6-octadiene ^{a**}	-	-	-	5	5	8	3	2	-	-
11	1028	1- <i>p</i> -menthene ^b	-	-	-	tr	tr	tr	-	tr	-	-
12	1035	limonene ^b	1	1	8	-	tr	tr	-	-	-	-
13	1075	3,7-dimethyl-1-octen-7-ol ^b	-	-	-	tr	tr	tr	-	-	-	-
14	1086	<i>p</i> -cresol ^a	8	5	13	tr	tr	tr	tr	tr	5	tr
15	1093	2-nonanone ^b	1	tr	-	tr	tr	tr	-	-	-	-
16	1109	<i>n</i> -nonanal ^b	1	tr	-	-	-	-	-	-	-	-
17	1201	methyl salicylate ^b	4	4	8	-	-	-	-	-	-	tr
18	1210	<i>n</i> -decanal ^b	-	-	-	-	-	-	-	-	-	tr
19	1301	indole ^a	-	-	-	-	-	-	-	-	9	tr
20	1354	unidentified sesquiterpene	tr	2	tr	-	-	-	-	-	-	-
21	1368	citronellyl acetate ^b	tr	tr	tr	tr	1	tr	4	tr	-	-
22	1376	α -copaene ^b	-	-	-	-	-	-	-	-	1	tr
23	1404	unidentified sesquiterpene	12	15	13	11	9	6	20	4	1	7
24	1409	(<i>Z</i>)-caryophyllene ^b	tr	tr	tr	4	2	1	3	tr	2	2
25	1426	(<i>E</i>)-caryophyllene ^b	tr	tr	tr	7	3	3	7	1	13	5
26	1443	aromadendrene ^b	tr	tr	-	-	-	-	-	-	tr	tr
27	1464	α -humulene ^b	-	-	-	tr	tr	tr	tr	6	9	7
28	1475	allo-aromadendrene ^b	-	-	-	-	-	-	-	-	4	3
29	1489	unidentified sesquiterpene	-	-	-	tr	tr	-	-	-	7	8
30	1510	bicyclogermacrene ^b	-	tr	-	tr	tr	-	-	-	4	6
31	1531	δ -cadinene	tr	tr	tr	-	tr	-	-	-	4	5
32	1543	(<i>Z</i>)-nerolidol ^b	-	-	-	tr	tr	-	-	-	-	-
33	1575	(<i>E</i>)-nerolidol ^b	-	-	-	tr	tr	-	-	-	-	-
34	1716	unidentified sesquiterpene	-	-	-	-	-	-	-	-	14	16
35	1773	pentadecanol ^b	-	-	-	-	-	-	-	-	11	5
36	1788	1-octadecene ^b	-	-	-	-	-	-	-	-	3	11
37	1801	octadecane ^b	-	-	-	-	-	tr	-	-	2	2
38	1828	unidentified alkene	-	-	-	-	tr	tr	-	-	tr	3
39	1834	unidentified	-	-	-	-	-	-	-	-	tr	2
40	1906	<i>n</i> -nonadecane	-	-	-	-	-	tr	-	-	2	7
41	1987	1-eicosene ^b	-	-	-	-	-	-	-	-	4	tr
42	2000	<i>n</i> -eicosane ^b	-	-	-	-	-	-	-	-	2	2

RI = Retention index of component on BPX5

Component assignment criteria:

a = comparison of mass spectrum and retention index with standard. b = comparison of mass spectrum and retention index with published data (Adams 1995). c = comparison of mass spectrum with published data (Mikaya *et al.* 1999).

*Compound 9 was assigned as the reduction product of 10 by analogy with the occurrence of 8 and its reduction product 6. Compounds 9 and 6 had very similar mass spectra. No chromatographic or mass spectral data on authentic 3,7-dimethyl-2-octene was available.

** A standard of *cis*-2,6-dimethyl-2,6-octadiene from the Aldrich Library of Rare Chemicals gave a RI of 986 but showed a minor component at RI 1003 with the same mass spectrum, which also matched 10. Compound 10 was therefore tentatively assigned as the *trans* form.

population was sampled on any one day. On each collection day, inflorescences in late female phase were examined at random until ten inflorescences were found that contained captive insects. A record was kept of how many inflorescences needed to be examined to find ten with captives. All insects caught were extracted from the inflorescence using a pooter (a suction tube attached to a collecting pot) and preserved in 70% alcohol for later identification. This method caused no damage to the inflorescence. The inflorescences were labelled so that success of seed set could be determined from berry formation over the following two months. Seed set was scored as simply either present or absent to avoid disrupting the infructescences of *A. italicum* subsp. *neglectum*.

COMPARISON OF POLLEN IMPORT

The number of pollen grains brought in by different insect species was counted by extracting freshly captured insects out of inflorescences (by suction, using a pooter), stunning the insects with diethyl ether and then mounting them on microscope slides smeared with a small amount of gel. Cover slips were placed over the insects and gently pressed down to squash the specimens. Pollen grains carried per insect were then counted using a light microscope with a 100 × magnification. Insects were collected from ten plants per species on each study site. All collections were made during peak flowering phase.

RESULTS

PSYCHODA AVAILABILITY

The number of *Psychoda phalaenoides* captured on the sticky traps was not significantly related to season in any of the sites studied (Figure 1). This suggests that, within each site, *A. maculatum* and *A. italicum* experienced similar availability of *P. phalaenoides*. However, there were significant differences in *P. phalaenoides* capture per site (Kruskal Wallis $H = 29.82$, $P < 0.001$), with the highest numbers captured at Wareham and Ridge and the lowest at Dancing Ledge. This indicates that *Arum* may experience different levels of pollinator availability at different sites.

APPENDIX ODOUR COMPOSITION

The appendix odour from three inflorescences of *A. italicum* subsp. *italicum*, five inflorescences of *A. italicum* subsp. *neglectum*, and two of *A. maculatum* were successfully trapped and analysed (Table 2). The results obtained for *A. maculatum* were similar to those reported previously for the species (Kite, 1995) in that the odour showed the presence of 2-heptanol, *p*-cresol and indole together with various sesquiterpenoids and long-chain aliphatic compounds. However, the odours of two inflorescences analysed in the present study showed a greater relative abundance of an unidentified sesquiterpene alcohol (compound **34** in Table 2), also reported by Kite (1995), which accounted for the largest relative peak area in the total ion chromatograms.

In contrast, the inflorescence odours of both subspecies of *A. italicum* were characterised by high relative amounts of acyclic monoterpenes and related alkenes (mainly compounds **6–10**) with indole being undetectable. This also concurs with the results obtained by Kite *et al.* (1998) for *A. italicum* in cultivation. Exact structural assignment of these compounds by GC-MS is problematic and the criteria for their assignments are given in Table 2, but certainly the compounds were not detectable in the odour of *A. maculatum*.

The odours of the two subspecies of *A. italicum* differed in the profile of acyclic monoterpenes and alkenes they contained. While 3,7-dimethyl-1,6-octadiene (β -citronellene, **8**) and its reduced form 3,7-dimethyl-1-octene (**6**), both assigned against authentic standards, were present at high relative abundance in both subspecies, *A. italicum* subsp. *neglectum* also contained 2,6-dimethyl-2,6-octadiene (**10**) and an alkene (**9**) that is likely to be its reduced form. Amongst other differences, the odours examined of *A. italicum* subsp. *italicum* could also be distinguished from those of subspecies *neglectum* by the higher relative abundance of *p*-cresol in the former.

The major sesquiterpene (**23**) in the odour of both subspecies of *A. italicum* did not give any matches with mass spectra of sesquiterpenes included in the NIST 98 (Mikaya *et al.* 1999) or Adams (Adams 1995) libraries. This compound also occurred in the odour of *A. maculatum*, but the major unidentified sesquiterpene alcohol (**34**) in the odour of *A. maculatum* was not detected in the analyses of *Arum italicum*. These sesquiterpenoids will require isolation for structural characterisation.

TABLE 3. NUMBER OF INFLORESCENCES, IN LATE-FEMALE PHASE OF FLOWERING, EXAMINED AT EACH VISIT TO OBTAIN TEN INFLORESCENCES THAT HAD CAPTURED AT LEAST ONE INSECT. EACH SITE WAS VISITED THREE TIMES FOR EACH SPECIES OF *ARUM* PRESENT

	E-Meon	Arundel	Dancing	Wareham	Ridge
<i>A. maculatum</i>	12	14	22	10	-
	15	10	16	15	-
	13	12	20	11	-
<i>A. italicum</i>	11	13	15	-	14
	10	14	20	-	11
	12	15	23	-	13

INSECT CAPTURE

The number of inflorescences sampled per site and per species of *Arum* to obtain ten inflorescences that had caught insects are given in Table 3. Results differed significantly between sites (Kruskal-Wallis $H = 6.92$, $P = 0.075$ for *A. maculatum* and $H = 9.03$, $P = 0.029$ for *A. italicum*) but not between species of *Arum* (Mann Whitney $U = 57.5$, $P = 0.5989$) (Table 3). The number of inflorescences that captured insects was far lower at Dancing Ledge than at the other sites, as was the maximum and average number of insects caught per inflorescence.

All insects captured were Diptera (true flies) and the vast majority belonged to the sub-order Nematocera (thread horn flies). The few non-Nematocera caught were insects belonging to one of many different families of Diptera from the sub-order Cyclorrhapha (blow flies, house flies, fruit flies, hover flies). Most insects captured by all taxa of *Arum* on all sites were female *Psychoda phalaenoides*, Nematocera belonging to the family Psychodidae. (Figure 2, 3 and 4). The second most abundant group of insects captured by *A. maculatum* and *A. italicum* subsp. *neglectum* on all sites were female *Smittia pratorum* Goetghebuer. These are Nematocera belonging to the family Chironomidae. By contrast, the population of *A. italicum* subsp. *italicum* studied was found to capture very few *S. pratorum* but instead captured considerable numbers of *Psychoda grisea* Eaton and a range of species of Nematocera belonging to the family Ceratopogonidae. Species of Nematocera from families other than Psychodidae, Chironomidae and Ceratopogonidae were captured by *Arum* only infrequently and so are presented together as "other Nematocera" in Figures 2, 3 and 4. The composition of the "other Nematocera" did not differ between taxa of *Arum* and consisted of insects from the following families: Sciaridae, Mycetophilidae and Bibionidae.

COMPARISON OF POLLEN IMPORT

The only species that were found to carry pollen grains into any of the taxa of *Arum* studied were *P. phalaenoides* and *S. pratorum*. Of these two species, *P. phalaenoides* was the most frequent importer of pollen for all *Arum* taxa and also brought in a far larger average number of pollen grains per fly than did *S. pratorum* (Table 4).

SEED SET

A comparison of the relationship between seed set and insect capture found that success of seed set was significantly less likely if capture of female *Psychoda phalaenoides* did not occur (Figure 5) (Mann Whitney $U = 905$, $P < 0.0001$ for *A. maculatum*; $U = 38$, $P = 0.003$ for *A. italicum* subsp. *neglectum* and $U = 484$; $P = 0.0002$ for *A. italicum* subsp. *italicum*).

DISCUSSION

The differences in the profile of the major compounds trapped from the odours of *A. maculatum* and *A. italicum* is remarkable given that both mainly attract *P. phalaenoides*. This difference in the chemical composition was noted before in a preliminary chemical survey of the odours of *Arum* species in cultivation (Kite *et al.*, 1998). This earlier study found that the odour profile of *A. italicum* was closer to that of Mediterranean species of *Arum* (such as *A. nigrum* Schott) than to *A. maculatum*, even though *A. italicum* is thought to be more closely related to *A. maculatum*.

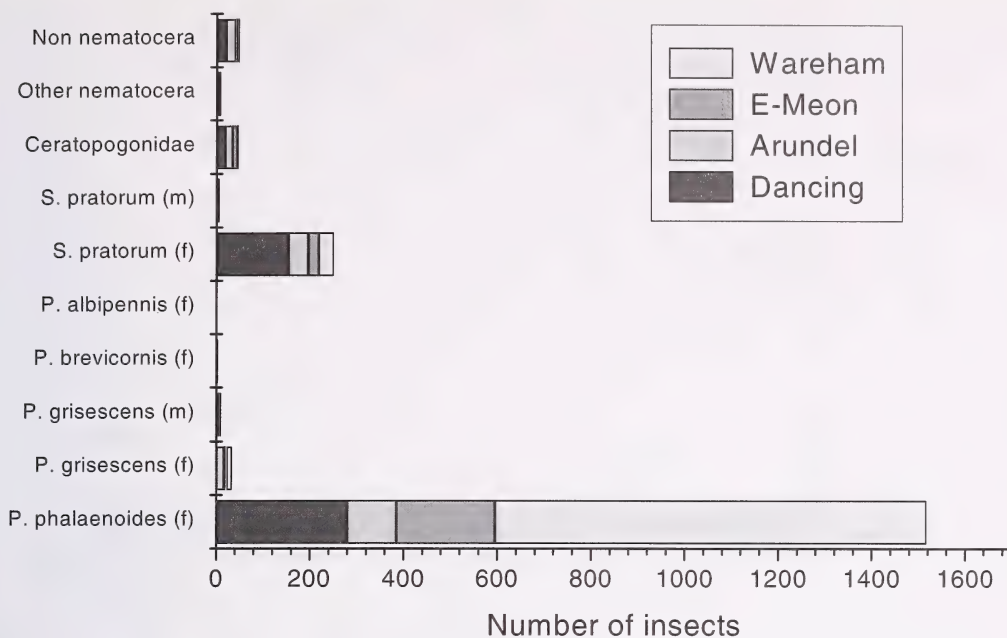


FIGURE 2. The total number of invertebrates captured by *A. maculatum* inflorescences in each of the study sites.

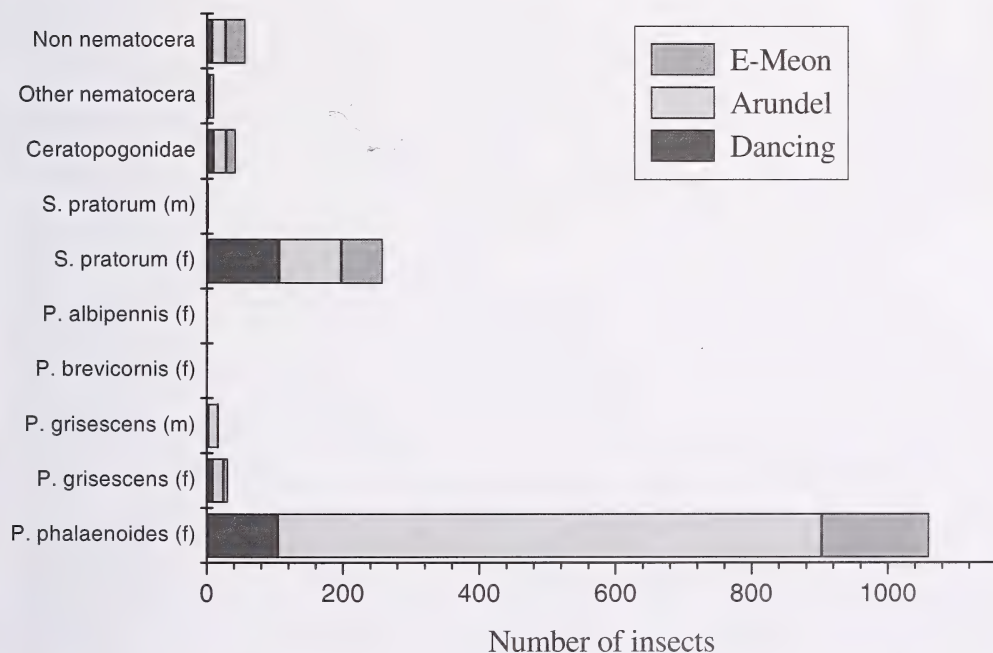


FIGURE 3. The total number of invertebrates captured by *A. italicum* subsp. *neglectum* in each of the study sites.

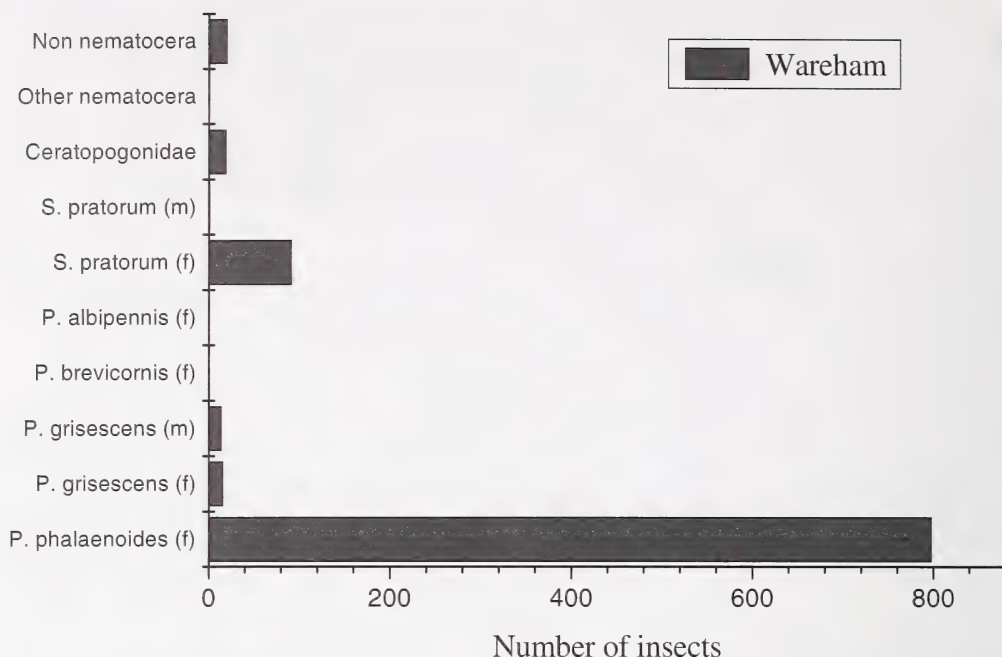


FIGURE 4. The total number of invertebrates captured by *A. italicum* subsp. *italicum* in the Ridge study site.

(Boyce 1993). Inflorescences of these Mediterranean species have been observed to attract a variety of insects that breed on dung, including flies (Diptera: Sphaeroceridae) and beetles (Coleoptera: Staphylinidae), but not *Psychoda* (Drummond & Hammond 1991; 1993). Consequently, Kite *et al.* (1998) questioned an observation by Méndez and Obesco (1992) that *Psychoda* was the main pollinator of *A. italicum*. Clearly, though, our present work supports Méndez and Obesco (1992) and shows that, in southern England at least, *P. phalaenoides* is the chief pollinator of both *A. maculatum* and *A. italicum*. Further work is currently being carried out to establish what insects pollinate *A. italicum* and *A. maculatum* plants in France and Spain.

Previously, *p*-Cresol was suggested as being a possible attractant for *Psychoda phalaenoides* since it was detected as a common component of the odour of *A. maculatum* and of cow dung, one breeding habitat of *P. phalaenoides* (Kite 1995). *p*-Cresol, particularly in combination with indole and 2-heptanone, was later shown to attract *Psychoda* species in a field behavioural assay (Kite *et al.* 1998). *p*-Cresol and 2-heptanone were two of the components common to the odours of *A. maculatum* and *A. italicum* and so could be responsible for attracting *Psychoda* to both, although it was only present in trace amounts in the odour of *A. italicum* subsp. *neglectum*. Indole could not be detected in either subspecies of *A. italicum*. Another common component is the uncommon sesquiterpene (number 23 in Table 2) that will require isolation for identification. The true attractants may not, of course, be among either the major odour components that are more readily detected by GC-MS or those components common to both species.

This study found that a second species of insect, *Smittia pratorum*, also functioned as a pollinator of *Arum maculatum* and *A. italicum* subsp. *neglectum* in Britain. *Smittia* are terrestrial chironomids whose larvae develop in wet soil (Frouz 1997). It is possible that *S. pratorum* may be attracted to *Arum* to feed on the stigmatic exudate as species in this genus have been reported as feeding on the stigmatic exudate of *Pseudowintera colorata* (Winteraceae) (Lloyd & Wells 1992). *A. italicum* subsp. *italicum* was not recorded as catching *S. pratorum* in this study but instead caught greater numbers of *Psychoda griseus* than the other two taxa. Only one population was studied and further work is clearly required to establish whether there are consistent differences in insect capture between *A. italicum* subsp. *italicum* and the other two taxa studied.

TABLE 4. A COMPARISON OF THE NUMBER OF POLLEN GRAINS CARRIED INTO *ARUM* INFLORESCENCES BY *PSYCHODA PHALAEANOIDES* AND *SMITTIA PRATORUM*

<i>Psychoda phalaenoides</i>					
Taxon	Site	Number of flies examined	% flies with pollen	Mean No. pollen grains per fly	Max No. pollen grains per fly
<i>A. maculatum</i>	E-Meon	85	69	65	346
	Arundel	114	79	51	244
	Dancing	98	65	57	268
	Wareham	224	85	55	290
<i>A. italicum</i> subsp. <i>neglectum</i>	E-Meon	89	70	58	261
	Arundel	280	72	71	304
	Dancing	40	58	60	335
<i>A. italicum</i> subsp. <i>italicum</i>	Wareham	102	75	53	321
<i>Smittia pratorum</i>					
<i>A. maculatum</i>	E-Meon	12	8	3	3
	Arundel	10	10	5	5
	Dancing	61	5	11	31
	Wareham	9	0	0	0
<i>A. italicum</i> subsp. <i>neglectum</i>	E-Meon	22	4	4	4
	Arundel	35	6	11	20
	Dancing	32	9	6	19
<i>A. italicum</i> subsp. <i>italicum</i>	Wareham	1	0	0	0

The finding that both male and female *Psychoda grisescens* were captured by *A. maculatum* and *A. italicum* agrees with a previous study of *A. maculatum* (Edwards 1940) and is interesting given that *Arum* scent is thought to mimic egg laying sites. Little is known of the ecology of *P. grisescens* other than that it breeds in dung and in the fungus *Coprinus atramentarius* (Satchell 1947; Withers 1988). One possible explanation for the capture of both male and female *P. grisescens* is that males and females fly together and that as the males pursue the females they are inadvertently lured into *Arum* inflorescences.

This study has found that the vast majority of *Arum* pollen imported into inflorescences of *A. maculatum*, *A. italicum* subsp. *neglectum* and *A. italicum* subsp. *italicum* was being carried in by *Psychoda phalaenoides*. This finding, together with the results from the study of seed set, indicating dependence on visits by *P. phalaenoides*, confirm that *P. phalaenoides* is the main pollinator for *Arum*, at least in Britain. The very high frequency with which *P. phalaenoides* are carrying *Arum* pollen is a testimony to the remarkable effectiveness of a deception which is good enough to lure in *P. phalaenoides* but not so good as to stimulate egg laying. The study found that *P. phalaenoides* not only carry *Arum* pollen more frequently than *S. pratorum*, they also generally carry a greater number of pollen grains per insect. Scanning electron microscopy reveals that the reason for this appears to be that pollen can more easily lodge on the much hairier body of *P. phalaenoides*.

In conclusion, this study has found that scent production appears to differ between the three *Arum* taxa studied but that this caused no differences in the types of insect captured by *A. maculatum* and *A. italicum* subsp. *neglectum* and only small differences between these and *A. italicum* subsp. *italicum*. In particular, there was no difference between taxa in their ability to capture their main pollinator, *P. phalaenoides*. Female *P. phalaenoides* are readily available throughout the flowering period of *A. maculatum* and *A. italicum* and so results from this study indicate that pollinator limitation is unlikely to be a reason for the current rarity of *A. italicum* subsp. *neglectum* in Britain.

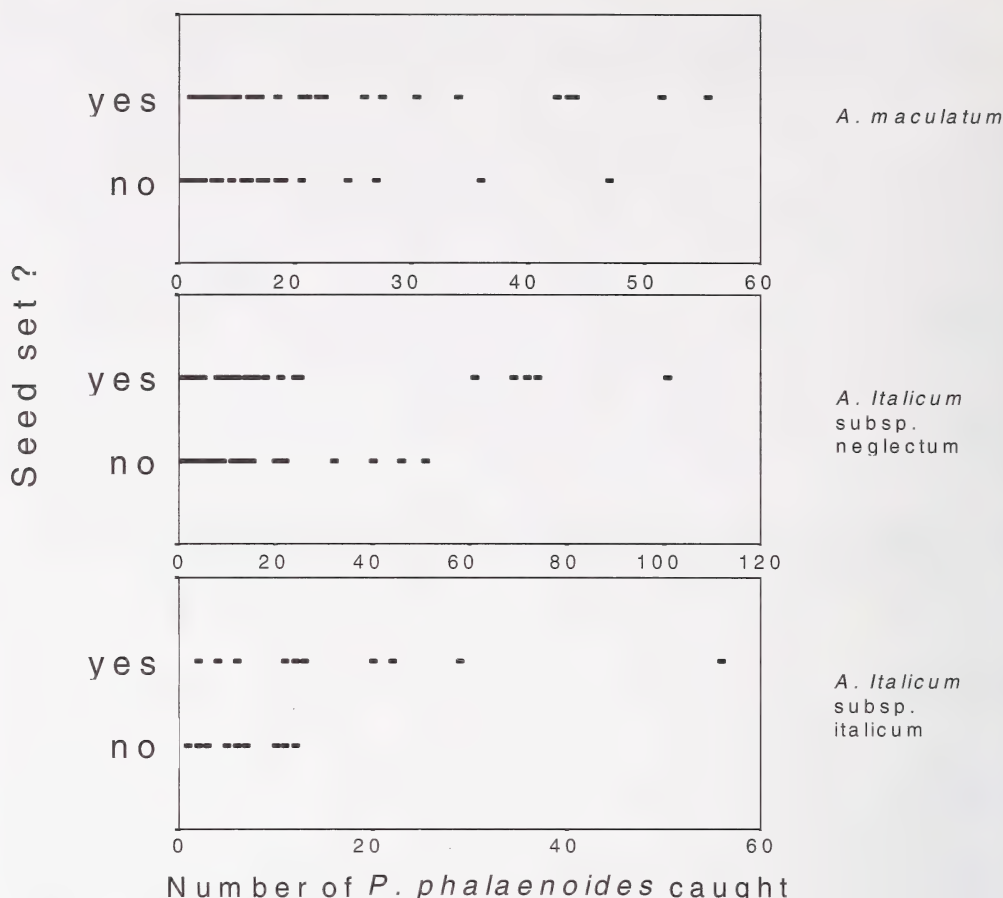


FIGURE 5. The relationship between number of *Psychoda phalaenoides* caught by plants in each taxa of *Arum* and success of seed set.

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Distribution and population sizes of *Asparagus prostratus* Dumort., Wild Asparagus, in Britain

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ABSTRACT

Asparagus prostratus Dumort., Wild Asparagus, is a western European maritime endemic. In Britain it is a Red Data Book species and is listed as a Priority Species under the UK Biodiversity Action Plan. Historical records have been researched and collated with recent field surveys for Britain. A number of records are errors due to confusion with *A. officinalis*. It has been recorded from at least 34 sites in V.c. 1, 2, 9, 13, 41, 45 and 52. It has not been recorded recently in six sites (18% decline), is extinct in West Sussex and Anglesey and is on the verge of extinction in Dorset. Of the 28 extant populations, nine have fewer than ten plants and only three sites have more than 100 plants. At least three extant colonies are declining.

KEYWORDS: *Asparagus officinalis* L. subsp. *prostratus* (Dumort) Corb. England. Wales.

INTRODUCTION

Asparagus prostratus Dumort. (*Asparagus officinalis* L. subsp. *prostratus* (Dumort.) Corb.), Wild Asparagus, is a western European endemic of the coasts of Belgium, Britain, The Channel Islands, France, Germany, Ireland, Spain and the Netherlands. In Britain it is a Red Data Book species classified as 'vulnerable' (Wilkinson 1999) and is a Priority Biodiversity Species (UK Biodiversity Group 1998).

The Biodiversity Action Plan requires that population sizes should be maintained at all known sites (UK Biodiversity Group 1998); in order to maintain the population sizes, it is first necessary

to know what they are. As part of the work towards that action plan objective, information on its distribution was first collated in detail by Kay (1997) whose work has been extended here. The historical records for Britain have been researched in collaboration with the Threatened Plants Database, and are collated with current field survey data partly funded or undertaken by the Botanical Society of the British Isles, the Countryside Council for Wales, the National Museums and Galleries of Wales and the National Trust. Miss S. McSweeney is preparing similar data for the populations in Ireland.

Records of *A. prostratus* need to be carefully assessed as it has often been confused with its close relative *A. officinalis*, for taxonomic and nomenclatural reasons. Historically there has been much uncertainty about whether *A. prostratus* should be a species or a subspecies or variety of *A. officinalis*, and therefore the taxa were not consistently separated. Kay *et al.* (2001) found it merited species status as it differed morphologically with distinctive characters that were retained in cultivation, it was tetraploid compared to the diploid *A. officinalis* (which therefore cannot have been derived from *A. prostratus*), the two taxa were reproductively isolated, and *A. prostratus* is a NW European maritime endemic whilst *A. officinalis* is believed to be of eastern European or western Asian origin. Further confusion has arisen from use of the name *A. maritimus* (L.) Mill. (a Mediterranean taxon) to which coastal populations of both *A. officinalis* and *A. prostratus* were regularly ascribed.

The two species are readily identifiable; characters separating them are given in Table 1. Only very rarely do they grow together and we have not observed them doing so in Britain.

SOURCES OF INFORMATION

Data were abstracted from herbarium specimens in **BEL, BIRM, BM, BMH, BREM, BRISTM, BTN, C, CGE, DBN, DZS, HLL, K, L, MBH, NMW, OXF, P, RNG, TBY** and **TCD** (identifications confirmed by Q. O. N. Kay or T. C. G. Rich), published literature sources, Biological Records Centre (B.R.C.), unpublished survey reports, the B.S.B.I. database, correspondence with botanists and field observations in England and Wales. In addition, some data were included from previously abstracted records from **CLE, DOR, HDD, JSY, LANC, LIV, LTR** and **RAMM**, but the identifications have not been checked.

A total of 363 records have been traced. They are summarised below; full details are held in the Threatened Plants Database. Some historical population data are also given. Data from Cornwall have been compiled from surveys carried out for the National Trust, the large amount of fieldwork for the *Flora of Cornwall* (French *et al.* 1999), field work by the authors and some historical data from E. W. Davies and J. Roseweir (now held by T. C. G. Rich). Data for Dorset were compiled by H. J. M. Bowen. Populations in V.c. 41 Glamorgan were surveyed by L. K. and T. C. G. Rich and others 1996–2001. Populations in V.c. 45 Pembrokeshire have been surveyed regularly by S. B. Evans and A. McConnell 1996–2001. These records were used to direct the field surveys in 2001.

It is difficult to know exactly how many individuals there are in a population as some clumps may be composed of more than one individual (as shown by some patches with plants of different sexes). Isolated fronds may be distinct plants or belong to an adjacent clump. The rhizomes of some large plants may also fragment giving the appearance of more than one plant (e.g. Kay & John 1995 found using isozyme analysis a separation of 180 cm between crowns of the largest individual). It is best to regard the population estimates as the number of 'clumps' which may or may not be single plants. J. Roseweir for his undergraduate studies in 1959 was often able to distinguish individuals by their unique morphology, showing that more detailed counts may be possible in some cases. Seedlings were counted when seen.

DISTRIBUTION AND POPULATIONS SIZES

Sites are listed in vice-county order, and clockwise around the coast within each vice-county.

V.C. 1, WEST CORNWALL

There are four main groups of sites on The Lizard (SW61, SW71), where plants are scattered along sections of cliff. There are also many records simply ascribed to The Lizard, without specific information.

TABLE 1. CHARACTERS DISTINGUISHING *ASPARAGUS OFFICINALIS* AND *A. PROSTRATUS* (AFTER KAY *ET AL.* 2001)

	<i>Asparagus officinalis</i>	<i>Asparagus prostratus</i>
Colour of plant	Usually mid- to olive-green or yellowish-green, often shiny.	Usually glaucous (especially when exposed), sometimes green
Stems	(40–)80–200 cm tall, erect, straight (sometimes sinuous towards apex)	10–70(–130) cm tall, at least the largest usually prostrate, decumbent or ascending, rarely erect with tops curving sideways, usually curved and/or sinuous
Internode length	Mean 12–36 mm (range of all internodes 4–89 mm)	Mean 3–15(–20, exceptionally –50) mm (range of all internodes 2–50 (exceptionally 150) mm)
Longest cladodes (needle leaves) on branches	Mean length (6–)10–32 mm (range 4·5–34 mm), often curved, thin, flexible	Mean length 2–16(–18) mm (range 2–24 mm), straight, often stout and rigid
Flowers	Usually spaced out, sometimes mixed with cladodes on side branches	Usually abundant, mixed with cladodes on side branches
Pedicels	Mean pedicel length (6–)7–15 mm (range 5–17(–25) mm)	Mean length 3·2–10·4 mm (range 2–13 mm)
Male perianth	Mean length 4·0–5·7 mm (range 3·8–7 mm), yellow (rarely flushed pinkish), tips straight	Mean length 4·7–8·0 mm (range 4·2–8·3 mm), often reddish or copper-flushed yellow, out-curved at tip
Female perianth	Mean length 3·1–4·1 mm (range 2·7–4·3 mm), pale yellowish-green, tips straight	Mean length 3·5–5·9 mm (range 3·3–7·5 mm), yellow to whitish-green, out-curved at tips
Chromosome number	Normally $2n = 20$ (diploid), rarely some cultivars $2n = 40$ (tetraploid)	$2n = 40$ (tetraploid)

Enys Head to Cadgwith (including Terrick Colt, Kildown Point, Carn Barrow), SW7113–SW7215
It appears to have been first reported from the Cadgwith area in 1847 by C. A. Johns, and has been recorded by numerous botanists since in a series of about six populations over 0·5 km of cliff from Enys Head to the well-known 'Asparagus Ravine' (Terrick Colt) at Cadgwith which has one of the largest and most concentrated populations in Britain. Plants have been variously reported on grassy slopes, on cliffs and rocks, in a gully, in a serpentine quarry, and on hedgebanks.

Surveys of the sub-populations were carried out on 1 July 2001 by I. J. Bernallick. At Enys Head (SW7215), 31 plants were found. Between Enys Head and Asparagus Ravine (SW7214), 13 plants were found. At Asparagus Ravine (SW7214), 177 plants were observed, and five more inaccessible plants occurred on cliffs towards Cadgwith.

Two sites south-west of Cadgwith (SW7214 and SW7113), each with single plants, were first found by R. Holder in 2000 during a vegetation survey for the National Trust and both were seen again on 5 July 2001 by I. J. Bernallick.

Lizard Point area (including Lizard Head, Lizard Lighthouse, Pen Olver), SW7011–SW7111

Plants were first reported from Lizard Point by J. Ray in 1667 (Ray 1690). Plants are now well known on sea cliffs near the Lighthouse, but not from Lizard Point itself; all records may refer to sites near the Lighthouse. There is further confusion about records cited for Lizard Point or Lizard Head as both names have been used for the southernmost point in SW7011 and the headland to the west in SW6911; it has not been confirmed in SW6911.

In 1959 J. Roseweir recorded seven plants below the lighthouse. On 2 July 2001, 30 plants were found by I. J. Bernallick in two sub-populations in the lighthouse area (SW7011).

The population at Pen Olver (SW7111, Signalhouse Point) was first reported in 1994 by the National Trust. On 2 July 2001, four plants and two seedlings were found by I. J. Bernallick.

Kynance to The Horse (including Asparagus Island, Lawarnick Pit, Rill Ledges, Rill Head), SW6813–SW6713

Plants have been widely reported from this area since at least 1829 on rocks and in coastal grassland in at least five sites. In 1959 J. Roseweir recorded c. 24 plants on Asparagus Island and 13 plants at Rill Cove with one seedling.

Surveys of the sub-populations were carried out on 2, 3, 8 and 15 July 2001 by I. J. Bernallick. On Asparagus Island (SW6813), 44 plants were found. At Lawarnick Pit (SW6813), 68 plants were found. At Kynance Cliff (SW6713), 23 plants were found. At Rill Cove (SW6713), 17 plants were found. From Rill Cove to north of The Horse (SW6713 to SW6714), 398 plants were found.

George's Cove to Mullion, SW6615–SW6619

A further group of four populations occurs on sea cliffs to the north of Kynance in what could be regarded as an extension of the previous population group. There is a record for Mullion in 1904 by Mrs Woods, which may refer to Lower Predannack Cliffs or Pol Cornick, or perhaps another historical site to the north. The sites are on precipitous sea cliffs and are very difficult of access.

At George's Cove (SW6715) about 50 plants were reported by A. J. Byfield and R. FitzGerald in 1983, and probably about the same number are still present on an inaccessible slope visible with binoculars, 8 July 2001, I. J. Bernallick.

It was first reported from Pol Cornick (SW6615) in 1977 by D. E. Coombe, and was seen again in 1988 by P. A. Gainey and R. F. John. A survey on 8 June 2001 by I. J. Bernallick was unsuccessful, though P. A. Gainey has seen a few plants within the last three years (pers. comm. 2001); there has been a cliff fall at this site recently so plants may have been lost but the difficulties of survey make this impossible to confirm.

P. A. Gainey has seen a few plants at Lower Predannack Cliffs (SW6615) within the last three years (pers. comm. 2001). No plants were seen on the steep cliffs with binoculars by I. J. Bernallick on 8 July 2001.

A few plants have been seen by P. A. Gainey at Laden Ceyn SW6617, which is south of Mullion Cove, within the last three years (pers. comm. 2001). The area was searched by I. J. Bernallick on 15 July 2001 without success.

The Vessacks, St Levan, SW3721

Jones (1821) noted 'our search for *Asparagus officinalis*, which has been found on rocks between Land's End and Castle Treryn [= Treryn Dinas], was not successful'. This record, which is most likely to refer to *A. prostratus*, is assumed to be the site on sea cliffs near The Vessacks at which *A. prostratus* was refound in 1992 by M. Thomas (LANC). On 7 July 2001, one plant was seen by I. J. Bernallick.

Tubby's Head, SW6950

It was first reported at Tubby's Head by L. J. Margetts in 1976, when 49 plants were found. On a B.S.B.I. field meeting on 28 May 1989, more than 80 plants were recorded. The colony, which occurs in maritime heath, the edges of flushes and on old mine spoil, is still thriving. On 12 June 2001, 220 plants were found by I. J. Bernallick.

Dinas Head, SW8576

15 plants were first reported from the inaccessible base of the cliffs at this site in 1977 by L. J. Margetts. Most recently two plants were reported by J. Stewart on 28 July 1997, but there is unlikely to have been a decline. On 19 July 2001, 17 plants were found by I. J. Bernallick.

A record for SW716146 in French *et al.* (1999) is an error for Cadgwith (R. J. Murphy, pers. comm. 2000).

V.C. 2, EAST CORNWALL

Rocky Valley, SX0789

Six plants were reported at Rocky Valley by R. E. N. and C. J. Smith, 2 July 1988, on a steep, rocky slope, and 10–20 plants were subsequently reported by Miss R. J. Murphy and Mrs M. G. C. Atkinson on 5 September 1991. On 11 June 2001, five discrete clumps, one of which was very large and could have contained more individuals, were found by I. J. Bernallick and T. C. G. Rich.

Trevalga Cliffs, Darvis's Point, SX0790

A. and M. G. C. Atkinson found several inaccessible plants on the edge of a cliff on 25 June 1996. On 28 June 2001, two discrete clumps were found by I. J. Bennallick.

V.C. 6, SOMERSET/V.C. 34, WEST GLOUCESTER

Ray (1724) cited a record from 'below Looks Folly, two miles from Bristol' which probably refers to *A. officinalis*. There is a specimen in **BRISTM** from rocks in the Avon Gorge composed of a mixture of *A. prostratus* and *A. officinalis*; it is likely that there has been some confusion of specimens. Other records from the various floras of Somerset and Gloucestershire refer to *A. officinalis* (Kay 1997).

V.C. 9, DORSET

There are a number of records for the Isle of Portland and Weymouth purporting to date from W. Turner in 1551 onwards (H. J. M. Bowen in Kay 1997) but the references cited have not been verified. The earliest unambiguous reference is that of Turner & Dillwyn (1805), and the earliest dated herbarium specimen is from 1822, J. Sowerby (**BM**), though it is probable other records such as A. B. Lambert's record in Smith (1800) also refer to *A. prostratus*. The records probably refer to one of the two following sites.

Portland Bill, SY6768

Turner & Dillwyn (1805) noted it at the 'extremity of the island', and Barrett (1912) noted 'a fine plant in depressions of an unquarried stone, close to cliff, towards Lower Lighthouse, 1876', and may have been seen by J. C. Mansel-Pleydell some time before 1895 (Mansel-Pleydell 1895). The site was probably quarried away with Portland Stone.

Ferrybridge – Small Mouth, SY6774–SY6675

There are many records for near the Ferry, Small Mouth or Chesil Beach from about 1782, W. Sole onwards (Barrett 1912), often cited as occurring on sandy waste and in sandy fields. It was in 'great abundance' at Small Mouth in 1795 (Good 1948). J. W. White recorded that plants he had seen in 1885 subsequently had a torpedo factory built on them, and the population seems largely to have been lost until rediscovered on a nearby old railway in 1951 by A. W. Graveson and then lost again after 1961 (Kay 1997). One clump was rediscovered in 1997 by P. Sterling & R. J. Surry, which was nearly destroyed by drainage works in November 2000 (D. A. Pearman, pers. comm. 2000).

There are a number of other Dorset records which have not been accepted. A record for Chesil Beach south of Moonfleet, 1970s, J. K. Hasler (Bowen 2000) is possible but requires confirmation. Specimens from Poole Harbour are *A. officinalis* (e.g. Lilliput and Saltern's Pier, **BMH** cf. Mansel-Pleydell 1895, Bowen 2000).

V.C. 10, ISLE OF WIGHT

Grose (1935) reported '*A. maritimus*' from Norton Spit; there are no specimens in his herbarium at **DZS** or **BM** and all other specimens seen from this site and elsewhere on the Isle of Wight are *A. officinalis*.

V.C. 13, WEST SUSSEX

All the Sussex records are referred to *A. officinalis* with the following exceptions.

Shoreham, TQ20

Three independently-collected vegetative herbarium specimens demonstrate its occurrence on Shoreham Beach between 1877, Mrs Bell Oakeshott and 1895, T. Hilton (**BTN**, **BM**); the T. Hilton record from Southwick Beach in Wolley-Dod (1937) probably also refers to this site. It is surprising, given the number of botanists visiting Shoreham beach to look for *Trifolium stellatum*, that it has not been more widely reported and it may have been a transient population.

V.C. 41, GLAMORGAN

Skerr Sands, Porthcawl, SS7979 (or possibly SS87)

Plants were first found on coastal sand hills at Skerr Point, Porthcawl on 7 June 1901 by W. A. Shoolbred and E. S. Marshall (**BM**, **CGE**, **NMW**). They were last seen by Miss E. M. Thomas in 1933 and 1935 (**NMW**).

The site has been fairly heavily sheep-grazed for the last 50 years, and the plant is not known to the local tenants (J. Blundell, pers. comm. 2001). It has been searched on a number of occasions (e.g. in 2000 and 2001 by T. C. G. Rich), and it is considered extinct. Sker Point is adjacent to the ungrazed but very well-recorded Kenfig NNR where no asparagus has been reported.

Oxwich Bay to Three Cliffs Bay, SS5287–SS5487

Plants were first recorded from cliffs in Oxwich Bay by H. J. Riddelsdell in June 1904 (**BM**, manuscript in **NMW**) but the exact site at which he saw them is unknown. We have traced no further records for the area until plants were rediscovered in 1989.

Two discrete populations are currently known. The first occurs mostly on wind-blown sand on low cliffs with 21 plants in two sub-populations 1996–1999. In 2001 only 19 plants were recorded, two small vegetative plants having been lost, one through localised natural erosion and the other possibly through shading by *Ulex*. The second population on limestone cliffs was refound during a National Trust survey in 1996, and may be Riddelsdell's site. A maximum of 26 plants have been recorded 1997–1999; 24 plants were seen in 2001. Fruiting is observed regularly though variable between years in both sites, but there is no obvious recruitment at the former site (L. K. Rich, unpublished data).

Culver Hole, Port Eynon, SS4684

It was first recorded at this site in 1821 (**OXF**; no recorder) and this appears to have been the best-known and most-visited Glamorgan site since. It is possible that the population has been significantly reduced historically by collecting.

When Q. O. N. Kay was first shown the site in by G. Goodman in 1965, fewer than ten plants survived. In 1984, Kay & John (1995) recorded only six plants. One plant was lost to coastal erosion perhaps aggravated by footpath trampling in 1991, and another to natural erosion of the soil by storms in about 1998. The population in 1999–2001 consists of four plants and no recruitment has been observed (L. K. & T. C. G. Rich, unpublished data).

Worm's Head, SS4087

Dillwyn (1840) reported it 'On the Wormshead, and several other cliffs in Gower'. Vachell (1936) noted it 'flourishes on rocks near the Worm's Head' but there are no further specific details in her diaries or specimens at **NMW**, and she may have been citing Dillwyn's record. Worm's Head has been well studied in recent years, and there are no further reports (T. King, pers. comm. 2000).

Broughton Bay, SS4293

A record for 'sands of Broughton Bay near Whiteford Burrows' by H. J. Riddelsdell (Riddelsdell 1907, and unpublished manuscript in **NMW**) is accepted as *A. prostratus* although no specimen has been traced and it has not been refound.

In addition, there are a number of other unconfirmed or erroneous Glamorgan records (see Kay 1997). A record for Bacon Hole, 30 June 1917, E. Vachell is a transcription error for Culver Hole mentioned as being visited on that day in her diaries. Another 1942, E. Vachell record for Barry Island (ST06) is more likely to refer to *A. officinalis* which is currently naturalised on sea cliffs there; no specimens have been traced though there is some suitable habitat.

V.C. 44. CARMARTHEN

Reported from Pembrey by Marshall & Shoolbred (1900) and Hamer (1912), but all material seen from this site is *A. officinalis* (e.g. **NMW**).

V.C. 45. PEMBROKE

Giltar Point area, SS1298–SS1198

It was first found on the 'cliff beyond at Giltar Point' by E. Lees in 1836 (**BM**, **CGE**) and has since been seen regularly in the area, even being described as 'plentiful' in 1847 by Falconer (1848). The exact number of populations is not clear. Whilst many records refer to the Point itself, some, like Lees' original record and another in C. C. Babington's diaries at **CGE** ('saw Asparagus at Giltar Head or rather halfway between it and Lydstep Haven') indicate two sites.

Detailed surveys by R. A. Jones (Jones 1993, 1994) and by S. B. and A. E. Evans and A. McConnell 1996–2001 (unpublished data) show two populations at or near Giltar Point which probably correspond to the historic sites. The first in rank *Festuca rubra* grassland has seven

scattered plants, and the second in grazed pasture several hundred metres to the west has 15 clumps in five clusters.

The B.R.C. record for Manorbier, 1936, E. Brazier plotted in SS09 in Wilkinson (1999) is an error resulting from a mistranscription on a record card (J. Croft, pers. comm., 2000).

V.C. 52, ANGLESEY

Llanfaelog, SH3271

The Anglesey records were discussed by Rich, Jones & Lockton (2000). It was first recorded by Edward Lhwyd in 1694 'near the pool at Llanfaelog' on a sandy hillock by the sea, and last recorded in 1889 by J. E. Griffith who described it as 'only in one spot on Maelog Sands, between Llyn Maelog and Trecastell, near the beach' (Griffith 1895). All accounts suggest it occurred in small quantity (e.g. 'confined to one spot only two yards across', **P**).

SCOTLAND

An undated specimen of *A. prostratus* in **BM** is labelled 'Gosforth, Scotland, Mr Lees', but the specimen and label have been remounted and it is possible some confusion may have occurred. There are no Gosforths in Scotland, although there is a Gosford in the Lothians. It is considered that this is an error.

DISCUSSION

Asparagus prostratus has been recorded from at least 34 sites in v.cc. 1, 2, 9, 13, 41, 45 and 52. It has not been recorded recently (post-1999) in six sites where it is probably extinct (18% decline), is extinct in West Sussex and Anglesey and is on the verge of extinction in Dorset. The records are mapped in Figure 1.

There are a significant number of erroneous records due to confusion with *A. officinalis*; we have been fairly strict in what we have accepted and, in the absence of voucher material or other confirmation, have not accepted some records though they are possible (e.g. Moonfleet). The relatively recent discovery of a number of new sites in Cornwall and rediscovery of a lost one in Glamorgan, coupled with the dangerous, inaccessible nature of its typical cliff habitat, suggests there may be more unknown populations around the coast. It can also be a very difficult species to see amongst other vegetation, the two best times to survey being May–June before other vegetation grows up, and in autumn when the berries ripen and senescent plants appear yellow.



FIGURE 1. Distribution map of *Asparagus prostratus* in England and Wales.

●, 1999–2001. ○, pre-1999. x, Error

We would welcome details of any further populations. Given its rarity and small population sizes please do not collect plants; photographs are sufficient for identification in most cases.

It is difficult from the limited historic population data to be certain whether individual populations are declining, stable or increasing. The evidence for decline on most sites is weak, and differences between observers and the types of survey being a major compounding factor. For instance, population counts have been made independently for nine sites during brief visits by T. C. G. Rich between 1999 and 2001 whilst either recording vegetation or looking specifically for *Asparagus*. On average only about half of the number of plants were recorded during these non-dedicated surveys (unpublished data). Many of the differences result from not having full details of the previous records to work from, limited time, and failure to find some of the very small

TABLE 2. SUMMARY OF POPULATION SIZES OBSERVED IN *ASPARAGUS PROSTRATUS* DURING DETAILED SURVEYS 1999-2001

SITE	Number plants 1999-2001
1. Enys Head	31
2. Enys Head-Asparagus Ravine	13
3. Asparagus Ravine	177
4. West of Asparagus Ravine	5
5. South of Cadgwith	1
6. Carri Barrow	1
7. Pen Olver	6
8. Lizard lighthouse area	30
9. Asparagus Island	44
10. Lawarnick Pit	68
11. Kynance Cliff	23
12. Rill Cove	17
13. Rill Cove – The Horse	398
14. George's Cove	c. 50
15. Pol Cornick	few
16. Lower Predannack cliffs	few
17. Laden Ceyn	few
18. The Vessacks	1
19. Tubby's Head	220
20. Dinas Head	17
21. Rocky Valley	5
22. Darvis's Point	2
23. Portland Bill	Extinct
24. Ferrybridge – Small Mouth	1
25. Shoreham	Extinct
26. Sker Sands	Extinct
27. Oxwich Bay 1	19
28. Oxwich Bay 2	24
29. Port Eynon	4
30. Worm's Head	Extinct
31. Broughton Bay	Extinct
32. Giltar Point 1	7
33. Giltar Point 2	15
34. Llanfaelog	Extinct
Total	c. 1200 plants in 28 sites

populations. This indicates the likely reliability of historic counts, i.e. they may be significant under-estimates. At many sites the historic estimates and current population counts are remarkably similar. At some sites such as Tubby's Head, the numbers of plants appears to be increasing as further surveys are carried out; this may be a function of being able to add to existing knowledge or could represent a real increase. Other than the six extinct sites, there is probably only strong evidence for decline at Ferrybridge – Small Mouth, Culver Hole and possibly Giltar Point. There is a clear need for regular, consistent survey and monitoring to determine population trends.

The population sizes found in 1999–2001 after reasonably detailed surveys are summarised in Table 2, which now give a firm baseline against which the success of the UK Biodiversity Action Plan in maintaining the populations can be assessed. Of the 28 populations known in 1999–2001, four have single plants and another five have fewer than ten plants; these might all be regarded as at significant risk of extinction (in effect, those with a single plant are already doomed as there will be no regeneration unless plants of a different sex colonise their sites). Only three populations have more than 100 plants, and could be regarded as secure.

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An analysis of the characters of *Bromus racemosus* L., *B. commutatus* Schrad. and *B. secalinus* L. (Poaceae)

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ABSTRACT

The characters currently used to distinguish *Bromus racemosus*, *B. commutatus*, and *B. secalinus* are analysed. The lengths of the spikelets, lemmas, anthers and rhachillas and the shape of the lemma margins were found to be often unreliable. Two more diagnostic characters are proposed to separate *B. racemosus* from *B. commutatus*. The characters of *B. secalinus* are discussed. A new key for these species is proposed.

KEYWORDS: Brome-grasses, morphological characters, panicle structure, key.

INTRODUCTION

Ever since Linnaeus described *B. secalinus* in 1753 and *B. racemosus* in 1762 and Schrader described *B. commutatus* in 1806, botanists have encountered difficulties in distinguishing these three annual brome-grasses.

In *Bromus* it is rarely possible to determine a taxon using only one character and an appraisal of all the information provided by several different characters is usually necessary. The couplets in the keys in Clapham *et al.* (1987), Smith (1980) and Stace (1997) use the lengths of the spikelets, lemmas, anthers, and rhachillas and the shape of the lemma-margins. Unfortunately, all too often, not all the characters lead to the same conclusion. *B. secalinus* is readily identified when it is in fruit but it is often difficult to determine before fruiting. Consequently an analytical study of the characters of these three species was undertaken to evaluate the reliability of the existing criteria and to seek new criteria that might be helpful.

MATERIALS AND METHODS

846 specimens (281 of *B. racemosus*, 392 of *B. commutatus* and 173 of *B. secalinus*) were assessed using the characters and potential characters in Table 1. 742 were herbarium specimens from **BDD, BM, BRISTM, CGE, DBN, E, GL, HANU, K, LTR, NMW, OXF, RAMM, RNG, SLIB, SUN, TCD, TOR, and WARMS**. 104 were fresh or new specimens collected by the author and others during the four years 1998 to 2001. All specimens had been collected in the British Isles. The technique involved in preparing material for observation was described in Spalton (2001) and is greatly assisted by pre-soaking the lemmas.

The data listed in Table 1 include all the characters of these grasses mentioned in Clapham *et al.* (1962, 1987), Hubbard (1954, 1968), Sell & Murrell (1996), Smith (1973, 1980), and Stace (1997), together with some others from Acedo & Llamas (1999), Ammann (1981), Bomble & Scholz (1999), Conert (1997, 2000), Kerguélen (1995), Portal (1995), Scholz (1970, 1997 & pers. comms., 2000, 2001) and Tzvelev (1976), plus some other data selected by the author.

MORPHOLOGICAL OBSERVATIONS

All specimens had lemmas of leathery texture and in dried specimens the veins of the lemmas did not protrude. This very important character distinguished the three species from the *B. hordeaceus* group where the lemmas were of papery texture and the veins protruded when dried.

TABLE 1. DATA COLLECTED ON *BROMUS RACEMOSUS*, *B. COMMUTATUS*, AND *B. SECALINUS*

Character	Measurement
Culm:	height.
Lower leaf-sheath:	indumentum.
Panicle:	appearance; structure; length; length of pedicels and of branches.
Spikelets:	shape; length; width before and after divarication.
Glumes:	shape; length; length in relation to spikelet length.
Lemmas (2nd lowest):	texture, papery or leathery; whether veins protrude in dried specimens; glabrous, scabrid or pubescent; type of pubescence and its location; shape of margin; depth of hyaline area; width and depth of apical notch if present.
Paleas:	length and its relationship to length of the lemma; width; whether surfaces are pubescent, scabrid or smooth; whether 'eyelash' hairs continue to palea apex.
Awns:	length; width; shape; shape at fruiting.
Rhachillas:	length of lowest before fruiting; tough or brittle at fruiting; whether some are clearly visible at fruiting.
Anthers (from lowest florets):	length of mature undehisced anthers; length of dehisced anthers and evidence of chasmogamy.
Caryopses (mature):	length and width; length in relationship to lengths of lemma and of palea; thickness and shape in cross-section.

The indumentum of the lower leaf-sheath, which is much used by continental European botanists, proved to be a useful character, especially in fresh material but was less reliable if the sheath had been damaged or became shrivelled. In *B. racemosus* and *B. commutatus* the hairs were patent and appeared to be stiff because they did not bend at the ends. In *B. hordeaceus* subsp. *hordeaceus* the hairs were dense and softly villous (Fig 1). However in *B. hordeaceus* subsp. *longipedicellatus* the sheath had long and short patent hairs which, while not villous, were often slightly bent at the ends. 41% of the *B. commutatus* specimens were *B. commutatus* var. *pubens* Wats. which had hairy lemmas and the indumentum of the sheath varied from that of *B. commutatus* var. *commutatus* to that of subsp. *hordeaceus*. The latter character also separated *B. secalinus* from the other species, since its sheath was glabrous, though, especially in *B. secalinus* L. var. *hirtus* (F. Schultz) Aschers. & Graebn., sparse, thin, usually short hairs often also occurred on the sheath.

BROMUS RACEMOSUS AND *B. COMMUTATUS*

It was found that the most important character to distinguish *B. racemosus* from *B. commutatus* was the panicle structure (Fig. 2) including the lengths of the pedicels and panicle branches, especially the latter. In fresh mature specimens, the narrow $\pm$ lax, usually unbranched (96.3%), panicle of *B. racemosus* was markedly different from the broad, often robust, panicle of *B. commutatus* with its long panicle branches and/or pedicels. It will be seen from the scatter diagram (Fig 3.) that the length of the longest pedicel or panicle branch (whichever was the longer) of *B. racemosus* did not usually exceed 4 cm but the longest pedicel or panicle branch (whichever was the longer) of mature *B. commutatus* was longer than 4 cm. For the purpose of this study panicle branches were measured from the node to the base of the terminal spikelet.

These differences were not immediately obvious in many herbarium specimens because the panicles constrict on drying and the spikelets then lie close to the rachis. Only a minority of herbarium specimens examined were mounted to display the panicle in its natural state at anthesis. In examining herbarium specimens, it became obvious that C. E. Hubbard, P. M. Smith and T. G. Tutin must also have considered the appearance and structure of the panicle to be very important, since, in many of the specimens seen, they could not have separated *B. racemosus* from *B. commutatus* in any other way.

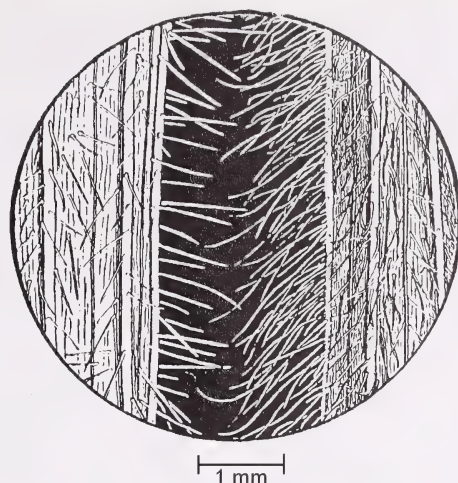


FIGURE 1. Indumentum of the lower sheath. Left: *Bromus commutatus*. Right: *B. hordeaceus* subsp. *hordeaceus*. Drawing by A. Tröger.



FIGURE 2. A. Scan of panicle of *Bromus secalinus*, Hooperton, Devon, waste ground, 28/7/2000, acc. 3438. B. *B. commutatus*, Hatch Beauchamp, Somerset, edge of wheat, coll. 21/7/1999, acc. 392. C. *B. racemosus*, Honiton, Devon, moist pasture, 13/5/1999, acc. 103. L. M. Spalton.

H. Scholz (pers. comm., 2001) suggested that the relative length of the awns of the lowest lemmas might be worth investigating in British specimens of these two species. This proved to be good character. In *B. commutatus* the awn of the lowest lemma was usually shorter than the other awns while in *B. racemosus* they were $\pm$ equal.

The indumentum of the lemma was definitive but only in some of the taxa investigated. The lemmas of *B. racemosus* and *B. commutatus* var. *commutatus* were always glabrous, though often very minutely scabrid, but the lemmas of *B. commutatus* var. *pubens* Wats. were pubescent.

The lemma-length character has been much used to distinguish these two species, and most floras have continued to quote the measurements in Hubbard (1954): *B. racemosus* 6.5–8 mm and *B. commutatus* 8–11 mm (Table 2). In this study, no specimens of *B. racemosus* had lemmas shorter than 7 mm and 42% had lemmas exceeding 8 mm, up to 9 mm in length.

From an analysis of 673 specimens (281 of *B. racemosus* and 392 of *B. commutatus*) it was clear that the appropriate lemma-lengths should be: *B. racemosus* 7–9 mm and *B. commutatus* 7.5–11 mm and these figures were used throughout this study. There was an overlap at 7.5–9 mm in these lemma-measurements and 496 specimens (74%) had lemmas with lengths within this overlapping range (Fig. 3). So it is suggested that the lemma-length character should only be accepted if the length is outside the overlapping range viz. less than 7.5 mm, indicating *B. racemosus*, or more than 9 mm, indicating *B. commutatus*, and then only as a secondary, indicative character.

The spikelet-lengths quoted in the floras are listed in Table 2. From the 673 specimens examined it was found that the most appropriate lengths were *B. racemosus* 11–18 mm and *B. commutatus* 15–30 mm. The overlapping lengths were 15–18 mm and 37% of the specimens fell within this range. Consequently, it is suggested that the spikelet-length character should only be used when the length of the spikelets is less than 15 mm, indicating *B. racemosus*, or more than 18 mm, indicating *B. commutatus*, and then only as a secondary, indicative character.

The lemma-margin of *B. racemosus* has been described as smoothly curved and that of *B. commutatus* as broadly angled. It was found, however, that the shape was frequently unclear and often varied in the same panicle. After a cultivation study of *B. commutatus*, Vivant (1964) reported that in young specimens of *B. commutatus* the lemma-margin was smoothly curved and only appeared broadly angled towards anthesis. This phenomenon was also observed during this study.

There is no doubt that in many mature specimens of *B. commutatus* the lemma-margin is definitely broadly angled and that of *B. racemosus* is definitely smoothly curved but in 61% of the specimens examined it was indeterminate. So it is suggested that this is also a secondary indicative character, which should only accepted when the conclusion is certain and consistent throughout the panicle.

TABLE 2. *BROMUS RACEMOSUS* AND *B. COMMUTATUS*: LENGTHS OF LEMMAS, SPIKELETS AND ANTHERS

	LEMMAS (mm)		SPIKELETS (mm)		ANTHERS (mm)	
	<i>racemosus</i>	<i>commutatus</i>	<i>racemosus</i>	<i>commutatus</i>	<i>racemosus</i>	<i>commutatus</i>
Clapham <i>et al.</i> (1962)	c. 7	c. 9	c. 15	15–20	2–2.5	1–1.5
Clapham <i>et al.</i> (1987)	6.5–8	8–11	15	15–25	1.5–3	1–1.5
Conert (1997)	6.5–8	8–11	16–20	16–28	1.5–2.5	1–1.5
Conert (2000)	6.5–8	8–11	12–16	8–18	1.5–2.5	1–1.5
Hubbard (1954, 1968)	6.5–8	8–11	12–16	18–28	Mostly 2–3	Mostly 1.5–2
Portal (1995)	6.5–8	8–11	10–15	15–30	(1.5) 2–3	1–1.5
Sell & Murrell (1996)	6–8.5	8–11	10–16	15–28	Mostly 2–3	1–1.5
Smith (1973)	6.5–8	8–11	10–15	15–25	1.5–3	up to 1.5
Smith (1980)	6.5–8	8–11.5	10–15	15–25	1.5–3	c. 1.5
Stace (1997)	6.5–8	8–11	10–16	15–28	Mostly 1.5–3	Mostly 1–1.5
Tzvelev (1976)	6.5–8	7.5–11	12–20	18–28	1.5–3.2	0.8–2.3
Spalton (2001)	7–9 (1)	7.5–11 (1)	11–18	15–30	1.5–3.5 (2)	1.3–2.5 (2)

(1) 2nd lowest lemma.

(2) Mature undehisced anthers from the lowest florets, others less

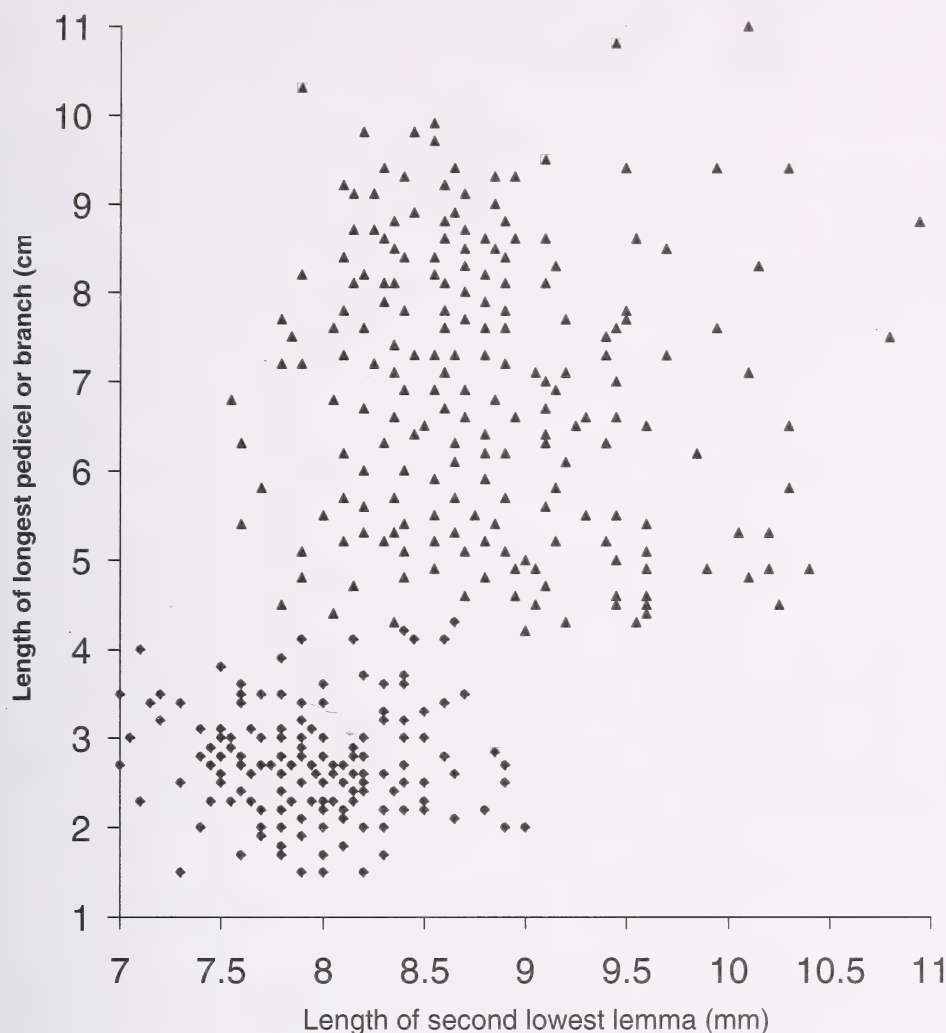


FIGURE 3. Scatter diagram of the lengths of the longest pedicels or branches in panicles plotted against length of second lowest lemma of *Bromus racemosus* ● and of *B. commutatus* ▲. Note the large overlap in the length of the lemmas.

Anther lengths are listed in Table 2. Between the figures for *B. racemosus* (1.5–3.5 mm) and *B. commutatus* (1.3–2.5 mm), established in this study, there is an overlap. Consequently this character should only be used if the mature undehisced anthers from the lowest florets exceed 2.5 mm, indicating *B. racemosus*. There was also a practical difficulty with this character. Spalton (2001) reported that the lengths of dehisced anthers are unreliable. They are usually less than those of undehisced anthers and very variable. As soon as the anthers matured the filaments lengthened, the florets opened, the anthers were extruded, dehisced and were then dropped. So there was only a very short period during which mature undehisced anthers could be measured and in very many specimens this was not possible. Consequently 89% of the specimens could not be determined by anther-length.

In all the mature specimens of *B. racemosus*, *B. commutatus* and *B. secalinus*, the length of the lowest rhachilla exceeded 1.3 mm (and thus differed from c.1 mm in *B. hordeaceus*), but the variations in length were too great to be of use in separating the three species. None of the other features listed in Table 1 were found to be of significant value in distinguishing *B. racemosus* from *B. commutatus* in the British Isles.

Only 2.5% of the specimens studied were indeterminate using panicle-structure and the 4 cm length of the longest pedicel or branch character. 9.4% were indeterminate using the relative length of the lowest awn. Taken together these proved to be good diagnostic characters which could sometimes be supplemented by the secondary indicative characters already described.

Because separating these two species has often been very difficult, some botanists have reported that there are 'intermediates'. It is suggested that many of these 'intermediates' may have been specimens that were indeterminate using the current characters but might have been determined by the two new characters proposed in this report and more precise use of traditional characters.

Immature *B. commutatus* (and immature *B. secalinus*) with small spikelets, short pedicels and branches and apparently smoothly curved lemma-margins frequently resembled *B. racemosus*. Glumes became mature before the upper florets develop, so in immature spikelets they appeared rather longer than usual in relation to the length of the spikelet. Immaturity in *B. commutatus* was suggested if the length of the spikelet was significantly less than twice the length of the upper glume. Immaturity was confirmed by examining the anther cuticle and pollen grains under a high-power microscope. In immature specimens the cuticle was fragile and $\pm$ translucent and the pollen was transparent.

In all the herbarium specimens of *B. commutatus* and *B. racemosus* examined only three had been determined as an (?)intermediate or (?)hybrid of the two taxa. There are no confirmed reports of *B. commutatus* $\times$ *B. racemosus* in the British Isles. P. M. Smith (pers. comm., 2001) tried very hard to hybridise *B. racemosus* and *B. commutatus* and failed to do so, though he considered that this may have been a technical problem. He and his co-worker, F. Sales, and the present author have examined a great many *Bromus* specimens in British herbaria, and we have all failed to find any material of certain hybrid origin. The status of 'intermediates' of *B. racemosus* and *B. commutatus* is still being investigated and may be the subject of a later report. Fresh specimens are being sought in the field, especially in those few places where *B. racemosus* and *B. commutatus* still grow together. Putative specimens will be analysed and some cultivated. The author will be pleased to receive specimens for examination.

BROMUS SECALINUS

The panicle of *B. secalinus* usually had long pedicels or branches, but not always, and the spikelets were very different when fruit formation commenced. At this time the spikelets became much wider as the florets divaricated and the lemma wrapped around the developing caryopsis eventually causing many of the rhachillas to be visible (Fig. 2). In addition the rhachillas became tough, which could be detected by gently pulling an upper floret with forceps. Consequently the spikelets were slow to disarticulate and when this eventually occurred some florets were often dropped still joined together.

In cross-section, the mature caryopses of *B. secalinus* were U or V shaped and those of *B. commutatus* and *B. racemosus* were $\pm$ flat with upturned ends, or crescent shaped. Although the caryopsis has been described as 'thick' in *B. secalinus* and 'thin' in *B. commutatus* and *B. racemosus*, this was not confirmed (data in Table 3). Bomble & Scholz (1999) have also recognised that *B. secalinus* can have thin fruits and have referred such specimens to a proposed new taxon, *B. secalinus* subsp. *decipiens* Bomble & Scholz. This taxon has not yet been found in Britain but may occur on the edges of wheat-fields.

The panicles of young specimens of *B. secalinus* and *B. commutatus* were often rather similar but *B. secalinus* had a glabrous lower leaf-sheath which differed from the pubescent sheath of *B. commutatus* (Fig. 1). However, sparse thin, usually short, hairs were sometimes present, especially in *B. secalinus* var. *hirtus*, which constituted 49% of the specimens of *B. secalinus* examined. This variety could be readily distinguished from other *Bromus* taxa by the characteristic very dense and very short patent hairs on its lemmas.

The awns of *B. secalinus* were frequently shorter and stouter in relation to their varied lengths (0 to 7 mm) than in the other two species. Eventually they often became bent, curved, or sinuous, specially in *B. secalinus* var. *secalinus*. The awns of *B. commutatus* and *B. racemosus* remained straight.

KEY

The following key is proposed to separate *B. racemosus*, *B. commutatus*, and *B. secalinus* in the British Isles.

1. Spikelets substantially widening by divarication as fruit forms with eventually many rhachillas becoming visible as the lemmas wrap around the caryopsis which is U or V shaped in section. Rhachillas becoming tough and slow to disarticulate. Some florets often dropped still joined together. Lower leaf-sheath glabrous or with sparse, thin, usually short hairs. Lemmas glabrous or with very dense very short patent hairs. Awns short, stout, 0–7 mm often becoming bent, curved or sinuous.2
1. Spikelets not substantially widening in fruit. Lemmas continuing to obscure most of the fragile rhachillas. Florets readily disarticulating. Caryopsis flat or crescent shaped in section. Lower leaf-sheath with many patent hairs (Fig. 1). Lemmas glabrous or pubescent.3
2. Lemmas glabrous *B. secalinus* L. var. *secalinus*
2. Lemmas with very dense, very short patent hairs *B. secalinus* L. var. *hirtus*
3. Panicle narrow, $\pm$ lax, usually unbranched; pedicels (and branches) less than 4 cm in length. Spikelets 11–18 mm long*. 2nd lowest lemma 7–9 mm long*, glabrous, often with a definite smoothly curved margin. All awns $\pm$ equal. Mature undehisced anthers from the lowest florets 1.5–3.5 mm long* *B. racemosus* L.
3. Panicle broad and spreading with some pedicels or branches exceeding 4 cm in length. Spikelets 15–30 mm long*. 2nd lowest lemma 7.5–11 mm long*, glabrous or pubescent, often with a definite broadly angled margin. Awn of the lowest lemma shorter than the others. Mature undehisced anthers from the lowest florets 1.3–2.5 mm long*4
4. Lemmas glabrous *B. commutatus* var. *commutatus*
4. Lemmas pubescent *B. commutatus* var. *pubens* Wats.

*These characters should only be used when the measured lengths are outside the overlapping lengths.

There is a summary of these data in Table 3.

DISCUSSION

B. racemosus occurs in wet pasture and old hay-meadows; it was formerly found in water-meadows. It is now rare in the British Isles because of habitat destruction. *B. commutatus* also grew in water-meadows but is now mainly a plant of disturbed ground and arable weed (especially wheat-fields). The arable weed form is usually more robust, with longer branches than the earlier water-meadow plants and is therefore more distinctive from *B. racemosus*. *B. commutatus* var. *pubens* is found in the same habitats but also in grassland. It is believed to be under-recorded because it only has varietal status and is usually not quite so robust as the arable weed form. *B. secalinus* occurs on the margins of wheat-fields and waste ground. It was traditionally associated with rye and was probably a grain contaminant. It is now rare but can occasionally still be found.

TABLE 3. SIGNIFICANT CHARACTERS USED FOR THE DETERMINATION OF *BROMUS RACEMOSUS*, *B. COMMUTATUS* AND *B. SECALINUS*

	<i>B. racemosus</i>	<i>B. commutatus</i>	<i>B. secalinus</i>
Lower leaf-sheath indumentum	stiff patent hairs	stiff patent hairs	glabrous or sparse thin short hairs
Panicle structure	narrow $\pm$ lax usually unbranched	broad with long branches	spreading or compact
Longest branches/ pedicels (cm) (1)	<4	>4	2.1–9.5
Spikelets* length (mm) (2)	11–18	15–30	11–27
Lemma* length (mm)	7–9	7.5–11	7–9
Lemma indumentum	glabrous (3)	glabrous (3) or pubescent	glabrous or dense v. short patent hairs indistinct
Lemma margin	definitely curved	definitely angled	
Rachillas at fruit	$\pm$ concealed, brittle	$\pm$ concealed, brittle	many visible, tough
Awn shape	straight	straight	often bent, curved or sinuous
Awn length* (mm)	5–9 $\pm$ same	5–10 lowest <	0–7 stout variable
Anther length* (mm) undehisced (4)	1.5–3.5	1.3–2.5	1.2–2.5
Caryopsis section	$\pm$ flat or crescent shaped	$\pm$ flat or crescent shaped	U- or V-shaped
Caryopsis thickness (mm)	0.2–0.7 mean: 0.45	0.2–0.6 mean: 0.35	0.2–0.8 mean: 0.5

(1) Branches measured from the node to the base of the terminal floret.

(2) Before divarication.

(3) Often glabrous and very minutely scabrid.

(4) From the lowest floret.

* These characters should only be used when the measured lengths are outside the overlapping lengths.

All three species are related tetraploids ($2n = 28$), though according to Bomble & Scholz (1999) an octoploid ($2n = 56$) population of *B. commutatus* has been reported. This has not been identified in Britain. Most floras and most authors have described the three taxa as species, however in North Africa Maire (1955), in France Vivant (1964) but not Kerguelen (1995) and not Portal (1995), in Switzerland Ammann (1981) and Lauber & Wagner (1996), in the Netherlands Meijden (1996) and in Iberia Acedo & Llamas (1999) treated *B. commutatus* as a subspecies of *B. racemosus*.

In Britain, Stace (1997) described *B. commutatus* as a species but added that *B. commutatus* might be better as *B. racemosus* subsp. *commutatus*. In North America, Pavlick (1995) and in South America Planchuelo & Peterson (2000), after listing the two taxa as species, suggested that *B. racemosus* might be a depauperate form of *B. commutatus*. Smith (1973), in the last major study of the taxa in Britain, concluded that, at least until the distribution of *B. racemosus* and *B. commutatus* is better known, they should be regarded as species and added (pers. comm., 2001) something is keeping them apart; they are not identical but overlap ecologically.

In Germany, Bomble & Scholz (1999) have identified a new subspecies of *B. secalinus*, which morphologically resembles *B. commutatus* to some degree and *B. racemosus* to a lesser extent. They have named the new subspecies *B. secalinus* subsp. *decipiens*, but they have retained *B. commutatus* and *B. racemosus* as species. In Spain, Lloret (1993) regarded *B. commutatus* as a subspecies of *B. secalinus*. As, morphologically, *B. commutatus* appears to be in a central position between *B. racemosus* and *B. secalinus*, if subspecies status is indicated, "*B. commutatus* subsp. *secalinus*" and "*B. commutatus* subsp. *racemosus*" should not be excluded as possibilities. It is possible that the three taxa may have originated from an unidentified common diploid ancestor which may no longer exist.

The author believes that more information is required and suggests that DNA sequence studies and isozyme analyses together with more field work using the characters suggested in this paper may eventually enable taxonomists to come to more definite conclusions.

Using isozyme analyses, Oja (1998) found that *B. secalinus* and *B. commutatus* had very similar enzyme phenotypes, indicating their strong genetic affinity, but still differed in PRX-F homoeozymes of one composite genome. Unfortunately, at that time, she had no seed of *B. racemosus* and the *B. secalinus* and *B. commutatus* seed was from continental European countries. There may be some differences between British and continental taxa. For instance, according to H. Scholz (pers. comm., 2001), *B. commutatus* var. *pubens* and *B. secalinus* var. *hirtus*, which are frequent forms of these taxa in Britain, are very rare in Germany. Seed of most British *Bromus* taxa has been sent to T. Oja and these plants are being analysed in her study. This may provide some useful information not only about these three species but also about other *Bromus* taxa as well. T. Oja (in prep.) has already found that the isozyme phenotypes of *B. racemosus* L. distinguish it as a separate species from *B. commutatus* Schrad.

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A checklist of Characeae of the British Isles

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ABSTRACT

We provide for the first time a checklist of charophytes of the British Isles (comprising Great Britain, Ireland, the Isle of Man and the Channel Islands) that includes in the synonymy all the basionyms and all the other names known to us to have been used in the British and Irish literature, and the literature references to all the places of publication of these names. The taxa are all included in one family, Characeae, which is divided into two tribes, five genera and 34 species, plus six extra varieties. One new combination is made: *Chara virgata* Kütz. **var. annulata** (Lilj.) N. F. Stewart & J. A. Bryant, **comb. nov.**

KEYWORDS: Charophytes, *Chara*, *Lamprothamnium*, *Nitellopsis*, *Nitella*, *Tolypella*.

INTRODUCTION

Although now usually considered to be a distinct phylum of algae (Charophyta), or at least a distinct class (Charophyceae) of the green algae or Chlorophyta, the charophytes, charads or stoneworts were traditionally studied along with vascular plants by 19th Century field naturalists because in their macroscopic dimensions and gross morphology they superficially resembled such plants as *Equisetum* and *Potamogeton*. Moreover they can be preserved as herbarium specimens like vascular plants, and are the only algae to be included under the term ‘macrophytes’ by freshwater ecologists. Hence, by little more than historical accident, they are listed alongside vascular plants in *BSBI Strategy 2000*, which sets out the aims and objectives of the Botanical Society of the British Isles.

Checklists of charophytes were first provided in the fifth edition (Watson & Syme 1857) of *The London Catalogue of British Plants* (1844–1925). The development in our understanding of the taxa in the British Isles over a 68 year period can be seen by comparing the list in the fifth edition (16 species in one genus) with that in the eleventh edition (Hanbury 1925) (34 species in five genera). The latter list differs only in detail from the present one; one species of *Chara* was not included, one extra split was recognised, and several nomenclatural differences are evident. Charophytes were also included in the two checklists of Druce (1908, 1928), but were omitted from those of Dandy (1958) and Kent (1992). The standard reference work to our charophytes is *The British Charophyta* by Groves & Bullock-Webster (1920, 1924), whose scheme was followed very closely by the 11th edition of the *London Catalogue* (1925), by Druce (1928) and by Allen (1950). However, a radically different approach was adopted by Moore (1986), who attempted to reconcile the taxonomy of Groves & Bullock-Webster with the world monograph by Wood (1965). Hence Moore recognised only 25 species, the others being reduced to varietal level. Today the consensus of opinion amongst charologists is that Wood’s broad species concept, where many

erstwhile species are reduced to varieties and forms, is untenable. A reversion to the species concepts of Groves & Bullock-Webster has been adopted in the charophyte *Red Data Book* (Stewart & Church 1992) and in the present paper. The latter agrees exactly with the treatment of charophytes in *The Freshwater Algal Flora of the British Isles* (Bryant & Stewart 2002). We consider that the publication of this checklist is timely because of its coincidence with the latter floristic account.

The data included here are part of the B.S.B.I. Database (Leicester), and are contained in the file TAXA along with the comparable data on vascular plants, part of which was published as the *List of Vascular Plants of the British Isles* (Kent 1992). For the first time the present checklist of charophytes includes in the synonymy all the basionyms and all the other names known to us to have been used in the literature of the British Isles (comprising Great Britain, Ireland, the Isle of Man and the Channel Islands), as well as the literature references to all the places of publication of these names. Abbreviations of authorities follow Brummitt & Powell (1992), of book titles TL2 (Stafleu & Cowan 1976–2000), and of journal titles BPH (Lawrence *et al.* 1968; Bridson 1991). The genera have been placed in the generally accepted systematic sequence, but the species and varieties have been ordered alphabetically due to the absence of any widely accepted specific sequence. Accepted names are in boldface and synonyms in italics. Where an accepted name has a basionym the latter is the first synonym listed, all the other synonyms following in date (not alphabetical) order.

It should certainly not be inferred that all the taxonomic concepts and nomenclatural conclusions concerning our charophytes are fixed. The varietal concept is particularly contentious. During the preparation of this list J.A.B. and N.F.S. examined the type specimen of *C. hispida* L. in LINN and concluded that it represents another species, *C. aspera* Dethard. ex Willd. However, we have not emended the names in our list according to this conclusion, but instead a proposal to conserve the names of these two familiar taxa according to their current concepts is being prepared by the above two authors. There is also much confusion surrounding the status and nomenclature of the species here named as *C. aculeolata* Kütz., a name which has also been used in the sense of *C. hispida*. Further study is necessary to clarify the correct application of this name.

THE CHECKLIST

Signs: * – alien; † – extinct

CHARACEAE Tribe CHAREAE

CHARA L., *Sp. Pl.* 1156 (1753)

C. aculeolata Kütz. in Rchb., *Fl. Germ. Excurs.* 843 (1832)

Chara hispida L. var. *pseudocrinita* A. Braun, *Ann. Sci. Nat. Bot., Sér. 2*, **1**: 355 (1834)

C. pedunculata Kütz., *Flora* **17**: 706 (1834)

C. polyacantha A. Braun, nom. illegit. in A. Braun, Rabenh. & Stizenb., *Charac. Eur.* 48 (1859)

C. hispida L. forma *polyacantha* (A. Braun) R. D. Wood, *Taxon* **11**: 9 (1962)

C. aspera Dethard. ex Willd., *Ges. Naturf. Freunde Berlin Mag. Neuesten Entdeck. Gesamnten Naturk.* **3**: 298 (1809)

Chara delicatula Desv. in Loisel., *Not. Fl. France* 137 (1810)

C. aspera Dethard. ex Willd. var. *subinermis* Kütz., *Sp. Alg.* 521 (1849)

C. aspera Dethard. ex Willd. var. *capillata* A. Braun, *Consp. Charac. Europ.* 6 (1867)

C. aspera Dethard. ex Willd. var. *lacustris* H. Groves & J. Groves, *J. Bot.* **18**: 129 (1880)

C. globularis Thuill. var. *aspera* (Dethard. ex Willd.) R. D. Wood, *Taxon* **11**: 11 (1962)

C. aspera Dethard. ex Willd. var. *aspera* sensu J. A. Moore, *Charoph. Gr. Brit. Ireland* 73 (1986)

C. baltica Bruzelius, *Observ. Charae* 11 (1824)

Chara baltica Bruzelius var. *rigida* J. Groves & Bull.-Webst., *J. Bot.* **62**: 34 (1924)

C. hispida L. var. *baltica* (Bruzelius) R. D. Wood, *Taxon* **11**: 9 (1962)

†***C. braunii** C.C. Gmel., *Fl. Bad.* **4**: 646 (1826)

Chara coronata Ziz ex Bisch., *Krypt. Gew.* t.1 (1828)

C. canescens Desv. & Loisel. in Loisel., *Not. Fl. France* 139 (1810)*Chara crinita* Wallr., *Annus Bot.* 190 (1815)**C. connivens** Salzm. ex A. Braun, *Flora* **18**: 73 (1835)*Chara globularis* Thuill. forma *connivens* (Salzm. ex A. Braun) R. D. Wood, *Taxon* **11**: 10 (1962)**C. contraria** A. Braun ex Kütz., *Phycol. Germ.* 258 (1845)**var. contraria***Chara vulgaris* L. forma *contraria* (A. Braun ex Kütz.) R. D. Wood, *Taxon* **11**: 8 (1962)*C. vulgaris* L. var. *contraria* (A. Braun ex Kütz.) J. A. Moore, nom. inval., *Charoph. Gr. Brit. Ireland* 53 (1986)**var. hispidula** A. Braun, *Neue Denkschr. Allg. Schweiz. Ges. Gesamnten Naturwiss.* **10**: 16 (1847)*Chara vulgaris* L. forma *hispidula* (A. Braun) R. D. Wood, *Taxon* **11**: 8 (1962)*C. vulgaris* L. var. *hispidula* (A. Braun) J. A. Moore, nom. inval., *Charoph. Gr. Brit. Ireland* 53 (1986)**C. curta** Nolte ex Kütz., *Tab. Phycol.* **7**: 22 (1857)*Chara aspera* Dethard. ex Willd. var. *curta* (Nolte ex Kütz.) A. Braun ex Leonh., *Verh. Naturf. Vereins Brünn* **2**: 205 (1864)*C. desmacantha* (H. Groves & J. Groves) J. Groves & Bull.-Webst., *Brit. Charoph.* **1**: 94 (1920)*C. globularis* Thuill. forma *curta* (Nolte ex Kütz.) R. D. Wood, *Taxon* **11**: 11 (1962)**C. denudata** A. Braun, *Neue Denkschr. Allg. Schweiz. Ges. Gesamnten Naturwiss.* **10**: 5 (1847)*Chara dissoluta* A. Braun ex Leonh., *Verh. Naturf. Vereins Brünn* **2**: 182 (1864)*C. vulgaris* L. var. *denudata* (A. Braun) R. D. Wood, *Taxon* **11**: 9 (1962)*C. vulgaris* L. forma *dissoluta* (A. Braun ex Leonh.) R. D. Wood, *Monogr. Char.* 128 (1965)**C. fragifera** Durieu, *Bull. Soc. Bot. France* **6**: 185 (1859)*Chara globularis* Thuill. forma *fragifera* (Durieu) R. D. Wood, *Monogr. Char.* 177 (1965)**C. globularis** Thuill., *Fl. Env. Paris, éd. 2*, 472 (1799)*Chara capillacea* Thuill., *Fl. Env. Paris, éd. 2*, 474 (1799)*C. fragilis* Desv. in Loisel., *Not. Fl. France* 137 (1810)*C. pulchella* Wallr., *Annus Bot.* 184 (1815)*C. fragilis* Desv. var. *hedwigii* (C. Agardh ex Bruzelius) Kütz., *Phycol. General.* 319 (1843)*C. fragilis* Desv. var. *fulcrata* (Ganterer) Bréb., *Fl. Normandie, éd. 3*, 382 (1859)*C. fragilis* Desv. var. *capillacea* (Thuill.) H. Groves & J. Groves, *J. Bot.* **18**: 102 (1880)*C. fragilis* Desv. var. *sturrockii* H. Groves & J. Groves, *J. Bot.* **22**: 2 (1884)*C. globularis* Thuill. var. *capillacea* (Thuill.) Zaneveld, *Blumea* **4**: 195 (1940)*C. vulgaris* L. forma *sturrockii* (H. Groves & J. Groves) R. D. Wood, *Monogr. Char.* 104 (1965)*C. sturrockii* (H. Groves & J. Groves) R. D. Wood, nom. inval., *Monogr. Char.* 765 (1965)*C. globularis* Thuill. var. *hedwigii* (Agardh ex Bruzelius) J. A. Moore, nom. inval., *Charoph. Gr. Brit. Ireland* 30 (1986)**C. hispida** L., *Sp. Pl.* 1156 (1753)*Chara hispida* L. forma *major* Hartm., *Handb. Skand. Fl.* 376 (1820)*C. hispida* L. var. *gymnoteles* A. Braun, *Ann. Sci. Nat. Bot., Sér. 2*, **1**: 355 (1834)*C. hispida* L. var. *macracantha* Kütz., *Sp. Alg.* 525 (1849)*C. horrida* auct., non Nordst. & Wahlst., *Bidr. Skand. Charac.* 24 (1862)*C. baltica* Bruzelius var. *affinis* H. Groves & J. Groves, *J. Bot.* **19**: 353 (1881)*C. major* (Hartm.) Hy, *Bull. Soc. Bot. France Mém.* **26**: 37 (1913)*C. hispida* L. var. *major* (Hartm.) R. D. Wood, *Taxon* **11**: 9 (1962)**C. intermedia** A. Braun in A. Braun, Rabenh. & Stizenb., *Charac. Eur.* 46 (1859)*Chara papillosa* Kütz., *Tab. Phycol.* **7**: 28 (1857), non Kütz., *Flora* **17**: 707 (1834)*C. contraria* × *hispida* sensu H. Groves & J. Groves, *Characeae Britannicae Exsiccatae* **2**: 42 (1900)*C. contraria* × *hispida* sensu J. Groves & Bull.-Webst., *British & Irish Charophyta* **2**: 33 (1924)†**C. muscosa** J. Groves & Bull.-Webst., *J. Bot.* **62**: 33 (1924)*Chara vulgaris* L. forma *muscosa* (J. Groves & Bull.-Webst.) R. D. Wood, *Taxon* **11**: 8 (1962)**C. rudis** (A. Braun) Leonh., *Verh. Naturf. Vereins Brünn* **2**: 185 (1864)*Chara hispida* L. var. *rudis* A. Braun in A. Braun, Rabenh. & Stizenb., *Charac. Eur.* 4 (1857)*Chara hispida* L. subsp. *rudis* (A. Braun) A. Braun & Nordst., *Fragm. Monogr. Charac.* 102 (1882)*C. hispida* L. forma *rudis* (A. Braun) R. D. Wood, *Taxon* **11**: 9 (1962)

C. tomentosa L., *Sp. Pl.* 1156 (1753)

Chara latifolia Willd., *Ges. Naturf. Freunde Berlin Mag. Neuesten Entdeck. Gesammten Naturk.* 3: 298 (1809)

C. ceratophylla Wallr., *Annus Bot.* 192 (1815)

C. virgata Kütz., *Flora* 17: 705 (1834)

Chara globularis Thuill. var. *virgata* (Kütz.) R. D. Wood, *Taxon* 11: 10 (1962)

var. annulata (Lilj.) N. F. Stewart & J. A. Bryant, **comb. nov.**

Basionym: *Chara diffusa* Lilj. taxon *annulata* Lilj., *Utkast Sv. Fl.*, ed. 3, 684 (1816)

Other synonyms: *Chara delicatula* C. Agardh, non Desv., nom. illegit. var. *annulata* (Lilj.) J. Groves & Bull.-Webst., *Brit. Charoph.* 2: 68 (1924)

C. globularis Thuill. var. *annulata* (Lilj.) J. A. Moore, nom. inval., *Charoph. Gr. Brit. Ireland* 72 (1986)

var. virgata

Chara capillacea auct., non Thuill., *Fl. Env. Paris*, éd. 2, 474 (1799)

C. delicatula C. Agardh, *Syst. Alg.* 130 (1824), nom. illegit., non Desv. in Loisel., *Not. Fl. France* 137 (1810)

C. delicatula Desv. var. *barbata* (Ganterer) J. Groves & Bull.-Webst., *Brit. Charoph.* 2: 68 (1924)

C. vulgaris L., *Sp. Pl.* 1156 (1753)**var. crassicaulis** (Schleich. ex A. Braun) Kütz., *Sp. Alg.* 523 (1849)

Chara foetida A. Braun var. *crassicaulis* Schleich. ex A. Braun, *Ann. Sci. Nat. Bot., Sér. 2*, 1: 355 (1834)

Chara crassicaulis (Schleich. ex A. Braun) Kütz., *Tab. Phycol.* 7: 25 (1857)

C. vulgaris L. forma *crassicaulis* (Schleich. ex A. Braun) R. D. Wood, *Taxon* 11: 8 (1962)

var. longibracteata (Kütz.) J. Groves & Bull.-Webst., *Brit. Charoph.* 2: 24 (1924)

Chara longibracteata Kütz. in Rchb., *Fl. Germ. Excurs.* 2: 843 (1832)

Chara vulgaris L. forma *longibracteata* (Kütz.) H. Groves & J. Groves, *J. Bot.* 18: 133 (1880)

var. papillata Wallr. ex A. Braun, *Monatsber. Königl. Preuss. Akad. Wiss. Berlin* 1867: 910 (1867)**var. vulgaris**

C. foetida A. Braun, *Ann. Sci. Nat. Bot., Sér. 2*, 1: 354 (1834)

C. gymnophylla auct., non A. Braun, *Flora* 18: 62 (1835)

C. vulgaris L. var. *atrovirens* (Lowe) H. Groves & J. Groves, *J. Bot.* 18: 133 (1880)

C. vulgaris L. var. *gymnophylla* auct., non (A. Braun) Nyman, *Consp. Fl. Eur. Suppl.* 1: 875 (1884)

C. vulgaris L. var. *refracta* (Kütz.) J. Groves & Bull.-Webst., *Brit. Charoph.* 2: 25 (1924)

LAMPROTHAMNIUM J. Groves, *J. Bot.* 54: 337 (1916)

Lamprothamnus A. Braun, *Abh. Königl. Akad. Wiss. Berlin* 1882: 100 (1882), nom. illegit., non Hiern in Oliv., *Fl. Trop. Afr.* 3: 130 (1877) (Rubiaceae)

L. papulosum (Wallr.) J. Groves, *J. Bot.* 54: 337 (1916)

Chara papulosa Wallr., *Fl. Crypt. Germ.* 2: 107 (1833)

Chara wallrothii Rupr., *Distr. Crypt. Vasc. Ross.* 12 (1845)

C. alopecuroides Delile ex A. Braun, nom. illegit., *Neue Denkschr. Allg. Schweiz. Ges. Gesammten Naturwiss.* 10: 13 (1847)

Lychnothamnus alopecuroides (Delile ex A. Braun) H. Groves & J. Groves, *J. Bot.* 18: 161 (1880)

Lamprothamnus alopecuroides A. Braun, *Abh. Königl. Akad. Wiss. Berlin* 1882: 100 (1882)

L. papulosus (Wallr.) Bég. & Formigg., *Boll. Soc. Bot. Ital.* 1907: 108 (1907)

NITELLOPSIS Hy, *Bull. Soc. Bot. France* 36: 398 (1889)**N. obtusa** (Desv.) J. Groves, *J. Bot.* 57: 127 (1919)

Chara obtusa Desv. in Loisel., *Not. Fl. France* 136 (1810)

Chara stelligera F.A. Bauer in Mössler, *Handb. Gewächsk.*, ed. 2, 1595 (1830)

Lychnothamnus stelligera (F.A. Bauer) A. Braun, *Abh. Königl. Akad. Wiss. Berlin* 1882: 77 (1882)

Tribe NITELLEAE Leonh., *Lotos* 13: 69 (1863)**NITELLA** C. Agardh, *Syst. Alg.* xxvii (1824)†**N. capillaris** (Krock.) J. Groves & Bull.-Webst., *Brit. Charoph.* 1: 96 (1920)

Chara capillaris Krock., *Fl. Siles.* 3: 62 (1814)

Nitella capitata (Nees) C. Agardh, *Syst. Alg.* 125 (1824)

N. syncarpa (Thuill.) Chevall. var. *capitata* (Nees) Kütz., *Phycol. Germ.* 256 (1845)

N. confervacea (Bréb.) A. Braun ex Leonh., *Lotos* **13**: 146 (1863)

Nitella gracilis (Sm.) C. Agardh var. *confervacea* Bréb., *Fl. Normandie*, éd. 2, 338 (1849)

Nitella batrachosperma (Thuill.) A. Braun, nom. illegit., *Neue Denkschr. Allg. Schweiz. Ges. Gesamten Naturwiss.* **10**: 10 (1847)

N. nordstedtiana J. Groves, *J. Bot.* **28**: 66 (1890)

N. flexilis (L.) C. Agardh, *Syst. Alg.* 124 (1824)

Chara flexilis L., *Sp. Pl.* 1157 (1753)

Nitella flexilis (L.) C. Agardh var. *crassa* A. Braun in Nordst. & Wahlst., *Charac. Scand. Exs.* 14 (1871)

N. flexilis (L.) C. Agardh var. *fryeri* J. Groves & Bull.-Webst., *J. Bot.* **57**: 102 (1919)

N. flexilis (L.) C. Agardh var. *flexilis* sensu J. A. Moore, *Charoph. Gr. Brit. Ireland* 88 (1986)

N. gracilis (Sm.) C. Agardh, *Syst. Alg.* 125 (1824)

Chara gracilis Sm. in Sowerby, *Engl. Bot.* **30**: t.2140 (1810)

†**N. hyalina** (DC.) C. Agardh, *Syst. Alg.* 126 (1824)

Chara hyalina DC. in Lam. & DC., *Fl. Franç.*, éd. 3, **6**: 247 (1815)

N. mucronata (A. Braun) Miq. in H. C. Hall, *Fl. Belg. Sept.* **2**: 428 (1841)

Chara mucronata A. Braun, *Ann. Sci. Nat. Bot., Sér.* **2**, **1**: 351 (1834)

Nitella furcata (Roxb. ex Bruzelius) C. Agardh subsp. *mucronata* (A. Braun) R. D. Wood, *Monogr. Char.* 497 (1965)

var. gracillima J. Groves & Bull.-Webst., *J. Bot.* **55**: 324 (1917)

var. mucronata

Nitella mucronata (A. Braun) Miq. var. *heteromorpha* (A. Braun) Kütz., *Phycol. Germ.* 256 (1845)

N. opaca (C. Agardh ex Bruzelius) C. Agardh, *Syst. Alg.* 124 (1824)

Chara opaca C. Agardh ex Bruzelius, *Observ. Charae* 23 (1824)

Nitella syncarpa auct., non (Thuill.) Chevall., *Fl. Gén. Paris* **2**: 125 (1827)

N. opaca (C. Agardh ex Bruzelius) C. Agardh var. *attenuata* H. Groves & J. Groves, *J. Bot.* **19**: 356 (1881)

N. opaca (C. Agardh ex Bruzelius) C. Agardh var. *brachyclema* J. Groves & Bull.-Webst., *J. Bot.* **62**: 33 (1924)

†**N. spanioclema** J. Groves & Bull.-Webst. ex Bull.-Webst., *J. Bot.* **57**: 1 (1919)

Nitella flexilis (L.) C. Agardh var. *spanioclema* (J. Groves & Bull.-Webst. ex Bull.-Webst.) R. D. Wood, *Taxon* **11**: 15 (1962)

N. tenuissima (Desv.) Kütz., *Phycol. General.* 319 (1843)

Chara tenuissima Desv., *J. Bot. (Desvaux)* **2**: 313 (1809)

Chara flexilis L. var. *stellata* Wallr., *Annus Bot.* 178 (1815)

Chara stellata (Wallr.) Gray, *Nat. Arr. Brit. Pl.* **2**: 28 (1821)

N. translucens (Pers.) C. Agardh, *Syst. Alg.* 124 (1824)

Chara translucens Pers., *Syn. Pl.* **2**: 531 (1807)

TOLYPELLA (A. Braun) A. Braun, *Abh. Königl. Akad. Wiss. Berlin* **1856**: 338 (1857)

Nitella subgen. *Tolypella* A. Braun, *Hooker's J. Bot. Kew Gard. Misc.* **1**: 194, 199 (1849)

T. glomerata (Desv.) Leonh., *Lotos* **13**: 129 (1863)

Chara glomerata Desv. in Loisel., *Not. Fl. France* 135 (1810)

Chara smithii Bab., *Ann. Mag. Nat. Hist., Ser.* **2**, **5**: 86 (1850)

Tolypella giennensis Prósper, *Carofit. España* 83 (1910)

T. glomerata (Desv.) Leonh. var. *erythrocarpa* J. Groves & Bull.-Webst., *J. Bot.* **57**: 225 (1919)

T. nidifica (O. Müll.) Leonh. var. *glomerata* (Desv.) R. D. Wood, *Taxon* **11**: 23 (1962)

T. intricata (Trentep. ex Roth) Leonh., *Lotos* **13**: 57 (1863)

Chara intricata Trentep. ex Roth, *Catal. Bot.* **1**: 125 (1797)

Chara polysperma A. Braun, *Ann. Sci. Nat. Bot., Sér.* **2**, **1**: 352 (1834)

T. nidifica (O. Müll.) Leonh., *Verh. Naturf. Vereins Brünn* **2**: 176 (1864)

Conferva nidifica O. Müll. in Oeder et al., *Fl. Dan.* **5(13)**: t.761 (1777)

Nitella flexilis (L.) C. Agardh var. *nidifica* (O. Müll.) Hartm. ex Wallman, *Förs. Syst. Uppställn. Charac.* 34 (1853)

Tolypella nidifica (O. Müll.) Leonh. var. *nidifica* sensu J. A. Moore, *Charoph. Gr. Brit. Ireland* 108 (1986)

T. prolifera (Ziz ex A. Braun) Leonh., *Lotos* **13**: 57 (1863)

Chara prolifera Ziz ex A. Braun, *Ann. Sci. Nat. Bot., Sér. 2*, **1**: 352 (1834)

Chara borrieri Bab., *Ann. Mag. Nat. Hist., Ser. 2*, **5**: 87 (1850)

Tolypella intricata (Trentep. ex Roth) Leonh. forma *prolifera* (Ziz ex A. Braun) R. D. Wood, *Taxon* **11**: 23 (1962)

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Rumex × *xenogenus* Rech. fil. (Polygonaceae), the hybrid between Greek and Patience Docks, found in Britain

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ABSTRACT

Rumex × *xenogenus* Rech. fil. has been found in Rainham, S. Essex, v.c. 18, new to the British flora. The Rainham plant appears to be a hybrid between *Rumex cristatus* DC. and *R. patientia* L. subsp. *orientalis* Danser, so representing a different nothotaxon from the type, which had *R. patientia* subsp. *patientia* as a parent. The hybrid is illustrated and its distinguishing characteristics are identified.

KEYWORDS: hybridization, Essex.

INTRODUCTION

Greek and Patience docks (*Rumex cristatus* DC and *R. patientia* L.) are both large alien docks, up to 2 m high, frequent on waste ground in the London area. They are occasionally found growing together in Britain, but some records of proximity may be the result of confusion, particularly through recorders mistaking *R. cristatus* for *R. patientia*.

Their natural distribution shows little overlap. *R. cristatus* is native to Greece, extending from the southern part of the Balkan peninsula to western Anatolia, Cyprus, and Sicily. *R. patientia* is more widespread, from the northern limits of Greek Dock's native range and extending through eastern and south-eastern Europe (Jalas & Suominen 1979). Both are naturalised elsewhere in Europe, and this may bring the two species into proximity; but the only previous confirmed record that has been traced of the hybrid between these species is that of K. H. Rechinger fil., from Vienna in 1947 (Hegi 1958), the basis of the taxonomic description by Rechinger (1948).

DISCOVERY IN RAINHAM

Both putative parent species occur in abundance at Rainham, S. Essex (v.c. 18). *R. cristatus* is present in large colonies on Rainham marshes, hybridizing with *R. crispus* L., *R. obtusifolius* L. and *R. palustris* Sm. *R. patientia* is less frequent, but dominates two rat-infested stretches of roadside embankment consisting of tipped material, each about 60 m long, along Coldharbour Lane, a private road to Rainham landfill site off Ferry Lane. It seems to be confined to those embankments, while *R. cristatus* grows intermixed there, but also extends to the rank vegetation of the former grazing marshlands beyond.

Within this jointly occupied habitat, there would appear to be ample opportunity for hybridization between the two species, especially in view of the disturbed nature of the habitat. On 16 August 2000, the author undertook a survey of these embankments for the purpose of establishing whether hybrids were present. Two adjoining plants of *Rumex* × *xenogenus* Rech. fil., 75 cm apart, were found on the embankment opposite the Tilda works entrance (TQ516807). No *Rumex* species were present, apart from *R. cristatus* and *R. patientia*, both of which were present in abundance and within 1 m of the hybrid plants.

At this stage of the season, parents and hybrids were well past flowering and stems were desiccated, with decayed leaves. The hybrids were distinctive from a distance, not through any intermediacy of features, but because of their ragged appearance, exhibiting highly irregular fruiting and with most tepals having dropped early, indicating sterility. This "ragged jizz" is generally a characteristic feature of hybrid docks (Lousley 1939, Lousley & Williams 1975).

TABLE 1. COMPARISON OF SOME CHARACTERS OF *R. CRISTATUS*, *R. PATIENTIA* AND THE RAINHAM HYBRIDS

Character	<i>R. cristatus</i>	<i>R. patientia</i>	Rainham hybrids
height	100–200 cm	80–200 cm	142–187 cm
basal leaf midrib/vein angle	60–90°	45–60°	60–75°
valve dentation	teeth to 1 mm	untoothed	varying from scarcely toothed to 0.5 mm teeth
valve maturation	mature by end of June, dropping in autumn	mature by end of June, dropping in autumn	maturation erratic, beginning to drop by end of June
tubercles on valves	one large (2.7–2.9 × 1.7–2.0 mm*), conspicuous and reddening; with or without others, small and inconspicuous	one small (1.8–2.1 × 1.0–1.3 mm*), inconspicuous and pale; other minute tubercles may be present, but were not recorded at Rainham	one, varying widely in size, but mostly small ((0.7)1.0–2.3 × (0.3)0.5–1.0 mm*), generally pale and rarely reddening, generally not particularly conspicuous; occasionally with other minute tubercles.

* Tubercle measurements are taken from plants at Rainham. Lousley (1939) gives the length of *R. cristatus* tubercles as 2–3 mm, and the length for *R. patientia* as c.1.5 mm (subsp. *patientia*) and 2–3 mm (subsp. *orientalis*).

In contrast, *R. cristatus* and *R. patientia* carried dense panicles with massed mature tepals. Closer examination showed that the remaining mature tepals were highly variable, exhibiting a range of intermediacy between *R. cristatus* and *R. patientia*. They also contained nuts that were small and not fully formed, being largely, if not wholly, sterile.

A further visit on 30 June 2001 confirmed other intermediate characters. The plants are likely to have been present for some time, the rootstocks being at least 22 cm across, and the larger plant carrying 9 flowering stems.

Details of relevant characters of parents and hybrids are set out in Table 1, and the hybrid is illustrated in Fig. 1.

DISCUSSION

While the two Rainham plants were convincingly hybrid, and their intermediate characters as well as their proximity to *R. cristatus* and *R. patientia* (and no other docks) point to their identification as *Rumex* × *xenogenus*, it is also possible to rule out other hybrid combinations. Several other *Rumex* species and hybrids are present on Rainham marshes, and the site is a little over 1 km from the unique location for another interesting dock hybrid, *Rumex* × *akeroydii* (Rumsey 1999).

The small teeth on the valves of the Rainham plants indicate valve toothling in at least one parent. *R. obtusifolius* is ruled out by the absence of any scabridity on the midrib of the underside of the leaf. The relative shortness of the teeth also rules out *R. palustris* as a parent (and *R. maritimus*, for which there are records at Rainham marshes, although the author has not seen that species there). This leaves *R. cristatus*. In order to produce progeny with smaller teeth than *R. cristatus*, it is probable that this last species shall have hybridized with a species bearing entire valves. Potential local candidates are *R. crispus*, *R. conglomeratus* and *R. patientia*. *R. cristatus* × *crispus* bears longer, more crisped leaves than were exhibited by the Rainham plants. A hybrid between *R. cristatus* and *R. conglomeratus* would be expected to show some influence from the lingulate shape of the latter's valves; but this was not evident. So, elimination of the possible alternatives provides further evidence of the Rainham plants as being hybrids between *R. cristatus* and *R. patientia*. The hybrid's leathery leaves are common to both species.

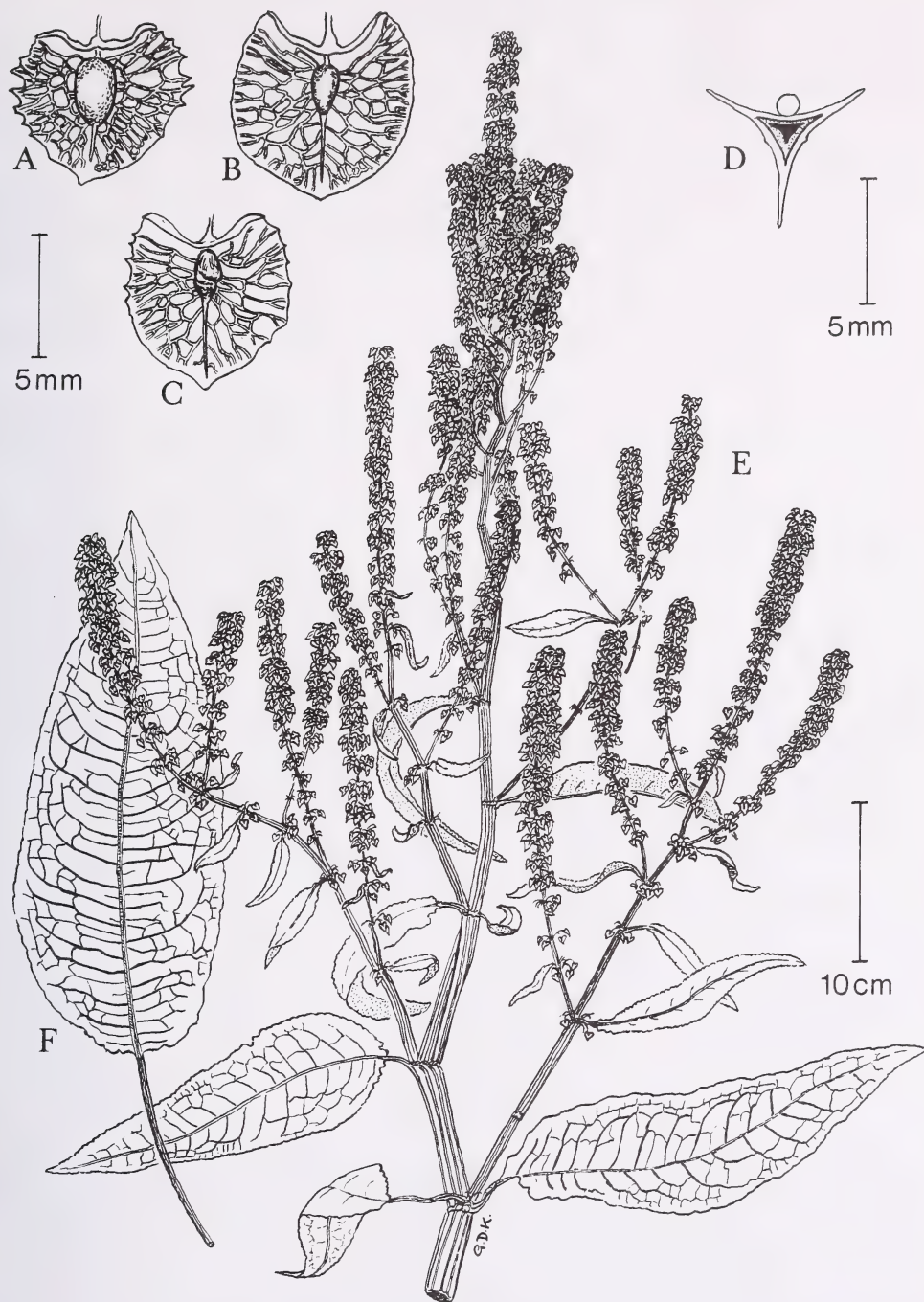


FIGURE 1. *Rumex x xenogenus* C-F. A. *Rumex cristatus* fruit. B. *Rumex patientia* fruit. C. *R. x xenogenus* fruit. D. Diagrammatic section of fruit. E. Inflorescence. F. Basal leaf.

It is sometimes supposed that the distinction between *R. cristatus* and *R. patientia* is not always as clear as in typical plants. There may be scope for debate as to whether the taxonomic relationship between the two should be subspecies, rather than species (Stace 1997). Burton (1983) comments on observations of plants with leaves characteristic of *R. patientia* having toothed valves approaching those of *R. cristatus*; and on the determination by Rechinger of a specimen found by the Thames at Kew, that wavered between the two species. However, any potential for such intermediacy is not relevant to the determination of plants such as those at Rainham, whose hybridity is indicated by sterility as well as intermediacy.

Rumex $\times$ *xenogenus* was described by Rechinger from material found on a railway bank at the Ostbahn, Vienna (Rechinger 1948). Until the present record, it had not been reported since. There is some confusion in British botanical literature, where the cross has been wrongly cited as *Rumex* $\times$ *xenogenus* Reichenb. (Lousley & Williams 1975, Lousley & Kent 1981). Rechinger's description can, except in one particular, readily be related to the Rainham plants. He remarks on the hybrid "jizz"; the intermediate leaf nervation with veins diverging from the midrib at a less acute angle than is found in *R. patientia*; and the uneven development of the valves, with uneven toothing smaller than that of *R. cristatus*.

The description differs, however, in that the valves are said to have been somewhat larger than those of *R. patientia*. The valves of the Rainham plants were highly variable, and the inclusion of any less developed valves in measurements would lower their average dimensions. Nevertheless, it is not possible to say that even the most developed valves of the Rainham hybrids were materially larger than those of *R. patientia* in the vicinity.

The explanation for this appears to be that the variant of *R. patientia* at Rainham is subsp. *orientalis* Danser. This is the usual taxon naturalised in Britain, in so far as the subspecies may readily be distinguished. A caveat seems appropriate, in that the separation of material by valve width, namely 5–6(–7) mm in subsp. *patientia* and 8–10 mm in subsp. *orientalis* according to Lousley (1939) and Lousley & Kent (1981), suggests a distinctness that is not always apparent, even in determinations by Lousley or Rechinger. Specimens at K determined by these authorities exhibit valves for subsp. *orientalis* that are frequently narrower than 8 mm, although those for subsp. *patientia* invariably fall below that width. The Rainham *R. patientia* matches the determinations of subsp. *orientalis* and its valve width reaches (but does not exceed) 8 mm. *Flora Europaea*, which recognizes the two subspecies, and keeps *R. cristatus* distinct from *R. patientia*, frequently accepted such overlap in subspecies' measurements (J. R. Akeroyd, pers. comm.).

R. patientia subsp. *patientia*, of which the valves occupy the lower range of width measurements, is the subspecies present in Vienna (as mapped in Hegi 1958) and so is to be expected to be a parent to Rechinger's record of *R.* $\times$ *xenogenus*. Intermediacy between wide-valved *R. cristatus* and narrower-valved *R. patientia* subsp. *patientia* should accordingly feature valves slightly wider than the *R. patientia* parent, as in the Viennese hybrid. If subsp. *orientalis* is substituted, then the valves of the cross should not be wider than those of the *R. patientia* parent. This is borne out by the Rainham plants. These therefore appear to represent a nothotaxon different from the one previously recorded.

The extreme rarity of *Rumex* $\times$ *xenogenus* is clearly related to the limited coincidence of the adventive distribution of the parents. It may also be due to a lack of recognition, which this paper hopes to remedy.

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Notes

THE ENIGMA OF MONTANE *SAGINA MARITIMA* DON

Last September I collected a group of *Sagina* seedlings from a roadside at 300 m altitude on Shap Fell, Cumbria near plants of *Sagina nodosa*. On cultivation I thought that they would turn out to be the latter but I was very surprised to find that they produced plants of *S. maritima*. Michael Braithwaite had already given intimation of this species occurring as a roadside halophyte up to 350 m on roadsides in Berwickshire (Braithwaite 1997). As it is a plant I rarely see, I consulted my Floras and was intrigued to see that it is given as a mountain plant in Scotland. Clapham, Tutin and Warburg (1952) state: “occasionally on Scottish mountains to 4000 ft. (var. *alpina* Syme)”. This statement was unchanged in the second edition (1962). Clapham, Tutin and Moore (1987) had modified this to: “occasional on Scottish mountains to 1200 m.” Flora Europaea (1964) followed CTW stating that it occurred “occasionally inland, and on mountains up to 1300 m in Scotland.” However the second edition of Flora Europaea (1993) had changed this to: “rarely on mountains in Scotland.” The most recent references give its montane status as: “rarely slightly inland on mountains in Scotland.” (Stace 1997) and “rarely inland on salted roads or on mountains in Scotland” (Stace 1999). Raven and Walters (1956), when discussing the difficult taxonomy of mountain pearlworts in the British Isles, state that: “to make matters worse, there is even a mountain form of Sea Pearlwort (*S. maritima*) which is said to occur, notably on Ben Nevis at altitudes up to 4000 ft.”

Older references on which these recent ones are obviously based are naturally much more specific. William Hooker (1821) states: “*Sagina maritima*: on Ben Nevis. This very distinct species of *Sagina*, first discovered by the acute Mr G. Don, has been for many years known as a native of the coast of Ireland, where it was detected by my learned friend R. Brown Esq. In England too it is not infrequent”. J. D. Hooker (1884) states under *S. apetala* subsp. *S. maritima* Don. var. *alpina*, Syme: “Top of Ben Nevis, Don”. Williams (1909) gives an interesting historical account of this species listed under *Sagina stricta* Fries. He notes its discovery by George Don on the summit of Ben Nevis in 1794 and again in 1803, although he states that we have only his son David Don’s word that his father found it again on the later occasion. It was described by Don as a new species in 1810, (1806 on title page). Material collected by him in 1794 is in BM and the collection of 1803 in LINN-SMITH. It was from cultivated plants grown by Don from his collection of 1794 that plate 2195 by J. Sowerby in J. E. Smith’s “English Botany” (Smith 1790–1814) was drawn (Garry 1903). The Royal Botanic Garden, Edinburgh has a set of Don’s fascicles including number 155, *Sagina maritima*. (D. McKean, pers. comm.). The label accompanying the specimen gives the following localities and habitat. “On the sea coast, not infrequent, in Angus-shire, Isle of Skye, near Aberdeen, Queensferry, and Edinburgh.” There is no mention of Ben Nevis. Although credited to Don, it was Robert Brown who first described (in MS. only) *maritima* in 1797 as *Sagina maritima* Nost. from specimens collected in 1795–7 from the coast at Ballycastle and Larne in Antrim, Northern Ireland (Britten 1888), and Browns’s specimens from Ireland were received by Sir J. E. Smith for “English Botany” in 1799 (Garry 1903). Babington (1881) describes the various forms of *S. maritima* and mentions that: “Fries states that this plant sometimes occurs upon mountains in Norway; and G. Don seems to have found it on Ben Nevis”.

H. C. Watson must have had reservations on Don’s discovery. In Topographical Botany (1837) he makes a reference to *Sagina maritima* casting doubt on Don’s find: “may not the latter locality (Ben Nevis) be referable to *Sagina saginoides*?” and makes no mention of it as a montane species in his Cybele Britannica (Watson 1847) where he states: “but the species is even yet only imperfectly understood by English botanists.” In his Topographical Botany (1883), Ben Nevis in v.c. 97 is given in brackets. More recently, Albert Wilson (1956) in his comprehensive work on altitudinal data of British and Irish plants makes no reference to Don’s *S. maritima* on Ben Nevis and quotes Druce’s altitude of 300 ft (91 m) in “Zetland” as the altitudinal limit.

Druce appears to have had some reservations about Don’s find. He gives details of the species British distribution including a queried Ben Nevis record in his Comital Flora (Druce 1932). He attempted to refind Don’s plant on Ben Nevis but was defeated by cold and driving rain and was unsuccessful (Williams 1909). He was sure he collected identical plants “which appeared to be

Don's *Sagina alpina*" (presumably *S. maritima* var *alpina* Syme.) from Coire an t-Sneachda and elsewhere in the Cairngorms and Arthur Bennett agreed with him (Druce 1892). However he was almost certainly mistaken as Williams (1909) noted that these plants had sepals equalling the petals. Presumably these plants were *S. saginoides* or *S. × normaniana* which are both recorded from this corrie (Webster 1978). *S. maritima* is always apetalous or minutely petaloid. Elliston Wright (1938) stated that he was sure that a *Sagina* he collected from the Ben Lawers area was *S. maritima*. However when cultivated it grew to be *S. caespitosa* (now *S. nivalis*). He further stated that: "he should not be willing to accept the validity of any plant from such an inland mountain habitat as *S. maritima* without the opportunity of growing it or examining the seed". There is an interesting reference in Wilson (1938) where the "var. *alpina* Syme (of *S. maritima*) is recorded from Helvellyn at 3000 ft. in *Black's Guide to the English Lakes*, 1882. Confirmation is needed". It has never been seen there since and can be discounted as an error and was ignored by Halliday (1997). The mainland Inverness-shire survey of 1970–75, which covers the Ben Nevis range (Hadley 1985), mentions Don's record but makes no further mention of the plant which was presumably not found during the survey.

My attempts to confirm literature records of it as a montane species in Europe have been unsuccessful. Hultén (1950) does not show it away from the coast in Fennoscandia and Lid (1963) makes no mention of it occurring on mountains there. The relevant map in Jalas & Suominen (1983) shows it as a native coastal plant species there and in the rest of Europe. Although its northern range has recently been extended to 69° North latitude on the coast in Troms in northern Norway (Engelskjøn & Skifte 1995), it does not reach the true Arctic and is absent from the Faeroes and Iceland. Polunin does not include it in his Circumpolar Arctic Flora (Polunin 1959).

All the references to *Sagina maritima* occurring as a montane species appear to be based almost solely on George Don's two collections from Ben Nevis in 1794 and 1803. To my knowledge no one has ever seen it there again nor have there been confirmed reports of it from montane localities elsewhere in the British Isles or indeed in Europe. Don described this species as new to science from these collections so the identity of the species is not in doubt and there is supporting herbarium material. The history of this species occurring on mountains therefore became firmly established and accepted by most of the botanical establishment. However it is not a montane or arctic species and being an annual, would have difficulty maintaining a population under the severe climatic conditions at over 1200 m altitude. It is known that Don's garden contained a remarkably large stock of plants, a catalogue at that time listing over 2000 species and it is recognised that mistakes in the provenance of some of the plants were made Roger (1986). Don knew the plant from coastal localities and I believe that the plants of *Sagina maritima* thought to come from Ben Nevis were actually from coastal sites. It is an odd plant to grow in a garden and one which self seeds so readily it could spread well outside its allotted space and appear in areas labelled for other species. As 200 years have passed with no confirmed reports of it being seen on Ben Nevis again or as a montane species elsewhere in the British Isles or Europe, I feel that any further references to *Sagina maritima* as a plant of the Scottish mountains should be omitted from the Floras and doubt expressed as to its past occurrence on Ben Nevis.

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OBSERVATIONS ON INTROGRESSION BETWEEN *CAREX NIGRA* AND *C. BIGELOWII* (CYPERACEAE)

My interest in *Carex bigelowii* Torr. ex Schwein. was stimulated when I noted that the first Atlas of the British Flora (Perring & Walters 1962) gave *C. bigelowii* as erroneously recorded for v.c. 80 (Roxburghshire). When George Swan found it new to v.c. 67 (South Northumberland) on Peel Fell in 1970, I felt it must occur in v.c. 80 as this hill straddles the national and county boundary. Sure enough the sedge was locally abundant on the summit area extending well into v.c. 80. As there were no other records for this circumpolar Arctic-montane species for v.c. 79 (Selkirkshire) and v.c. 80, and as this biogeographical element of the flora is absent apart from *Thalictrum alpinum* L. in these two vice-counties, I felt it was worth looking for in a systematic way and was soon able to confirm its presence on several of the higher hills in both vice-counties descending as low as 500 m in two localities.

In 1997 Arthur Chater produced information on the distribution of stomata on *Carex* leaves including *C. nigra* L. and *C. bigelowii*. The stomata are easily visible especially on fresh material with a 10 × or 20 × hand lens as tiny white dots and can be visualised in herbarium material by removing the leaf epidermis and examining it under the microscope. *Carex nigra* has the upper leaf surface densely covered with stomata with none or only a few scattered on the lower surface of the leaf whereas *C. bigelowii* has no stomata on the upper leaf surface but the lower surface is densely covered. I checked my collections of *C. bigelowii* and although the great majority of the material had no stomata on the upper surface of the leaves, there were some plants resembling *C. bigelowii* with abundant stomata on both leaf surfaces. These latter plants had puzzled me in the

field as they were not quite typical of *C. bigelowii* and it struck me that these plants could be hybrids with *C. nigra*. I revisited some of the populations and cultivated plants from three separate ones. They are all fertile with good pollen. Although two of the populations appear identical, the third is a more robust plant. I also cultivated a plant which resembled *C. nigra* which also had stomata abundantly on both leaf surfaces and it too has produced good pollen and was fertile.

Chromosome studies and experimental hybridisation have been carried out by Faulkner on *Carex* section *Acutae* which includes the two species under discussion (Faulkner 1972, 1973). He was able to synthesise hybrids which were partially fertile and also produced some fertile backcrosses, although Stace (1975) states that wild populations of the hybrid *C. × decolorans* are sterile. I believe the fertile populations I have found are more likely to have arisen from introgression by repeated back crossing of *C. nigra* and *C. bigelowii* probably over a long period of time. This has resulted in a range of variation of fertile plants resembling the parents at each end of the spectrum and probably explains the origins of plants described in the literature as montane forms of *Carex nigra*. The broad field character differences are given in Table 1.

TABLE 1. BROAD DIFFERENTIAL FIELD CHARACTERISTICS FOR INTROGRESSED PLANTS OF *CAREX BIGELOWII* AND *C. NIGRA*

Character	Plants resembling <i>C. bigelowii</i>	Plants resembling <i>C. nigra</i>
Rhizomes and scales	Rhizomatous with purplish scales	More tufted with paler scales
Leaves	Relatively broad with upper surface strongly ribbed Apices with relatively short trigonous points	Relatively narrow and less strongly ribbed Apices with long attenuated trigonous points
Inflorescences	Stems relatively stout Male spike with short pedicel Female spikes contiguous Subtending leafy bract usually shorter than inflorescence	Stems relatively slender Male spike with long pedicel Female spikes more widely spaced Subtending leafy bract equalling or longer than inflorescence

It is essential to examine the distribution of the leaf stomata first before looking at the general morphology of the plants in order to check the possibility of hybridisation or introgression. The total lack of stomata on the upper leaf surface of *C. bigelowii* holds true. In the field this gives the leaf surface a shiny appearance compared with the dull leaf surface of introgressed plants. Plants resembling *C. bigelowii* are far more likely to attract attention in the field than introgressed plants resembling *C. nigra*. The former look different from "good" *C. nigra* whereas plants resembling *C. nigra* do not stand out from such a common, variable and widespread species. Listed in Table 2 are the sites where I have recorded these plants. Herbarium material is in **Herb. RWMC**.

My observations of the "hybrid" are virtually limited to the rounded and rather featureless hills of South East Scotland and the Northern Pennines where blanket bog and acid grasslands dominate the terrain. *Carex nigra* is very common in the wetter sites whereas *C. bigelowii* is more local in the drier and higher parts of the hills. It does not occur below 500 m. Of the 22 sites I have listed for the "hybrid", 73% had *C. bigelowii* at or close to the sites. On Cauldcleuch Head in v.c. 80 where the "hybrid" was especially common, the habitat was shared with large beds of dominant *Luzula sylvatica* which, because of their vigour and extent, gave the appearance of almost overwhelming the habitat. The topography of these hills probably favours hybridisation by allowing good populations of the parent species to grow close to one another. More rugged terrain with fewer populations of *C. nigra* may perhaps help to keep the populations apart. The advent of blanket afforestation in parts of Southern Scotland and the cessation of grazing above the planted tree line has allowed *C. bigelowii* and *C. nigra* together with the "hybrid" to grow with uncropped leaves and to produce conspicuous inflorescences. Plants of *C. bigelowii* with inflorescence stems 40 cm long have been seen. This ungrazed growth has made it possible to examine the plants much more easily and has helped to postulate the idea of introgression. It was originally thought that the

TABLE 2. A. LOCALITIES OF INTROGRESSED PLANTS RESEMBLING *C. BIGELOWII*.
 * DENOTES THE PRESENCE OF *C. BIGELOWII* AT OR CLOSE TO THE SITE.

Vice-county	Locality	O.S. grid reference	Altitude (m)	Date(s) of collection
67	Limestone Knowe, Carter Fell	NT673020	540	26.6.1993
*67	Peel Fell, Kielder	NY624996	600	11.9.2001
*70	Ashness Fell, E. of Alston	NY767395	530	20.5.1999
*70	Great Dodd, Matterdale	NY3521	670	10.8.1999
*70	High Scar, Melmerby Fell	NY6634	600	11.7.1999
72	Arkleton Hill, Ewes Water	NY408926	500	14.4.1996
*75	Cairn Table, Muirkirk	NS724244	533	15.9.1986
75	Hare Hill, Afton Water	NS655097	590	20.8.1995
*78	S. of Pikestone Hill, Manor Water	NT171307	670	10.11.1984
*78	The Scrape, Manor Water	NT176325	715	10.11.1984
*78	Windlestraw Law, Innerleithen	NT364424	625	14.9.2001
79	The Wiss, S. of St Mary's Loch	NT264206	580	1984 & 28.8.1998
*80	Carlin Tooth, Wauchope Forest	NT630025	540	22.9.1990
*80	Cauldcleuch Head, Teviothead	NT461109	580	1981 & 30.7.1999
*80	W. of Cauldcleuch Head, Teviothead	NT450010	550	30.7.1999
80	Hartsgarth Fell, Newcastleton	NY447941	530	1981 & 24.5.1998
*80	Peel Fell, Wauchope Forest	NT624999	580	1972 & 11.9.2001
80	Roan Fell, Newcastleton	NY451921	550	1971 & 21.4.1974
*80	Starcleuch Edge, Greatmoor Hill, Teviothead	NT483008	550	1981 & 26.7.1999
*111	S. of Peerie Water, Rousay, Orkney	HY495291	152	5.8.1987

B. LOCALITIES OF INTROGRESSED PLANTS RESEMBLING *C. NIGRA*.

Vice-county	Locality	O.S. grid reference	Altitude (m)	Date of collection
*65	Widdale Little Tarn, Great Knoutberry Hill, Hawes	SD7988	625	30.5.1984
*72	Wisp Hill, Teviothead	NY387992	590	26.9.1999

C. bigelowii-like plants were *C. nigra* × *bigelowii* (*C.* × *decolorans*) as a result of simple hybridisation but the fertility and production of good pollen complicate the picture and the variation in the morphology of the populations makes introgression much more likely. Much of the variation in montane *C. nigra* is probably the result of introgression with *C. bigelowii*. I believe that these introgressed plants are almost certainly widespread in montane sites where *C. bigelowii* and *C. nigra* occur, especially where their populations are in relatively close contact. Where these "hybrids" are found in areas where *C. bigelowii* is absent, it may mean that the latter was present at one time but has now become extinct. Although it is a strong competitor and able to withstand centuries of prolonged and intensive grazing, some of the populations of *C. bigelowii* seen were very small. There is no doubt that both it and the "hybrid" benefit from the lack of grazing. It should be stressed that this work is based purely on field observations and no experimental evidence of introgression has been produced. Further studies are required on the morphology of these hybrid plants and on their distribution. Modern molecular techniques may help to clarify the situation.

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A THIRD LIST OF BRITISH SPECIES OF *RUBUS* L. (ROSACEAE) IN NORTH-WEST FRANCE

The *Rubus* flora of those portions of France closest to England was almost unknown to British specialists in the genus until very recent years. Although the Low Countries have been explored intensively by Dutch and Belgian batologists, the loss of interest in the genus among botanists in France since the 1940s has resulted in continuing uncertainty about the true extent of *Rubus* endemism in Britain as well as about the range limits of those British species already known to occur on the other side of the Channel.

Two lists have now appeared (Allen 1996a, 2000) reporting some of the results of a series of forays in this connection into certain of the nearer parts of Normandy and Brittany. In the meantime exploration has been taken further southwards and westwards, to the region of the middle Loire on the one hand and to the far west of Brittany on the other, and the results of this are now due for reporting in turn. To these can be added some new records of interest that have come to light in herbaria.

In this latest list, as in its predecessor, species recorded for the first time from mainland Europe are highlighted with an asterisk, while an obelisk (†) against a locality indicates the material from there has been seen, and the determination assented to, by A. Newton. In the case of *départements* renamed in recent years the previous name is adhered to for the sake of consistency with earlier records – by analogy with the vice-county system of Britain and Ireland. Specimens have all been lodged in BM apart from one or two duplicates donated to NMW. Except where indicated the records are my own and date from 1999 or 2000.

- R. riparius* W. C. Barton ex Newton Orne: a third population – well to the south of the two reported earlier from the ‘Suisse Normande’ in Calvados – in an unconiferised fragment of the Forêt des Andaines opposite the Manoir du Lys outside Bagnoles-de-l’Orne.
- **R. ramosus* Bloxam ex Briggs Finistère: a colony in heathy scrub at 180 m on the east margin of the Forêt Communale d’Argol about 4 km east of Ménez-Hom†. Long known round Plymouth, this species is still unrecorded in Britain other than in Cornwall, Devon and the westernmost tip of Dorset.
- R. hylophilus* Rip. ex Genev. Loir-et-Cher: Forêt de Montrichard, one patch. (The Falaise record in the previous list should be deleted; the specimen has proved to be of some other, non-British species).
- R. adscitus* Genev. This western species is still impressively plentiful, despite its mainly sub-maritime range, in forests in *départements* as close to the centre of France as Indre-et-Loire (Forêt d’Amboise) and Loir-et-Cher (Forêt de Montrichard). On the other hand its penetration of Brittany is as unexpectedly truncated as it is of Cornwall: in the west of Finistère, as in v.c. 1, it all but disappears, relatively abruptly, seemingly intolerant of their more oceanic conditions.
- **R. longus* (Rogers & Ley) Newton Manche: locally common on a heath margin, la Pernelle, near Quettehou, 1991† (“fairly sure” but some lingering doubt - A. N.).
- **R. aequalidens* Newton Côtes-du-Nord: single patches in three widely-separated localities along the Côte de Granit Rose†.

- R. fuscoviridis* Rilstone Finistère: one bush in lane near the coast south of Tréfeuntec, 3 km west of Plonévez-Porzay†. Previously known (outside Britain) only near Cherbourg, in Normandy.
- **R. hastiformis* W. C. R. Watson Côtes-du-Nord: widespread, in several places in abundance, north from Trébeurden along the Côte de Granit Rose† (where, unexpectedly, several western species common elsewhere in Brittany and in parts of Normandy are rare or absent). Finistère: plentiful on the margins of a valley wood 2 km east of St.-Thégonnec.
- R. melanodermis* Focke ex Rogers Extends to far west Brittany, where it is locally abundant in at least one place in Finistère†.
- R. raduloides* (Rogers) Sudre Côtes-du-Nord: Forêt de Coat-an-Hay, near Guingamp, one patch only. The westernmost find.
- R. trichodes* W. C. R. Watson Aisme: Bois de Crépy en Valois, 1939, J. Arènes & G. Didier (Ronces Gauloises, fasc. 9, no. 1170, as *R. pallidus* var. *crispulifolius* Sudre: **BM**†). New to France, but known already in Belgium.
- **R. adamsii* Sudre Orne: Forêt de Bellême, in quantity in open heathy scrub†.
- R. longithyrsiger* Lees ex Focke Local to abundant in woods in the Cotentin Peninsula of Normandy (1998) and along the far north and far west peripheries of Brittany, but elsewhere seen only in a chestnut copse near La Bazoge in Sartre (and there only one bush).
- **R. peninsulae* Rilstone Côtes-du-Nord: frequent in Le Grand Traouïéro (the longer of two deep wooded coombes between Trégastel and Ploumanac'h), especially towards the upper end†.
- R. asperidens* Sudre ex Bouvet To the group of *départements* in Anjou can now be added Ille-et-Vilaine to the west (wood on E50 about 10 km south-east of Vitré) and Orne to the east (Forêt de Bellême, one clump – confirming the rarity of this species in Normandy). The claim by Watson (1958) to have seen material from Seine-et-Oise of *R. adenolobus* W. C. R. Watson, recently shown to be synonymous with this species, after being earlier discounted (Allen 1996b), has turned out to be supported by specimens in **SLBI**, received by him from Didier.
- **R. bercheriensis* (Druce ex Rogers) Rogers Loir-et-Cher: Forêt de Montrichard, abundant throughout†.
- R. scabripes* Genev. Orne: Forêt de Bellême, one patch.
- R. tamarensis* Newton Loir-et-Cher: one patch in an oakwood clearing (roost casual?), park of Château de la Menaudière, Montrichard†. Previously known only in central Normandy, far to the north.
- **R. vigursii* Rilstone Manche: three bushes in hedge of D122 south of La Glacerie Église crossroads, near Cherbourg, 1987†.

Also worthy of mention is an unnamed member of series *Radula* (Focke) Focke locally common in the Forêt de Coat-an-Hay, near Guingamp (Côtes-du-Nord), which was seen only a few days later in S. Devon, v.c. 3 (a patch among bracken by Burrator Reservoir†). This will merit description should it prove to have a wider range in either country.

These latest additions, together with further ones made in the meantime by H. Vannerom in Belgium, A. van de Beek in The Netherlands and G. Matzke-Hajek in North Rhine-Westphalia in Germany, raise to 47 the number of indigenous species believed to be endemic to the British Isles at the time of the monograph by Edees & Newton (1988) that have since been detected in mainland Europe. As the interpretation of endemism adopted in that work embraced species with ranges extending to the Channel Islands, territory which could be regarded as classed more properly with mainland Europe, the total is arguably somewhat greater. On either reckoning, the post-1988 discoveries on the mainland are sufficient in number to alter the ratio between endemics and non-endemics very markedly, to a point where the two categories are currently almost equal in size, as shown in Table 1.

TABLE 1. *RUBUS* SPECIES ENDEMIC TO THE BRITISH ISLES

No. of indigenous species	Edees & Newton (1988) 299	added since 35	total 334	% endemic
Endemic (on present knowledge) to:				
British Isles	163	23	186	56%
Britain & Ireland & Isle of Man				
without Channel Islands	156	19	175	53%
Britain only	154	18	172	52%

These figures still slightly exaggerate the proportion of endemism, for the 299 included a number of species with ranges so narrowly local that they would not qualify for taxonomic recognition on the more stringent criteria observed in European botany today. Precisely how many belong in that category is open to argument, but 12 might be a reasonable minimum. Offsetting that figure, though, are currently several more species, including some in Ireland, with 'regional' distributions that entitle them to be described in the not-too-distant future. Thus, even if species supposedly confined to Britain and/or Ireland continue to be detected on the European mainland in some numbers, the ratio of endemics to non-endemics may not alter significantly for quite some time to come.

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NOMENCLATURAL COMPLEXITIES IN PUBLICATIONS OF SUDRE AND BOUVET ON *RUBUS* L. (ROSACEAE)

Thirty-one species of *Rubus* currently accepted as occurring in Britain (and in three cases in Ireland as well) owe their names, solely or in combinations, either to Sudre, the foremost authority on the group in Europe during the first two decades of the twentieth century, or to his principal regional collaborator in France, Bouvet, who had been studying *Rubus* in the province of Anjou over a long period of years. Most of these names were published before 1907 and have proved unproblematic. In that year, however, apparently in deference to Sudre (with whom he had entered into frequent correspondence), Bouvet departed from his practice up till then of using the species as the standard rank in the group and took to employing a hierarchy of subordinate ranks as well. A more elaborate version of that hierarchy, including the novel rank of 'microgene', was then published by Sudre (1908–13). In contrast to their previous publications, these later ones are all too easy to misinterpret nomenclaturally, for a variety of reasons.

Foremost among those reasons is these authors' reliance on different typefaces to indicate the subordinate ranks. Though Sudre provided a key to those used by him on page 7 of the introduction to his monograph (where it is liable to be overlooked by the uninitiated), Bouvet's intended ranks can be established only from internal evidence in successive papers of his. Unique to Bouvet is the further trap that he used the word 'espèce' in a generalised sense, analogous to the present-day 'taxon' or 'morphotype'. Sudre in his turn published certain names initially in a series of printed notes issued in conjunction with his 1903–17 set of exsiccatae, *Batotheca Europaea*, but in citing those names subsequently he failed to make clear that his references are to the page numbers of the notes and not to the individual exsiccatae. Not all institutions in possession of the *Batotheca*, moreover, appear to have received or at least retained the series of notes, much less placed them with the specimens to which they relate. To complicate matters still further, the two authors interpreted differently their respective roles in cases where Bouvet anticipated Sudre by describing a taxon on his behalf. In place of Bouvet's 'Sudre in litt.' Sudre invariably wrote in those cases 'Sudre in Bouvet' (which Bouvet himself adopted subsequently). As a result the authorship of the names in question has been wrongly credited to Sudre alone in everyday usage. In fact it was Bouvet who was the author validating these names, which should accordingly be attributed to 'Sudre ex Bouvet'.

Most of the taxa exposed by these idiosyncrasies and pitfalls to misinterpretations in nomenclature are probably restricted in range to the European mainland, but two that occur in the

British Isles are currently listed under names that have turned out on closer scrutiny to be in use at ranks differing from those at which the taxa were described originally. If these are to be treated as species, as now conventional in *Rubus*, some minor adjustments in nomenclature are accordingly necessary.

R. asperidens Sudre ex Bouvet is one of the names. In an earlier note (Allen 1996), reporting the identity of the British species latterly known as *R. milesii* Newton with a French bramble bearing that prior legitimate epithet, Bouvet's use of the words "cette espèce" in the protologue was taken as indication that he intended specific rank for the new taxon he described. Fuller study of Bouvet's practices has since shown that assumption to be unsustainable. The particular typeface allotted to the new bramble is the one he employed in that paper for subspecies, and it was at that rank under *R. koehleri* Weihe that it is now clear that it was placed. That subsequently Sudre (1912) treated it as a subspecies too, unambiguously, adds strength to that conclusion. Later, however, after finding the bramble rather common in Anjou, Bouvet (1923: 8) decided it deserved promotion to a species – and this time, by placing Sudre's name in brackets and also citing the subspecific name in synonymy, made the intended rank quite explicit. The correct citation at species level is thus *R. asperidens* (Sudre ex Bouvet) Bouvet.

The second name, *R. subopacus* Sudre, was first introduced into the British Isles list by Druce (1928), though at varietal level under *R. subintegribasis* Druce, a purely nomenclatural transfer that has never found support on taxonomic grounds. Its current use at specific rank dates from Watson (1946). Previously, *Rubus* specialists in Britain preferred to call this bramble (long known in parts of Cornwall and Devon, v.cc. 1–4) by the name under which it was distributed (as no. 106) in the 'Set of British Rubi': *R. nitidus* subsp. *opacus* fa. *minor*. A description of the taxon was supplied by Rogers (1900) shortly after that distribution. Subsequently Sudre (1904) identified no. 106 of the Set with a bramble from dép. Maine-et-Loire of which he had received material from Bouvet, and that was followed (Sudre 1908) by his pronouncing it identical in turn with specimens seen by him from two more *départements* further west, in Brittany. This trans-Channel distribution seemed to warrant a rank higher than that of a mere forma but, perhaps under a misapprehension that that name had not been published, Sudre avoided using the epithet *minor* as the basionym and decided on a different one. In the event this new name was first published, with an accompanying description, by Bouvet (1907), citing 'Sudre in litt.', and not by Sudre, as subsequent authors have been misled by Sudre (1908) into supposing. What is more, contrary to more recent British usage, Bouvet published the new taxon not as a species but as a variety. This is evidenced by his employment of the lower-case italics he elsewhere used for that rank, by the words "var. *subopacus*" on the line above the description and, most conclusively, by his listing of the new taxon in that form in a "tableau synoptique" which he appended to his paper by way of a summary. Sudre in turn retained the taxon at that rank. Later, presumably in the light of the trans-Channel distribution that Sudre had meanwhile claimed to have detected, Bouvet (1911) opted for a higher rank but, by leaving it unclear whether that was to be a subspecies or a 'microgene', rendered the intended promotion invalid. His contemporary counterparts in Britain might have taken a similar view, or perhaps preferred to raise the taxon to a species, but Sudre's lack of acquaintance with British *Rubi* other than as herbarium specimens – and commonly single ones at that – and some of the manifestly dubious taxonomic conclusions reached by him as a result (Riddelsdell 1923, 1930) were seen by them as good reason to treat his determinations with reserve. For many years afterwards, therefore, they adhered to fa. *minor*. That was unavailable as a basionym, though, had they wished to promote it to a species, for the epithet was preoccupied at that rank by a Chinese taxon described by Kuntze (1879).

A bramble with so narrow an Anglo-French range is likely to have received mention only in the French or British literature. Subsequent French students of *Rubus* adhered to Sudre's nomenclature so faithfully that any promotion of this taxon to specific rank by one of them is hardly to be expected. As no employment of the name at that rank by a British author prior to 1 January 1935 has been discovered, and no formal and valid publication to that effect after that date would appear to have taken place, the requisite new combination is accordingly now made:

***R. subopacus* (Sudre ex Bouvet) D. E. Allen, stat. nov.**

BASIONYM: *R. nitidus* var. *subopacus* Sudre ex Bouvet, Bulletin de la Société d'Études scientifiques D'Angers n.s. 36: 7 (1907).

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RANGE EXTENSIONS FOR *RUBUS RHOMBIFOLIUS* WEIHE EX BOENN. AND *R. BABINGTONIANUS* W. C. R. WATSON IN EAST ANGLIA

At the time of publication of *Brambles of the British Isles* by Edees and Newton *Rubus rhombifolius* had only one record in the whole of East Anglia and, until recently, the source of that record could not be traced. However, whilst transferring old records from the late E. L. Swann's card index, Mrs G. Beckett came across an entry for this species "B.S.B.I. excursion to Roydon Common (near Kings Lynn) v.c. 28, 1964, Miss K. Marks." For many years now, the present author has plotted a *Rubus* species in Norfolk, which had baffled the late E. S. Edees as well as A. Newton and at one stage a specimen was sent to Prof. H. E. Weber in Germany. Always on poor soils in Breckland and often in shaded conditions, the plant did not seem to tally completely with any known taxon and was code-named 'Breckland 1'. During the summer of 2001, whilst plant recording with a party for a forthcoming Flora of Suffolk, the plant was found growing in some abundance by the road along the edge of Thetford golf course which is in v.c. 26, West Suffolk. Though the panicles were still round topped and compact, with short pedicels, the bushes were robust and strong and the leaves were clearly white felted beneath, a characteristic which had only been dubiously present in a few specimens hitherto, though most gatherings did have at least a few hairs on the anthers.

As this record was new to the vice-county, and was reinforced by a second about five miles away at Brandon, a further gathering was sent to A. Newton who, after considerable deliberation, named the sheet as *Rubus rhombifolius* and admitted specimens previously gathered from TL78, 79, and 89, the present specimen being in TL88. A further recently named sheet collected in 1972 from Holt Lowes, v.c. 27, TGO3, and specimens from the above hectads are all in **herb. A. L. Bull.** A. Newton suggests that the Breckland form of *Rubus rhombifolius* is accounted for by the very arid conditions in which it is always found growing in Breckland.

Rubus babingtonianus has always been recognised as a Cambridgeshire endemic, though it has been suggested that one of the dots in Edees and Newton, either TL64 or 66 (Haverhill or Newmarket areas) may refer to a specimen collected from a site just in v.c. 26, West Suffolk. Be that as it may, *Simpson's Flora of Suffolk* does not mention the species at all, even though E. S. Edees had a week visiting every corner of the county for this Flora in 1965.

In 1997 specimens were collected from a site at Snailwell, v.c. 29, having received a grid reference from A. Newton and, though an eye was kept open for it subsequently, nothing further was found until 2001 when a visit was paid to collect a requested specimen of another *Rubus* from a known site at Barton Mills TL77 v.c. 26 when a low growing thicket of *Rubus babingtonianus* was found just a few metres away. On the same recording meeting that led to the discovery of *Rubus rhombifolius* above, the present taxon was discovered in the Horse Meadows at Thetford, v.c. 26, and two weeks later a further colony was found in TL78 at Fenhouse Drove, Lakenheath.

Finally, whilst visiting Thompson Common, v.c. 28, West Norfolk, TL99, during mid-August, a colony was found at that site, just about doubling the previously known range for this species. All specimens have been agreed by A. Newton and are in **herb. A. L. Bull.**

REFERENCES

- EDEES, E. S. & NEWTON, A. (1988). *Brambles of the British Isles*. Ray Society, London.
SIMPSON, F. W. (1982). *Simpson's Flora of Suffolk*. Suffolk Naturalists' Society, Ipswich.

A. L. BULL

Hillcrest, East Tuddenham, Dereham, Norfolk, NR20 3JJ

Plant Records

Records for publication must be submitted to the appropriate Vice-county Recorder (see *BSBI Year Book* 2002), and not to the Editors. The records must normally be of species, hybrids or subspecies of native or naturalised plants (listed in Kent (1992) or Stace (1997)), belonging to one or more of the following categories: 1st or 2nd v.c. record; 1st or 2nd post-1930 v.c. record; only extant v.c. locality, or 2nd such locality; a record of an extension of range by more than 100 km. Such records will also be accepted for the major islands in v.cc. S, 102–104 and 110. Only 1st records can normally be accepted for *Rubus*, *Hieracium*, *Taraxacum* and hybrids. Records for subdivisions of vice-counties will not be treated separately; they must therefore be records for the vice-county as a whole. Records for *Taraxacum* must normally be additional to those in *Dandelions of Great Britain and Ireland* by A. A. Dudman & A. J. Richards (1997).

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. Taxa not in that book follow *New Flora of the British Isles* Ed. 2 by C. A. Stace (1997). 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.

Records from the following vice-counties are included in the text below (superscript figures indicate number of taxa): S⁷, 2¹, 3², 6¹, 8², 10¹⁰, 11⁵, 12¹¹, 13¹⁶, 17¹, 19¹, 21⁴, 27¹, 29³, 35¹³, 37¹, 39⁵, 41¹⁷, 42¹⁶, 43⁶⁸, 44¹⁴, 45²⁰, 46⁶⁶, 47¹⁸, 49²⁴, 50¹⁷, 51³⁷, 52¹⁶, 58¹⁰, 61⁵, 64⁸, 67², 68⁷, 73², 77³⁸, 78⁹, 79³, 80⁸, 81⁴⁷, 95¹, 96¹⁰, 98¹, 103¹, 106¹, 107³⁸, 108¹, 110¹, H3¹.

The following signs are used:

* before the record: to indicate a new vice-county record.

† before the species number: to indicate that the plant is not a native species of the British Isles.

‡ before the record: to indicate a species which, though native in some parts of the British Isles, is not so in the locality recorded.

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

1/1.1. HUPERZIA SELAGO 35, Mons.: In small hollow in shelter of bedrock exposure, Blaenavon between Garn-yr-erw and Pwll du, SO244111, P.D. Moore, 1999. 2nd record & 1st since A. Ley's of 1890.

1/4.2a. DIPHASIASTRUM COMPLANATUM subsp. ISSLERI *108, W. Sutherland: In good quantity on a small area of hillside in extremely poor stony ground, Canisp, NC2216, A.G. Kenneth, 1985, **BM**, det. A.C. Jermy. Mainly in open conditions but some plants under *Calluna*.

†2/1.2. SELAGINELLA KRAUSSIANA *77, Lanarks.: Established weed in glasshouses, Glasgow Botanic Gardens, NS5667, P. Macpherson, 1998, **herb. P.M.**, conf. D.R. McKean.

3/1.1×2. ISOETES × HICKEYI (I. ECHINOSPORA × E. LACUSTRIS) *46, Cards.: NE corner of Llyn Pendam, SN709839, A.O. Chater & A.C. Jermy, 1997, **BM**, conf. D. Britton. 1st confirmed British record.

4/1.1. EUISETUM HYEMALE 27, E. Norfolk: Roadside verge, Morley St Botolph, TM068988, S. Plant, 1999, conf. A.L. Bull. 1st recent record.

4/1.4×5. EUISETUM × LITORALE (E. FLUVIATILE × E. ARVENSE) *43, Rads.: Gilfach River shingle, SN966720, S.P. Chambers, 1997, conf. A.O. Chater.

14/1.1. THELYPTERIS PALUSTRIS *2, E. Cornwall: Wet moorland near *Salix cinerea* scrub, Tregonetha Downs, near Criftoe, SW944635, I.J. Bennallick, 1999, **BM**. 1st confirmed record & only extant site.

15/2.6. ASPLENIUM VIRIDE 47, Monts.: Locally abundant on walls of old mine buildings, Upper Afon Hore, Llangurig (Hafren Forest), SN827873, A.J. Morton, 1998. 2nd record.

†17/2.1. CYRTOMIUM FALCATUM *46, Cards.: Cellar wells, Laura Place, Aberystwyth, SN581816, A.O. Chater, 1998.

17/3.10. DRYOPTERIS EXPANSA *50, Denbs.: Rocky cwm, Cwm Ffynnon, Berwyn, SJ093295, P. Thomas, 1998, det. R.H. Roberts.

17/3.8×9. DRYOPTERIS × DEWEVERI (D. CARTHUSIANA × D. DILATATA) *107, E. Sutherland: Plantation, Shinness Lodge, Lairg, NC556141, BSBI group, 1999.

†20/3.1. TSUGA HETEROPHYLLA *77, Lanarks.: Seedling in unused vehicle park, Happenden, NS8533, P. Macpherson, 1998, **herb. P.M.**, det. C.S. Crook. 1st record as established alien.

†20/7.peu. PINUS PEUCE *46, Cards.: Five self-sown trees 4-10 years old on leadmine spoil heap and in adjacent gully, Ystrad Einion mine, 3km SE of Eglwys-fach, SN707938, A.O. Chater, 1999.

†21/1.1.×21/2.noo. ×CUPRESSOCYPARIS LEYLANDII (CUPRESSUS MACROCARPA × CHAMAECYPARIS NOOTKATENSIS) *77, Lanarks.: Seedling by railway, S of Sandymount Cemetery, Glasgow, NS6564, P. Macpherson, 1998, **herb. P.M.**, det. C.S. Crook. 1st record as established alien.

26/1.1. NYMPHAEA ALBA †51, Flints.: Introduced to Llyn Helyg, SJ1177, N.F. Stewart, 1998. 2nd recent record.

†26/2.adv. NUPHAR ADVENA *77, Lanarks.: Well established in long abandoned pond, Corehouse, NS8742, P. Macpherson & J. Waddell, 1998, **herb. P.M.**

†28/6.1×var. ACONITUM × CAMMARUM (A. NAPELLUS × A. VARIEGATUM) *43, Rads.: Roadside hedge, Fron Goch, SO225725, D.R. Humphreys, 1997.

†28/9.2. ANEMONE APENNINA *13, W. Sussex: Patch 2×2m by hedge at E side of churchyard, Henfield, TQ212162, A.G. Knapp, 1997. Still thriving in 2000.

†28/9.3. ANEMONE RANUNCULOIDES *96, Easternness: Frequent on E bank of R. Nairn, by Nairn, NH8855, B.W. Ribbons, 1980. Seen again in 2000.

28/13.4. RANUNCULUS SARDOUS 12, N. Hants.: New verge, Digby Way (Greatham by-pass), SU7831, A. Brewis, 1998, **herb. A.B.** 1st recent record.

28/13.17b. RANUNCULUS FICARIA subsp. BULBILIFER *12, N. Hants.: Side of War Memorial, Blackmoor, SU780336; Side of lane, Chiltlee Lane, Liphook, SU846317; both A. Brewis, 1998, **herb. A.B.** 1st & 2nd records.

28/13.19×20. RANUNCULUS × NOVAE-FORESTAE (R. OMIOPHYLLUS × R. TRIPARTITUS) *45, Pems.: Spittal Common, SM972225, S.B. Evans, 1999.

28/13.20. RANUNCULUS TRIPARTITUS *49, Caerns.: Bare peat in trampled heath, Mynydd Cilan, Porth Ceiriad SSSI, SH292245, R.A. Jones, 2000.

28/13.27. RANUNCULUS CIRCINATUS *43, Rads.: River island, River Wye, SO179398, M.A.V. Gill, 1996. 51, Flints.: Small, shallow quarry lake, N of Knowl Hill, Buckley, SJ286646, N.F. Stewart, 1998. 1st record since 1918.

28/17.4. THALICTRUM MINUS 47, Monts.: 1 plant on cliff beside River Vyrnwy, Pontrobert, SJ1013, R.G. Woods, 1999. 2nd record as a native.

29/1.1. BERBERIS VULGARIS †*52, Anglesey: Scrub on edge of Marianglas common, SH5084, J. Hawksford, 1992.

†29/1.9×emp. BERBERIS × STENOPHYLLA (B. DARWINII × B. EMPETRIFOLIA) *46, Cards.: Roadside hedgebank, Gwynfryn, Llanarth, SN422S73, A.O. Chater, 1999, **NMW**. Along 5m of laneside hedgebank 300m SE of Vicarage Crossroads, Aberaeron, SN459618, A.O. Chater, 1999. 1st and 2nd records.

†30/1.2. PAPAVER ATLANTICUM *51, Flints.: Casual on roadside near house, Bridge End, Caergwrle, SJ310573, G. Wynne, 1999.

†30/6.1. ESCHSCHOLZIA CALIFORNICA *43, Rads.: Sandy stream bank, Glasbury, SO177388, M.A.V. Gill, 1996.

31/5.6. FUMARIA PURPUREA *81, Berwicks.: Amongst turnips, by Smiddyhill Bridge, NT697613, M.E. Braithwaite, 1998, det. M.G. Daker. Set-aside land, near Lurgie Craigs, NT675399 & 675400, M.E. Braithwaite & L. Gaskell, 1999. 1st & 2nd records.

†32/1.occxori. PLATANUS × HISPANICA (P. OCCIDENTALIS × P. ORIENTALIS) *35, Mons.: Field / road edge, Piercefield Park, Chepstow racecourse, ST5294, T.G. Evans, 1995. *43, Rads.: Hedgerow, Pentre, SO2466, D.R. Humphreys & E.R. Dean, 1994.

33/1.1×3. ULMUS × VEGETA (U. GLABRA × U. MINOR) *43, Rads.: Hedgerow, Glasnant, SO1850, D.R. Humphreys & E.R. Dean, 1997.

†33/1.1×3×4 ULMUS × HOLLANDICA (U. GLABRA × U. MINOR × U. PLOTII) *43, Rads.: Two layered trees in hedge, Pentrosfa SO058595, S.P. Chambers. 1998.

†34/1.1. *CANNABIS SATIVA* *45, Pembs.: Several plants on site of former pheasant pen, disturbed sand dune, Kilpaison Burrows, SM897002, S.B. Evans & A. McConnell, 1999.

†36/3.1. *SOLEIROLIA SOLEIROLII* *42, Brecks.: Abundant in road verge turf over several square metres, Llangattock, SO208183, M. Porter, 1999. *51, Flints.: Established on roadside outside garden, Cilcain, SJ175650, G. Wynne, 1998. 2nd recent record.

40/1.1×2. *BETULA* × *AURATA* (*B. PENDULA* × *B. PUBESCENS*) *43, Rads.: Glasbury Churchyard, SO177385, M.A.V. Gill, 1996. *77, Lanarks.: Small wood, Coulter Allers, NT0331, P. Macpherson, 1999, **herb. P.M.**, conf. A.McG. Stirling.

†40/2.2. *ALNUS INCANA* *51, Flints.: Copse near farm, 'Deeside House', Sealand, SJ349677, G. Wynne, 1999. 2nd record. *81, Berwicks.: Established and proliferating in wet wood, Well Burn, Cranshaws, NT680616, M.E. Braithwaite, 1998. 1st record as established. *107, E. Sutherland: Riverbank, Ascoile, Loch Brora, NC825105; Roadside, Loch Shin, NC567101; both BSBI group, 1999. 1st & 2nd records.

†42/8.3. *CARPOBROTUS GLAUCESCENS* S, Channel Is. (Sark): Covering part of roadside wall, adjoining garden, La Valette de Bas, WV472761, R.M. Veall, 1999, **herb. Société Sercquaise**. 1st record for Sark.

43/1.13. *CHENOPODIUM FICIFOLIUM* †*49, Caerns.: Llangian, SH294288, A. Daly, 1999.

43/3.3×4. *ATRIPLEX* × *TASCHEREAU* (*A. GLABRIUSCULA* × *A. LONGIPES*) *68, Cheviot: Edge of saltmarsh, Warkworth, NU260055, A. Coles, 1999, **HAMU**, det. J.R. Akeroyd.

43/3.6. *ATRIPLEX LITTORALIS* †*81, Berwicks.: Established on road verge, Nisbett Hill, NT799503, L. Gaskell, 1998. Road verge, Edington, NT897562, M.E. Braithwaite, 1999. 1st & 2nd records.

43/6.6. *SALICORNIA FRAGILIS* *52, Anglesey: Lower saltmarsh, Inland Sea, Rhoscolyn, SH2876, T.C.G. Rich, det. I.K. Ferguson, 1999.

43/7.1. *SUAEDA VERA* *52, Anglesey: Upper shore, Inland Sea, Rhoscolyn, SH2975, T.C.G. Rich, 1999, **NMW**.

†44/1.6. *AMARANTHUS ALBUS* *8, S. Wilts.: Large arable field normally used for fodder beet or maize, Hamptworth, SU235197, P.J. Wilson, 1999.

45/3.1a. *MONTIA FONTANA* subsp. *FONTANA* *43, Rads.: Wet flush, Glanhirin, SN8671, BSBI Meeting, 1996, det. A.O. Chater.

46/10.7a. *SAGINA APETALA* subsp. *APETALA* *67, S. Northumb.: Roadside verge, near bridge, Mindrum, NT854334, G.A. & M. Swan, 1999, **herb. G.A.S.**, det. N. Jardine.

46/10.8. *SAGINA MARITIMA* *80, Roxburghs.: Extreme edge of road, Broomhouse, E of Maxton, NT637308, L. Gaskell, 1999, **herb. R.W.M. Corner**, conf. M.E. Braithwaite.

46/13.1. *HERNIARIA GLABRA* †*13, W. Sussex: Several patches established at junction of River Rd. & Terminal Rd, Littlehampton, TQ022021, E. Bishop, 1999. Still present in 2001. *51, Flints.: Floor of disused sandstone quarry, Caer Estyn, 1km E of Caergwrle, SJ315576, G.M. Kaye, 1999. *107, E. Sutherland: Industrial estate, Helmsdale village, ND034152, BSBI group, 1999.

46/17.3. *SPERGULARIA MARINA* †*21, Middlesex: Abundant on roadside, W side of Hanger Lane, Ealing, TQ18, P.H. Oswald, 1998. 1st record as an established alien. *64, Mid-W. Yorks.: Roadside, Blubberhouses, SE15, J. & S. Hartley, 1998. 2nd record.

46/20.2. *SILENE NUTANS* *44, Carms.: 23 plants on coastal shingle spit, Penrhyngwyn, SS516973, T. & V. Lewis, 1999.

†46/24.3. *PETORRHAGIA SAXIFRAGA* *47, Monts.: 1 plant forming a 20cm cushion in pavement outside Town Hall, Llanidloes, SN955845, D. Woodland & C.A. Small, 1999. Locality is where market stalls sell plants!

46/25.5. *DIANTHUS DELTOIDES* †*107, E. Sutherland: Probably planted on river bank, Balnacoll Lodge, NC804113, BSBI group, 1999.

†46/25.car. *DIANTHUS CARTHUSIANORUM* *50, Denbs.: Waste ground, roadside, Pentrefoelas, SH874514, J.A. Green, 1999.

47/1.8. *PERSICARIA VIVIPARA* *77, Lanarks.: Upland hill top, Gana Hill, NS9601, E.L.S. Lindsay & P. Macpherson, 1998, **herb. P.M.** 2nd record & 1st for over 100 years

47/1.11×14. *PERSICARIA* × *INTERCEDENS* (*P. MACULOSA* × *P. HYDROPIPER*) *46, Cards.: Fallow enclosure by farmyard, Cymerau Farm, Glandyfi, SN698961, A.O. Chater & J.P. Woodman, 1998, **NMW**, conf. J.R. Akeroyd.

47/1.16. *PERSICARIA* *MINOR* *43, Rads.: Wet meadow, Pwll Patti, SO166392, M.A.V. Gill, 1998, conf. D.R. Humphreys.

†47/1.cap. *PERSICARIA* *CAPITATA* *39, Staffs.: Pavement, alleyway leading from Stanley Street, Leek, SJ983565, J.E. Hawksford, 1998. Pavement, by wall, W side of road, near entrance to car park of The Chetwynd Centre, Stafford, SJ922228, J.E. Hawksford, 1999. 1st and 2nd records.

47/4.1. *POLYGONUM* *MARITIMUM* 13, W. Sussex: A small group on sand, with *P. oxyspermum* & *P. aviculare*, W. Wittering, SZ773977, P.D. Stanley, 1995. 1st recent record.

47/4.2a. *POLYGONUM* *OXYSpermum* subsp. *RAII* 44, Carms.: Driftline of sandy beach, Machynys, Llanelli, SS50697, I.K. Morgan, 1998, **NMW**. 2nd recent record.

47/4.6. *POLYGONUM* *RURIVAGUM* †67, S. Northumb.: Roadside verge, near Minsteracres, NZ023549, G.A. & M. Swan, 1999, **herb. G.A.S.**, det. J.R. Akeroyd. 2nd record. †68, Cheviot: Roadside verge, Brunton Bridge, NU220255, G.A. & M. Swan, 1999, **herb. G.A.S.**, det. J.R. Akeroyd. 2nd record.

†47/5.1. *FALLOPIA* *JAPONICA* var. *COMPACTA* *64, Mid-W. Yorks.: Old quarry, Woodside Quarry, Ireland Wood, Leeds, SE254384, Leeds Naturalists' Club, 1998.

†47/8.6. *RUMEX* *PSEUDOALPINUS* *107, E. Sutherland: Portgower, NC91, BSBI group, 1999.

47/8.8×19. *RUMEX* × *HYBRIDUS* (*R. LONGIFOLIUS* × *R. OBTUSIFOLIUS*) *107, E. Sutherland: Flush, E of Helmsdale village, ND0315, BSBI group, 1999.

47/8.10. *RUMEX* *HYDROLAPATHUM* *80, Roxburghs.: River bank, N side of R. Tweed, Kittyfield, Melrose, NT573348, L. Gaskell, 1999, **herb. R.W.M. Corner**.

47/8.13b. *RUMEX* *CRISPUS* subsp. *LITTOREUS* *107, E. Sutherland: Helmsdale, ND01, BSBI group, 1999.

47/8.13×14. *RUMEX* × *SCHULZEI* (*R. CRISPUS* × *R. CONGLOMERATUS*) *45, Pembs.: 1 plant on grassy roadside by marsh, Trefeiddan Moor, St David's, SM730253, G. Kitchener, 1998.

47/8.13×19. *RUMEX* × *PRATENSIS* (*R. CRISPUS* × *R. OBTUSIFOLIUS*) *45, Pembs.: 1 plant in grassy field, Solva, SM798242, and 1 plant in grassy field by coast, Whitesands Bay, St David's, SM734271, both G. Kitchener, 1998. 1st & 2nd records. *47, Monts.: British Waterways Reserve, Wern Claypit, Arddlin, SJ252140, R.V. Lansdown, 1997.

47/8.14×19. *RUMEX* × *ABORTIVUS* (*R. CONGLOMERATUS* × *R. OBTUSIFOLIUS*) *45, Pembs.: 1 plant in rough vegetation near pond, Tre-henlliw, St David's, SM757266, G. Kitchener, 1998. *80, Roxburghs.: With both parents in wet hollow by burn, SW of Sprouston, Kelso, NT754347, R.W.M. Corner, 1998, **herb. R.W.M.C.**, det. J.R. Akeroyd.

47/8.15×19. *RUMEX* × *DUFFTII* (*R. SANGUINEUS* × *R. OBTUSIFOLIUS*) *80, Roxburghs.: With both parents on bank of R. Teviot below Roxburgh Castle, NT713337, R.W.M. Corner, 1999, **herb. R.W.M.C.**, det. J.R. Akeroyd.

47/8.18. *RUMEX* *PULCHER* 51, Flints.: Weed in managed area by car park, Rhyl, SJ012820, J. Hughes & J. Phillips, 1998. 2nd record & 1st since 1923.

50/1.2. *ELATINE* *HYDROPIPER* *77, Lanarks.: Lochend Loch, Drumpellier Country Park, NS7066, O.O. Lassi re & C.L. Dines, 1996, **herb. P. Macpherson**. Seen by P.M. in 2000.

†51/1.3×4. *HYPERICUM* × *INODORUM* (*H. ANDROSAEMUM* × *H. HIRCINUM*) *77, Lanarks.: Established on grassy bank, Carnbrae, NS7463, P. Macpherson, 1998, **herb. P.M.**, det. N.K.B. Robson.

†51/1.4. *HYPERICUM* *HIRCINUM* *43, Rads.: Base of brick wall, Llandrindod Wells, SO058612, S.P. Chambers, 1997, conf. N.K. Robson.

†51/1.4a. *HYPERICUM* *HIRCINUM* subsp. *MAJUS* 46, Cards.: Old wall 30m E of Aberaeron church, SN457627, A.O. Chater, 1998, **NMW**, det. N.K.B. Robson. 2nd record.

51/1.6×7. *HYPERICUM* × *DESETANGSII* (*H. PERFORATUM* × *H. MACULATUM*) *43, Rads.: Bank of cutting, Rhayader tunnel, SN963673, S.P. Chambers, 1997. *107, E. Sutherland: Grassy verge, Loch Fleet, NH780959, P. Eaglesfield & M.E. Murray, 1998, det. J.K. Butler. In stones on loch shore, Lairg village, NC583065, BSBI group, 1999. 1st & 2nd records.

52/1.1. *TILIA PLATYPHYLLOS* ***43**, Rads.: Edge of farmland, Glasbury, SO178387, M.A.V. Gill, 1996. Hedge, Withybeds, Presteigne, SO310649, S.P. Chambers, 1997, det. D. Pigott. 1st & 2nd records. †**77**, Lanarks.: Edge of wood, with many seedlings, Dalziel Estate, NS7555, P. Macpherson, 1997, **herb. P.M.** 1st record as established alien.

†53/5.1. *SIDALCEA MALVIFLORA* ***107**, E. Sutherland: Ruderal, Kildonan Station, NC9021, BSBI group, 1999.

57/1.3×4. *VIOLA* × *BURNATII* (*V. RUPESTRIS* × *V. RIVINIANA*) ***64**, Mid-W. Yorks.: 2 plants in open, gravelly turf on limestone, Crummack, Ingleborough, SD770714, F.J. Roberts, 1998, conf. I. Nordal.

57/1.4×5. *VIOLA* × *BAVARICA* (*VIOLA RIVINIANA* × *V. REICHENBACHIANA*) ***50**, Denbs.: Deciduous woodland, Ruthin, SJ125554, S. Chambers, 1996, det. D. Moore.

57/1.4×6. *VIOLA* × *INTERSITA* (*V. RIVINIANA* × *V. CANINA*) ***13**, W. Sussex: By Benbow Pond S of A272, Eastbourne, SU911220, 1996, T.C.G. Rich.

†61/1.3×del. *POPULUS* × *CANADENSIS* (*P. NIGRA* × *P. DELTOIDES*) ***43**, Rads.: Wet woodland, Withybeds, Presteigne, SO309650, S.P. Chambers, 1997.

61/2.4. *SALIX TRIANDRA* **79**, Selkirks.: River's edge, N bank of R. Tweed above Gala Foot, NT506344, R.W.M. Corner, 1999, **herb. R.W.M.C.** Only known extant site.

61/2.5×9. *SALIX* × *RUBRA* (*S. PURPUREA* × *S. VIMINALIS*) ***50**, Denbs.: Industrial estate, Wrexham, SJ380493, J.A. Green, 1998, **NMW**.

61/2.9×10. *SALIX* × *SERICANS* (*S. VIMINALIS* × *S. CAPREA*) †***S**, Channel Is. (Sark): Presumably planted in wet ground near stream, Harbour Hill, WV474758, R.M. Veall, 1999, **herb. Société Sercquaise**, det. R.D. Meikle. ***107**, E. Sutherland: Brora, NC923051, BSBI group, 1999.

61/2.9×11. *SALIX* × *SMITHIANA* (*S. VIMINALIS* × *S. CINEREA*) ***45**, Pembs.: Stream valley, Merry Vale, St David's, SM744250 & SM752258, G. Kitchener, 1998. 1st confirmed records.

61/2.10×11. *SALIX* × *REICHARDTII* (*S. CAPREA* × *S. CINEREA*) ***107**, E. Sutherland: Roadside, Strath of Kildonan, NC91; †Probably planted on river bank, Balnacoll Lodge, NC804113; both BSBI group, 1999. 1st & 2nd records.

61/2.10×15. *SALIX CAPREA* × *S. PHYLICIFOLIA* ***77**, Lanarks.: Waste ground, Partick, Glasgow, NS5466, P. Macpherson, 1998, **herb. P.M.**, det. R.D. Meikle.

61/2.16. *SALIX REPENS* **10**, Wight: Single plant on flushed clay coastal slope, Headon Warren, SZ526910, C.R. Pope, 1998, **herb. C.R.P.**, det. C.R.P. & T.D. Dines. Only extant site.

†62/5.1. *ISATIS TINCTORIA* ***107**, E. Sutherland: Industrial estate, Helmsdale village, ND034152, BSBI group, 1999.

†62/7.1. *ERYSIMUM CHEIRANTHOIDES* **81**, Berwicks.: Established in Turnip field, near Gledswood East Lodge, NT592352, L. Gaskell, 1999. 2nd extant record.

†62/7.dec×per. *ERYSIMUM* × *MARSHALLII* (*E. DECUMBENS* × *E. PEROFKIANUM*) ***47**, Monts.: Old spoil-heap, Pwll Penarth Nature Reserve, nr Newtown, SO1392, C.A. Small, 1998.

†62/10.1on. *MATTHIOLA LONGIPETALA* ***47**, Monts.: Casual in crack between shop-wall and pavement, Severn St, Welshpool, SJ226075, A. Markwick, 1999.

62/12.1×2. *RORIPPA* × *STERILIS* (*R. NASTURTIUM-AQUATICUM* × *R. MICROPHYLLA*) **47**, Monts.: By Montgomery Canal, near Welshpool, SJ230077, R.V. Lansdown, 1998. 2nd recent record.

†62/14.cor. *CARDAMINE CORYMBOSA* ***35**, Mons.: Over 100 plants as weed in pots and nursery beds, Waterwheel Nursery, Bullyhole Bottom, ST462963, C. Evans, 1999, **NMW**. 1st Welsh record. ***96**, Easternness: Established weed in alpine garden, Fort Augustus, NH3709, M.E. Braithwaite, c.1988. Nursery weed, Inshriach, Strathspey, NH873073, P.R. Green, 1996. 1st & 2nd records.

†62/2.1. *DESCURAINIA SOPHIA* ***43**, Rads.: 1 plant on former dung heap, Llanstephan, SO127417, R.G. Woods. 1997. ***46**, Cards.: Weed in garden of Tawelfan, Penrhyn-coch, SN641840, A.G. Bates, 1983, **NMW**, det. A.O. Chater.

†62/20.1. *LOBULARIA MARITIMA* ***47**, Monts.: Grit from R. Severn, Pwll Penarth Nature Reserve, nr Newtown, SO1392, M. Wainwright, 1998. 2nd record.

62/22.1. *EROPHILA MAJUSCULA* *52, Anglesey: Road verge NE of Malltraeth, SH4169, R.H. Roberts, det. T.T. Elkington, 1995. *81, Berwicks.: Sandy grassland, Bay W of Ramsheugh, NT774722, M.E. Braithwaite, 1998, det. T.T. Elkington.

62/22.3. *EROPHILA GLABRESCENS* *52, Anglesey: Sand dunes, Aberffraw, SH3568, J. Lowell, det. T.T. Elkington, 1994.

62/23.2a. *COCHLEARIA PYRENAICA* subsp. *PYRENAICA* 77, Lanarks.: Burn side, Daer Reservoir, NS9709, P. Macpherson, 1994, **herb. P.M.**, conf. D.H. Dalby. Burn side, just S of Beattock Summit, NT0013, P. Macpherson, 1995, **herb. P.M.**, conf. D.H. Dalby & T.C.G. Rich. 1st & 2nd confirmed records for subsp.

62/23.5. *COCHLEARIA DANICA* *42, Brecks.: Road verge, 2km E of Bryn-mawr, SO217126, M. & C. Porter, 1999.

†62/29.3. *IBERIS UMBELLATA* *50, Denbs.: Lane by garden, Brymbo, SJ284539, BSBI group, 1999.

62/30.2. *LEPIDIUM CAMPESTRE* *107, E. Sutherland: Roadside ditch, Tirrystide, Lairg, NC51, BSBI group, 1999.

†62/30.4. *LEPIDIUM VIRGINICUM* *44, Carms.: Roadside, Crosshands, SN51, A.M. Pell, 1985, NMW, det. T.C.G. Rich (as *L. densiflorum*).

62/30.5. *LEPIDIUM RUDERALE* *68, Cheviot: B6341 roadside verge, salted in winter, N of Rothbury, NZ068036, Mrs J.M. Humphris, 1998, **herb. G.A. Swan**.

†62/30.8a. *LEPIDIUM DRABA* subsp. *DRABA* *43, Rads.: Roadside, Presteigne, SO312647, 1994; Old station yard, Penybont Gravel yard, SO098648, 1995; both R.G. Woods, 1st & 2nd records.

62/41.1. *CRAMBE MARITIMA* *58, Cheshire: Developing dune/shingle on shore below clay cliffs, between Heswall and Thurstaston, SJ2482, E.F. Greenwood, 1998. 1 seedling noted in 1995, flowered 1998 with some seed set.

†62/42.sat. *RAPHANUS SATIVUS* *43, Rads.: Glangwye Farm, SO1537, M.A.V. Gill, 1997. 51, Flints.: Arable field, near path, N of Alltami, SJ265665, J. Phillips, 1998. 2nd record.

65/12.1. *ERICA CILIARIS* *3, S. Devon: Acid mire, Blackdown Hills, ST11, M.J. Edginton, 1998, conf. D. McClintock. 1st record as a native.

65/12.1x3. *ERICA* × *WATSONII* (*E. CILIARIS* × *E. TETRALIX*) *3, S. Devon: Acid mire, Blackdown Hills, ST11, M.J. Edginton, 1998, conf. D. McClintock.

65/13.2. *VACCINIUM MICROCARPUM* *77, Lanarks.: Boggy mossy ground, SE of Henshaw Hill, NT0654, P. Macpherson & BSBI group, 1998, **herb. P.M.**, conf. D.R. McKean.

65/13.4x6. *VACCINIUM* × *INTERMEDIUM* (*V. VITIS-IDAEA* × *V. MYRTILLUS*) *46, Cards.: A few plants in *Molinia* tussock mire, rand of West Bog, Cors Caron, SN686634, J.P. Savidge, c.1980.

†65/8.2. *GAULTHERIA PROCUMBENS* *46, Cards.: Under oaks in estate grounds S of Trawsgoed mansion, SN671730, A.O. Chater & R.G. Woods, 1989.

†65/LEU.fon. *LEUCOTHOE FONTANESIANA* *46, Cards.: Mixed estate woodland 200m N of Ynyshir Hall, Eglwys-fach, SN682961, P. Condry & A.O. Chater, NMW, 1998. Naturalised here for over 40 years; 1st Welsh record. *73, Kirkcudbrights.: Naturalised in wood at Munches S of Dalbeattie, NX8358, O.M. Stewart, 1992, **E**, det. D.R. McKean. 1st British record.

66/1.1. *PYROLA MINOR* *41, Glam.: In *Betula/Salix* woodland, Jersey Marine, SS714936, C.R. Hipkin, 1998.

66/1.3. *PYROLA ROTUNDIFOLIA* *107, E. Sutherland: Ben Grian Mor, NC83, BSBI group, 1999.

†69/1.8. *PRIMULA SIKKIMENSIS* 49, Caerns.: Rock ledge, Cwm Glas Mawr, SH615554, G. Battershall & W. McCarthy, 1999.

69/4.2. *LYSIMACHIA NUMMULARIA* 107, E. Sutherland: Roadside, Tirrystide, Lairg, NC51, BSBI group, 1999. 1st recent record.

†69/4.5. *LYSIMACHIA PUNCTATA* *51, Flints.: Waste ground behind sea wall, W of Greenfield Dock, SJ195784, G. Wynne, 1998. *107, E. Sutherland: Ruderal, Kildonan Station, NC9021, BSBI group, 1999.

69/6.3. *ANAGALLIS MINIMA* **42**, Brecks.: Flush near stream on Llangoed Common, 2.5km N of Llandefalle, SO087385, M. & C. Porter, 1998. 2nd record.

†72/1.1. *ESCALLONIA MACRANTHA* ***47**, Monts.: Roadside hedge, lane between Anchor Bridge and Kerry Pole, SO170857, S. Kingsbury, 1999.

72/2.1. *RIBES RUBRUM* ***110**, Outer Hebrides: Possibly native in cleft of burn in wild habitat, Easgarry, Barra, NL7099, J. Swindells & R.J. Pankhurst, 1998.

†73/1.3. *CRASSULA HELMSII* **42**, Brecks.: Pool, Glasfynydd Forest, SN876259, M. Howells, 1999. 2nd record. ***43**, Rads.: Welsh Show Ground, Llanelwedd SO049519, J. Donovan, 1991. Penywrlod Pond, SO2146, S. Holtermann, 1999. 1st & 2nd records. ***52**, Anglesey: Garden pond, Dwyran, SH4465, P. Whalley, 1993. ***81**, Berwicks.: Established in ornamental garden pond, Caldra House, NT773494, M.E. Braithwaite & BSBI party, 1998.

†73/3.1. *SEMPERVIVUM TECTORUM* ***51**, Flints.: Cottage roof, Cilcain, SJ176650, J. Phillips, 1998. 1st recent record.

73/5.5b. *SEDUM TELEPHIUM* subsp. *FABARIA* ***43**, Rads.: Shady bank, Rhayader tunnel, SN963673, S.P. Chambers, 1997.

†73/5.8. *SEDUM STOLONIFERUM* ***46**, Cards.: Shaded streambank, Llwyndafydd, SN370554, A.O. Chater, 1998, **NMW**. Roadside hedgebank 300m E of Capel Dewi church, SN453426, A.O. Chater, 1999. 1st & 2nd records.

†73/5.11. *SEDUM RUPESTRE* **81**, Berwicks.: Established on rocks by river, opposite Old Melrose, NT585338, L. Gaskell, 1999. 2nd record.

†73/5.13. *SEDUM SEXANGULARE* **46**, Cards.: Capel Dewi churchyard, SN452425, A.O. Chater, 1998. 2nd record.

†73/5.19. *SEDUM HISPANICUM* ***64**, Mid-W. Yorks.: Wall between field and road, Pateley Bridge, SE148665, P.P. Abbott, 1998.

†73/5.cep. *SEDUM CEPAEA* ***41**, Glam.: Persistent garden weed, Cwm Ivy, Llanmadoc, SS438937, Q.O.N. Kay, 1998.

†74/2.sam. *RODGERSIA SAMBUCIFOLIA* ***77**, Lanarks.: Established on wooded bank, Avon Water, Barncluith, Hamilton, NS7254, P. Macpherson, 1998, **herb. P.M.**, det. E.J. Clement.

†74/3.1. *BERGENIA CRASSIFOLIA* ***46**, Cards.: Streambank, Aber-arth, SN479639. A.O. Chater, 1998.

†74/5.2. *SAXIFRAGA CYMBALARIA* ***46**, Cards.: Old wall, Alltyroddyn, Capel Dewi, SN450443, M.L. Lewes, c.1921, **ABS**, det. A.D.Q. Agnew & A.O. Chater.

†74/5.7. *SAXIFRAGA CUNEIFOLIA* subsp. *CUNEIFOLIA* ***77**, Lanarks.: Well established on damp wall, pathside by R. Nethan, Lesmahagow, NS8139; Steep bank above Avon Water, Barncluith, Hamilton, NS7254; both P. Macpherson, 1998, **herb. P.M.**, det. R.J. Gornall. 1st & 2nd records.

†74/5.8. *SAXIFRAGA UMBROSA* **51**, Flints.: Road verge, Nercwys Mountain, SJ224578. J. Hughes & J. Phillips, 1998. 1st recent record.

†74/6.1. *HEUCHERA SANGUINEA* ***64**, Mid-W. Yorks.: 1 plant in old quarry, Woodside Quarry, Ireland Wood, Leeds, SE254384, M. Wilcox, 1998.

†74/8.1. *TELLIMA GRANDIFLORA* ***35**, Mons.: Track by overgrown garden, Angiddy Valley, Tintern, SO512004, B.J. Gregory, 1998. ***41**, Glam.: Hedgebanks, Penmaen and Bishopston, SS5388 & 5788, A.S. Lewis, 1998. ***46**, Cards.: Roadside bank, Blaenpant, Dihewyd, SN491556, **NMW**; Streambank, 100m W of Llanfihangel-y-Creuddyn church, SN664760; both A. O. Chater, 1999. 1st & 2nd records.

†75/3.1. *SPIRAEA SALICIFOLIA* ***12**, N. Hants.: Forest wasteland, Bordon, SU7836, A. Brewis, 1997, **herb. A.B.**

†75/3.1×2. *SPIRAEA* × *ROSALBA* (*S. SALICIFOLIA* × *S. ALBA*) ***81**, Berwicks.: Established in Policy woodland, by Hen Poo, Duns Castle, NT7755, M.E. Braithwaite, 1999. 2nd record.

†75/3.1×3. *SPIRAEA* × *PSEUDOSALICIFOLIA* (*S. SALICIFOLIA* × *S. DOUGLASII*) ***107**, E. Sutherland: Ruderal, Kildonan Station, NC902218, BSBI group, 1999.

75/6.1. *FILIPENDULA VULGARIS* ***41**, Glam.: Limestone grassland on cliff-top at Oxwich Point, far from roads and houses and apparently native, SS507848, B. Pawson, 1997.

- †75/7.1. *KERRIA JAPONICA* *43, Rads.: Roadside, Penisarplwyf, SO112444, D.R. Humphreys & E.R. Dean, 1999. *51, Flints.: Naturalised in old abandoned nursery, Sealand, SJ355674, G. Wynne, 1999.
- †75/8.2. *RUBUS TRICOLOR* *51, Flints.: Climbing over old stone wall (away from houses), Blaenau, Rhydtalog, SJ252559, J. Hughes & J. Phillips, 1998. *77, Lanarks.: Established on roadside bank, near Newmains, NS8355, P. Macpherson, 1999, **herb. P.M.**, det. A. McG. Stirling.
- †75/8.9. *RUBUS SPECTABILIS* *81, Berwicks.: Plentifully established in cut-down wood, Well Burn, Cranshaws, NT681616, M.E. Braithwaite, 1998.
- 75/8.95. *RUBUS CISSBURIENSIS* *10, Wight: Plantation margin, Quarr Road, Fishbourne, SZ558928, D.E. Allen & B. Goater, 1998, **BM**.
- 75/8.120. *RUBUS RHOMBIFOLIUS* *46, Cards.: Felled woodland, Coed Newydd, Coedmor, SN196443, D.E. Allen & A.O. Chater, 1998, **BM**, conf. A. Newton.
- 75/8.123. *RUBUS SEPTENTRIONALIS* *64, Mid-W. Yorks.: Scrub, Meanwood Valley, Leeds, SE298367, K. Pyne, 1998, det. A. Newton.
- 75/8.158. *RUBUS ORBUS* *10, Wight: Woodland clearing, Great Lynn Common, SZ532898, D.E. Allen, 1998, **BM**, conf. A. Newton.
- 75/8.171. *RUBUS MUCRONATIFORMIS* *46, Cards.: Roadside hedgebank and field margin, Warren Farm, Penparc, SN201477, D.E. Allen & A.O. Chater, 1997, **BM**, conf. A. Newton.
- 75/8.172. *RUBUS MUCRONATOIDES* *46, Cards.: Felled woodland, Coed Newydd, Coedmor, SN196443, D.E. Allen & A.O. Chater, 1998, **BM**, conf. A. Newton.
- 75/8.193. *RUBUS MELANODERMIS* *46, Cards.: Rocky slope by road, 1.5km NW of Cenarth, SN258424, D.E. Allen & A.O. Chater, 1998, **BM**, conf. A. Newton.
- 75/8.199. *RUBUS RADULOIDES* *46, Cards.: Cwm Einion, SN69, W.H. Painter, 1906, **BM**, det. D.E. Allen, conf. A. Newton.
- 75/8.224. *RUBUS BLOXAMII* *13, W. Sussex: Chestnut plantations, Stansted Forest, SU7410, D.E. Allen, 1998, **BM**.
- 75/8.231. *RUBUS ECHINATOIDES* *11, S. Hants.: Shady green lane, Winchester, SU469301, D.E. Allen, 1997, **BM**.
- 75/8.241. *RUBUS LARGIFICUS* *46, Cards.: Felled woodland, Gwachal Dwmlo, 1.5km NW of Cenarth, SN258425, D.E. Allen & A.O. Chater, **BM**, conf. A. Newton.
- 75/8.243. *RUBUS MALVERNICUS* *46, Cards.: Replanted conifer plantation, Allt Maestir, 3.5km NW of Lampeter, SN546503, D.E. Allen & A.O. Chater, 1997, **BM**, conf. A. Newton.
- 75/8.280. *RUBUS PHAEOCARPUS* *21, Middlesex: Park Wood, Ruislip, TQ0988, D.E. Allen, 1998, **BM**.
- 75/8.295. *RUBUS ANGLOSERPENS* *64, Mid-W. Yorks.: Shrog Wood, South Stainley, SE298633, K. Pyne, 1998, det. A. Newton.
- 75/8.305. *RUBUS BRITANNICUS* *13, W. Sussex: Banks of roads through Stansted Forest, SU755106, D.E. Allen, 1998, **BM**.
- 75/8.ari. *RUBUS ARICONIENSIS* †*12, N. Hants.: Apparently accidentally introduced in rhododendron plantation, Longstock House, Leckford, SU366285, D.E. Allen & B. Goater, 1999, **BM**, det. M. Porter.
- 75/8.ven. *RUBUS VENETORUM* *41, Glam.: Bank on wood margin, Mill Lane, Blackpill, Swansea, SS615906, R.J. Pankhurst, 1993, **BM**, det. D.E. Allen.
- †75/9.1. *POTENTILLA FRUTICOSA* *43, Rads.: Boughrood Brest, SO1438, M.A.V. Gill, 1997.
- 75/9.5. *POTENTILLA ARGENTEA* †*77, Lanarks.: Fallow bed weed, Glasgow Botanic Gardens, NS5667, P. Macpherson, 1999, **herb. P.M.** Presumed accidental introduction; not planted.
- 75/9.13b. *POTENTILLA ERECTA* subsp. *STRICTISSIMA* *43, Rads.: Burfa Bog on *Molinia* tussocks, SO274610, S.P. Chambers, 1997, conf. A.O. Chater.
- 75/9.14×15. *POTENTILLA* × *MIXTA* (*P. ERECTA* × *P. REPTANS* & *P. ANGLICA* × *P. REPTANS*) *43, Rads.: Churchyard, Glasbury, SO177385, M.A.V. Gill, 1996. Disused railway, Rhayader tunnel, SN962671, S.P. Chambers, 1997. 1st & 2nd records.

†75/11.2. *FRAGARIA MOSCHATA* *80, Roxburghs.: Good sized, well naturalised colony, on ruined wall top, near ruined North Lodge of Stobs Castle, NT505099, R.W.M. Corner, 1999, **E** & **herb. R.W.M.C.**, det. D. McKean.

†75/11.3. *FRAGARIA ANANASSA* 47, Monts.: Large patch nr chapel on species-rich roadside bank, Dolfor, SO106869, S. Kingsbury, 1999. 1st recent record.

†75/13.3. *GEUM MACROPHYLLUM* 46, Cards.: Roadside runnel and hedgebank, 2km SE of Tregaron, SN694582, A.O. Chater, 1998, **NMW**.

75/17.3a. *SANGUISORBA MINOR* subsp. *MINOR* 46, Cards.: One plant in churchyard, Llanddeiniol, SN560721, B. Evans, 1997. 2nd record. 81, Berwicks.: Limestone grassland, Hilton Bay, NT967593, M.E. Braithwaite, 1999. 2nd extant record.

†75/18.1. *ACAENA NOVAE-ZELANDIAE* 10, Wight: Roadside verge, Brighstone, SZ425831, M.J. Burnhill, 1998, det. C.R. Pope. 1st record as an established alien. 46, Cards.: Roadside verge, Rhydyfelin hill, SN593792, S.P. Chambers, 1998. 2nd record.

†75/18.3. *ACAENA OVALIFOLIA* *13, W. Sussex: W edge of stony area S of church & edge of adjacent grass, Coolhurst, TQ200299, A.G.Hoare, 1999. 1st reported in 1999 by J. Simons as *A. anserinifolia*.

†75/19.15. *ALCHEMILLA MOLLIS* S, Channel Is. (Sark): On roadside bank, Clos à Jaôn, WV466761, R.M. Veall, 1999, **herb. Société Sercquaise**. 1st record for Sark. 81, Berwicks.: Established in mown grass, Marchmont, NT743485, M.E. Braithwaite & BSBI party, 1998. 1st record as established.

75/19.3. *ALCHEMILLA GLAUCESCENS* 81, Berwicks.: Perhaps 500 plants in limestone grassland, Hilton Bay, NT967593, M.E. Braithwaite, 1999, det. S.M. Walters. 2nd record.

†75/21.1. *ROSA MULTIFLORA* *51, Flints.: 1 bush (probably self-sown) on verge of carriageway, near Penryffordd, SE of Buckley, SJ299619, S.P. Chambers, 1998, det. A.L. Primavesi.

75/21.4×11. *ROSA* × *PSEUDORUSTICANA* (*R. ARVENSIS* × *R. STYLOSA*) *11, S. Hants.: Hedge, Mead End, Sway, SZ267986, P.D. Stanley, 1998, conf. A.L. Primavesi.

75/21.4×12. *ROSA* × *IRREGULARIS* (*R. ARVENSIS* × *R. CANINA*) 39, Staffs.: Roadside scrub, Ecton, SK0956, A.L. Primavesi & R. Maskew, with *R. arvensis* as female parent, 1996. 1st record since 1889.

75/21.5. *ROSA PIMPINELLIFOLIA* *78, Peebles.: Locally frequent on scree, Juniper Craigs, NT2435, D.J. McCosh, 1997.

†75/21.9. *ROSA VIRGINIANA* 46, Cards.: Hedge in chapel graveyard, Ponterwyd, SN749809, A.O. Chater, 1999, **NMW**. 2nd record.

†75/21.10. *ROSA GALLICA* *46, Cards.: Hedgebank of lane 100m S of Fronbadarn, Llanbadarn Odwyn, SN633603, 1998, **NMW**; Hedge by road 1km E of Tregaron, SN688593, both A.O. Chater, 1998. 1st & 2nd records.

75/21.11×12. *ROSA* × *ANDEGAVENTIS* (*R. STYLOSA* × *R. CANINA*) *13, W. Sussex: Hedgerow W of Slinfold by field on public footpath, Slinfold, TQ111319, 1997, Sussex Botanical Recording Society, conf. A.L. Primavesi. *68, Cheviot: In hedge, Haggerston, NU040438, G.A. Swan, 1999, **herb. G.A.S.**, det. A.L. Primavesi.

75/21.12×13a. *ROSA* × *DUMALIS* (*R. CANINA* × *R. CAESIA* subsp. *CAESIA*) *78, Peebles.: Roadside, N of Blyth Bridge, NT1245, D.J. McCosh, 1998, **E**, det. A.L. Primavesi.

75/21.12×16. *ROSA* × *ROTHSCHILDII* (*R. CANINA* × *R. SHERARDII*) *77, Lanarks.: Close to river bank, N of Birkenshaw, NS6963, P. Macpherson, 1998, **herb. P.M.**, det. R. Maskew.

75/21.12×17. *ROSA* × *MOLLETORUM* (*R. CANINA* × *R. MOLLIS*) *39, Staffs.: Under-the-Hill, near Longnor, SK083658, A.L. Primavesi & R. Maskew, 1996. *78, Peebles.: Bank by track, Soonhope Cottages, Peebles, NT2641, D.J. McCosh, 1998, **E**, det. A.L. Primavesi.

75/21.12×18. *ROSA* × *NITIDULA* (*R. CANINA* × *R. RUBIGINOSA*) *11, S. Hants.: Scrub, Studland Common, Milford on Sea, SZ278921, P.D. Stanley, 1998, conf. A.L. Primavesi.

75/21.13b. *ROSA CAESIA* subsp. *VOSAGIACA* 78, Peebles.: Roadside, N of Blyth Bridge, NT1245, D.J. McCosh, 1998, **E**, det. A.L. Primavesi. 1st recent record.

75/21.13×16. *ROSA CAESIA* × *R. SHERARDII* *78, Peebles.: Merlindale Bridge, NT1333, D.J. McCosh, 1998, **E**, det. A.L. Primavesi.

- 75/21.16. *ROSA SHERARDII* **78**, Peebles.: Fairliehope Burn, NT15, D.J. McCosh, 1998, **E**, det. A.L. Primavesi. 1st recent record.
- 75/21.17. *ROSA MOLLIS* **78**, Peebles.: The Linn, Carlips, NT157337, D.J. McCosh, 1998, **E**, det. A.L. Primavesi. 1st recent record.
- 75/21.18. *ROSA RUBIGINOSA* **107**, E.Sutherland: One plant only on embankment of brackish ditch, The Mound, NH766985, det. A.L. Primavesi; 4 bushes found in disused sandstone quarry between golf course and shore, Dornoch, NH806896; both M.E. Murray, 1998. 1st & 2nd localised records.
- †75/22.5b. *PRUNUS DOMESTICA* subsp. *INSITTIA* ***43**, Rads.: Roadside, Glasbury, SO188396, M.A.V. Gill, 1996.
- †75/22.12. *PRUNUS SEROTINA* **13**, W. Sussex: Planted and self seeding on roadside, Rogate, TQ222335, A.G. Hoare, 1997. **46**, Cards.: Estate woodland, Trecwn, 3km S of Blaen-porth, SN258458. A.O. Chater, 1998. 2nd record. ***52**, Anglesey: Roadside edge of Newborough Forest, planted, SH4167, G. Halliday, 1996.
- †76/22.14. *PRUNUS LAUROCERASUS* **81**, Berwicks.: Established in woodland, Douglas Dean, NT7671, M.E. Braithwaite & L. Gaskell, 1998. 1st record as established alien.
- †75/25.1. *CHAENOMELES SPECIOSA* ***107**, E. Sutherland: Probably planted on river bank, Balnacoll Lodge, NC804113, BSBI group, 1999.
- †75/27.2. *MALUS DOMESTICA* ***107**, E. Sutherland: Deserted garden, Letlaidh Burn, NC696042, BSBI group, 1999.
- †75/31.1. *PHOTINIA DAVIDIANA* ***41**, Glam.: Parc-le-breos Woods, SS5389, A.S. Lewis, 1998.
- †75/32. 9x10. *COTONEASTER* × *WATERERI* (*C. FRIGIDUS* × *C. SALICIFOLIUS*) ***81**, Berwicks.: Selfsown on riverside cliff, Hutton Castle, NT892547, L. Gaskell, 1998, det. M.E. Braithwaite.
- †75/32.10. *COTONEASTER SALICIFOLIUS* ***51**, Flints.: Disused limestone quarry, near houses, Prestatyn, SJ073821, G. Wynne, 1981, det. J. Fryer.
- †75/32.11x18. *COTONEASTER* × *SUECICUS* (*C. DAMMERI* × *C. CONSPICUUS*) ***58**, Cheshire: Canal wall, Lymm, SJ683873, G.M. Kay, 1998, conf. J. Fryer.
- †75/32.18. *COTONEASTER CONSPICUUS* ***51**, Flints.: Disused quarry, Caer Estyn, Caergwrle, SJ316576, G. Wynne, 1999, det. J. Fryer.
- †75/32.27. *COTONEASTER NITENS* ***51**, Flints.: Disused quarry, Caer Estyn, Caergwrle, SJ316576, G. Wynne, 1999, det. J. Fryer. ***77**, Lanarks.: Surviving in wooded area, Bothwell, NS6959, P. Macpherson, 1998, **herb. P.M.** det. J. Fryer.
- †75/32.33. *COTONEASTER SIMONSII* ***43**, Rads.: Glasbury Churchyard, SO177385, M.A.V. Gill, 1996, det. G. Hutchinson.
- †75/32.34. *COTONEASTER BULLATUS* ***51**, Flints.: 1 plant in hedge near public footpath, Northophall, SJ274673, J. Phillips, 1998, det. J. Fryer. ***80**, Roxburghs.: A single large bush (possibly birdsown) on steep wooded roadside bank, N of Stobs Castle, Hawick, NT508091, R.W. M. Corner, 1999, **E & herb. R.W.M.C.**, det. D. McKean.
- †75/32.40. *COTONEASTER STERNIANUS* **49**, Caerns.: Side of wall, Nebo near Penygroes, SH4750, G. Battershall & J. Hawksford, 1998, det. J. Fryer. 2nd record.
- †75/32.mar. *COTONEASTER MARGINATUS* ***77**, Lanarks.: Established along a fence, Firhill, Glasgow, NS580679, P. Macpherson, 1998, **herb. P.M.**, det. J. Fryer.
- †75/35.4. *CRATAEGUS CRUS-GALLII* ***51**, Flints.: Edge of mixed wood, Big Wood, Gwysaney, Mold, SJ234665, J. Phillips, 1998.
- †77/1.1. *ROBINIA PSEUDOACACIA* ***51**, Flints.: Waste ground, factory environs, Shotton Paper Mill, SJ307715, G. Wynne, 1999.
- 77/6.1. *ONOBRYCHIS VICIFOLIA* **51**, Flints.: Waste ground, factory environs, Shotton Paper Mill, SJ306714, G. Wynne, 1999. 1st recent record.
- 77/10.3. *ORNITHOPUS PERPUSILLUS* **79**, Selkirks.: Locally common from 270-380m alt. on forestry tracks, Midgehope, Ettrick, NT274126, R.W.M. Corner, 1999, **herb. R.W.M.C.** 2nd record.

77/14.11b. *VICIA SATIVA* subsp. *SEGETALIS* *43, Rads.: Hedgebank, Knucklas Castle, SO248744, D.R. Humphreys, 1996. †*81, Berwicks.: Grassland, Core, NT783717, M.E. & P.F. Braithwaite & J. Waddell, 1998. *107, E. Sutherland: Damp slacks, Embo, NH8193, W. Hay & W. McCarthy, 1999.

77/14.8. *VICIA TETRASPERMA* †81, Berwicks.: Old railway line, Little House Plantation, NT824545, L. Gaskell & K. Velandar, 1998. 2nd record.

77/15.12. *LATHYRUS NISSOLIA* †77, Lanarks.: About 50 plants in rough grassland and path side, Peel Park, East Kilbride, NS6054, P. Macpherson, 1998, **herb. P.M.** 2nd established colony.

†77/15.9. *LATHYRUS LATIFOLIUS* 46, Cards.: By footpath in coastal scrub, 1.5km W of New Quay, SN373592, A.O. Chater, **NMW**, 1999. 2nd record. 50, Denbs.: Shingle beach, Pensarn, SH942787, J.A. Green, 1999. 2nd record. *81, Berwicks.: Established on bank, near Edrington Castle, NT939535, M.E. Braithwaite, 1999.

†77/18.tru. *MEDICAGO TRUNCATULA* *13, W. Sussex: Established just E of Kingston lighthouse, Kingston, TQ235049, E. Bishop, 1997, conf. P.A. Harnes & A.G. Knapp. Very few found in 2000.

†77/21.1. *LUPINUS ARBOREUS* *43, Rads.: Roadside, Boughrood Brest, SO1438, M.A.V. Gill, 1997.

†77/22.1. *LABURNUM ANAGYROIDES* 51, Flints.: Birch wood, Caer Estyn, Caergwre, SJ315576, G. Wynne, 1999. 2nd record. 81, Berwicks.: Well established with over a dozen bushes on riverside cliff, above Fogo Bridge, NT776492, M.E. Braithwaite, 1998. 1st record as an established alien.

†77/22.1×2. *LABURNUM* × *WATERERI* (*L. ANAGYROIDES* × *L. ALPINUM*) *45, Pembs.: Roadside bank, B4313, W of Cilrhedyn, SM999344; Roadside bank, W of Vagwrlas, SN030322; both S.B. & A.E. Evans, 1999. 1st & 2nd records.

†77/23.3. *CYTISUS STRIATUS* *41, Glam.: Regenerating abundantly on bank of roadside cutting by A4067, Alltwen, SN722034, A.S. Lewis, 1999.

77/26.1×2. *ULEX EUROPAEUS* × *U. GALLII* *46, Cards.: Gorsey slope, W side of Pendinas, Aberystwyth, SN582804, A.O. Chater, 1997, **NMW**, conf. P.M. Benoit.

77/26.2. *ULEX GALLII* 81, Berwicks.: Four bushes on road verge, adjacent to former moorland, near Middlethird, NT683437, M.E. Braithwaite, 1999. Only extant record.

†79/2.2. *MYRIOPHYLLUM AQUATICUM* 39, Staffs.: Dominating half of a small pond, Tittensor Chase, SJ876364, I.J. Hopkins, 1998. 2nd record.

79/2.4. *MYRIOPHYLLUM ALTERNIFLORUM* 39, Staffs.: A few plants in the small pond to the N of fishing lake, Biddulph Grange Country Park, Biddulph, SJ898590, J.E. Hawksford, 1999. 1st record since 1920.

†80/1.1. *GUNNERA TINCTORIA* *49, Caerns.: Side of Afon Eidda near Penamachno, SH8350, G. & I. Battershall, 1998.

81/1.1. *LYTHRUM SALICARIA* *107, E. Sutherland: Helmsdale, ND01, BSBI group, 1999.

84/1.1×2. *EPILOBIUM* × *SUBHIRSUTUM* (*E. HIRSUTUM* × *E. PARVIFLORUM*) *45, Pembs.: 1 plant on steep bank to car park, Broad Haven, SM861135, G. Kitchener, 1998.

84/1.2×8. *EPILOBIUM* × *FLORIDULUM* (*R. PARVIFLORUM* × *E. CILIATUM*) *45, Pembs.: 1 plant by garden wall on clifftop roadside, Penyraber, Solva, SM802241, G. Kitchener, 1998.

84/1.2×9. *EPILOBIUM* × *RIVULARE* (*E. PARVIFLORUM* × *E. PALUSTRE*) *45, Pembs.: 2 plants with both parents in wet, semi-open break in generally thickly vegetated marsh, Trefeiddan Moor, St David's, SM730253, G. Kitchener, 1998.

84/1.5×8. *EPILOBIUM* × *MENTIENS* (*E. TETRAGONUM* × *E. CILIATUM*) 17, Surrey: One plant with parents on disturbed soil by R. Wey, RHS Gardens, Wisley, TQ062592, A.C. Leslie, 1999, det. G. Kitchener. 1st recent record.

84/1.6×8. *EPILOBIUM* × *VICINUM* (*E. OBSCURUM* × *E. CILIATUM*) *42, Brecks.: Ditches in forestry plantation nr Dol-y-gaer Reservoir, SO050151, M. Porter, 1998. *45, Pembs.: 4 plants in Middle Mill Quarry, Solva, SM804269, G. Kitchener, 1998.

84/1.6×9. *EPILOBIUM* × *SCHMIDTIANUM* (*E. OBSCURUM* × *E. PALUSTRE*) *52, Anglesey: Cors Erddreiniog, SH4782, I.C. Lawrence, 1999.

84/1.7. *EPILOBIUM ROSEUM* *81, Berwicks.: Clearing, in Douglas Dean, NT771721, M.E. Braithwaite & L. Gaskell, 1998, det. G. Kitchener. Ruderal in, Edington Mill, NT896548, L. Gaskell & K. Velander, 1998, det. M. Braithwaite, 1st & 2nd records.

†84/1.13. *EPILOBIUM PEDUNCULARE* *41, Glam.: Wall and stony slope by road in southern Pontarddulais, SN601034, Q.O.N. Kay, 1998.

†84/4.3. *OENOTHERA BIENNIS* *43, Rads.: Roadside, Glasbury, SO185389, M.A.V. Gill, 1996.

†84/4.4. *OENOTHERA CAMBRICA* *43, Rads.: Near Church, Boughrood, SO1239, M.A.V. Gill, 1998.

†84/CLA.amo. *CLARKIA AMOENA* *43, Rads.: Pavement weed, Llandrindod Wells, SO057613, S.P. Chambers, 1997.

†85/1.1. *CORNUS SANGUINEA* 81, Berwicks.: Established in woodland, Kelsoe, NT8353, L. Gaskell, 1998, det. M.E. Braithwaite, 1st certain record.

†85/1.2. *CORNUS SERICEA* *107, E. Sutherland: Probably planted on river bank, Balnacoll Lodge, NC804113, BSBI group, 1999.

†88/1.2. *EUONYMUS LATIFOLIUS* *80, Roxburghs.: A single bush, possibly birdsown on steep wooded roadside bank, N of Stobs Castle, Hawick, NT508091, R.W.M. Corner, 1999, **E & herb. R.W.M.C.**

†89/1.1xper. *ILEX* × *ALTACLERENSIS* (*I. AQUIFOLIUM* × *I. PERADO*) *45, Pembs.: Woodland edge, NW Park House, Stackpole, SR979962, J. Webber & H. Garlick, 1998.

†91/2.15. *EUPHORBIA CYPARISSIAS* *43, Rads.: Roadside banks, E side of B4567 nr A481 W of bridge & electricity substation, Llanellwedd, SO062517, S.P. Chambers, 1999.

†91/2.17. *EUPHORBIA CHARACIAS* subsp. *CHARACIAS* *46, Cards.: Scrub by lane NW of Llanbadarn Fawr church, SN596813, A.O. Chater, 1999, **NMW**.

†91/2.5. *EUPHORBIA DULCIS* *81, Berwicks.: Established on roadside, near Whitehouse, NT630330, M.E. Braithwaite, 1999.

91/2.7. *EUPHORBIA SERRULATA* †*43, Rads.: Garden weed, Glasbury, SO177384, M.A.V. Gill, 1996.

†91/2.obl. *EUPHORBIA OBLONGATA* *46, Cards.: Scrub slope above church hall, Llanbadarn Fawr, SN598810, S.P. Chambers, 1991, conf. B. Wurzell & E.J. Clement.

†93/2.1. *PARTHENOCISSUS QUINQUEFOLIA* *43, Rads.: Hedge, Pwll Patti, SO164391, M.A.V. Gill, 1996.

†94/1.2. *LINUM USITATISSIMUM* *43, Rads.: Nr Walton, SO263581, J.O. Mountford, 1971. Roadside, Treble Hill, SO183394, M.A.V. Gill, 1996. 1st & 2nd records.

95/1.lb. *POLYGALA VULGARIS* subsp. *COLLINA* *43, Rads.: Dry spoil mound, Gilfach, SN964716, S.P. Chambers, 1997.

†100/1.1. *RHUS TYPHINA* 46, Cards.: Riverbank, Llanfarian, SN589776, A.O. Chater & S.P. Chambers, 1998. 2nd record.

†102/1.3. *OXALIS CORNICULATA* *43, Rads.: Glangwye, SO1538, M.A.V. Gill, 1997.

†102/1.4. *OXALIS EXILIS* *77, Lanarks.: Well established weed in and between glasshouses and adjacent pathsides, Daldowie, by Glasgow, NS6761, P. Macpherson, 1998, **herb. P.M.**

†102/1.11. *OXALIS LATIFOLIA* 81, Berwicks.: Established weed in walled garden, Marchment, NT744484, M.E. Braithwaite & BSBI party, 1998.

†103/1.1. *GERANIUM ENDRESSII* *43, Rads.: Roadside, Harley's Hill, SO2964, Roadside, D.R. Humphreys, 1999.

†103/1.1x2. *GERANIUM* × *OXONIANUM* (*G. ENDRESSII* × *G. VERSICOLOR*) *51, Flints.: Garden throw-out established in dry ditch, Middle Common, Buckley, SJ276651, J. Phillips and BSBI group, 1996.

†103/1.2. *GERANIUM VERSICOLOR* 46, Cards.: Laneside verge, Bryn-y-mor, Aberystwyth, SN589825, A.O. Chater, 1998, **NMW**. 1st record since 1929.

†103/1.17. *GERANIUM MACRORRHIZUM* *43, Rads.: Former tip, Aberedw Rocks, SO076459, R.G. Woods, 1996.

103/2.1. *ERODIUM MARITIMUM* **51**, Flints.: Slag from Iron Works, Mostyn Breakwater, SJ160817, P. Day, 1995. 1st recent record.

103/2.4. *ERODIUM LEBELII* ***46**, Cards.: At least six plants at edge of dune slack, Ynys-las Dunes NNR, SN607936, J. Higgins, 1999, conf. P.M. Benoit. 1st confirmed record.

†103/PEL.inq×zon. *PELARGONIUM* × *HYBRIDUM* (*P. INQUINANS* × *P. ZONALE*) ***49**, Caerns.: Waste ground, Llandegai, Bangor, SH5971, G. & I. Battershall, 1998.

†103A/LIM.dou. *LIMNANTHES DOUGLASII* ***43**, Rads.: Roadside, Cwmbach, SO166396, M.A. V. Gill, 1996.

†104/1.maj. *TROPAEOLUM MAJUS* **S**, Channel Is. (Sark): Bank of garden refuse, edge of field beside wood, Le Vert, WV466759, M.H. Marsden, 1999, **herb. Société Sercquaise**. 1st record for Sark. ***49**, Caerns.: Waste ground near railway station, Llandudno, SH7881, W. McCarthy, 1998.

105/1.1. *IMPATIENS NOLI-TANGERE* **58**, Cheshire: Small colony on bank of stream in wood, Peover Superior, SJ772727, G.M. Kay, 1998. 1st recent record.

†106/1.1. *HEDERA COLCHICA* ***80**, Roxburghs.: Well, and long, established on old railway bridge and embankment, Roxburgh village, NT697305, L. Gaskell, 1999, **herb. R.W.M. Corner**.

106/1.2b. *HEDERA HELIX* subsp. *HIBERNICA* ***107**, E. Sutherland: Crakaig, NC91, BSBI group, 1999.

107/1.ran. *HYDROCOTYLE RANUNCULOIDES* **10**, Wight: Roadside pond, Yafford Farm, SZ449818, M.J. Burnhill, 1998, **herb. C.R.P.**, det. C.R. Pope. 1st record as an established alien. ***58**, Cheshire: Pond, Marple, Hawkgreen, SJ948872, J.H. Clarke, 1999.

107/19.1. *OENANTHE FISTULOSA* ***77**, Lanarks.: Pool at periphery of abandoned steel mill, Gartcosh, NS7068, M. Bates, 1998, **herb. P.M.**, conf. M.F. Watson.

†107/3.1. *ASTRANTIA MAJOR* **51**, Flints.: Hedge, Talfryn Wood, N of Trelawnyd, SJ091811, J. Hughes & J. Phillips, 1998. 1st recent record.

107/6.1. *BERULA ERECTA* ***78**, Peebles.: Upland burn, Garwald Burn, above Ferniehaugh, NT15, D.J. McCosh, 1998.

107/30.1. *SISON AMOMUM* ***43**, Rads.: Garden weed, Glasbury, SO177384, M.A.V. Gill, 1996, det. D.R. Humphreys.

†107/40.1. *PASTINACA SATIVA* **42**, Brecks.: Edge of railway track, Garth Station, SN953494, L.J. Smith, 1996. 2nd record & 1st for 50 years.

†110/1.1. *NICANDRA PHYSALODES* ***50**, Denbs.: Farmyard, The Conery, Bronington, SJ499387, J.A. Green, 1999, **NMW**.

†110/2.1. *LYCIUM BARBARUM* ***107**, E. Sutherland: Flush, E of Helmsdale village, ND0315, BSBI group, 1999.

†110/7.1. *LYCOPERSICON ESCULENTUM* ***50**, Denbs.: Weed in field, Worthenbury, SJ408467; Shingle beach, Pensarn, SH937785; both J.A. Green, 1999. 1st & 2nd records.

†110/8.7. *SOLANUM TUBEROSUM* ***107**, E. Sutherland: Building site, Brora, NC943060, BSBI group, 1999. **47**, Monts.: Growing in river gravel beside River Severn, Llanidloes, SN955847, M. Oliver, 1999. 2nd record.

†110/8.ros. *SOLANUM ROSTRATUM* **S**, Channel Is. (Sark): Garden manure heap, ?from poultry feed, Rue du Fort, WV467767, B. Gurden, 1999, **herb. Société Sercquaise**. 1st record for Sark.

111/3.2ax3. *CALYSTEGIA* × *SCANICA* (*C. SEPIUM* × *C. PULCHRA*) **46**, Cards.: Roadside hedgebank 600m S of Aber-porth church, SN250507, R.K. Brummitt & A.O. Chater, 1996, **K**.

111/3.3x4. *CALYSTEGIA* × *HOWITTIIORUM* (*C. PULCHRA* × *C. SYLVATICA*) ***21**, Middlesex: Bramble & nettle covered bank at edge of sports field, Highwood Hill, TQ222942, A.H. Vaughan, 1998, det. R.K. Brummitt. Known since 1986.

†111/3.4. *CALYSTEGIA SYLVATICA* subsp. *DISJUNCTA* ***44**, Carms.: Roadside hedge, S of Coedshon, Sawdde Gorge, SN719256, A.O. Chater, J. Bevan, G. Hutchinson & R.D. Pryce, 1997, **NMW**, det. A.O.C. 1st record for subsp.

†115/1.1. *PHACELIA TANACETIFOLIA* *41, Glam.: Waste ground, High St., Swansea, SS650937, A.S. Lewis, det. C.R. Hipkin, 1999. *44, Carmrs.: Near public conveniences, S side of W Harbour, Burry Port, SN444005, P. Day, 1999, NMW. *45, Pembs.: At edge of cornfield, Little Castle Head, Sandy Haven, SM854065, R. Stearn, 1998.

116/2.1. *ECHIMUM VULGARE* †*43, Rads.: Sandy stream bank, Glasbury, SO177388, M.A.V. Gill, 1996. *107, E. Sutherland: Helmsdale, ND01, BSBI group, 1999.

†116/10.1. *TRACHYSTEMON ORIENTALIS* *46, Cards.: Scrub slope above shore, New Quay, SN390595, A.O. Chater & J.P. Woodman, 1998, NMW. 81, Berwicks.: Established in several places on wooded bank, Paxton Burn, NT932522, M.E. & P.F. Braithwaite, 1999.

†116/4.1. *SYMPHYTUM OFFICINALE* 46, Cards.: Roadside W of Gartheli House, Gartheli, SN587564, A.O. Chater, 1998. 2nd record.

†116/4.1×2×4. *SYMPHYTUM* 'Hidcote Blue' (*S. GRANDIFLORUM* × ?*S. × UPLANDICUM*) *50, Denbs.: Farm gateway, Llanrhaeadr, SJ075631, J.A. Green, 1998, det. F.H. Perring. *51, Flints.: Garden throwout, well established on roadside, Cilcain, SJ174649, G. Wynne, 1998, det. F.H. Perring.

116/4.3. *SYMPHYTUM TUBEROSUM* †*12, N. Hants.: Garden escape, seen many times previously on highway bank, Church Oakley, SU569503, M. Taylor, 1998.

†116/4.4. *SYMPHYTUM GRANDIFLORUM* *35, Mons.: By woodland stream, Whitebrook, SO530068, B.J. Gregory, 1998. *46, Cards.: Scrub by old cottage site, 600m NNW of crossroads, Rhydownen, SN441457, A.O. Chater, 1999, NMW. *51, Flints.: Road verge, country lane, near waterworks, Cilcain, SJ172647, G. Wynne, 1998, det. F.H. Perring.

118/1.5×6. *STACHYS × AMBIGUA* (*S. SYLVATICA* × *S. PALUSTRIS*) *43, Rads.: River bank, Castell Foel-allt, SO1738, SO1739, SO258676, D.R. Humphreys & E.R. Dean, 1993.

118/20.1. *ORIGANUM VULGARE* *S, Channel Is. (Sark): In scrub beside cliff path (over 100m from nearest garden) from La Valette to Harbour, WV475760, R. Bellinger, 1999, **herb. Société Sercquaise**.

†118/23.3×lon. *MENTHA × VILLOSONERVATA* (*M. SPICATA* × *M. LONGIFOLIA*) *44, Carmrs.: Nr southernmost pond, Machynys, Llanelli, SS5197, I.K. Morgan, 1982, NMW, det. R.M. Harley.

118/23.4. *MENTHA SUAVEOLENS* *43, Rads.: Roadside, Glasbury, SO178386, M.A.V. Gill, 1996.

118/25.4. *SALVIA VERBENACA* *19, N. Essex: Just inside v.c. in hedgebank on N side of road, Great Chishill, TL419389, S.C.A. Rathnen, 1993.

†118/4.1c. *LAMIASTRUM GALEOBDOLO* subsp. *ARGENTATUM* *51, Flints.: Narrow lane, Cilcain, SJ183655, J. Phillips, 1995. Large patch by path under scrub, possible garden throwout, near Buckley Mountain, SJ283652, P. Harmes, 1996. 1st & 2nd records.

†118/5.2. *LAMIUM MACULATUM* 46, Cards.: Roadside verge 300m S of Brongwyn church, SN286435, A.O. Chater, 1999. 1st localised record since 1904.

†118/LAV.ang×lat. *LAVANDULA × INTERMEDIA* (*L. ANGUSTIFOLIA* × *L. LATIFOLIA*) *49, Caerns.: Edge of marina, Conwy, SH7778, G. & I. Battershall, 1998.

120/1.6. *CALLITRICHE BRUTIA* *51, Flints.: Ditch in conservation grassland restored opencast site, Maes-y-Grug, Alltami, SJ261666, S.J. Whild, 1995. 1st definite record, may have been recorded as *C. hamulata* in the past.

121/1.3b. *PLANTAGO MAJOR* subsp. *INTERMEDIA* *45, Pembs.: Damp open areas in maritime heath, Trevalen Downs, Bosherton, SR968931, S.B. Evans, S.J. Leach, R.J. Haycock & A. Jones; Farm track, Lower Treginnis, St Davids, SM723238, S.B. Evans & A. Jones; both 1999. 1st & 2nd records.

121/1.4. *PLANTAGO MEDIA* *43, Rads.: Dolyhir Quarry Grassland, SO2458, H. Bowen, 1987. Churchyard, Glasbury, SO177385, M.A.V. Gill, 1996. 1st & 2nd records.

†122/1.3. *BUDDLEJA GLOBOSA* *49, Caerns.: Planted on roadside verge, near Penmaenmawr, SH77, G. Battershall, 1999.

†123/1.sus. *FORSYTHIA SUSPensa* *77, Lanarks.: Surviving on bank of River Kelvin, Kelvinside, NS5667, P. Macpherson, 1998, **herb. P.M.**, det. E.J. Clement & D.R. McKean.

†123/1.sus×vir. FORSYTHIA × INTERMEDIA (F. SUSPENS A × F. VIRIDISSIMA) *43, Rads.: Glasbury SO1738, M.A.V. Gill, 1996.

†123/JAS.bee. JASMINUM BEESIANUM *49, Caerns.: Established on grassland near ruined cottage, Vardre, Deganwy, SH7879, W. McCarthy, 1999, det. P.S. Green.

†124/1.10. VERBASCUM SPECIOSUM *46, Cards.: Four plants by footpath in coastal scrub, 1.5km W of New Quay, SN373592, A.O. Chater, 1999, **NMW**.

†124/1.11. VERBASCUM PULVERULENTUM *43, Rads.: Garden weed, Glasbury, SO1738, M.A.V. Gill, 1997.

†124/1.6. VERBASCUM DENSIFLORUM *11, S. Hants.: West road verge, Ramley, Upper Pennington, SZ299962, V. Scott, 1998, det. E.J. Clement. 12, N. Hants.: Sand-pit, Kingsley, SU780379, A. Brewis, 1998. 2nd record.

†124/11.2. CYMBALARIA PALLIDA *46, Cards.: Wall and alleyway, Pendre, Tregaron, SN679595, A.O. Chater, 1998, **NMW**. Old roadside wall by cottages, Felin-fach, SN530557, A.O. Chater, 1999. 1st and 2nd records. *77, Lanarks.: Established on stony track side, Robertson, NS9428, P. Macpherson, 1999, **herb. P.M.**

†124/13.3. LINARIA PURPUREA *107, E. Sutherland: Helmsdale, ND01, BSBI group, 1999.

†124/15.1. ERINUS ALPINUS 81, Berwicks.: Large colony, established on sandstone rock face, A68 near Chapel South Lodge, NT564461, L. Gaskell, 1998. 1st record from semi-natural habitat.

†124/16.18. VERONICA PEREGRINA *42, Brecks.: Imported in soil of potted plants, now well established in garden, between Llanafan-fawr and Newbridge-on-Wye, SN992570, R.G. Woods, 1998.

†124/16.2. VERONICA REPENS *11, S. Hants.: In lawns, Mud Island Nurseries, North Boarhunt, SU594106, P.D. & P.C. Stanley, 1998, conf. E.J. Clement.

124/16.20. VERONICA POLITA *43, Rads.: Road verge, Broadheath, SO334635, D.R. Humphreys & E.R. Dean, 1996.

124/16.24a. VERONICA HEDERIFOLIA subsp. HEDERIFOLIA *43, Rads.: Roadside, Llanbedr, SO1446, D.R. Humphreys, 1995. 1st record for subspecies.

124/16.24b. VERONICA HEDERIFOLIA subsp. LUCORUM *43, Rads.: Roadside, Sulphur Springs, SO1463, D.R. Humphreys, 1994. 1st record for subspecies.

†124/17.1. HEBE SALICIFOLIA *77, Lanarks.: Surviving on retaining wall of Crossbasket, NS6656, P. Macpherson, 1998, **herb. P.M.**, conf. E.J. Clement.

124/2.3. SCROPHULARIA UMBROSA *79, Selkirks.: Two large plants on river bank, N side of Tweed above Galafoot, NT508346, R.W.M. Corner, 1999, **herb. R.W.M.C.**

124/2.4. SCROPHULARIA SCORODONIA †*37, Worcs.: Locally frequent, perimeter of parking lot, Blackpole Industrial Estate, Worcester, SO867581, J.J. Day, 1999, **herb. J.J.D.**

124/20.5×7. EUPHRASIA ARCTICA × E. NEMOROSA *49, Caerns.: Floor of old slate quarry, Talysarn near Penygroes, SH4952, BSBI meeting, 1998, det. A.J. Silverside.

124/20.7×18. EUPHRASIA NEMOROSA × E. MICRANTHA *42, Brecks.: In damp heathy field, between Coelbren and Pont-nedd-fechan, SN963106, M. Porter, 1998, det. A.J. Silverside. 1st confirmed record.

124/20.11. EUPHRASIA FRIGIDA *77, Lanarks.: Short grassland, Green Lowther, NS8911, P. Macpherson, 1999, **herb. P.M.**, det. A.J. Silverside.

124/20.11×19. EUPHRASIA FRIGIDA × E. SCOTTICA *77, Lanarks.: Heathy slope, Gana Hill, NS9601, P. Macpherson & E.L.S. Lindsay, 1998, **herb. P.M.**, det. A.J. Silverside.

124/20.19. EUPHRASIA SCOTTICA *50, Denbs.: Upland grass, Llyn Aled, SH913687, W. McCarthy, 1998.

124/23.1. PARENTUCELLIA VISCOSA *50, Denbs.: Grassland, reclaimed coal mine, Chirk, SJ296383, G. Kay, 1999, conf. J.A. Green & W. McCarthy.

124/24.2a. RHINANTHUS MINOR subsp. MINOR *43, Rads.: Streamside, Rhyd y Clwydau, SO0078, A.J. Morton, 1995. 1st record for subspecies.

124/25.2b. PEDICULARIS SYLVATICA subsp. HIBERNICA *52, Anglesey: Bryn, Rhoscolyn. SH2876, T.G. Rich, 1999.

124/4.2×cup. *MIMULUS* × *BURNETII* (*M. GUTTATUS* × *M. CUPREUS*) *81, Berwicks.: River bank, Whiteadder at The Bell, NT670633; River shingle, Playhaugh Bridge, NT688625; both M.E. Braithwaite, 1998. 1st & 2nd records. *107, E. Sutherland: 1 clump in burn, Achany Bridge, Lairg, NC570020, BSBI group, 1999.

125/2.5. *OROBANCHE ALBA* 98, Main Argyll: Raised beach cliff, N of village, Cullipool, Luing, NM739135, B.H. Thompson, 1999. 1st record for Luing.

†129/1.10. *CAMPANULA POSCHARSKYANA* *12, N. Hants.: Embankment wall of stream, Petersfield, SU7423, A. Brewis, 1998, **herb. A.B.** *81, Berwicks.: Established on wall, Cockburnspath, NT774710, M.E. & P.F. Braithwaite, 1998.

129/1.12. *CAMPANULA TRACHELIUM* †*46, Cards.: Rough grassland, Tyglyn Aeron, SN5059, M.L. Lewes, 1908, **ABS**.

†129/1.3. *CAMPANULA LACTIFLORA* *107, E. Sutherland: Crakaig, NC976119; Wet flush, Helmsdale, ND0315; both BSBI group, 1999. 1st & 2nd records.

†129/1.4. *CAMPANULA PERSICIFOLIA* 46, Cards.: Hedgebank in cemetery just N of Tal-y-bont, SN654900, A.O. Chater, 1998, **NMW**. 2nd record.

†129/7.2. *LOBELIA ERINUS* *51, Flints.: Casual garden escape on brick wall, outside garden, Cross Street, Holywell, SJ185759, G. Wynne, 1998.

†130/4.1. *PHUOPSIS STYLOSA* *44, Carms.: Derelict garden, The Parade, Carmarthen, SN418203, V. & T. Lewis, 1999.

130/6.14. *GALIUM PARISIENSE* *6, N. Somerset: Gravel path, garden of 'Beryl', Wells, ST560468, B.G. Wanford, 1999, **herb.I.P.G.**, det. I.P. Green. 1st confirmed record.

130/6.5b. *GALIUM PALUSTRE* subsp. *ELONGATUM* *43, Rads.: Burfa Bog, SO275612, S.P. Chambers, 1997. *107, E. Sutherland: Damp slacks, Embo, NH8193, W. Hay & W. McCarthy, 1999.

†131/5.1. *LEYCESTERIA FORMOSA* *42, Brecks.: One small bush in scrub, canal bank, Llangynidr, SO154201, M. Porter, 1999.

†131/6.3. *LONICERA INVOLUCRATA* *43, Rads.: Well naturalised by bridge, streamside, David's Well, SO060786, D.R. Humphreys & E.R. Dean, 1996, det. R.G. Woods. *44, Carms.: Laugharne Castle grounds, SN302108, G. Hutchinson & R.D. Pryce, *et al.*, 1991, **NMW**. *81, Berwicks.: Established on roadside, Chirnside turning to Bluestoneford, NT875564, L. Gaskell, 1998, det. M.E. Braithwaite.

†131/6.4. *LONICERA XYLOSTEUM* *81, Berwicks.: One self sown bush on river bank, Whiteadder Water, Allanton, NT864546, L. Gaskell, 1998, det. M.E. Braithwaite.

†131/6.8. *LONICERA CAPRIFOLIUM* *46, Cards.: Scrub on sea cliffs NW of pier, New Quay, SN388601, A.O. Chater, 1998.

133/1.2. *VALERIANELLA CARINATA* *52, Anglesey: Wall-base outside transport garage, Llanedwen, SH5069, I.R. Bonner, 1999. Wall-bases, Llangefni, SH4575, independently recorded by J. Hawksford and I.R. Bonner, 1999. 1st & 2nd records. 58, Cheshire: Foot of hedge, Tattenhall, SJ484583, J.E. Hawksford, 1998, conf. P.J. Wilson. 1st confirmed record this century.

133/1.3. *VALERIANELLA RIMOSA* 10, Wight: 11 plants in arable field margin, Cridmore Farm, SZ503811, P.J. Wilson, 1998. 1st record this century.

133/1.5. *VALERIANELLA ERIOCARPA* *49, Caerns.: Grassy limestone outcrops, Great Orme, Llandudno, SH7782, W. McCarthy, 1998. Probably the first Welsh record as a native plant.

133/2.3. *VALERIANA DIOICA* 46, Cards.: *Molinia* tussock mire, Cross Inn, Nebo, SN549636, S.L.N. Smith & M.D. Sutton, 1999. Only extant record.

134/1.1. *DIPSACUS FULLONUM* *107, E. Sutherland: Rogart Station, NC725019, BSBI group, 1999.

134/1.3. *DIPSACUS PILOSUS* *44, Carms.: 2 plants on shaded steam bank, Gwenlais Quarry, Llandybie, SN604164, V. & T. Lewis, 1999.

†134/2.1. *CEPHALARIA GIGANTEA* *77, Lanarks.: Well established on waste ground, East Kilbride, NS643559, B. Simpson, 1998, **herb. P. Macpherson**.

†135/1.1. *ECHINOPS SPHAEROCEPHALUS* *49, Caerns.: 6 flower heads in bud on waste ground, Llandudno Junction, SH8077, J.A. Green, 1994.

†135/1.3. *ECHINOPS BANNATICUS* *12, N. Hants.: Wasteland, Oxney Farm, SU789372, A. Brewis, 1998.

135/3.1. *ARCTIUM LAPPA* *43, Rads.: Roadside, Presteigne, SO3164, D.R. Humphreys, 1994. Track edge behind entrance gate, Llanbwchllyn SO115466, S.P. Chambers, 1998. 1st & 2nd records.

135/5.4. *CARDUUS NUTANS* 81, Berwicks.: Field border, Ladykirk, NT891476, D. Walton, 1998. Only extant record.

†135/5.aca. *CARDUUS ACANTHOIDES* *29, Cambs.: Roadside verge opposite Wheatsheaf, Eversden, TL377525, P.D. Sell, 1998, **CGE**. The plant formerly known as *C. acanthoides* in Cambs. is *C. crispus*.

135/16.1b. *LEONTODON AUTUMNALIS* subsp. *PRATENSIS* *77, Lanarks.: Adjacent to Carsehope burn, NS9404, P. Macpherson, 1999, **herb. P.M.**, conf. D.R. McKean.

135/16.3. *LEONTODON SAXATILIS* 81, Berwicks.: Limestone grassland, Hilton Bay, NT967593, M.E. Braithwaite, 1999. 2nd record as native.

135/18.1. *SCORZONERA HUMILIS* 41, Glam.: Single patch in species-rich meadow at Little Hills Farm, SS539928, J. Woodman, 1997. 2nd record.

135/19.16. *TRAGOPOGON PRATENSIS* subsp. *MINOR* *107, E. Sutherland: Helmsdale, ND01, BSBI group, 1999. 1st record as subspecies.

†135/23.2a. *CICERBITA MACROPHYLLA* subsp. *URALENSIS* 42, Brecks.: Beside track in conifer plantation, 4km NW of Llanwrtyd Wells, SN8547, M. & C. Porter, 1999. 2nd record.

135/25.7. *TARAXACUM DEGELII* *35, Mons.: Waste ground, Upper Race near Pontypool, ST2799, T.G. Evans, 1998, **NMW**, det. A.J. Richards.

135/25.63. *TARAXACUM FULVICARPUM* *35, Mons.: Hedgebank N of Llanfihangel Crucorney, SO323219, T.G. Evans, 1999, **NMW**, det. A.A. Dudman & A.J. Richards.

135/25.64. *TARAXACUM GELERTII* *49, Caerns.: Roadside verge, Gwydr Castle, Llanrwst, SH7860, P. Hackney, 1973, **BEL**, det. A.J. Richards. (See *Nature in Wales* 14: 203 (1975)).

135/25.89. *TARAXACUM HAMATUM* *49, Caerns.: Spruce plantation and garden weed in lawn, Nant Bwlch yr Haiarn, SH7860, P. Hackney, 1973, **BEL**, det. A.J. Richards. (See *Nature in Wales* 14: 203 (1975)).

†135/25.93. *TARAXACUM LANCIDENS* *35, Mons.: Garden weed, Chepstow, ST5293, T.G. Evans, 1998, **NMW**, det. A.J. Richards.

135/25.100. *TARAXACUM SPICULATUM* *35, Mons.: Small rough field, Cock-y-north, Henllys, ST2793, T.G. Evans, 1998, **NMW**, det. A.J. Richards.

135/25.101. *TARAXACUM SUBHAMATUM* *49, Caerns.: Garden weed, Rhyd-y-Fuwch, near Bethel, SH5364, T.D. Dines, 1998.

†135/25.102. *TARAXACUM ABERRANS* *35, Mons.: Grass verge, near Penallt Old Church, SO5210, T.G. Evans, 1999, **NMW**, det. A.A. Dudman & A.J. Richards.

135/25.125. *TARAXACUM CYANOLEPIS* †*49, Caerns.: Roadside verge, Gwydr Castle, Llanrwst, SH7860, P. Hackney, 1973, **BEL**, det. A.J. Richards. (See *Nature in Wales* 14: 203 (1975)).

†135/25.coa. *TARAXACUM COARTATUM* *35, Mons.: Grassy verge, Llanllowell, ST3998, T.G. Evans, 1998, **NMW**, det. A.J. Richards.

135/26.3. *CREPIS BIENNIS* 46, Cards.: Disused railway embankment, Teifi Marshes Reserve, Cardigan, SN186454, A.O. Chater, 1998. 2nd record.

135/27.2. *PILOSELLA OFFICINARUM* subsp. *TRICHOSOMA* *43, Rads.: On tumulus mound, Burfa Bog, SO273611, S.P. Chambers, 1997.

135/28.17. *HIERACIUM CALCARICOLA* 12, N. Hants.: Path, Hogmoor Enclosure, Whitehill, SU791344, A. Brewis, 1998, **herb. A.B.** 1st recent record.

135/28.72. *HIERACIUM DIAPHANUM* *43, Rads.: Bank of cutting, Rhayader tunnel, SN963673, S.P. Chambers, 1997.

135/30.2. *FILAGO LUTESCENS* 13, W. Sussex: One patch in field, Watersfield, TQ011162, 1997, F. Abraham. 2nd recent record.

- †135/40.1ep. *SOLIDAGO LEPIDA* *46, Cards.: Near Lampeter, SN54, H.J. Riddelsdell, 1900, **BM**, det. D.H. Kent 1952. Status unknown. 1st Welsh record.
- †135/41.4. *ASTER NOVI-BELGII* *107, E. Sutherland: In stones on loch shore, Lairg village, NC583065, BSBI group, 1999.
- †135/41.4×5. *ASTER* × *SALIGNUS* (*A. NOVI-BELGII* × *A. LANCEOLATUS*) *43, Rads.: Boughrood Brest, SO1438, M.A.V. Gill, 1997.
- †135/41.con. *ASTER CONCINNUS* *46, Cards.: Riverbank at tidal limit, Afon Cletwr, Tre'r-ddol, SN654929; Riverbank at tidal limit, Afon Rheidol, Aberystwyth, SN587812; both A.O. Chater, 1990, **CGE**, det. P.F. Yeo & P.D. Sell. 1st & 2nd Welsh records.
- †135/43.1. *ERIGERON GLAUCUS* *46, Cards.: Retaining walls, Grays Inn Road, Aberystwyth, SN583815, A.O. Chater, 1998.
- †135/43.4. *ERIGERON KARVINSKIANUS* 42, Brecks.: Paving by roadside, 1.6km SW of Gilwern, SO239141, M. Porter, 1999. 2nd record.
- †135/44.2. *CONYZA SUMATRENSIS* *29, Cambs.: A single plant, in fruit, in alleyway from 'The Eagle' to the Zoology Dept., Cambridge, TL448583, M.J. Crawley, 1999, **CGE**.
- †135/50.2. *ARTEMISIA VERLOTIORUM* *96, Easterness: Large well established patch on N verge of A96, E of Auldearn, NH940558, P.R. Green, 1997, conf. E.J. Clement. Grassy verge of seafront walk, Nairn, NH883570, I.P. Green, 1998. 1st & 2nd records.
- 135/50.3. *ARTEMISIA ABSINTHIUM* †81, Berwicks.: Established on wall, Edington Mill, NT895549, M.E. Braithwaite, 1998. 2nd extant record. †*107, E. Sutherland: Industrial estate, Helmsdale village, ND025153, BSBI group, 1999.
- †135/57.1. *LEUCANTHEMELLA SEROTINA* *77, Lanarks.: Grassy waste ground, Gartcosh, NS703680, K. Watson, 1995, **GL**.
- †135/58.lac×max. *LEUCANTHEMUM* × *SUPERBUM* (*L. LACUSTRE* × *L. MAXIMUM*) *81, Berwicks.: Established in cliff top grassland, Core, NT781717, M.E. & P.F. Braithwaite & J. Waddell, 1998.
- †135/62.3. *SENECIO INAEQUIDENS* *13, W. Sussex: Casual only in pavement, E end of village near Bonhams Farm, Yapton, SU974034, D.M. Donovan, 1992, conf. J.M. Mullin. *96, Easterness: Large established stand on S bank, River Beaulieu, Kilmorack, NH499437, P.C.H. Wortham, 1999.
- †135/62.4. *SENECIO FLUVIATILIS* 96, Easterness: By drainage channel at edge of saltmarsh, East Beach, Nairn, NH9057, M. Barron, 2000. 2nd record.
- 135/62.10×11. *SENECIO* × *OSTENFELDII* (*S. JACOBAEA* × *S. AQUATICUS*) *45, Pembs.: A range of intermediates present on damp, cattle-trampled, pasture, E of Clegyr-boia, St David's, SM742251, G. Kitchener, 1998.
- 135/62.13×15. *SENECIO* × *BAXTERI* (*S. SQUALIDUS* × *S. VULGARIS*) *46, Cards.: Garden weed, Fairview, Llanbadarn Fawr, SN598810, J.H. Salter, 1935, *Fl. Pl. Ferns Cards*: 82 (1935). A hitherto overlooked record as only mentioned in passing.
- †135/69.1×2×3. *DORONICUM* × *EXCELSUM* (*D. PARDALIANCHES* × *D. PLANTAGINEUM* × *D. COLUMNAE*) *77, Lanarks.: Well established in tiny wood by roadside, Bowhousebog, NS8558, P. Macpherson, 1999, **herb. P.M.**, det. E.J. Clement.
- †135/73.1. *CALENDULA OFFICINALIS* 47, Monts.: Canal bank, Montgomery Canal, SO161951, R.V. Lansdown & S. Whild, 1997. 2nd & 1st recent record.
- †135/80.1. *GALINSOGA PARVIFLORA* *44, Carms.: 3 plants, Machynys, Llanelli, SS511983, R.N. Stringer & R.H. Davies, 1999.
- 137/4.2. *ALISMA LANCEOLATUM* 51, Flints.: Pool in refugium at opencast coal site, Maes-y-Grug, SJ263663, S. Whild, 1994 & 1995, det. I.C. Trueman. 2nd record. *68, Cheviot: Recently constructed pond, near Branton, NU045167, G.A. & M. Swan, 1999, **herb. G.A.S.**
- †138/4.2. *ELODEA NUTTALLII* 50, Denbs.: Lake, Brymbo, SJ287538, G. Kay, 1999. 2nd record. *52, Anglesey: Llyn Rhosddu, Newborough, SH4264, N.F. Stewart, 1996.
- †138/6.1. *LAGAROSIPHON MAJOR* 46, Cards.: Upland ponds 2km NNE of Ffair-rhos, SN750697, M.D. Sutton, 1997. 2nd record.

142/1.1×6. POTAMOGETON × SPARGANIIFOLIUS (P. NATANS × P. GRAMINEUS) **45**, Pembs.: Shallow pool dominated by *Menyanthes* swamp, Trefeiddan Pool, St David's, SM7325, N. Stewart, 1998. Rediscovery of 1964 record at the only known site in v.c.

142/1.5×6. POTAMOGETON × ANGUSTIFOLIUS (P. LUCENS × P. GRAMINEUS) ***41**, Glam.: SW part of Kenfig Pool, SS796812, N. Stewart, 1996.

142/1.5×9. POTAMOGETON × SALICIFOLIUS (P. LUCENS × P. PERFOLIATUS) **13**, W. Sussex: Under footbridge, old canal NW of Billingshurst, TQ068276, A.G. Knapp, 1998, conf. C.D. Preston. 1st record since 1888.

142/1.6×9. POTAMOGETON × NITENS (P. GRAMINEUS × P. PERFOLIATUS) ***41**, Glam.: Pool on Margam Dunes, SS782838, N. Stewart, 1996.

142/1.7. POTAMOGETON ALPINUS **13**, W. Sussex: Several plants in ditch, South Stoke, TQ026103, N. Stewart, 1998, det. C.D. Preston. 1st recent & only extant record.

142/1.13. POTAMOGETON PUSILLUS **58**, Cheshire: Flooded sand quarry, Newchurch Common, SJ603692, G.M. Kay, 1998, det. C.D. Preston. 1st recent record.

142/1.14. POTAMOGETON OBTUSIFOLIUS **81**, Berwicks.: Reservoir, Greenlawdean, NT704470, M.E. Braithwaite, 1998. Pond, Cranshaws, NT6861, J.J. Day, 1997. 1st & 2nd extant records.

†147/1.1. ACORUS CALAMUS ***52**, Anglesey: Reservoir margin, Menai Bridge, probably planted, SH5476, J. Bratton, 1997.

†147/5.2b. ARUM ITALICUM subsp. ITALICUM ***41**, Glam.: Caswell, SS5897, A.S. Lewis 1997. ***50**, Denbs.: Open pasture, Llanferres, SJ197604, A. Yates, 1996, **NMW**, det. G. Hutchinson.

148/1.1. SPIRODELA POLYRHIZA **44**, Carm's.: 'Levels' ditch, 'The Swannery' WWT, Penclawdd, SS538985, Llanelli Naturalists' *et al.*, 1999, det. I.K. Morgan, G. Hutchinson & R.D. Pryce. 1st localised record.

148/2.3. LEMNA TRISULCA **45**, Pembs.: A 3m² patch with other *Lemna* spp. and algae at the margins of the eastern end of Frainslake Pool, SW Castlemartin, SR898976, R.J. Haycock, 1998. Also some scattered small populations in the swamp vegetation on the S side of the main pool. 2nd records.

†148/2.4. LEMNA MINUTA ***45**, Pembs.: In ditch, Ramsey Island, SM705237, G. Kitchner, 1998. ***50**, Denbs.: Small lake, Gresford, SJ351529, N.F. Stewart, 1998. ***52**, Anglesey: Pond, constructed about 10 years ago, Llanrhyddlad, SH337892, I.R. Bonner, 1998.

151/1.15. JUNCUS BULBOSUS subsp. KOCHII ***43**, Rads.: Streamside, Nant Cletwr, SN8868, A.J. Morton, 1995.

151/1.25×26. JUNCUS × DIFFUSUS (J. EFFUSUS × J. INFLEXUS) ***51**, Flints.: 1 clump in marshy grassland, W of Coppa House, S of Buckley, SJ274613, S.P. Chambers, 1998.

151/1.26×27. JUNCUS × KERN-REICHGELTII (J. EFFUSUS × J. CONGLOMERATUS) ***46**, Cards.: Blanket mire NW of Llyn Eiddwen, SN603671, A.D.Q. Agnew, 1997. ***81**, Berwicks.: Moss, Lurgie Loch, NT676395, M.E. Braithwaite & L. Gaskell, 1999.

151/1.6. JUNCUS FOLIOSUS **42**, Brecks.: Beside muddy track, Nant Cerdin, N of Llanwrtyd Wells, SN877492, A.O. Chater, S. Bosanquet & I. Henning, 1999, det. AOC. 1st recent record.

151/1.8. JUNCUS AMBIGUUS ***107**, E. Sutherland: Helmsdale, ND01, BSBI group, 1999.

[151/1.20 JUNCUS MARITIMUS **81**, Berwicks.: Saltmarsh, Bay E of Ramsheugh, NT777723, M.E. Braithwaite & BSBI party, 1979. This record is now considered erroneous and should be deleted.]

151/2.1. LUZULA FORSTERI ***49**, Caerns.: Under trees, Penrhyn Castle, Bangor, SH6071, G. Hutchinson, 1994.

152/16.1. CAREX PANICULATA ***107**, E. Sutherland: Fresh water flush on sea-loch shore, Loch Fleet, NH780959, W. Hay, 1998.

152/16.3. CAREX DIANDRA ***43**, Rads.: Patch, 16×5m, central flushes, Pentrosfa Mire, SO0559, S.P. Chambers, 1997, conf. A.O. Chater.

152/16.18. CAREX DIOICA **51**, Flints.: Fen, SW of Llyn Helyg, SJ105767, S.P. Chambers, 1996, conf. A.O. Chater. 2nd localised record.

152/16.39. *CAREX LAEVIGATA* **81**, Berwicks.: Flushed grassland, near Birkie Wood, NT574497, M.E. Braithwaite, 1999. 2nd extant record.

152/16.44x46. *CAREX* × *FULVA* (*C. HOSTIANA* × *C. VIRIDULA*) **50**, Denbs.: Upland flush, Llyn Aled, SH898895, W. McCarthy, 1998. 1st recent record. ***81**, Berwicks.: Flush, foot of Rotten Cleugh, NT663625, M.E. Braithwaite, 1998.

152/16.46a. *CAREX VIRIDULA* subsp. *BRACHYRRHYNCHA* **47**, Monts.: Ditches fed by moorland flushes, Crugyn Llwyd, SO016796, S. Kingsbury, 1999. 1st recent record.

152/16.64x65. *CAREX AQUATILIS* × *C. ACUTA* ***46**, Cards.: Ditch by disused railway, 100m S of Teifi bridge, Cors Caron NNR, SN708662, A.O. Chater, NMW, conf. A.C. Jermy & P.M. Benoit.

152/2.2a. *TRICHOPOPHORUM CESPITOSUM* subsp. *GERMANICUM* **81**, Berwicks.: Heather moorland, Long Moss, NT586682; Heather moorland, near Lammerlaw Burn, NT5260, both M.E. Braithwaite, 1999. 1st & 2nd critically determined records.

152/2.2ax2b. *TRICHOPOPHORUM CESPITOSUM* nothosubsp. *FOERSTERI* (*T. CESPITOSUM* subsp. *CESPITOSUM* × subsp. *GERMANICUM*) ***46**, Cards.: Flush in blanket mire 1.5km SE of Hafod, SN771717, A.O. Chater, 1963, NMW, det. G.A. Swan, proliferous form. 1st record for the form. ***81**, Berwicks.: Raised bog, Long Moss, NT855683, M.E. Braithwaite, 1999.

152/3.3. *ELEOCHARIS UNIGLUMIS* ***77**, Lanarks.: Damp hollow beside a pool, Gartcosh, NS7068, P. Macpherson, 1997, **herb. P.M.**, conf. S.M. Walters.

†152/5.atr. *SCIRPUS ATROVIRENS* ***77**, Lanarks.: Established adjacent to pool, Gartcosh, NS7068, C. MacIver, 1998, **BM & herb. P. Macpherson**, det. D.A. Simpson, 1st British record as established alien.

152/9.1. *ELEOGITON FLUITANS* ***79**, Selkirks.: With *Apium inundatum* in margins of fen, W of Whitmuir Loch, Selkirk, NT492271, R.W.M. Corner, 1999, **herb. R.W.M.C.**

†153/1.1. *YUSHANIA ANCEPS* ***81**, Berwicks.: Strongly established in damp woodland glade, Newton Don, NT712369, M.E. Braithwaite, 1999.

†153/3.1. *SASA PALMATA* ***49**, Caerns.: Penrhyn Castle, Bangor, SH6070, G. Hutchinson, 1994. ***50**, Denbs.: Riverside, Pentrefoelas, SH824528, J.A. Green, 1998. ***58**, Cheshire: Well naturalised in woodland, Walton, SJ592837, G.M. Kay, 1998. ***81**, Berwicks.: Extensively established in damp woodland glade, Newton Don, NT712369, M.E. Braithwaite, 1999.

†153/4.1. *SASAELLA RAMOSA* ***41**, Glam.: Naturalised and spreading at edge of woodland to S of Coltshill Cemetery, Mumbles, SS607884, Q.O.N. Kay, 1999. ***58**, Cheshire: Well naturalised in woodland, Walton, SJ592837, G.M. Kay, 1998.

†153/5.1. *PSEUDOSASA JAPONICA* ***49**, Caerns.: Castle grounds, Penrhyn Castle, Bangor, SH6070; Bodlondeb Wood, Conwy, SH7877; both G. Hutchinson, 1994. 1st & 2nd records.

153/12.1x2. *FESTUCA* × *ASCHERSONIANA* (*F. PRATENSIS* × *F. ARUNDINACEA*) ***52**, Anglesey: Waste ground near the Fish Dock, Holyhead, SH2582, W. McCarthy & I.R. Bonner, 1999, det. T.A. Cope & C.A. Stace.

153/12.4. *FESTUCA ALTISSIMA* ***106**, E. Ross: Population of 10 - 20 plants in one locality on sides of wooded gorge, E end of Allt nan Caorach, NH555680, P.C.H. Wortham, 1998, conf. P. Lusby & D. McKean.

153/12.7e. *FESTUCA RUBRA* subsp. *ARCTICA* ***77**, Lanarks.: Upland burn side, Whitelaw Burn, NT0223, P. Macpherson, 1997, **herb. P.M.**, det. C.A. Stace.

153/12.8c. *FESTUCA OVINA* subsp. *OPHIOLITICOLA* ***52**, Anglesey: Bodior, SH2876, T.C.G. Rich, 1999, NMW. ***81**, Berwicks.: Calcareous grassland, Foulden Dean, NT920548, M.E. Braithwaite, 1999.

153/12.2x13.1. ×*FESTULOLIUM HOLMBERGII* (*FESTUCA ARUNDINACEA* × *LOLIUM PERENNE*) ***51**, Flints.: Roadside verge, Waun, St Asaph, SJ055757, J.A. Green, 1995, det. T.A. Cope.

153/12.7x14.1. ×*FESTULPIA HUBBARDII* (*FESTUCA RUBRA* × *VULPIA FASCICULATA*) ***51**, Flints.: With Marram on active dunes, Point of Ayr, SJ122850, P.L. Thomas, 1999.

153/12.7x14.3. *FESTUCA RUBRA* × *VULPIA MYUROS* **35**, Mons.: By railway line, Mitchell Troy, SO4910, E. Nelmes, 1951, **K**, det. C.A. Stace. The earliest record from any part of the world.

153/14.4. *VULPIA CILIATA* **10**, Wight: Sandy coastal bank, Ryde Canoe Lake, SZ602926, C.R. Pope, 1998, **herb. C.R.P.**, conf. C.A. Stace. 2nd extant site.

153/16.2. *PUCCINELLIA DISTANS* ***96**, Easternness: Roadside verge, A833 at Culnakirk Brae above Milton, NH4931, G.M. Kay, 1995. Roadside verge, A833 at Glen Convinth, NH5035, M. Barron, 1996. 1st & 2nd records.

†153/17.2. *BRIZA MINOR* **10**, Wight: Arable field, Alverstone Farm, Whippingham, SZ525929, B. Shepard, 1998. det. C. Pope. 2nd extant site.

153/18.1. *POA INFIRMA* ***13**, W. Sussex: Many plants on beach at edge of concrete area E of lighthouse, Kingston, TQ235049, P.A. Harmes, 1998. Many plants on NW verge of rough road opposite Salty Tower, Pagham, SZ889971, P.D. Stanley, 1999. 1st & 2nd records.

†153/18.7. *POA CHAIXII* ***73**, Kirkcudbrights.: Plantation woodland, Glenlee, NX611803, P. Stanley & O.M. Stewart, 1998, E.

153/18.9. *POA COMPRESSA* **73**, Kirkcudbrights.: Gravel car park, Glenlee Power Station, Dalry, NX607806; Floor of quarry below Earlstoun Dam, NX614822; both P. Stanley, 1998. 1st & 2nd recent records.

153/23.1. *PARAPHOLIS STRIGOSA* **50**, Denbs.: Disused railway bank, Kimmel Bay, SH995800, J.A. Green, 1998. 2nd record.

153/27.1. *ARRHENATHERUM ELATIUS* subsp. *BULBOSUS* ***43**, Rads.: Hillside, Cefn Llech, SN9577, A.J. Morton, 1995.

†153/28.3. *AVENA FATUA* ***43**, Rads.: Roadside, Knowle, SO2261, D.R. Humphreys, 1995.

†153/28.4a. *AVENA STERILIS* subsp. *LUDOVICIANA* ***46**, Cards.: Manure heap among pastures 400m N of Pen-y-cefn, 2km NNE of Tregaron, SN693613, A.O. Chater, 1998, **NMW**. 2nd record.

153/32.1b. *DESCHAMPSIA CESPITOSA* subsp. *PARVIFLORA* ***42**, Brecks.: Edge of woodland, in gorge, Cwm Clydach, near Blackrock, SO217125, H. McAlister, L. Kilgallen & M. Porter, 1996, det. H. McA. Edge of wood along river, Gwynne Fawr, near Pont Cadwgan, SO268250, M. Porter, 1997. 1st & 2nd records. ***46**, Cards.: Occasionally flooded ancient woodland, Teifi gorge 1km SW of Llechryd Bridge, SN209430, A.O. Chater, 1998, **NMW**. Alder carr in valley 200m S of Lledrod church, SN645699-SN645700, A.O. Chater, 1999. 1st & 2nd records.

†153/38.5. *PHALARIS PARADOXA* ***61**, S.E. Yorks.: Capped landfill site, North Ferriby, SE9925, P.J. Cook, 1999, conf. E. Chicken.

†153/39.3. *AGROSTIS CASTELLANA* ***61**, S.E. Yorks.: Planted with grass & wildflower mix on MAFF Countryside Stewardship field margins, Manor Farm, Eddlethorpe, SE76, W.R. Meek, 1999.

†153/39.9. *AGROSTIS SCABRA* **58**, Cheshire: Old railway, Oldfield Brow, Altrincham, SJ750889, G.M. Kay, 1998. 2nd record.

153/42.1. *GASTRIDIMUM VENTRICOSUM* **10**, Wight: Roadside wall, Shorwell, SZ457830, M.J. Burnhill, 1998, **herb. C.R. Pope**, conf. R.M. Payne. 2nd extant site.

153/44.1. *APERA SPICA-VENTI* **10**, Wight: Neglected arable field, Alverstone, SZ580850, C.D. Preston, T.D. Dines & G.M. Kay, 1998, **herb. G.M.K.**, det. C.D. Preston. 1st recent record.

153/44.2. *APERA INTERRUPTA* **†*21**, Middlesex: Derelict railway sidings, Feltham Marshalling Yards, TQ1173, G. Hounscome, 1998.

153/46.1. *POLYPOGON MONSPELIENSIS* **†*64**, Mid-W. Yorks.: Many plants in old sand quarry, Woodside Quarry, Ireland Wood, Leeds, SE254384, M. Wilcox, 1998. Probably the only extant site. **†*68**, Cheviot: Grassland a few metres above edge of saltmarsh, Beal Point, NZ079428, Mrs J.M. Humphris, 1998, **herb. G.A. Swan**, det. R.M. Payne.

153/47.6. *ALOPECURUS MYOSUROIDES* ***43**, Rads.: Fields, Little Lloyney, SO074204, D.R. Humphreys & E.R. Dean, 1997. **47**, Monts.: Newly excavated soil beside old farmhouse, Llansantffraid, SJ186149, T. Teearu, 1999. 2nd & 1st recent record.

153/50.3. *BROMUS RACEMOSUS* **42**, Brecks.: Field entrance, Penderyn, SN950093, G.S. Motley, 1999. 2nd record. **51**, Flints.: Hayfield, Caer Estyn, between Caergwile and Abermorddu, G. Wynne, 1999. 2nd recent record.

†153/50.5. *BROMUS LEPIDUS* ***46**, Cards.: Waste ground by bridge over Afon Stewi, Penrhyn-coch, SN644843, A.O. Chater, 1956, **NMW**, conf. AOC. 1998. 1st confirmed record.

†153/50.7. *BROMUS SECALINUS* *61, S.E. Yorks.: Cereal crop margin, Wawne, TA0738, P.J. Cook, 1999, conf. L. Spalton, T.B. Ryves & T.A. Cope.

†153/51.4a. *BROMOPSIS INERMIS* subsp. *INERMIS* *46, Cards.: Nettle patch E of Visitor Centre, Ynys-las Dunes NNR, SN609941, S.P. Chambers, 1998, NMW.

†153/52.1. *ANISANTHA DIANDRA* *61, S.E. Yorks.: Cereal crop margin, near Gransmoor, TA115607, E. Chicken, 1999, **det. L. Spalton**. In a crop of Quinoa, Manor Farm, Eddlethorpe, SE777654, W.R. Meek, 1999. 1st & 2nd records.

†153/53.1. *CERATOCHLOA CARINATA* *61, S.E. Yorks.: Farm track, Easington, TA4119, P.J. Cook, 1999, **det. L. Spalton**.

†153/53.3. *CERATOCHLOA CATHARTICA* 46, Cards.: Roadside verge and garden weed, Maesyreglwys, Aber-arth, SN476632, A.O. Chater, 1999, NMW. 2nd record.

153/56.1x3. *ELYTRIGIA* × *LAXA* (*E. REPENS* × *E. JUNCEA*) *46, Cards.: Sandy top of sea beach, Tan-y-bwlch, Aberystwyth, SN579799, S.P. Chambers, 1999, **herb. S.P.C.**, conf. T.A. Cope.

†153/59.3. *HORDEUM JUBATUM* *51, Flints.: Grass verge of dual carriageway road, near slip-road from A55 to St Asaph Industrial Estate, Bodelwyddan, SJ0175, W. McCarthy, 1999. *96, Easterness: Roadside verge, Drumashie Moor Road, c.9km SW of Inverness, NH619342, M. Barron & M. Fraser, 1997. Roadside verge, B9006, Culloden, NH754455, J. Hex, 1997. 1st & 2nd records.

153/59.4. *HORDEUM SECALINUM* *43, Rads.: Roadside, Glasbury, SO182382, M.A.V. Gill, 1996.

†153/60.1. *TRITICUM AESTIVUM* *49, Caerns.: Along disused railway near Caernarfon, SH4861, G. & I. Battershall, 1998.

†153/62.1. *CORTADERIA SELLOANA* 49, Caerns.: Several plants on waste ground, Llandudno Junction, SH7877, G. Battershall, 1998. 2nd record.

†153/62.1c. *CORTADERIA RICHARDII* *95, Moray: Eight clumps in Scots Pine wood, Thornshill, Castle Hill Wood, NJ214576, I. Green, 1998.

†153/70.1. *SETARIA VIRIDIS* S, Channel Is. (Sark): Garden, from birdseed, Rue du Fort, WV467767, R.M. Veall, 1999, **herb. Société Sercquaise**, **det. E.J. Clement**. 1st record for Sark.

†153/70.adh. *SETARIA ADHAERENS* *41, Glam.: Waste ground, High St., Swansea, SS650937, A.S. Lewis, **det. C.R. Hipkin**, 1999.

†153/70.pum. *SETARIA PUMILA* *12, N. Hants.: Abundant in neglected walled garden, Blackmoor House, SU779330, A. Brewis, 1998, **herb. A.B.**, **det. E.J. Clement**.

†153/71.1. *DIGITARIA ISCHAEMUM* 29, Cambs.: Coronation St., Cambridge, TL454575, P.H. Oswald, 1998, **CGE**, **det. P.D. Sell**. 2nd record.

†153/PAN.cap. *PANICUM CAPILLARE* *8, S. Wilts.: Large field of maize, Horningsham, ST812405, G. Ward, 1999, **det. T.B. Ryves**.

†153/PAN.mil. *PANICUM MILIACEUM* S, Channel Is. (Sark): Garden, from birdseed, Rue du Fort, WV467767, R.M. Veall, 1999, **herb. Société Sercquaise**. 1st record for Sark.

154/1.1a. *SPARGANIUM ERECTUM* subsp. *ERECTUM* 47, Monts.: Montgomery Canal, near Pool Quay, SJ256117, R.V. Lansdown, 1997. 2nd record.

154/1.1b. *SPARGANIUM ERECTUM* subsp. *MICROCARPUM* *77, Lanarks.: Edge of pool, Gartcosh, NS7068, P. Macpherson, 1998, **herb. P.M.**, conf. R.V. Lansdown.

154/1.1c. *SPARGANIUM ERECTUM* subsp. *NEGLECTUM* *77, Lanarks.: Burn edge, SW of Coulterhaugh, NT0034, D.J. McCosh, 1997.

154/1.1d. *SPARGANIUM ERECTUM* subsp. *OOCARPUM* *35, Mons.: Drainage ditch, Pentre Bach, ST289924; Edge of Brecon-Newport Canal, Two Locks, Cwmbran, ST290940; both T.G. Evans, 1999, conf. R.V. Lansdown. 1st & 2nd records. *47, Monts.: Montgomery Canal, near, Carreghofa, SJ254202, R.V. Lansdown, 1997.

155/1.1x2. *TYPHA* × *GLAUCA* (*T. LATIFOLIA* × *T. ANGUSTIFOLIA*) *49, Caerns.: Edge of small lake, Afon Wen, SH4537, N. Stewart, 1998.

155/1.2. *TYPHA ANGUSTIFOLIA* **68**, Cheviot: Recently constructed pond, near Branton, NU045167, G.A. & M. Swan, 1999. 2nd and only extant record.

†157/1.1. *PONTERDERIA CORDATA* ***58**, Cheshire: Well naturalised in small pond, Marston, Northwich, SJ664760, G.M. Kay, 1998.

†158/12.2. *LILIUM PYRENAICUM* **81**, Berwicks.: Established in wood, near Halidean Hill Moss, NT594347, L. Gaskell & K. Velander, 1999. 2nd record.

158/14.1. *POLYGONATUM MULTIFLORUM* †***81**, Berwicks.: Three good patches on old bank, Eccles, NT756410, M.E. & P.F. Braithwaite, 1998. 1st critically assessed record, **not** the hybrid.

[158/14.2. *POLYGONATUM ODORATUM* **81**, Berwicks.: Craigswalls Wood, Edrom, NT8455, Dr C. Stuart, 1871. Apparently an error. A specimen in herb. F.M. Norman from the same locality in 1878 is *P. multiflorum*.]

†158/18.2. *ORNITHOGALUM ANGUSTIFOLIUM* ***43**, Rads.: Churchyard, Glasbury, SO17738, M.A.V. Gill, SO177385, 1996.

†158/19.bit. *SCILLA BITHYNICA* ***77**, Lanarks.: Established on bank of R. Kelvin, Kelvininside, Glasgow, NS5767, K. Watson, 1998, **herb. P.M.**, conf. E.J. Clement.

158/20.2×3. *HYACINTHOIDES NON-SCRIPTA* × *H. HISPANICA* †***42**, Brecks.: Established in native woodland by Afon Clydach, Gilwern, SO244145; Naturalised in wood by river, W of Abercraf, SN800126; both M. Porter, 1999. 1st & 2nd records. †***43**, Rads.: Churchyard, Glasbury, SO177385, M.A.V. Gill, 1996. †***45**, Pembs.: Stream bank, Merryvale Common, St David's, SM748254; Woodland path, Old Mill grounds Nature Reserve, Haverfordwest, SM952160; both S.B. Evans, 1999. 1st & 2nd records. †***52**, Anglesey: Road bank, Pont Sarnlew, SH4769, I.R. Bonner & N. Brown, 1999.

†158/23.2. *MUSCARI ARMENIACUM* ***43**, Rads.: Roadside, Ackhill, SO2966, D.R. Humphreys, 1994.

†158/24.12. *ALLIUM CARINATUM* **81**, Berwicks.: Established, Grasslaw, Kimmerghame, NT811512, L. Gaskell, 1998. 2nd record.

†158/24.3. *ALLIUM ROSEUM* ***45**, Pembs.: Neutral grassland in and just outside Haroldston churchyard, SM866154, S.B. & A.E. Evans, S. Schofield & C. Moseley, 1999.

†158/24.5. *ALLIUM SUBHIRSUTUM* ***46**, Cards.: Roadside hedgebank, Pont Gilfachreda, 2km NW of Llanarth, SN410588, A.O. Chater, 1998, **NMW**.

†158/24.7. *ALLIUM TRIQUETRUM* ***46**, Cards.: Wooded dingle SW of school, New Quay, SN387594, A.O. Chater, 1998, **NMW**. 2nd record.

†158/24.9. *ALLIUM PARADOXUM* ***41**, Glam.: Hen Parc Lane, Upper Killay, SS592923, A.S. Lewis, 1999.

†158/33.3. *NARCISSUS POETICUS* ***43**, Rads.: Roadside, Glasbury Village, SO1739, M.A.V. Gill, 1997.

†158/36.1. *ALSTROEMERIA AUREA* ***41**, Glam.: Eastcliff, Pennard, SS5567, A.S. Lewis, 1997.

†158/7.1. *COLCHICUM AUTUMNALE* ***46**, Cards.: Wooded slope 150m SE of crossroads, Pontsian, SN439460, A.O. Chater, 1999, **NMW**.

†159/13.1. *CROCOSMIA PANICULATA* ***77**, Lanarks.: Very well established in rough grassland, Douglas West, NS8230, P. Macpherson, 1998, **herb. P.M.**, conf. E.J. Clement.

†159/13.3. *CROCOSMIA POTTII* ***49**, Caerns.: Side of bank, Aber Ogwen near Bangor, SH6172, G. & I. Battershall, 1998.

†159/5.2. *IRIS SIBIRICA* ***42**, Brecks.: Introduced at margin of artificial lake and apparently naturalised, Abernant Lake, Llanwrtyd Wells, SN891461, R.G. Woods *et al.*, 1999.

†159/5.9. *IRIS LATIFOLIA* ***46**, Cards.: Widely naturalised in Tregroes churchyard, SN406448, A.O. Chater, 1999, **NMW**. Known here for at least 20 years but not previously identified.

162/3.1. *EPIACTIS PALUSTRIS* ***103**, Mid Ebudes: 1 non-flowering plant with *Ophioglossum vulgatum* in dune slack, Totamore, Coll, NM170570, L. Farrell, 1997.

162/5.1. *NEOTTIA NIDUS-AVIS* ***47**, Monts.: 1 plant on riverside gravel, Llanfair Caereinion, SJ0906, C. Faulkner, 1998. 2nd extant site.

162/6.2. *Listera cordata* *43, Rads.: Under heather, Beacon Hill, SO172767, R.G. Woods; and SO167767, D.R. Humphreys, both 1994. 1st records.

162/7.3. *Spiranthes romanoffiana* H3, West Cork: Bog/moorland, Currakeal, a few km NE of Glen Garriff, V943581, F. Horsman, 1999. 1st recent record.

162/10.1. *Hammarbya paludosa* 44, Carms.: Over 25 plants in relatively bare ground in slightly base-enriched flush, Derllwyn Isaf, Cwm Twrch, SN767147, I.K. Morgan & G.S. Motley, 1998, NMW. The only extant site.

162/14.1. *Anacamptis pyramidalis* *43, Rads.: Roadside, Glasbury, SO178388, M.A.V. Gill, 1996.

162/16.1×18.1. ×*Dactyloдения st-quintinii* (*Gymnadenia conopsea* × *Dactylorhiza fuchsii*) *78, Peebles.: Glenfield farm, Peebles, NT2641, W. Bell, 1998, E, det. R.M. Bateman.

162/18.3c. *Dactylorhiza incarnata* subsp. *pulchella* *107, E. Sutherland: One plant flowering in disused sandstone quarry between golf course and shore, Dornoch, NH806896, P. Eaglesfield & M.E. Murray, 1998, det. J.K. Butler. Another clump nearby with seed heads.

162/20.3. *Orchis morio* 47, Monts.: Species-rich pasture, Llansantffraid, SJ22, R. Dawes, 1998. Churchstoke, SO39, A. Law, 1998. 1st & 2nd recent records.

162/21.1. *Aceras anthropophorum* 12, N. Hants.: Juniper Bank, Leckford Estate, SU3636, B. & J. Goater, 1998. Only extant locality.

162/23.1×3. *Ophrys* × *Pietzschii* (*O. insectifera* × *O. apifera*) *13, W. Sussex: Fairmile Bottom Bank on SE side of A29 above broad verge with a clump of *O. insectifera*, Arundel, SU995101, B. Middleton, conf. D. Lang, 1998. The only extant UK site.

Book Reviews

Flora of Middlesex: A Supplement to The Historical Flora of Middlesex. D. H. Kent. Pp. xxxii +219. Ray Society (Volume no. 165), London, 2001. Hbk. £25. ISBN 0903874-288.

Douglas Kent had not completed this book at the time of his death, but it was adopted and taken to publication by Clive Stace and Rodney Burton, with other helpers, which I am sure Duggie would have appreciated. It is not easy to take on another man's work and the late change no doubt accounts for many criticisms of the flora. The book is exactly as titled, a supplement to the Historical Flora of Middlesex (HFM), and some familiarity with the layout of that work is useful in navigating the supplement.

The book opens with a three page biography of Douglas Kent, a pleasant personal touch which is continued later with a comprehensive list of recorders, to which abundant references are made in the text. In the HFM he had divided Middlesex into seven areas which he defined using text descriptions, and these are reiterated in the supplement. The descriptions are not easy to follow unless you have an intimate personal knowledge of the whole of Middlesex or have spent a couple of hours with a pencil, an OS map and an A to Z, and in an age of graphical user interfaces a map would have been much appreciated. A list of literary and herbarium sources is followed by the species records. Kent has chosen to replace the species order based on phylogenetic relationships with an artificial but practical list in alphabetical order of genera. Which of the two is better is a matter of personal preference, but it renders the index on page 205 redundant unless you are not sure whether the species you want to look up is a charophyte, a bryophyte or a vascular plant.

The records for each species follow the pattern used in the HFM. There is no explanation in the introduction of the way in which each record is laid out, or of the criteria for inclusion of detailed records for a species. By reference to the HFM it may be inferred that the less common species are updated with records made since 1975, the common ones with records for area 7 only and the very common ones not at all, but it would have been helpful to have had this explained in the introduction. The records for bryophytes are very detailed, making good the admittedly incomplete entries in the HFM. All the species of vascular plant listed there are represented in the supplement, as well as seventy eight new aliens, four new taxonomic creations and two extinct natives discovered in herbaria. Middlesex is a county where human activity has an overwhelming influence on the flora and casuals, aliens and garden escapes have been integrated into the supplement at the same level as everything else. Nothing could better illustrate the recent change in attitudes from a vision of a flora consisting of "good" natives adulterated with "bad" aliens to one showing a living and dynamic reflection of the environment and the factors that influence it.

In a work of this type errors are inevitable and start with the tulips on the dust jacket, attributed to Shortwood Common instead of Harefield. The review copy did not have an *errata* slip, but I believe one is now provided. Erroneous records are not so easy to spot unless you were the recorder! To mention a couple, that for *Cyperus congestus* has been either incorrectly attributed to G. Ho. or G. Ho.'s record for *C. eragrostis* in 1994 has been incorrectly entered. G. Ho. also appears as G. H. in some records. However, enough of this griping. The book is an essential purchase for anyone interested in the botany of Middlesex and is a fitting finale to the work of Douglas Kent.

G. HOUNSOME

Moccas: an English Deer Park. Edited by P. T Harding and T. Wall Pp. 348. English Nature, 2000. £20. ISBN 1-85716-511-X.

In 1981 Moccas Park became the first parkland National Reserve having been in English Nature's 'sights' for almost 20 years. The Park had been famous amongst coleopterists since the mid 1930s when a beetle (The Moccas beetle *Hypebaeus flavipes* (F.)), new to Britain was found there. This was followed by records of more rare saproxylic invertebrates; Moccas remains the only recorded British locality of *Hypebaeus flavipes*. Locally however, the beauty and interest of Moccas and its ancient trees had been well known to naturalists and writers since the mid 19th century. The Reverend Kilvert's Diaries includes a description of Moccas in the 1870s that Richard Mabey claims is the "most graphic account we have of the feel of an ancient wood-pasture" and the

activities of the local Naturalists Field Club at Moccas are well recorded from 1816 onwards. Moccas remains a seminal site for the conservation of deadwood invertebrates and a focus for the developing interest in parkland conservation that has gathered pace over the last 10 years.

An important, and rather unusual, feature of Moccas, is the degree to which the Park's owners have welcomed the attentions of naturalists over the last 150 years. This has produced an impressive array of data sets that are fully described in the text and listed in the Appendices. The book is beautifully produced with the large amount of information presented in attractive and digestible format. Informative photographs, plans and historic documents are well distributed throughout the text. The use of historic photographs is particularly interesting.

An intriguing aspect of the interest at Moccas is the relatively poor epiphytic lichen flora when compared to the site's outstanding richness in invertebrate fauna associated with veteran trees. Received wisdom is that continuity of habitat, and particularly old trees, is crucial for both. Pollution may be the problem but possibly the actuality of habitat continuity was more complex. At Moccas the first documentary reference to the Park deer is quite late at 1617, although this does not preclude an earlier history as wooded waste on or near the site. With regard to the continuity of fallen deadwood habitats, the vast resource of 'fallow wood' described by Kilvert was surely the product of the willingness of the owners in the late 18th and 19th century to forsake the firewood resource in the interests of the picturesque; medieval occupiers are unlikely to have been as profligate. Later the advent of large chainsaws in the 1970s would have created another threat to continuity. Clearly certain critical thresholds of habitat availability were maintained at Moccas when they were not at most other parkland localities but the precise details of these thresholds are obscure at present and need more consideration if future conservation is to be successful.

In addition to including the history, current landscape and detailed descriptions of the flora and fauna of the Park (including an interesting discussion on the use of invertebrates in the conservation evaluation of parklands), the book also covers management issues and a consideration of the process of integrating the current owner's objectives with the various, and sometimes conflicting, interests of the nature conservation and historic landscape conservation professionals. These latter two aspects, however, occupy less than 10% of the whole and their treatment is much less comprehensive than for the survey data. There are a number of interesting issues of methodology here that are skated over and I was expecting a more in-depth look at the background to some of the management practices described.

Overall, however, this is an important and enjoyable book that sets a high standard in the presentation of single site ecological studies.

A. POORE

Darwin's mentor: John Stevens Henslow 1796–1861. S. M. Walters & E. A. Stow. Pp. xx + 338 + 8 (colour plates). Cambridge University Press, Cambridge. 2001. £40. ISBN 0-521-59146-5.

Readers of S. M. Walters' book *The shaping of Cambridge botany* (1981) will already be aware of the importance of J. S. Henslow in developing the subject in 19th century Cambridge, and of his better known role as 'Darwin's mentor'. Max Walters and Anne Stow, who during their working lives were both associated with institutions founded by Henslow, have now followed the earlier book with a full biography of this charismatic figure.

Henslow was born into comfortable circumstances; his grandfather was Chief Surveyor to the Navy throughout the 'Age of Nelson'. Henslow showed a strong aptitude for natural history as a schoolboy, entered St John's College, Cambridge, in 1814 and by 1821 had published an important geological survey of Anglesey. He was appointed Professor of Mineralogy in 1822 but when Thomas Martyn died after over 60 years' tenure of the Regius Professorship of Botany, Henslow was elected to that chair as the fourth Professor in 1825.

During the first years of his botanical professorship, 1825–37, Henslow became a focus for those at the University who were interested in science. He took a broad approach to botany, emphasising that it consisted of much more than just plant taxonomy. His lectures attracted large audiences (including medical students, who had to attend) and his practical classes and field excursions made a particular impact. He reorganised the herbarium he had inherited from Martyn and expanded the collections, to be the effective start of 'CGE'. By 1831 he had obtained an Act of Parliament to allow the purchase of land for a New Botanic Garden, although problems with a sitting tenant (or, more precisely, her grasping lawyer) delayed the official opening until 1846.

It is fortunate that Charles Darwin arrived in Cambridge during this early period. He attended Henslow's lectures for three successive years (1829–31) and quickly became a favourite pupil. When Henslow had to recommend a naturalist for the *Beagle* voyage and his brother-in-law Leonard Jenyns declined to go, Darwin was the obvious next choice. It was Henslow who advised Darwin to take the newly published first volume of Lyell's *Principles of Geology* on the voyage, but "on no account to accept the views therein advocated". Darwin took the book but ignored the advice – Lyell's work had a profound effect on his thinking. Henslow was similarly unable to accept the conclusions Darwin himself reached about the origin of species, though nothing shows Henslow's character in a more attractive light than the efforts he made to ensure a fair hearing for his former pupil.

In 1837 Henslow was appointed Rector of Hitcham, a rural parish in Suffolk. Two years later he moved to Hitcham, retaining his professorship but returning to Cambridge for less than five weeks a year to give his annual lectures. He initially persuaded himself that he would have more time for botany at Hitcham, but a friend's warning that "you will get entangled in other interests and less able to pay attention to your Professorship" proved all too true. There was great poverty in rural Suffolk and Henslow threw himself into strenuous efforts to alleviate the causes in his village by initiatives designed to give villagers a wide range of new educational and recreational opportunities. This absorption in village affairs meant that the University lost not only his botanical stimulus, but also an influential champion of the sciences at a time when curriculum reform was sorely needed. Henslow died at Hitcham in 1861.

This very attractive book provides a scholarly but very readable account of Henslow's life, and can be recommended to anyone with an interest in the history of British botany, or in the wider history of science and education in 19th-century England. I particularly enjoyed the account of the Hitcham years, a stage in his life which is not described by Walters (1981) and which is treated here with great vigour and freshness. From the first sentence ("This book is about an admirable man ..."), Walters and Stow make no secret of their sympathy with their subject. Indeed, they celebrate him as a champion of liberal and Christian views which they clearly share. This enables them to enter with interest into all his varied activities, but only by sacrificing a certain degree of detachment. Their assumption that most people will share their adverse view of Henslow's critics is most strikingly demonstrated when, after citing C. C. Babington's criticisms (in a private letter) of the effect of Henslow's period as absentee professor on botany in Cambridge, they advise the reader not to be too harsh on *Babington*! However, the biography certainly provides enough material on Henslow's life to allow readers to form their own views.

There is something of a contrast, not unusual but perhaps under-explored in this book, between Henslow's stature as a teacher and founder of institutions and his own relatively modest scientific achievements. He clearly lacked that all-consuming, almost obsessive interest in the subject that motivates so many botanists, and the intense curiosity about causes that inspires great scientists. Few authors of botanical text-books can have thought it necessary to warn readers not to make "such studies too exclusively the objects of their thoughts and care". There could scarcely be a greater contrast between the teacher who regarded "an inquiry into the origin of species about as hopeless as an inquiry into the origin of evil" and his most famous pupil.

C. D. PRESTON

Biological collections and biodiversity. Edited by B. S. Rushton, P. Hackney and C. R. Tyrie. Pp. x + 326. Linnean Society Occasional Publications 3. Westbury Publishing, Otley, 2001. Hbk £35. ISBN 1-84103-005-8.

This volume contains the proceedings of the Annual Regional Conference of The Linnean Society of London in Belfast in August 1996 under the title of 'Systematics and Biological Collections', with an extra session sponsored by the Royal Horticultural Society on 'Botanical illustration and its relation to Systematics'. It contains 33 papers grouped under five main headings of traditional specimen collections, living collections and conservation, molecular diversity, uses of collections and data logistics and problems. There are also additional abstracts of other papers and posters presented at the meeting.

There is breadth in coverage of both the biodiversity (bacteria to mammals) and the collections (traditional museum specimens, illustrations, living collections and seed banks) which reflects the

rather disparate nature of the papers presented at the conference. There is much to interest B.S.B.I. members, with substantial amounts on vascular plants with a strong British and Irish component. For instance, Vicky Purewal points out photographic slides tend to fade after 20–30 years, but degrade slowest if kept in a freezer at -20°C . John Parnell estimates each herbarium specimen in TCD would cost about IR£8.60 to replace. Paul Hackney has looked at use of watercolours in ecological research and found they may only be useful for detecting gross changes in the countryside. C. S. Morgan notes the cultivar *Taxus baccata* 'brevifolia' in the Bedgebury Pinetum contains ten times more precursor to the anti-cancer drug Paclitaxol than any other cultivar. Martin *et al.* describe how the Threatened Irish Plant Seed Bank was established with about half of Ireland's endangered species. There are also interesting accounts of the evacuation and politics surrounding the Hamburg herbarium, the economic botany collections at Kew, botanical sculpturing and the R.H.S. fruit cultivar collection.

The book has been meticulously edited and nicely produced, and most papers, though mixed in presentation style are very readable. Inevitably, the five-year delay in publishing the proceedings has meant some articles are out of date, though some have been updated very recently. The diversity of its contents indicates the number of ways in which we need and use biodiversity, and there is much advice in this volume on how to do so. I recommend it to be borrowed to browse for the gems.

T. C. G. RICH

Flora – an illustrated history of the garden flower. B. Elliott. Pp 335. Scriptum Cartago, London in association with the Royal Horticultural Society, 2000. Hbk £45. ISBN 1-902686-14-4.

For hundreds of years, as Europe explored the world beyond its shores, intrepid adventurers, botanists and plant hunters sent back seeds and specimens of the thousands of flowers they came across on their travels. In Britain in particular, many nurserymen and aristocratic garden lovers set about experimenting with each new influx of botanical material, to create the garden flowers we know today. *Flora* tells the fascinating story of this evolution, drawing on the superb archive of the Royal Horticultural Society.

The exquisite illustrations within are notable not only for their historical value in charting the fascinating development of garden flowers, but also for their beauty, including works by the great names in botanical art.

The R.H.S. has built an unrivalled collection of artworks and rare books covering five centuries of plant history. Today the Society's Lindley Library is considered to be one of the world's finest horticultural archives, comprising thousands of paintings, illustrations and rare books. Dr. Brent Elliott is the Society's Librarian and Archivist.

The book covers Europe, Africa, The Americas, Asia and Australia. There is a short account of plant nomenclature, selected bibliographies and a list of the illustrations used.

This is a hefty, 'coffee table' style book. It is a beautifully produced publication celebrating the diversity of our garden flora through the illustrator's eye. As with many 'art' books the influence of the designer can be seen in the layout of the plates. Usually this is of benefit, but occasionally I found the close cropping of some illustrations annoying. The list of illustrations used gives rather minimal details on sources which are often repeated in the captions, but there is no information on the size of the original plates or on whether we are shown the whole plate or just a detail.

Whilst I found the pictures a joy to look at, the text, by comparison, is rather 'flat' and factual. It is full of useful detail, on the plants, their history and their collectors, but it is a text for dipping into rather than reading from cover to cover. This is a *reference* book and one is therefore willing to accept the repetition of some text in plate captions and the main text.

The book gives a very anglocentric view of plant collecting and gardening. The importance of early British accounts from Gerard and Parkinson is clear but there is little from other European countries, and no information on the long history of Japanese gardening. For many plants the book gives a date of introduction though it is sometimes unclear whether dates refer to introduction to Europe or Great Britain.

In general, the book illustrates nature's 'raw material' supplied to the nurseryman as species and their forms and varieties. Sometimes these include the 'freaks of nature' – double flowers, hose-in-hose, striped flowers from viral infections. There is comment on the horticulturists urge to

'improve' upon nature through hybridisation (starting in the late 18th century to produce bigger, brighter-coloured, longer lasting flowers (sometimes at the expense of the more subtle charms of elegance, scent etc.). New breeding techniques such as genetic modification will accelerate the production of such new plants and it is likely that many more of the 'old-fashioned' plants may be lost to cultivation. The book does not mention the excellent work of the National Council for the Conservation of Plants and Gardens in attempting to find and preserve these plants.

For British purists the section on Europe will be of most interest and it is intriguing to see some British natives described from a gardener's point of view. For instance, in the 16th and 17th centuries English gardeners grew purple, blush, and double white forms of the Wood Anemone, *Anemone nemorosa*. I found it hard to believe that 'by Gerard's time alpine gentians were already extensively planted at some country houses, and were beginning to naturalise in Britain.'

The very confusing sentence 'Gerard knew two forms of the native *Primula veris*, seven forms of cowslip and oxlip (the latter a natural hybrid)...' again reflects the gardener's view of variation rather than a botanist's. I had not realised how many forms of *Papaver rhoeas* were being grown in 18th century Germany well before the Rev. Wilks bred his 'Shirley' poppies in the late 1880s.

As well as providing an overview of where our garden plants have come from, the book gives an excellent picture of garden history. It demonstrates how much of fashion is driven by the influence of new materials. Examples of these include the brief popularity of cape heaths, which were common greenhouse subjects in the 19th century, the disappearance of the striped auriculas in favour of edged forms and the many Australian plants which enjoyed brief spells in 19th century greenhouses. There are also examples of some of the extraordinary flowers produced by the various florists' societies where carnations, anemones and others were bred to very exacting standards. There is little information on more recent trends; does garden history stop at the 2nd World War? The massive explosion in popular gardening over the last decade has continued to demand 'new' plants and there is certainly scope for another book on the sources and fashions driving modern garden plants.

The last section of the book gives potted biographies of some of the great plant hunters. I particularly like the illustration showing the great Joseph Hooker collecting *Rhododendron* species in the Himalayas. He is smartly dressed in smoking jacket and turban, comfortably seated under a tree whilst beautiful native maidens scour the surrounding lands for specimens and kneel before him to present their finds. For the armchair botanist this book will do that job for you by bringing the best and most beautiful flowers from around the world into your home.

M. N. SANFORD

Flora Nordica. Volume 2. Edited by B. Jonsell. Pp. xv + 430. The Bergius Foundation, The Royal Swedish Academy of Sciences, Stockholm. 2001. £55. ISBN 9171900373.

The publication of Volume 2 of *Flora Nordica*, only a little over a year after the first volume and more voluminous than it, is a notable event. Apart from feelings of admiration and an eagerness to scan the pages for new ideas and information, it brings to me an element of envy – here is a truly 'Critical Flora', very close in design to the planned 'Flora of Great Britain and Ireland' which failed because of the lack of national funding and absence of a sufficient number of trained taxonomists, both of which have contrived so conspicuously and successfully to produce this Nordic counterpart. The broad features of *Flora Nordica* were summarised by Arthur Chater in his review of Volume 1 (*Watsonia* **23**: 456-457, 2001), so will not be repeated here.

Volume 2 contains accounts of 510 species, 131 infraspecific taxa and 60 hybrids in 114 genera and 18 families, the largest of which are Chenopodiaceae, Caryophyllaceae, Ranunculaceae and Papaveraceae. The accounts were prepared by 29 authors, all based in the Nordic countries. My first action as a user rather than as a reviewer was to scan the pages carefully for treatments diverging from those accepted in our country. I accumulated three pages of them, involving differences in both taxonomic treatments and nomenclatural details. Some of the most significant taxonomic discrepancies are as follows: *Atriplex praecox* considered a subspecies of *A. longipes*; *Salicornia ramosissima* included in *S. europaea*; *Salsola kali* subsp. *iberica* (*ruthenica*) treated as a separate species, *S. tragus*; *Montia fontana* subsp. *chondrosperma* treated as a separate species, *M. minor*; the two morphs of *Spergula arvensis* considered as subspecies; *Sagina apetala* subsp. *erecta* treated as a separate species, *S. micropetala* (yet no mention of *S. filicaulis*); *Silene/Lychnis*

split into five genera, yet *Cucubalus* united with *Silene*; and the northern procumbent *Caltha palustris* recognised as subsp. *radicans* (yet no mention of the relevant work by Kootin-Sanwu & Woodell). Most radical of all is the treatment of *Ranunculus trichophyllus*: of the two subspecies in *Flora Europaea*, ours (*trichophyllus*) is reduced to *R. aquatilis* var. *diffusus*, while subsp. *eradicatus* is raised to specific rank as *R. confervoides*. Most examples in the above list really come down to a matter of opinion, which often diverges from region to region due to different taxonomic traditions and patterns of plant variation. It is likely that some but not all (and perhaps not most) of the Nordic treatments will find favour in Britain. *Flora Nordica* often but not always follows the most recent taxonomic literature; for example, while *Silene* has been further split, and *Roemeria* is included in *Papaver*, *Mahonia* has, surprisingly, been kept separate from *Berberis*. I also think that it is a pity that the family sequence followed is the very outdated Englerian system; more modern ones that could have been used would have more closely mirrored recent molecular-based systems.

In some ways the many nomenclatural differences are more perplexing, for surely one treatment must be right and therefore the other wrong, at least in many cases. I have not had time to analyse the divergences in Volume 2, but the results of a time-consuming study of those in Volume 1, which are only just completed, are instructive. To give two examples: of the six cases in *Salix*, the Kent List was correct in three and *Flora Nordica* in three; of the three cases in the conifers, the Kent List was correct in two and neither correct in the third. Clearly both sources could learn much from the other, yet there has been no cooperation between our countries to this end. Does chauvinism still reign supreme in taxonomy?

To those not intimately familiar with the Nordic flora there are plenty of surprises. For example they have 15 (vice 8) native species of *Stellaria*, four of *Anemone* and four of *Pulsatilla*; *Minuartia verna* is but a rare casual and *Moenchia erecta* does not occur at all; and the figures for *Ranunculus* (33 native species in Norden, 24 in Britain) obscure an even greater difference, since 15 of their 33 species do not occur in Britain. The special case of the apomictic *Ranunculus auricomus* aggregate, which in Scandinavia has for decades been split into hundreds of microspecies (actually treated as microsubspecies until recently) but for which no critical treatment has ever been published in Britain, deserves a mention. In the main account, the aggregate is covered in 18 pages, in which the variation is discussed and illustrated and then summarised by describing four main "grades" of microspecies. The 605 microspecies are not described, but are listed alphabetically together with synonymy, chromosome number, references to full descriptions, and distribution, in a further 16 pages at the end of the volume. I was surprised that the 'grade' to which each microspecies is allocated is not given.

Flora Nordica provides a wealth of data and ideas that will greatly assist any field botanist or taxonomist in his studies of the flora of the British Isles. Although not mentioned until now, it is the discussion under such headings as Variation, Biology and Taxonomy that frequently prove of the greatest value. Such data, singularly lacking in any modern British flora, are what turn an ordinary flora into a critical flora. They produce, for example, accounts of *Honckenya peploides* and *Sagina nodosa* each running to more than two and a half pages. The only major item that I have found lacking is the place of publication for all synonyms except the basionym, for rare casuals, and for most hybrids. *Flora Nordica* deserves our highest praise and should be used as the model to which future flora-writers should aspire.

C.A. STACE

Obituaries

DAVID MCCLINTOCK
(1913–2001)

David McClintock, who was without doubt one of the most distinguished and productive amateur botanists of his generation, died suddenly at his home, Bracken Hill, on Friday 23 November 2001, aged 88. He described himself as a writer, naturalist and plantsman and was all these to a generous degree. More unusually he bridged the gap between botanists and gardeners, working to bring the two together to learn from each other's experiences. He achieved a notable success in this respect in the 1971 Joint Conference between the Royal Horticultural Society and the B.S.B.I., which he had instigated. This occurred during his Presidency of the B.S.B.I. (1971–1973) and it was typical of David that in all the Societies he belonged to he made a significant contribution, not only as an active member, but often also in some office-bearing role.

To many B.S.B.I. members David was known first through the *Pocket Guide to Wild Flowers* (1956), which he wrote with Richard Fitter. In many ways this was David's most influential publication and many British botanists today made their first plant studies in field identification with this book in their hands. The 'Pocket Guide' sold over 250,000 copies and enthused a whole generation of botanists and flower lovers. It is full of original observations and field identification characters. Every plant was assigned an English name and, rather daringly, the plates were arranged by colour (a great boon to the tyro), whilst the star rating system for rarity added much to the thrill of a good find. Astonishingly the whole project had been completed in two years.

David Charles McClintock was born on 4 July 1913 at Jesmond, Newcastle-on-Tyne, the first child and the only son in a family that subsequently included five daughters. His father was a parson and the family moved regularly from parish to parish over a wide area of England. His mother was a Buxton and her large family home at Easneye at Ware in Hertfordshire was the venue for many early family gatherings and David always remembered the house with great affection. His father's family, as the spelling of his surname indicates, were of Northern Irish origin and David was to have a strong link to Ireland and Irish plants all his life.

His formal education began at West Downs prep school in Winchester from where he progressed to Harrow and Trinity College, Cambridge. He read French, German and history, graduating in 1934. A facility and an interest in languages served him well, enabling him ready access to much continental literature and increasing the opportunity to converse and forge friendships with enthusiasts abroad. As a young man he was a keen social sportsman and not above combining such activities with botany. In his unique compendium on British plants and botanists published as *Companion to Flowers* (1966) he recalls as an undergraduate finding pasque flowers (*Pulsatilla vulgaris*) whilst playing a round of golf on the course beside the Devil's Dyke at Newmarket. In the preface to this work he admits that it was written largely on his daily commuting journey to and from London and it was entirely typical of David that no time was ever wasted! In the same preface he confesses to being unable to write 'articles, let alone books, to a plan; they just grow' and this too was typical of the man, all the time his active mind would see so many avenues of interest to be followed up.

After graduation he chose to train as an accountant, qualifying in 1938, the same year he became a Territorial Army officer in the Hertfordshire Yeomanry (a choice reflecting his close association with his mother's old home). During the war years he was for an extended period an intelligence officer and trainer at the Intelligence Training Centre at Matlock in Derbyshire. He had joined the B.S.B.I. in 1935 and, as records in the Society's publications show, also used his time effectively in Derbyshire to hunt for plants (e.g. *Valerianella carinata*, Millers Dale, 1942). Following a period at the Civil Affairs Training Centre in London, he exercised his considerable administrative and logistic skills in organising parts of occupied Germany, where he rose to the rank of Lieutenant-Colonel.

In 1940 he had married (Elizabeth) Anne Dawson, who shared his interest in plants and indeed had joined the Wild Flower Society before him. His field notebooks recall their joint wartime visit with Canon Raven to see grass-poly (*Lythrum hyssopifolia*) in arable fields near Newmarket. This

locality became 'lost' to local botanists until 2001 when it was refound quite by chance, thousands of plants still growing happily in winter wet hollows. He was much amused by its 'reappearance' and it says much for his records that he could lay hands on his account without hesitation.

After a few years at Withyham, near Tunbridge Wells, the McClintocks settled in the village of Platt, near Sevenoaks, where David's father had the living and two of his children were subsequently baptised there by their grandfather. The three acre garden at Bracken Hill developed to reflect his multifarious botanical and horticultural interests and he was never happier than when conducting visitors around his plants, sharing bits and talking of their provenance. The beds were full of self-sown seedlings of great British rarities (*Filago gallica*, *Briza minor*, *Tuberaria guttata*) but there were important collections of two groups about which David became an internationally known expert: bamboos and heathers. He held the National Collection of the bamboo genus *Sasa* and contributed accounts of bamboos to several standard texts (most notably the *European Garden Flora*, a publication he had some part in initiating). Heathers though were an abiding enthusiasm and for many years David was the leading figure in the Heather Society, finally acting as its President from 1990–2000. He engineered strong links with professional and amateur growers, regularly broadcasting on the value of heathers as garden plants. He initiated and maintained the International Register of heather cultivars, finding many novelties himself. One of these, a pretty pinky mauve-tipped, white-flowered form of Dorset Heath was named in his honour: *Erica ciliaris* 'David McClintock'. It is a charmer and a fitting tribute.

David travelled widely throughout Europe to see heathers in the wild and reckoned to have seen all but one of the northern hemisphere taxa: the only exception being the Libyan endemic *Erica sicula* subsp. *cyrenaica*. Even for him this was a trip too difficult to arrange! It was on an expedition in 1999 to see another form of this species in Mount Cofano in Sicily that he fell down a scree slope, necessitating an air lift to hospital and 40 stitches in a head wound. He appeared to make a remarkable recovery and made little of the whole affair.

His professional career centred on the Coal Utilization Council from 1951–1973, where he became chief accountant and administrative officer. The job required travel all over the country and once again B.S.B.I. publications and countless records and acknowledgements in county floras bear witness to how he was able to use these trips to good effect. Family holidays were also similarly well arranged. He succeeded in recording over 3000 species in the British Isles and must have been to virtually every corner of the realm and seen every rarity. Aliens were always a particular interest and I remember a day over 30 years ago when my mother and I saw a tall, slim, erect, white-haired figure approaching us across Guildford tip. He had come on the off-chance of seeing *Silphium perfoliatum* which we had recorded as established there for several years and saw it he did!

All his finds were faithfully recorded in his Wild Flower Society Diary. David had joined the W.F.S. in 1934 and throughout his life devoted much thought, time and energy to its affairs, acting as its Chairman from 1981–1993 and treasurer from 1978–1982. For decades he contributed numerous pithy reviews of publications to its quarterly magazine and for many years produced a digest of alien plant records in his 'Exotics' report: a mine of information for alien plant enthusiasts at a time when little else was being published.

The offices of the C.U.C. were a few hundred yards from the R.H.S. exhibition halls and Lindley Library in London and David regularly attended the Shows, exhibiting in the heather competitions and serving on the Society's Scientific Committee from 1978–1994, latterly as vice-chairman and on its Publications Committee from 1982–1987. He was influential in setting up the R.H.S. journal *The Plantsman*, and was a regular contributor to its pages. He took a particular interest in the Society's National Heather Collection at Wisley. For his tremendous contribution to horticulture the Society awarded him its Gold Veitch Memorial Medal in 1981 and then in 1995 its highest accolade, the Victoria Medal of Honour.

His contribution and service to the B.S.B.I., of which he was made an honorary member in 1994, is evident from the list of publications below. He was a regular exhibitor at the Annual Exhibition meeting and acted as a referee for *Erica* from 1983–2001, to which he added *Calluna* and *Daboecia* in 1995. For 19 years (1976–1995) he was also referee for garden plants and bamboos and must have helped hundreds of people as a result. Of particular significance was his role as Recorder for the Channel Islands (excluding Jersey) a position he held from 1961–1996. Apparently his interest in the area stemmed from an involvement in the late 1940s with an early air service to Guernsey (using an aircraft locally called "The Pig") and a fascination with what he found on the old airstrip at L'Erée.



David McClintock drawn by Raymond Piper, 1978. Reproduced by kind permission of Andrew McClintock.

His infectious enthusiasm and organising ability were never put to better effect than in the preparation of his *Wild Flowers of Guernsey* (1970) which was a highly individual presentation of the island's flora. Several B.S.B.I./W.F.S. meetings were organised to help in the recording and David was assiduous in getting every relevant expert to comment on their group of plants. For 50 years he visited the Islands at least once every year and on 26 September 1996 the Société Guernesiaise, of which he was also an honorary member, held a special gathering to celebrate his first visit 50 years before to the day.

David was quietly but intensely proud of his association with the recording of the native, naturalised and cultivated plants in the garden at Buckingham Palace and the impetus he gave to others to study all aspects of its natural history. He visited the garden probably once a month for several decades and his first botanical survey was published in 1964. In 1999 the London Natural History Society (of which he was President at the time of his death) published his second botanical survey as part of a wide-ranging account of the garden's plants and animals. He was on the point of writing up a giant hogweed from the grounds as new to science and it was a particular disappointment to him that a fuller account of the history of the garden and its cultivated plants, on which he had been working, was not published as planned in 2001, having been delayed by Palace officials.

His record of service and contribution to a wide range of other Societies was equally impressive and it is impossible to do full justice to them all in this account. He was a Council member, vice-president and one-time editor for the International Dendrology Society, joining many of their tours (sometimes as leader) and responsible for long accounts of these in their Year Books. He served in similar capacities for the Linnean Society and frequently attended their meetings, receiving their H. H. Bloomer award for his contribution to natural history in 1993. He was a founder member of the Garden History Society, the Kent Field Club, the Kent Trust for Nature Conservation and the Kent Ornithological Field Club. He had at one time been a Council member and President of the Ray Society. Most of us would have felt satisfied with half these achievements!

In all it has been reported that David contributed to or wrote some 25 books, published literally hundreds of notes and papers and well in excess of 2500 book reviews. He was an equally assiduous and prodigious correspondent, his huge daily post bag always receiving prompt attention. The problem would come for the recipients of his communications, which were either written in turquoise ink in an almost indecipherable hand or bashed out on an old typewriter using a telegraphic style that needed careful study to understand (I'm sure David reckoned it all cut down the time to finish the job!) He was well aware of this fault and in *Companion to Flowers* highlights an anecdote about A. H. Wolley-Dod who clearly had a similar problem.

This is not to say that David was in any way slapdash in his approach. He was blessed with an amazingly retentive memory and worked meticulously on any script, checking every detail. He was, however, never best pleased at the results of anyone else's editing! Perhaps inevitably in an individual of decided views about how things should or needed to be done, he occasionally came up against those who disagreed and sometimes seemed genuinely puzzled as to why others did not take the course he thought most appropriate.

In the field David was an energetic worker and an acute observer of plants. He delighted in recording variants of native plants, often devoting time to seeking out the relevant epithet or coining one himself. From his earliest plant records it is clear that he took an interest in both alien and native plants and that his interest did not stop at the garden gate is manifest. He was a rare individual in so enthusiastically embracing plants wild and cultivated so effectively. A large part of his time was devoted to communicating about plants through his writing, talks, broadcasts and field meetings. He leaves us with an astonishing legacy.

In what little time remained from plants David enjoyed listening to classic music and at one time was a keen tennis player and skier. He always said that his request to anyone travelling abroad to bring back sugar wrappers was for a daughter who collected them but it was clear he took as much pleasure in the collection as she did!

David made meticulous arrangements for the disposal of his books and herbarium specimens. All his heather books and specimens have gone to the R.H.S. at Wisley; he claimed to have virtually every edition of every heather book published. The British Museum, Kew and the Linnean have been given first choice on the remainder of several thousand volumes and the rest will be sold. His bamboo herbarium specimens are to be presented to Kew and the remainder to

the British Museum. His National Collection of *Sasa* plants is to be saved and moved to another site. The house and garden are to be sold and the family hope this will be to an enthusiastic gardener.

Anne McClintock died in 1993, but he is survived by two sons, two daughters, eight grandchildren and two great grandchildren. Many will mourn the passing of a fine, gifted, generous and kindly man who so richly deserved the award of the M.B.E. 'for services to botany' of which he was informed shortly before he died.

ACKNOWLEDGMENTS

In preparing this account I have been given considerable assistance by the following individuals: Mrs Joanna Chisholm (daughter), Mrs Kathleen Kinahan (sister), Mrs Mary Briggs, Charles Nelson, David Small, Chris Brickell and Mrs Patience Ryan.

SELECTED LIST OF PUBLICATIONS

The following is a highly selective list of David McClintock's publications. It aims to include everything he published in the various journals of the B.S.B.I. together with all his books and other floristic lists. A full account of all his publications would be two or three times longer than this as David published regularly and extensively in journals of the Heather Society and the Wild Flower Society as well as intermittently in, amongst others, *The Plantsman/New Plantsman*, *The Garden*, *Report and Transactions of the Société Guernésiaise*, *Bulletin of the Kent Field Club*, *Irish Naturalists' Journal*, *Country Life*, *The Countryman*, *Year Book of the International Dendrology Society*, *Deutsche Baumschule*, *Botanical Journal of the Linnean Society*, *Glasra*, *Kew Bulletin*, *Bamboo Society Newsletter*, *Gardeners' Chronicle*, *Taxon*, *Karaca Arboretum Magazine*, *Die Heidegarten*, *Glasgow Naturalist*, *Moorea*, *Daffodil and Tulip Year Book*, *Plant Life*, *Cornish Gardener*, *Hortus*, *Zahradnictvie*, *The Living Countryside* and *De Levende Natuur*. In all David reckoned to have contributed to over 90 periodicals. A listing of all his heather publications is to appear in the *Yearbook of the Heather Society for 2002*, pp. 8–14 (March 2002).

1952

Plant note – *Urtica urens*. *Watsonia* 2: 287.

1953

(With J. E. Lousley) Field meeting report – April 6th, 1952 Ashford (Kent). *BSBI Year Book* 1953: 33–34.

(With E. F. Warburg) Plant note – *Cistus incanus* L. *Watsonia* 2: 412.

1955

Plant note – *Matthiola sinuata* (L.) R. Br. *Proceedings of the Botanical Society of the British Isles* 1: 320.

Plant note – *Anthyllis vulneraria* L. *Proceedings of the Botanical Society of the British Isles* 1: 320.

1956

(With R. S. R. Fitter) – *Collins pocket guide to wild flowers, including trees, shrubs, ferns, grasses and sedges*. Collins, London.

1957

Obituary – Hilda Sophia Annesley Dent (1903–56). *Proceedings of the Botanical Society of the British Isles* 2: 325.

Exhibition meeting report – *Aremonia* still in Britain. *Proceedings of the Botanical Society of the British Isles* 2: 301.

Exhibition meeting report – *Lagarosiphon major*. *Proceedings of the Botanical Society of the British Isles* 2: 301.

Exhibition meeting report – An American species possibly native in Europe. *Proceedings of the Botanical Society of the British Isles* 2: 301–302.

Supplement to the pocket guide to wild flowers. Privately published, Platt.

1958

Short note – *Hypericum canadense* L. in western Ireland. *Watsonia* 4: 145.

Exhibition meeting report – A narrow-leaved form of *Epilobium pedunculare*. *Proceedings of the Botanical Society of the British Isles* 3: 95.

Exhibition meeting report – *Saxifraga harti*. *Proceedings of the Botanical Society of the British Isles* **3**: 95–96.

1960

Exhibition meeting report – Alien lawn weeds. *Proceedings of the Botanical Society of the British Isles* **4**: 82.

1961

(With F. Le Sueur) – A check list of the flowering plants and ferns wild on Herm and its off-islets. *Report and Transactions of the Société Guernesaise* **17**: 36–48.

1962

The ferns of the Channel Islands. *British Fern Gazette* **9**: 34–37.

Additions to the flora of Jura. *Transactions and Proceedings of the Botanical Society of Edinburgh* **39**: 343–344.

1963

Exhibition meeting report – The *Oxytropis* in Kintyre. *Proceedings of the Botanical Society of the British Isles* **5**: 170.

Old records. In *Local Floras*. B.S.B.I. Conference Report no. 7: 59–68.

(With F. Le Sueur) – A checklist of flowering plants and ferns wild on Sark and its off-islets. *Report and Transactions of the Société Guernesaise* **17**: 303–318.

1964

Plant note – *Pteris vittata* L. *Proceedings of the Botanical Society of the British Isles* **5**: 337–338.

Plant note – *Vinca major* subsp. *hirsuta* (Boiss.) Stearn. *Proceedings of the Botanical Society of the British Isles* **5**: 341–342.

Exhibition meeting report – *Trichomanes* in wells. *Proceedings of the Botanical Society of the British Isles* **5**: 170–171.

Wild and naturalised vascular plants. In: Natural history of the garden of Buckingham Palace (with O. W. Richards and M. Knight). *Proceedings of the South London Entomological & Natural History Society* 1963: 14–25.

Cultivated plants. In: Natural history of the garden of Buckingham Palace (with O. W. Richards and M. Knight). *Proceedings of the South London Entomological & Natural History Society* 1963: 26–35.

Bryophytes and fungi. In: Natural history of the garden of Buckingham Palace (with O. W. Richards and M. Knight). *Proceedings of the South London Entomological & Natural History Society* 1963: 36–38.

1965

Exhibition meeting report – *Ambrosia psilostachya* established in Scotland. *Proceedings of the Botanical Society of the British Isles* **6**: 172.

Plant note – *Solanum dulcamara* L. *Proceedings of the Botanical Society of the British Isles* **6**: 50–51. Reporting on a stem 21 feet 8 inches long.

(With F. Le Sueur) – A check list of the flowering plants and ferns wild on Alderney and its off-islets. *Report and Transactions of the Société Guernesaise* **17**: 565–582.

1966

Exhibition meeting report – *Erica tetralix*, *E.* × *praegeri* and *E. mackaiana*. *Proceedings of the Botanical Society of the British Isles* **6**: 276.

Exhibition meeting report – Bamboos in flower. *Proceedings of the Botanical Society of the British Isles* **6**: 277–278.

Companion to flowers. G. Bell & Sons, London

1967

Plant note – *Melica uniflora* forma *albida* P. Junge. *Proceedings of the Botanical Society of the British Isles* **6**: 391.

Exhibition meeting report – *Erica ciliaris* in Ireland. *Proceedings of the Botanical Society of the British Isles* **7**: 79.

Exhibition meeting report – The Irish heather. *Proceedings of the Botanical Society of the British Isles* **7**: 79–80.

1968

Plant note – *Vinca major* subsp. *hirsuta* (Boiss.) Stearn. *Proceedings of the Botanical Society of the British Isles* **7**: 26.

Further notes on *Erica ciliaris* in Ireland. *Proceedings of the Botanical Society of the British Isles* **7**: 177–178.

Exhibition meeting report – *Eriocaulon aquaticum* (*E. septangulare*) in Ardnamurchan. *Proceedings of the Botanical Society of the British Isles* **7**: 509.

Plant note – *Vinca major* L. – production of fruit. *Proceedings of the Botanical Society of the British Isles* **7**: 191–192.

Exhibition meeting report – Bamboo seed. *Proceedings of the Botanical Society of the British Isles* **7**: 510.

- Exhibition meeting report – *Aster macrophyllus* L. and *A. schreberi* Nees. *Proceedings of the Botanical Society of the British Isles* 7: 510.
- Exhibition meeting report – *Pilosella flagellaris* (Willdenow) Sell & C. West subsp. *bicapitata* Sell & C. West. *Proceedings of the Botanical Society of the British Isles* 7: 509–510.
- Exhibition meeting report – *Symphytum leonhardtianum* Pugsley and *S. tuberosum* L. *Proceedings of the Botanical Society of the British Isles* 7: 509.
- Plant note – *Asplenium billotii* × *Phyllitis scolopendrium* = × *Asplenophyllitis microdon* (T. Moore) Alston. *Proceedings of the Botanical Society of the British Isles* 7: 387–389.
- Plant note – *Epilobium hirsutum* L. – Pink flowered forms. *Proceedings of the Botanical Society of the British Isles* 7: 390.
- (With P. F. Yeo) Plant note – *Geranium ibericum* Cav., *G. platypetalum* Fisch. & Mey. and *G. × magnificum* Hyl. *Proceedings of the Botanical Society of the British Isles* 7: 389.
- 1969
- Field meeting report – Mayo and Galway. 14th–20th April. *Proceedings of the Botanical Society of the British Isles* 7: 634.
- A guide to the naming of plants: with special reference to heathers*. The Heather Society. Second edition 1980.
- 1970
- Short note – *Geranium submolle* Steud. (or *G. core-core* Steud.) – In the Channel Isles. *Watsonia* 8: 47.
- Exhibition meeting report – The flora of Guernsey. *Watsonia* 8: 89–90.
- Field meeting report – Guernsey. 11th–20th April. *Watsonia* 8: 183–184.
- 1971
- Book review – Nightshades. The paradoxical plants (C. B. Heiser, Jr.). *Watsonia* 8: 320–321.
- Exhibition meeting report – The Guernsey flora in 1969. *Watsonia* 8: 335.
- Exhibition meeting report – *Chenopodium pumilio* – a Kentish obituary? *Watsonia* 8: 335–336.
- Field meeting report – Guernsey. 29th May–7th June. *Watsonia* 8: 428–429.
- 1972
- Exhibition meeting report – New Zealand *Epilobium* species in the British Isles. *Watsonia* 9: 60.
- Exhibition meeting report – How many seeds? *Watsonia* 9: 60.
- Exhibition meeting report – *Gaudinia fragilis*. *Watsonia* 9: 60.
- Exhibition meeting report – The Guernsey flora 1970. *Watsonia* 9: 60–61.
- Presidential address – The common ground of wild and cultivated plants. *Watsonia* 9: 73–79.
- Exhibition meeting report – The naming of narcissi. *Watsonia* 9: 201.
- Exhibition meeting report – Double-flowered *Calluna*. *Watsonia* 9: 201.
- Exhibition meeting report – Guernsey 1971. *Watsonia* 9: 201.
- (With J. B. Marshall) Exhibition meeting report – *Conyza* in Britain. *Watsonia* 9: 201–202.
- (With J. L. Mason) Exhibition meeting report – Bird-seed aliens. *Watsonia* 9: 202.
- Exhibition meeting report – New Zealand epilobiums in Britain. *Watsonia* 9: 140–142.
- Obituary – William Jocelyn Lewis Palmer (1894–1971). *Watsonia* 9: 178–179.
- Field meeting report – Guernsey. 9th–18th July. *Watsonia* 9: 184–186.
- President's introduction. *BSBI News* 1(1): 2–3.
- President's introduction. *BSBI News* 1(2): 22–23.
- President's introduction. *BSBI News* 1(3): 46–47.
- 1973
- Exhibition meeting report – *Heracleum sphondylium* × *H. mantegazzianum*. *Watsonia* 9: 429–430.
- Book review – August Garcke. *Illustrierte Flora – Deutschland und angrenzende Gebiete – Gefasskryptogamen und Blütenpflanzen* (ed. K. von Weihe). *Watsonia* 9: 402–403.
- Book review – Wildlife conservation in woodlands (R. C. Steele). *Watsonia* 9: 289.
- (With M. J. P. Scannell) Exhibition meeting report – Double-flowered forms of *Erica mackaiana*. *Watsonia* 9: 432.
- President's introduction. *BSBI News* 2(1): 2.
- President's introduction. *BSBI News* 2(2): 23–24.
- Mnemonics for plants. *BSBI News* 2(2): 34.
- 1975
- Short note – A note on *Fascicularia*, *Ochagavia* and *Rhodostachys*. *Watsonia* 10: 289–290.
- Book review – Culinary herbs (M. Page & W. T. Stearn). *Watsonia* 10: 312–313.
- Book review – Wild flowers of British Columbia (L. J. Clark). *Watsonia* 10: 313.
- Exhibition meeting report – The Guernsey flora in 1974. *Watsonia* 10: 468.

Exhibition meeting report – *Gunnera* in the British Isles. *Watsonia* **10**: 467–468.
 Exhibition meeting report – Heathers in Madeira and the Azores. *Watsonia* **10**: 467.
 Exhibition meeting report – Hairy-stemmed polygonums. *Watsonia* **10**: 467.
 (With J. D. Bichard) – *Wild flowers of the Channel Islands*. Chatto & Windus, London.
The wild flowers of Guernsey. Collins, London.
Early records of Guernsey plants. Channel Islands Anthology no. 3. Toucan Press, Guernsey.

1976

Book review – The rural tradition (W. J. Keith). *Watsonia* **11**: 86.
 (With K. Hollick) Exhibition meeting report – *Echinops* in Britain. *Watsonia* **11**: 179.
 Exhibition meeting report – The Guernsey flora in 1975. *Watsonia* **11**: 179.
 Exhibition meeting report – Some aberrant heathers. *Watsonia* **11**: 180.
 Exhibition meeting report – A new *Oenothera*. *Watsonia* **11**: 180.
The life of Joshua Gosselin of Guernsey, 1739–1813. Toucan Press, Guernsey.

1977

J. E. Lousley and plants alien in the British Isles. *Watsonia* **11**: 287–290.
 Exhibition meeting report – The Guernsey flora in 1976. *Watsonia* **11**: 429.
 (With F. H. Perring & R. E. Randall) Picking wild flowers: a fully illustrated description of those it is safe to collect. Jarrold, Norwich.

1978

Field meeting report – Guernsey. May 27th–June 2nd. *Watsonia* **12**: 65.
 Book review – Tree rings and climate (H. C. Fritts). *Watsonia* **12**: 58.
 Book review – Wild flowers of Britain (R. Phillips). *Watsonia* **12**: 183.
 Exhibition meeting report – A new form of broom. *Watsonia* **12**: 195.
 Exhibition meeting report – *Oenotheras* in Britain. *Watsonia* **12**: 195.
 Exhibition meeting report – *Digitalis* × *purpurascens* Roth. *Watsonia* **12**: 195.
 Exhibition meeting report – Three variegated plants. *Watsonia* **12**: 195.
 Exhibition meeting report – *Erica tetralix* L. var. *quinaria* Guffroy. *Watsonia* **12**: 192.
 (With P. R. Brough) – Heathers with parts in fives and sixes. *Watsonia* **12**: 156–157.
 Exhibition meeting report – *Veronica crista-galli* Stev. in the British Isles. *Watsonia* **12**: 196.

1979

The status of, and correct name for, *Erica* ‘Stuartii’. *Watsonia* **12**: 249–252.
 Exhibition meeting report – *Daboecia cantabrica* (Huds.) C. Koch with a split corolla. *Watsonia* **12**: 396.
 Book review – Flora of the Isle of Wight (J. Bevis, R. Kettel & B. Shepard). *Watsonia* **12**: 372–373.
 (With M. Marsden) – A revised check list of flowering plants and ferns wild on Sark and its off-islets. *La Société Guernesiaise*. St Peter Port.

1980

Bamboos. Report on talk at B.S.B.I. conference, Manchester. *Watsonia* **13**: 74.
 Short note – Descriptive key to bamboos naturalized in the British Isles. *Watsonia* **13**: 59–61.
 Short note – *Erica* × *stuartii* E. F. Linton – a correction. *Watsonia* **13**: 59.
 Exhibition meeting report – A small form of *Poa annua* L. *Watsonia* **13**: 167.
 Exhibition meeting report – *Crassula decumbens* Thunb. and *C. macrantha* Diels & Pritzel. *Watsonia* **13**: 167–168.
 Exhibition meeting report – Schizopetalous *Erica cinerea* L. *Watsonia* **13**: 168.
 (With J. do Amaral Franco) – Accounts of *Sasa* and *Arundinaria* in *Flora Europaea* **5**: 124–125.

1981

Book review – A Guinness book of wild flowers (M. Briggs). *Watsonia* **13**: 235.
 Book review – Flora of New Zealand. Vol. 3 (A. J. Healy & E. Edgar). *Watsonia* **13**: 351–352.
 Book review – Discovering botany (P. F. Hunt). *Watsonia* **13**: 236.
 (With W. T. Stearn) Exhibition meeting report – A new hybrid *Symphytum*. *Watsonia* **13**: 367.
 Help with the alien flora *BSBI News* **27**: 14. (This Flora never appeared but Eric Clement now has the plates that were drawn, is augmenting their number and hopes to get them published.)
 Long bramble. *BSBI News* **27**: 31.
 English names of wild flowers. *BSBI News* **28**: 23.

1982

Short note – *Sambucus racemosa* L. sensu lato. *Watsonia* **14**: 74–76.
 Short note – The story of *Cymbalaria toutonii* A. Chev. *Watsonia* **14**: 182–183.

Exhibition meeting report – *Sasaella ramosa* (Makino) Makino at Kew. *Watsonia* **14**: 231.
 Book review – Collins guide to the pests, diseases and disorders of garden plants (S. Buczacki & K. Harris).
Watsonia **14**: 212.

Dorset or ciliate heath. *BSBI News* **30**: 23.

Guernsey's earliest flora. *Flora Samiensis* by Joshua Gosselin, "began in 1788". Ray Society, London

1983
 (With A. Melderis) – The genera *Elymus* L. & *Leymus* Hochst. in Britain. *Watsonia* **14**: 391–395.

(With E. C. Nelson) Exhibition meeting report – *Erica andevalensis* Cabezudo & Rivera and other new heathers from Spain. *Watsonia* **14**: 454.

(With S. Thomas) Exhibition meeting report – *Milium scabrum* Rich. *Watsonia* **14**: 457.

1984
 Book review – An Irish florilegium. Wild and garden plants of Ireland (W. Walsh & E.C. Nelson). *Watsonia* **15**: 49.

Short note – Discoid daisies. *Watsonia* **15**: 119.

Exhibition meeting report – *Daboecia* with erect flowers. *Watsonia* **15**: 169.

White *Ericaceae* in the wild. *BSBI News* **36**: 33.

Accounts of the genera *Phyllostachys*, *Shibataea*, *Semiarundinaria*, *Otatea*, *Pleioblastus*, *Chimonobambusa*, *Sasa*, *Indocalamus*, *Sasaella*, *Sasamorpha*, *Pseudosasa* and *Chusquea* in *The European Garden Flora* **2**: 56–65.

1985
 Short note – *Bellis perennis* L. var. *discoidea* Hus. *Watsonia* **15**: 273.

Book review – An Irish flower garden (E. C. Nelson). *Watsonia* **15**: 285.

Book review – The European Garden Flora. Vol. 2. Monocotyledons (part 2). (Ed. S. M. Walters *et al.*).
Watsonia **15**: 284–285.

Conyza. *BSBI News* **40**: 11.

1986
 Book review – Flora of Jersey (F. Le Sueur). *Watsonia* **16**: 96–97.

Conference Report – The alien flora of Guernsey. *Watsonia* **16**: 218.

Harmonising botanical and cultivar classification, with special reference to hardy heathers. *Acta Horticulturae* no. 182: 277–283.

1987
 Supplement to the wild flowers of Guernsey. La Société Guernesiaise, St Peter Port.

1988
 The heathers of the Lizard. The Cornish Garden Society, Falmouth.
 (With J. B. Marshall) – On *Conyza sumatrensis* (Retz.) E. Walker and certain hybrids in the genus. *Watsonia* **17**: 172–173.

Book review – Planting a bible garden. (F. N. Hepper). *Watsonia* **17**: 204.

Bamboos. In: *Plant Crib*: 137–138.

1989
 Exhibition meeting report – Blue-flowered *Allium vineale*. *BSBI News* **51**: 50.
Calluna in Crete? *BSBI News* **53**: 58.

Exhibition meeting report – *Erica anthura* Link, a good species? *BSBI News* **51**: 50.

Exhibition meeting report – *Erica vagans* L. *BSBI News* **51**: 50.

Mini herbaria. *BSBI News* **52**: 11.

The wild and naturalised plants of the island of Brecqhou. *Report and Transactions of the Société Guernesiaise* **22**: 435–452.

More mobile flora. *BSBI News* **51**: 11.

1990
 Exhibition meeting report – *Erica bocquetii* Pesmen. *BSBI News* **54**: 51.

1992
 Obituary – John Alfred Codrington (1898–1991). *Watsonia* **19**: 53–54.
 On reaching 60. *BSBI News* **60**: 3.
 Dorothea Eastwood (1912–1961) – a memoir. *BSBI News* **60**: 31–33.
 Exhibition meeting report – Lt.-Col. John Codrington 1898–1991. *BSBI News* **60**: 65.

1993
 Obituary – Jocelyn Mary Lewis Russell (1905–1992). *Watsonia* **19**: 201–203.
 Exhibition meeting report – Jocelyn Russell (1906–1992). *BSBI News* **63**: 52.

1995

Obituary – Kathleen Margaret Hollick (1913–1993). *Watsonia* **20**: 322.

1996

Ecotypic distinction in *Herniaria ciliolata*? *BSBI News* **73**: 31.

1997

Obituary – Violet Vere Charlotte Schwerdt MBE (1900–1996). *Watsonia* **21**: 414–415.Book review – A natural history of Guernsey, Alderney, Sark and Herm (B. & J. Bonnard). *Watsonia* **21**: 293.Pink sports on yarrow. *BSBI News* **77**: 59.

1998

Profile – Richard Fitter. *BSBI News* **79**: 7.Obituary – Lady Ricketts (1919–1998). *BSBI News* **78**: 5.

1999

Verbascum virgatum near Milton, Oxfordshire. *BSBI News* **82**: 26–27.(With M. Lane & C. Bowl) – Buckingham Palace garden: geology, history and layout. In: The natural history of Buckingham Palace garden, London. Part 1. Supplement to *The London Naturalist* **78**: 5–8.(With E. Wiltshire) – Wild and naturalized plants in Buckingham Palace garden, 1995–1998. In: The natural history of Buckingham Palace garden, London. Part 1. Supplement to *The London Naturalist* **78**: 27–43.(With M. Lane) – Garden plants in Buckingham Palace garden. In: The natural history of Buckingham Palace garden, London. Part 1. Supplement to *The London Naturalist* no. **78**: 45–48.

2000

Yorkshire hospitality. *BSBI News* **84**: 30.*Melica uniflora* f. *albida*. *BSBI News* **85**: 19.*Glechoma hederacea* f. *rosea* (alas). *BSBI News* **85**: 20.

ALAN LESLIE

LILY BRED A BURT

1918–2001

With regret we report the death of Breda Burt on 11 November 2001. Breda, as she was known, was a B.S.B.I. member since 1963 and v.c. Recorder for East Sussex, v.c. 14 from 1984–1993. For most of her life Breda lived in the two adjacent small parishes of Iden and Playden near Rye in East Sussex and she had a very comprehensive knowledge of the flora of that area. Breda qualified with LRAM and taught music for a short time, then, after marrying Ernie Burt, she moved across the parish boundary to Boonsfield Farm in Playden. Here many botanists visited and were ensured of a warm welcome, hospitality and help with plant queries and localities.

Through the Sussex Flora Society Breda was a major contributor to *Sussex Plant Atlas* (P. C. Hall 1980), gaining a wider knowledge of local Sussex plants. From 1984, as B.S.B.I. v.c. Recorder, Breda became East Sussex Recorder for the renamed Sussex Botanical Recording Society (SBRS), through which she contributed many records towards the Sussex plant database, monitored rare plants in East Sussex and contributed records to B.S.B.I. projects e.g. the B.S.B.I. Monitoring Scheme 1987–1988 published by J.N.C.C. as *A sample survey of the flora of Britain and Ireland* 1995 and the B.S.B.I. Scarce Plants Survey published by J.N.C.C. as *Scarce Plants in Britain* 1994. Breda was an industrious but modest Recorder, diffident about her knowledge (more so than she had need to be) but always willing to check and look for or help others to find required records. Breda was always cheerful and a good companion.

With her husband, Breda was involved in the early planning and running of the Rye Harbour National Nature Reserve, recording and monitoring the botanical treasures there; they led numerous field meetings there and to other parts of eastern East Sussex and lectured widely in Sussex on local plants. They also travelled around Britain with other B.S.B.I. members to see species from further afield. Later, I had the pleasure of taking them on many botanical holidays abroad; they were splendid travelling companions, interested in everything, but Breda particularly

in the plants and Ernie in the farming and farm machinery. At home, surrounded by botanical books, Breda kept some of these on a trolley, with her card index, current specimens and her assorted notes, on wheels to be trundled from room to room for easy access and continuous use! But I remember that one of her great pleasures in life was walking daily the fields of their farm where she had lived for so many years. Botanising went alongside the sheep farming and Breda was acquainted with every plant in every hedgerow: vascular plants, ferns, bryophytes, lichens and fungi and she made a special study of the hedgerow *Rosa* species and hybrids, of which the identifications were confirmed for her by the Referees.

Soon after Ernie's death, Breda's health also failed, with Alzheimer's disease taking its toll. She will be sadly missed and we send sympathy to their son Michael and his family, the grandchildren and great-grandchildren.

MARY BRIGGS

ANDREW JOHN CADOUX MALLOCH

1945–2001

Andrew Malloch, a member of the Society for nearly 40 years, died last year at the early age of 56. His boyhood was spent in Somerset and Surrey, where he attended Tiffins School, Kingston-upon-Thames. He soon acquired a deep interest in many aspects of natural history, including bryophytes. He read Natural Sciences at Cambridge, graduating in Botany. It was there that he came under the stimulating influence of David Coombe and the then recently retired Alex 'Sandy' Watt. Not surprisingly he chose an ecology research project with a Lizard and Land's End emphasis: analysing cliff-top vegetation in south-west England. Cliff-top vegetation in general was a subject which was to interest him for the rest of his life. It was while at Cambridge that he met Rachel, a Botany undergraduate, who he subsequently married.

In 1972 Andrew took up his first, and only post as lecturer in the Biology Department at Lancaster University, then headed by Donald Pigott. With the introduction of a degree in Ecology Andrew became its first director, serving for many years. He took a keen interest in the developing Flora of Cumbria project and in 1981 he started producing the software programs enabling us to develop and manipulate the tetrad data base and produce distribution maps. These programs were progressively refined and no one looking at the final Flora can doubt the value of his input. With the start of the National Vegetation Classification, based at Lancaster, Andrew was one of the team working under the Director, John Rodwell, and he played a vital role in the development of techniques for vegetation analysis. At the same time he refined the Cumbria programs and made them more generally applicable, combining them with the vegetation analysis and classification programs in the popular Vespan package. He continued working on this, producing the third, 'Windows', version in 1999.

Andrew was a prominent member of the British Ecological Society and served for eight years as its general secretary. With Jonathan Mitchley he co-authored the *Sea cliff management handbook* (1991) and co-edited with me *Wildflowers: their habitats in Britain and northern Europe* (1981).

He was a staunch member of the Lancaster Quaker Meeting and a supporter of the local Haffner Orchestra. A dedicated teacher and adviser, Andrew was always ready to put aside his work and listen to students' problems. One couldn't have asked for a more helpful or considerate colleague.

Andrew suffered from a congenital heart defect which necessitated major surgery in 1977. Although benefitting from this he was to suffer recurring bouts of infection. With increasing weakness he took early retirement in 1998, though continuing to supervise students and to improve Vespan. He bore his ill health bravely, actively participating on student excursions and the annual field course to Loch Lomond.

Fittingly, the final N.V.C. volume of *British Plant Communities*, published in his last year, included his major contribution on sea-cliff vegetation. This kind, unassuming man will long be remembered not only by his family but by all who had the privilege to know and work with him.

GEOFFREY HALLIDAY

ANDREW A. DUDMAN
(1930–2001)

Andrew Dudman was a schoolteacher who embraced field botany relatively late in life. However, he dedicated several of his later years to *Taraxacum*, and was a co-author of the B.S.B.I. Handbook on Dandelions. He was also an important contributor to A Flora of Cumbria.

Andrew was raised in the London area, attending Highgate School before going to Oxford to read English. Although artistic by nature, with a passionate interest in philosophy and the theatre, Andrew was also keenly interested in a wide range of scientific and mathematical subjects, perhaps stimulated by his physicist father. In fact, following his retirement, Andrew gained a science degree from the Open University.

After graduation he spent a year in the States on a scholarship before taking up a post in the Civil Service, but he soon abandoned administration for a career in teaching. He moved to Manchester, where he met his wife Elaine, and taught at the William Hulme School for Boys.

In 1968 Andrew and Elaine moved to west Cumberland for Andrew to take up the post of head of the sixth form at Whitehaven Grammar School. At Whitehaven, Andrew became very friendly with the head of Biology, the late Chris Haworth, both being passionately concerned with conservation issues. As a member of 'Friends of the Earth' Andrew became deeply involved in the Sellafield 'Thorp' Public Inquiry. In time Andrew also caught Chris's infectious enthusiasm for field botany, joining the B.S.B.I. in 1980 and being a regular participant at Flora of Cumbria field meetings from 1982. Both Andrew and Chris played an indispensable role in collecting data for the Flora, particularly in west Cumbria. After Chris's untimely death in 1990, at the age of 50, Andrew was left, our only active botanist in the west, valiantly soldiering on.

During the 1980's, Chris devoted much of his spare time to an intensive study of *Taraxacum*. Together with AJR, considerable advances were made in the understanding of this complex genus in the British Isles, and plans were laid to write a definitive account of British and Irish dandelions as a B.S.B.I. Handbook. When Chris died, Andrew made a huge personal commitment to shoulder the burden that Chris had embraced, and particularly to mediate the publication of the Handbook. This caused Andrew to acquire considerable IT skills, and to accomplish massive tasks of heroic scale, such as the computerisation of some 30,000 records, drawing up full descriptions of 230 species, and the development of multi-access keys. He also housed, and in part revised and curated, the 'national' *Taraxacum* collection (now at the University of Newcastle). The publication of the Handbook in 1997 represented a personal triumph for Andrew and gave him great satisfaction, for without his major input it is unlikely that it would have been completed.

Fate was to deal Andrew a similar blow to that of his mentor, Chris. Shortly after the Handbook was published, he was found to be suffering from cancer. He and Elaine moved back to Stockport in 1999, but not before he had spent a considerable amount of time assisting with the collection of Cumbrian records for the new Atlas. Against expectations his health deteriorated rapidly and he died two years later.

Andrew was an extremely modest, unassuming person of great charm and wisdom and much loved by all his fellow Flora of Cumbria recorders and *Taraxacum* enthusiasts. With his death we have all lost a valued and ever-helpful friend, and our sympathies go to Elaine and his two children.

G. HALLIDAY and A. J. RICHARDS

HUMPHRY JOHN MOULE BOWEN
(1929–2001)

Humphry Bowen, distinguished chemist and naturalist, died unexpectedly in his beloved Dorset, aged 72, on the 9 August 2001. He was a true polymath, a dynamic person, exuding enthusiasm, who was able to organise his time and, thus, deliver the goods. His *Flora of Berkshire* (1968) was produced with exceptional speed. While working at The University of Reading, he often spent his lunch hours in the herbarium, identifying specimens, laying collections away and extracting records for Berkshire and Dorset. It was all done at the double: he was like a whirlwind. After

retiring to Dorset, he collected thousands of local plant records and produced *The Flora of Dorset* (2000).

Humphry John Moule Bowen was born in Oxford on 22 June 1929, the son of a celebrated physical chemist, E. J. Bowen. He was educated at The Dragon School, Oxford, and then Rugby where David E. Allen first met up with him. David writes: "There cannot be many schoolboys who have attained the God-like rank of a sixth former only three months after their sixteenth birthday. But to that Humphry's brilliance at Chemistry had taken him by the time I arrived at Rugby School as a lowly newcomer. It must have been the following summer that I began to become vaguely aware that this awesome figure had some knowledge of field botany. However, a further 'season' had to elapse before that shared interest brought us cautiously together. A difference in age of nearly four years decreed that officially we kept our distance, but the Natural History Society (of which he had become secretary) acted as neutral territory on which that chasm could in some small degree be bridged. By that time, I was well into compiling a Flora of the surrounding district and lists of plants in a familiar hand would turn up discreetly on my study chair almost every week, the fruit of excursions by bicycle to areas that tended to be beyond my physical capacity to reach. A further advantage he enjoyed was access during the school holidays to the Druce Herbarium in Oxford, where John Chapple was more than happy to provide a name for any plant with which he was unfamiliar.

Our paths crossed afresh shortly after university when, not unexpectedly, in 1951 I found myself welcoming him as a fellow B.S.B.I. member. By then, brilliant as ever, he had completed the research for his doctorate with a full year to spare – and, with marriage impending, had put that to good use buying furniture at auctions. At that period, his chief aim as a field botanist was to see as many of Britain's rarities as possible. I recall his gleefully relating how he had entertained J. E. Lousley at his home and extracted the whereabouts of numerous much-wanted species by plying him liberally with sherry. Affable and energetic, he was soon marked out as a natural choice as the Society's Meetings Secretary when John Dony stepped up to become the General Secretary, and for eight years he was to bring to that office a characteristic brisk efficiency and stimulating *brio*.

It was still the same Humphry, miraculously unchanged after all of 50 years, whom I eventually caught up with again after his retirement to the next-door county, Dorset – and foreordained, embarking on an updated account of its flora. This time it was his turn to be the compiler and mine the periodic contributor of records. That we had ended up as we had begun was a special pleasure for us both."

Sir John Cockcroft appointed him to his first job at the Atomic Energy Research Establishment (A.E.R.E.) in Harwell in 1953, to work in the Department of Physical Chemistry. However, he was transferred to Harwell's Medical Research Council Unit as his research on neutron activation analysis using the British Experimental Pile Operation reactor enabled tiny biological samples to be analysed. Thus, it was no longer necessary to kill organisms to carry out analyses. He looked at mutations caused by irradiating Chrysanthemums (producing eight colour variations of a pink cultivar), Roses and Carnations, but found no support for the Russian claims of increasing yields in grain crops following such treatment. He did show that growing plants in irradiated soil did give increased growth through sterilisation removing the competition from microorganisms. He went to the atomic bomb trials at Maralinga, Australia, to monitor the after-effects of an atomic explosion by analysis of plant and animal material. It is reported that he was unimpressed with the organisation there and appalled when others botched the analysis of his very limited data. He regarded his work there as wasted, though his four months studying the flora certainly was not.

He said he was often criticised for the propagation of his work on radioactive techniques around the world in case this led to hostile atomic activities. He felt very strongly that all his researches were for the peaceful use of atomic energy and for the economic benefit of the countries he was serving. His visits abroad brought him many overseas PhD students, who in turn brought him great recognition academically and personal delight.

In 1964, he was appointed Lecturer in Chemistry at The University of Reading, being promoted to Reader in 1974. He became Vice-county recorder for Berkshire in 1965 until 1988 and for Dorset (where he had regularly retreated at weekends to a cottage at Ringstead Bay) from 1961 until his death. He worked furiously on his *Flora of Berkshire*, published in 1968 in what must be a world record for the fastest production of a county Flora! He received a small legacy from an aunt and used this to publish it. He claimed afterwards to have calculated that he had received the

same amount of money after the last copy had been sold, as he would have done if he had invested it in a building society account. (Other Flora writers take note!)

During this time he started visiting and using the University of Reading herbarium and began depositing his voucher specimens there (earlier ones are in Oxford). Many of these were of his alien finds and supplemented those already in the herbarium from J. E. Lousley and E. C. Wallace. He was known to be especially happy botanising on a good rubbish tip. He would spend his lunch hours, not only working on his own collections, but also helping identify foreign collections and even laying specimens away, including a great many lichens. Identifications were done at some speed and are not always reliable, but they were as accurate as possible with the limitations of the specimens and literature available to him. He proved to be a great help in getting backlogs cleared. He also provided welcome large numbers of herbarium specimens from his own foreign trips, especially from the botanical holiday tours he led around Portugal, Greece and Turkey.

Throughout everything his unending enthusiasm came over and rubbed off on his students, colleagues and friends. He gave his Department of Chemistry the Bowen Cup to be presented annually to the best student performance in the second year course in analytical chemistry, returning each year to present it. He was also an important player in Reading Naturalists, helping to lead field meetings, collect records (not just of plants), write articles for *The Reading Naturalist*, etc. He supported the local county naturalists' trusts, especially B.B.O.N.T., now B.B.O.W.T. (Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust) by serving on their committees and by helping to raise money for them. He took students out on memorable field trips around Berkshire. On one he exclaimed: "Just look at that enormous bracket fungus", as he drove off the road and up a large bank. Fortunately, no damage was done and it was something that all were able to have a good laugh at. On another occasion, he became very concerned as an Indian student photographed the spectacular yellow Berkshire rape fields with A.E.R.E., Harwell, in the background.

Although, to a botanist he gave the impression that natural history was his main job, he was a very active research worker, developing analysis techniques and the removal of heavy metals (gold, uranium, iridium and rhodium) from solutions. The pollution from the *Torrey Canyon* tanker disaster horrified him and he used his Dunlop consultancy to develop foam 'booms' to contain oil spillages, too late to help save the wildlife of the Isles of Scilly, but still in use today. He published nine books, including: *Trace elements in biochemistry* (1966), *Chemical applications of radioisotopes* (1969), *Environmental chemistry of the elements* (1979), and even *Introduction to botany* (1965) with a Spanish translation (*Introducción a la botánica*) in 1979. He published a series of papers on pollution and its effect on plants, pushing him to examine lichens as pollution monitors. He served on the Council of The British Lichen Society (1972–1973) and on its Conservation Committee. His chief lichen publications were lichen floras of Berkshire, Buckinghamshire, Oxfordshire and Dorset in the *Lichenologist*.

After his retirement in 1988, he went to live in Winterborne Kingston in his beloved Dorset, where he concentrated on the collection of records for a new county flora, published in 2000 shortly before his death. He was probably one of only four people to have produced more than one county flora. This was his *magnum opus*, a work of scholarship and quite unlike his earlier *Flora of Berkshire*, complete with colour plates and more detailed distribution maps, based on tetrads. It is especially comprehensive and will set a very high standard for subsequent county floras.

He married Ursula Williams, a biologist in 1952 and is survived by their three sons. After the marriage ended in divorce in 1983, he married Muriel Wilson, who also survives him.

S. L. JURY



NAMES OF VICE-COUNTIES IN WATSONIA

S (113) Channel Islands

ENGLAND

- | | | |
|---------------------|--------------------------|--------------------------|
| 1. West Cornwall | 21. Middlesex | 54. North Lincolnshire |
| 1b. Scilly | 22. Berkshire | 55. Leicestershire |
| 2. East Cornwall | 23. Oxfordshire | 55b. Rutland |
| 3. South Devon | 24. Buckinghamshire | 56. Nottinghamshire |
| 4. North Devon | 25. East Suffolk | 57. Derbyshire |
| 5. South Somerset | 26. West Suffolk | 58. Cheshire |
| 6. North Somerset | 27. East Norfolk | 59. South Lancashire |
| 7. North Wiltshire | 28. West Norfolk | 60. West Lancashire |
| 8. South Wiltshire | 29. Cambridgeshire | 61. South-east Yorkshire |
| 9. Dorset | 30. Bedfordshire | 62. North-east Yorkshire |
| 10. Isle of Wight | 31. Huntingdonshire | 63. South-west Yorkshire |
| 11. South Hampshire | 32. Northamptonshire | 64. Mid-west Yorkshire |
| 12. North Hampshire | 33. East Gloucestershire | 65. North-west Yorkshire |
| 13. West Sussex | 34. West Gloucestershire | 66. Co. Durham |
| 14. East Sussex | 36. Herefordshire | 67. South Northumberland |
| 15. East Kent | 37. Worcestershire | 68. North Northumberland |
| 16. West Kent | 38. Warwickshire | 69. Westmorland |
| 17. Surrey | 39. Staffordshire | 69b. Furness |
| 18. South Essex | 40. Shropshire | 70. Cumberland |
| 19. North Essex | 53. South Lincolnshire | 71. Isle of Man |
| 20. Hertfordshire | | |

WALES

- | | | |
|---------------------|---------------------|------------------|
| 35. Monmouthshire | 45. Pembrokeshire | 50. Denbighshire |
| 41. Glamorgan | 46. Cardiganshire | 51. Flintshire |
| 42. Breconshire | 47. Montgomeryshire | 52. Anglesey |
| 43. Radnorshire | 48. Merionethshire | |
| 44. Carmarthenshire | 49. Caernarvonshire | |

SCOTLAND

- | | | |
|-----------------------|-------------------------|----------------------|
| 72. Dumfriesshire | 86. Stirlingshire | 99. Dunbarton |
| 73. Kircudbrightshire | 87. West Perthshire | 100. Clyde Isles |
| 74. Wigtownshire | 88. Mid Perthshire | 101. Kintyre |
| 75. Ayrshire | 89. East Perthshire | 102. South Ebudes |
| 76. Renfrewshire | 90. Angus | 103. Mid Ebudes |
| 77. Lanarkshire | 91. Kincardineshire | 104. North Ebudes |
| 78. Peeblesshire | 92. South Aberdeenshire | 105. West Ross |
| 79. Selkirkshire | 93. North Aberdeenshire | 106. East Ross |
| 80. Roxburghshire | 94. Banffshire | 107. East Sutherland |
| 81. Berwickshire | 95. Moray | 108. West Sutherland |
| 82. East Lothian | 96. Easterness | 109. Caithness |
| 83. Midlothian | 96b. Nairnshire | 110. Outer Hebrides |
| 84. West Lothian | 97. Westerness | 111. Orkney |
| 85. Fife & Kinross | 98. Main Argyll | 112. Shetland |

IRELAND

- | | | |
|----------------------|------------------------|----------------------|
| H1. South Kerry | H15. South-east Galway | H29. Co. Leitrim |
| H2. North Kerry | H16. West Galway | H30. Co. Cavan |
| H3. West Cork | H17. North-east Galway | H31. Co. Louth |
| H4. Mid Cork | H18. Offaly | H32. Co. Monaghan |
| H5. East Cork | H19. Co. Kildare | H33. Fermanagh |
| H6. Co. Waterford | H20. Co. Wicklow | H34. East Donegal |
| H7. South Tipperary | H21. Co. Dublin | H35. West Donegal |
| H8. Co. Limerick | H22. Meath | H36. Tyrone |
| H9. Co. Clare | H23. Westmeath | H37. Co. Armagh |
| H10. North Tipperary | H24. Co. Longford | H38. Co. Down |
| H11. Co. Kilkenny | H25. Co. Roscommon | H39. Co. Antrim |
| H12. Co. Wexford | H26. East Mayo | H40. Co. Londonderry |
| H13. Co. Carlow | H27. West Mayo | |
| H14. Laois | H28. Co. Sligo | |

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WATSONIA

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The cover illustration of *Primula scotica* Hook. (Scottish Primrose) was drawn by Rosemary Wise.

Four centuries of local Flora-writing: some milestones

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ABSTRACT

Published lists of the flora of limited areas originated as a by-product of the field instruction provided for medical students in various European centres from the Late Renaissance onwards. Caspar Bauhin's of the Basle district in 1622 was apparently the first. This semi-captive market permitted five Floras of Cambridgeshire even by 1800, starting with Ray's of 1660. Britain's counties and, even more, France's *départements* offered ready-made areas mostly of a size practicable for systematic exploration over a period of years and increasingly became the basis for the more ambitious book-length studies. A trend towards bulkiness from c. 1850 followed cheaper printing in Britain and the advent of some wealthy authors. Methodological advances from then on are considered in turn. Since c. 1950 English counties have been acquiring Floras at markedly more frequent intervals, despite increases, by and large, in technical rigour and overall scope.

KEYWORDS: local Floras, publishing history, distribution mapping.

INTRODUCTION

The number of county Floras – let alone ones of smaller or larger areas – published in these islands over the past decade is, by any standard, impressive. A major reason for what seems to have developed into an ever-growing torrent is that a much shorter period of time tends to be devoted to producing these often massive works than was the case till only comparatively recently. We evidently owe this speeding-up to a combination of factors: a more business-like approach all round; the more finite nature of the fieldwork involved, consequent upon the switch to grid-square recording, and the more precise indications that this method produces of when coverage has reached acceptable levels; the wider ownership among botanists of private cars, which makes that coverage achievable so much more quickly; in many cases, too, a sense that the countryside is nowadays altering so rapidly that it needs more frequent surveys.

Half a century ago the situation was very different. A tally of the number of county Floras then in preparation – however distant or faint the prospect of reaching print – came up with a total of 24 (Allen 1951). To some extent that figure reflected the slow recovery of this line of work from the disruption of field botany in Britain during the Second World War, for within ten years the total had risen to as many as 40 (Bowen 1963). Conspicuous among those 24 was the almost-forgotten Flora of South Lancashire, v.c. 59, the vice-county in which the present conference is taking place. At this, it transpired, the by then old and frail W. G. Travis had been doggedly labouring ever since 1906, when the newly-formed Liverpool Botanical Society had quickly appointed him secretary of the Flora Committee. Travis had been a protégé of the great J. A. Wheldon, probably the finest all-round field botanist the North of England has so far produced, and from him he had inherited the same exceptional breadth of expertise, which extended in particular to lichens, at that period not the fashionable field of study that it was later to become. The basic task of compiling records had reached the point by the 1920s that the Flora was judged almost ready for publication, but at that point “financial reasons”, presumably the steep rise in printing costs brought about by the immediate post-war inflation, had caused that end to be indefinitely deferred. Travis had nevertheless soldiered on, and he was still contentedly entering up records as they continued to trickle in when finally he died after 52 years at the task. Towards the end he had been gently persuaded to release his handwritten manuscript for a fellow member of the Society to type up; but when the product of that emerged, to general consternation the records alone turned out to fill 900 pages – and the numerous introductory sections that had been envisaged as their accompaniment

had not even been written. What proved to be a brilliant salvage operation was then mounted, and eventually, after five more years, a much-abridged version arrived in print, laudably acknowledging in its very title the key role played by Travis (Savidge *et al.* 1963).

A gestation of 57 years may well be thought a record for a British county Flora. That is not, however, the case. *The Flora of Gloucestershire* of Riddelsdell, Hedley and Price (1948) took no fewer than 71 years from conception to ultimate birth. Admittedly, though, that one lapsed for two quite lengthy periods. In the end two out of the three whose names appear on the title page had been dead for seven years by the time the book finally made it. In contrast to the lone, unceasing endeavours of Travis, that other project had had effectively six driving spirits in turn. And it was only thanks to the fact that it was the collective initiative of a society, and more directly the responsibility of a long-lasting committee – just as in South Lancashire – that the work was completed. Even that, bulky though it proved to be, had similarly shed a substantial portion of its intended contents in order to be publishable at all.

Yet the county pride that can sustain a Flora through to publication over in some cases such very extended periods does not necessarily have to be vested in a society to work its effects; it may be sufficient to enthuse a succession of individuals operating under their own independent auspices, engaged in what amounts to a kind of relay race. That *Flora of Surrey* which stands to the name of C. E. Salmon (1931), which itself was about half a century in preparation, embodied the cumulative work of three authors who embarked on the project in turn and then passed their data on to the next on giving up. It finally fell to a fourth to slash the end-product in order to reduce it to a size that the publication fund would stretch to. Look carefully and you can see the resulting scars: the latter part of the book is much terser than the major portion that precedes it.

Cases such as these best exemplify the remarkable tenacity that lies behind the compiling of local Floras. For a century and a half now this has been a central activity of field botany in these islands, a way in which the energies of the locally-based – or if not locally-based, at least locally-focused – have been able to be constructively brought to bear on a long-term goal. As a way of imparting a continuity and a sense of direction to the work of a local society (or at any rate of its botanical section) it is an activity that is surely beyond compare. Indeed, without a project of this kind to keep working away at, however distant the ultimate objective, local botanical endeavour would doubtless often have withered or even died away completely.

ORIGINS

There seems to be a good measure of truth in the notion that the compiling of local Floras on our large scale is a phenomenon rather special to Britain and Ireland. A century earlier, however, that would have been a notion harder to entertain. For France up to then had given rise to a no less impressive number of Floras of its *départements*. It is surely no coincidence that that country shared the good luck of our own in having been divided for administrative purposes into an unusually large number of precisely-defined areas, which in France's case had the further good luck to be all roughly equal in size, without many needing to be subdivided, as ours did, to secure greater equiformity. That size turned out to be conducive to reasonably thorough botanical investigation within a reasonable number of years. Had the (vice-)counties been significantly smaller, the challenge to embrace them scientifically would have been not clearly so great; had they been that much larger, the thought of covering them with any pretensions to thoroughness would have been off-putting. France, however, had the disadvantage that its *départements* date only from the Revolutionary years, whereas most of the counties of England have existed for more than a millennium – time in which to have generated a proportionately deeper loyalty.

If counties and *départements* had not existed, would series of Floras based on areas of around that size ever have been produced? It is hard to believe so. Without them, we would surely have had a goodly scatter of local works, but ones of areas of a much greater diversity in size: some of just smallish districts, others of broad regions, with many less accessible or botanically unappealing areas left more or less untouched. The great asset in inheriting a country-wide lattice made up of equal-sized sections (or one that readily lends itself to reshaping into the equivalent of that) is that once two or three have had Floras produced that serves as a challenge to provide Floras of more and more of the rest.

But an asset like this is not much help unless a sufficiency of florals to give the impression of a series can manage to appear in print. For a long time that was not at all easy. Up until the 1830s, when the benefits came through from the harnessing of steam-power to printing presses, the cost

of bringing out a book was so high as to constitute a serious deterrent – and for another thirty years after that there continued to be special taxes on publishing in Britain that kept that cost higher than it would otherwise have been (Allen 1996; Collet 1899). Unless you were George Luxford and had acquired the necessary skill to print the book physically yourself, as he did his *Flora of Reigate* (Luxford 1838), you either had to be rich enough to take in your stride the risk of the substantial investment needed or go to a great deal of trouble in soliciting enough subscriptions in advance. Not surprisingly, many a local Flora never made it into print, valuable though that would have been. Fortunately, a not inconsiderable number that fell short of that have at least survived in manuscript; others, however, exposed to all the vicissitudes to which a single copy of anything is liable, have no doubt been lost altogether.

For two hundred years there was only a single, reasonably assured ‘market’ for a printed list of the plants of a given local area. This was medical students. It is no accident that the earliest of those lists all seem to have been by-products of the regular outings into the countryside to be shown the commoner wild herbs that were arranged for students in numerous European centres from the Late Renaissance onwards (Allen 2000). The first such Flora seems to have been that by Caspar Bauhin (1622) of the country around Basle, which he is known to have conceived by 1592 at least, soon after starting teaching (Reeds 1991, p. 124). That by Tournefort (1698) of the environs of Paris had this origin too, as did the *Botanicum Londinense* which Petiver (1710) began writing for the benefit of the apprentices he was instructing in his capacity as Demonstrator of Plants for the Society of Apothecaries at their Physic Garden at Chelsea. Unfortunately, Petiver had founded a journal, the *Monthly Miscellany*, and it made best sense to him to publish his guide in that serially; but the journal soon stopped being published and the intended book was left unfinished.

The existence of this student ‘market’ explains why so many of the earlier local Floras were of areas containing a university, and in particular how Cambridgeshire came to be the subject of no fewer than five by no later than 1800. The first of that five, the *Catalogus* of Ray (1660), is entitled to be called the ancestor of all the Floras of counties that have followed after. Many students in those days were affluent – Banks, Smith and Salisbury spring to mind as salient examples of botanists who came into that category in Britain – and could easily have afforded to buy a book they expected to find useful provided its price was not exorbitant. Many other students, though, were by no means so well-placed, so if a Flora was aimed at them as well, it needed to be comparatively cheap if they were to have any hope of purchasing a copy. That consideration made for slimmness and a text that kept very much to the point.

GROWTH IN SIZE

Away from the few centres with a regular turnover of students in any considerable numbers, a book addressed to such a small and specialised section of what was still as yet a fairly limited book-buying public could count on selling only relatively very few copies. A sizeable subsidy was therefore invariably necessary if it was to appear in print at all, let alone extend to more than a bare modicum of pages or include illustrations. As a consequence, until well into the 19th Century, local Floras were minimalist affairs, uninviting to a modern eye and best described as *catalogues raisonnés* (as some of the French ones were indeed frankly so called). A few, though, were smaller than they needed to be on cost grounds, being designed to slip into a pocket. The pioneer account of the flora of the Channel Islands by Babington (1839) was one such duodecimo, a size its author went on to use for the many editions of his national Flora, the influential *Manual of British Botany*. That Channel Islands volume probably holds the double record of being not only the smallest work in this genre ever to have appeared, but also the fastest one ever produced: based on just two successive summers of fieldwork, it was written soon after the second of those and was out in the following June (McClintock 1975, p. 27).

If a local Flora at that period took the form of a fattish octavo, that is a sure sign that its author was well enough off to have the necessary money to spare. Leighton (1841), the first to break the size barrier, had been left financially independent while still in his twenties by the death of his father. Six hundred pages thick, his *Flora of Shropshire* owed most of that bulk to including descriptions of all the species as well. But in that it was not unique, for Bromfield (1856) was to permit himself the same extravagance for his *Flora Vectensis*.

Bromfield was the most lavishly self-indulgent local Flora-writer of all time. After training for a medical career, he was saved from having to pursue that by similarly inheriting money in early

youth. After university and leisurely travel on the Continent he tried living in various towns around England's coast before settling in 1836 in the up-and-coming seaside resort of Ryde. There he lost no time in embarking on the most thorough investigation of any part of Britain ever attempted up till then. The Isle of Wight was at that period a highly fashionable place to live, full of *rentiers* with time hanging heavy on their hands, and he was able to build up a small army of helpers, ranging from the widow of an admiral down to a groom. Free of domestic ties, amiable, infectiously enthusiastic and energetic, he was admirably equipped for such a task.

Unfortunately, after ten years or so of intensive fieldwork Bromfield's horizons began to broaden: his love of foreign travel returned and he decided to bring mainland Hampshire within his embrace as well (Wight being then part of that county administratively). Alarmed that this *Flora* of Floras might never be written up, friends pressed him to put the main meat into print, and because he had so much of more general interest than just lists of localities to report, the leading journal of the day devoted to British field botany, the *Phytologist*, accepted this for publication in serialised form. Even when thus drastically filleted, however, the text was so lengthy that it took 27 parts to complete serialisation (Bromfield 1848–50). It was the first local *Flora* of any considerable size to be published by that method, and in all the other cases the serialising seems to have been in the transactions of a local society, not exposed to a national readership like this.

It was only just in time – for in the year after the last of those parts appeared, Bromfield suddenly died, while travelling in the Middle East. Aware that he had also made superbly detailed descriptions of all the Isle of Wight's species of vascular plants, drawn up from fresh material, two friends, Sir William Hooker and Thomas Bell Salter, added those to the main substance of what had already been published of Bromfield's Wight data and brought the whole out as a book. The *Flora Vectensis* thus had the distinction of appearing in print in large part twice over. Always a rare work, it is a fascinating one that deserves to be better known.

Not the least of its fascinations is the wondrously expansive form in which Bromfield made a practice of presenting the records for the rarer species. This expansiveness extends even to the names of recorders, whom he apparently felt it unacceptable to indicate merely by initials. Instead, we read "found by my good friend George Kirkpatrick, Esquire" or "the discovery of my very good friend, Miss Georgiana Kilderbee". Here is how he chose to report the first locality for *Cyperus longus* to be discovered in the island:

"...in a marshy meadow through which runs a little stream, between the new lighthouse at St. Catherine's Point, emptying itself into the sea at Old Castle Point by Puckaster, the station being much nearer the latter, and below the farm of Little Buddle, by which there is a path that conducts almost to the spot, within 10 minutes walk of the Sand-rock Hotel" (Bromfield 1841).

That is virtually as precise as a six-figure grid reference and there are many records in the book fully as detailed as that. Despite the dangers from collectors, of which he must have been all too aware, Bromfield evidently saw it as more important that others should see, and share his own delight in, the island's special treasures.

Bromfield's ultra-expansiveness attracted no imitators. That can hardly have been because no other county *Flora* compiler could afford so heedlessly grandiose an approach, for several who came after were by no means inferior in wealth: major landowners like the author of the *Flora of Dorsetshire* (1874), J. C. Mansel-Pleydell, to whom a large slice of that county belonged personally, or prosperous businessmen like the co-author of the *Flora of Kent*, F. J. Hanbury (1899), and G. C. Druce, author of at least another five and whose *Flora of Berkshire* (Druce 1897) was certainly grandiose too but in other ways. Wealthier even than any of those was the little-known G. S. Gibson (1862), author of the *Flora of Essex*, who had inherited a large banking fortune and may have been tantamount to a billionaire in present-day terms – for even after a lifetime of philanthropy on a very extensive scale he was still worth a third of a million (Victorian) pounds at his death. No: the reason why Bromfield's *Flora* was *sui generis* was surely because the Isle of Wight, then only a semi-county in any case, was so much smaller an area to work than any of those that fell to be investigated by his subsequent counterparts. It was so small in fact that Bromfield saw no need to divide it for recording purposes into more than its natural halves – for that island is freakishly, but conveniently, substantially bisected by the river that runs from Newport to Cowes.

METHODOLOGICAL ADVANCES

It fell to a contemporary of the *Flora Vectensis* in its initial, embryonic form, the *Flora Hertfordiensis* of Webb and Coleman (1849), to break the pattern that county Floras had mostly been content to follow up till that point. The innovatory importance of this work was unhappily long obscured by the misleadingly lightweight appearance the book has at first sight, the result of the snippets of verse that precede the account of every plant family. These were included at the instance of the senior author, Webb, a local vicar and *littérateur*, who presumably thought they would widen the Flora's appeal. Coleman, luckily, was much more hard-headed, and it is clearly he that we have to thank for the notable steps forward that this book represents. A classics master at the Bluecoat School at Hertford, he found the traditional methods of recording unacceptably wayward and in a paper he contributed to the *Phytologist* (Coleman 1848) drew to wider attention the novel ones he had devised with a view to injecting a greater measure of system. An abridged version of that paper is usefully included in the book as an appendix. Most influential proved to be Coleman's dividing-up of the county into a number of botanical districts – in this case as many as twelve – and basing those on the river catchments. He went into detail in the paper about his reasons for that choice, explaining that various alternatives he had experimented with in turn had had to be rejected as too artificial as well as too hard to understand on the ground. The river drainages, he pointed out, had the asset of being readily discernible on the Ordnance Survey maps that he recommended as indispensable equipment; they were also the basis of the 'provinces' that Watson (1847–59) had adopted as the (very broad) mapping unit in his *Cybele Britannica*, which was just then beginning to appear and which seemed likely to dominate work on plant distribution in Britain for some years to come. That not everyone was converted by Coleman's arguments, though, is shown by the fact that only three years later a *Flora of Surrey* (J. D. Salmon 1863) appeared in which soil types were used as the basis for dividing up the county.

Much more striking, though, and startlingly ahead of its time, was the method Coleman had settled upon in order (as he put it) "to mitigate the evils arising from the distant residence or partiality [for richer districts] of the compiler" – in other words, to avoid the grossly uneven coverage that results if fieldwork is not strictly systematic. His solution to that problem was what would come to be known, nearly a century later, as the 'stand' method: that is, walking from a particular point and listing all the species met with over a standard distance. Instead of the field recording sheet or card that his 20th Century successors would use, though, he relied on filling a small vasculum with 'pinches' of each species, to serve as a check against the lists he drew up from memory whenever the vasculum was full or a convenient halting-place was reached.

Coleman clearly had a cast of mind that made him particularly receptive to the Humboldtian approach to the study of plant distribution that Watson was then pioneering and energetically promoting in Britain. Together with the rather younger J. G. Baker (to whom Watson was to be lastingly close, to the extent that he made him his executor) he shared the leading role in applying that Watsonian thinking at the local level. Another way of locating him historically therefore is as an unwitting anticipator of a later, second wave of ecogeographical enthusiasm, the discriminating of plant communities that would impact on local Flora work no less noticeably half a century later.

Twenty years after the *Flora Hertfordiensis* came the far better-known *Flora of Middlesex* of Trimen and Dyer (1869). By comparison, this has surely been over-praised, for the further innovations it was responsible for were not in the key matter of the standard of fieldwork but consisted of adding features that broadened the scope and appeal of the genre but were nevertheless only secondary to its purpose and value scientifically.

This work had an unusual origin in having grown out of the activities of a small, sadly short-lived London group, the Society of Amateur Botanists, which met in the shop in Piccadilly of the botanical bookseller Robert Hardwicke (who was to be the Flora's eventual publisher). Two sophisticated young men dominated this body and the book was essentially the joint product of their student years – and remarkable also just in that fact. By the time it reached print they had both embarked on what were to be distinguished careers in botany professionally, the affable, much-liked Trimen on the staff of the British Museum, the haughty, widely-disliked Dyer on the first rung of the ladder that would lead him to the Kew Directorship.

London-based botanists had been exploring Middlesex for generations by then, and given that so much of the county had disappeared under bricks already, this Flora was inevitably a historical one in large degree (as its recent successor (Kent 1975) has been too, more explicitly). It was from this

unusual character that its two innovations flowed. One of these was the citing of the first record of every species, a practice some would hold of dubious value when, as so often happens, it had been carried out indiscriminately. The other was an account of the previous botanists whose work had contributed to knowledge of the county's flora. In this the *Flora of Middlesex* set a standard that has hardly ever been matched. The appendix given over to the account was so lengthy and based on so much manifestly original research that it has credibly been supposed that it was the work of W. W. Newbould (Kent 1963), who alone of contemporary botanists is known to have devoted the necessary years of study to such matters in libraries and herbaria. Newbould was famously self-effacing and unwilling to allow his labours on behalf of others to be acknowledged in print. In this instance, the only glimpse the reader is given of his involvement is a thank-you in the preface for his assistance with proof-reading and for the loan of rare books. Yet without this massive appendix the rest of the text would hardly have earned the book the special acclaim it has received over the years. Although the *Flora* has been wholly superseded, it can surely only be for this marvellous repository of historical scholarship that it continues to fetch the high prices that it does.

FURTHER DEVELOPMENTS

Those two *Floras* of counties close to the main centre of botanical activity in Britain between them set the pattern for the style for almost a hundred years. Indeed, it could be argued that they did that all too well. For nothing really radical in the way of innovations followed until the 1930s and several major county *Floras* were conceived on the same broad lines as that of Middlesex so slavishly that they ended up unpublishable unless severely pruned. But at least there was a model, one which commanded general assent and encouraged subsequent authors to aim high, perhaps more especially in the range of topics covered in the introductory sections.

That model is widely agreed to have reached its finest expression in the *Flora of Bristol* of J. W. White (1912), which was particularly outstanding for two reasons. One was the generous amount of valuable or otherwise interesting comment appended to so many of the species entries, to the extent that it could be regarded as a return to the bravura expansiveness of Bromfield at least in that respect. The other was the author's graceful prose: as Noel Sandwith once remarked, it was a *Flora* that was a contribution to literature as well as a contribution to botanical knowledge.

Considering what could have happened, it is a matter for some pride that the standard of writing in the genre has been so consistently high, and has only once descended to the journalistic depths of (what can just about be categorised as) a local *Flora* by Reynolds (1915). This originated as a series of articles contributed to a local newspaper, describing various walks, to which a list of localities was subsequently added and the whole bound together and placed on sale, for a shilling, by an enterprising bookseller. There are some colourful reminders in it that it was written in the somewhat hysterical atmosphere of the earlier part of the First World War. That curious little work additionally serves as a reminder of how hard it almost invariably is to guess the occupation in life of authors of local *Floras* who are not professional botanists. Who would suspect, for instance, that J. D. Salmon otherwise spent his time running the firm which supplied all the ice for Victorian London's grander dinner-tables; or that the author of the *Flora of Cornwall*, F. Hamilton Davey (1909), was the manager of an arsenic mine; or that William Gardiner (1848), before he turned to collecting plants for a living and published his *Flora of Forfarshire*, earned his livelihood making and repairing umbrellas? Equally unlikely were the pair who produced the *Flora of the parish of Halifax*, Crump and Crossland (1904). Charles Crossland was a butcher, while his collaborator, William Crump, had to abandon schoolteaching because of deafness and became the proprietor of a cinema instead. Their *Flora* is noteworthy for breaking new ground with the special attention it devotes to describing the local plant communities. Crump was a leading pioneer of the study of ecology in Britain, and the West Riding of Yorkshire was where it had put down particularly strong roots.

Another author who embraced that novel approach with enthusiasm, writing and lecturing on it prolifically, was the Leicestershire botanist, A. R. Horwood. His *Flora* of that county and its diminutive neighbour, Rutland (Horwood & Noel 1933), never seems to have received the wider attention that the merest glance at its contents should be enough to show that it deserves. For the amount of information packed into its thousand pages – which are printed in unusually small type – is truly amazing (and there was a great deal more, the author assures us, that had to be left out). It stands today, along with many fellow members of the genre, as a permanently

embarrassing reminder of how much there is in local Floras, and county ones especially, that have yet to be put to adequate use.

Not the least remarkable feature of that book was the breakneck speed at which Horwood put it together. After two decades of unhurriedly amassing data, he was suddenly told by his Flora Committee that it had to be out in two years' time, to coincide with the annual meeting of the British Association for the Advancement of Science, which it had just been announced was to be held in Leicester. Entirely without assistance (his nominal co-author, the Earl of Gainsborough, presumably chosen to symbolise the contribution made by Rutland, was dead by then) and entirely in his spare time (for he had a full-time job), Horwood had first to spend a full six months reducing his field notebooks to 40,000 index cards. In the process, the localised records had to be assigned to one or other of no fewer than fifteen botanical districts, twice the usual number. On top of all that work, and perhaps as a result of it, he was ill for a third of the time available. Nevertheless, he managed to meet the stipulated deadline.

THE MODERN BREAKTHROUGHS

It was not until just after the Second World War, in 1948, that the writing of local Floras entered what was immediately recognisable as the technically much more sophisticated and operationally much more rigorous era that has prevailed down to the present. That year saw the publication of what amounted to a sharp break with the past in the shape of Professor Good's *Geographical handbook of the Dorset flora*, its deliberately unorthodox title signalling the work's entirely novel character.

Good was a Dorset man born and bred and, though an exile in Yorkshire for most of his career, he returned there as often as he possibly could. Apart from his almost lifelong study of its botany, he also wrote a book on its lost villages, another on its old roads and even a history of the town of Weymouth. At the start of the 1930s he got round to marrying this intense devotion to his native county to his academic specialism, the geography of flowering plants. This took the form of a decade-long survey of its 1,000 square miles (25,900 km²), with the aim of making Dorset a demonstration case of the insights into the factors determining distribution patterns that could be wrung from a properly thorough and systematic approach. In effect, he carried on where Coleman had left off.

The National Grid did not yet exist, so he had to invent an equivalent of that just for Dorset. The resulting squares he subdivided into sixteen parts. Regrettably, though, he failed to adopt an equally geometric approach for his recording in the field. Instead, he arbitrarily chose to study portions of countryside that constituted a well-defined habitat type to a greater or lesser extent. These portions he termed 'loci'. All the species he could recognise in a 'locus' made up what he termed a 'stand'. From his 7,575 'stands' he accumulated well over a quarter of a million records, and these he converted, manually, into a set of stunning dot-maps, a selection of which formed the outstanding feature of his book (Good 1948). It was, in fact, essentially an atlas accompanied by interpretative text; the catalogue of species with details of their frequency or records of their occurrence, the standard central feature of local Floras, rather pointedly relegated to the second half of the volume – and disappointingly rather cursory.

Good was one of nature's loners, and he had taken his approach as far as a single individual working unaided could reasonably have been expected to do. The obvious next step was for a similar approach to be applied by a group of people collaborating as a team.

Within two years of his book's appearance Good was invited to describe his Dorset work in more detail to Birmingham's Natural History and Philosophical Society (as that body was then called), and the immediate result was the initiating of a new Flora of Warwickshire (Cadbury *et al.* 1971) on essentially similar lines. The main difference was the dropping of Good's system of 'stands', as being too arbitrary, as well as liable to cause the frequency of species of artificial habitats to be underestimated.

The subsequent project broke new ground in a considerable variety of ways. Firstly, from start to finish it was a joint undertaking of a local society and a university. The society, thanks to ample endowment funds, was the one alone in a position to meet the administrative and research expenses. The successive members of the Botany Department staff of Birmingham University with the responsibility for teaching taxonomy – at first, briefly, P. S. Green, then J. G. Hawkes – at once

saw the possibilities the project offered for training students in fieldwork, and over the years numbers of those were allotted areas and investigated them conscientiously. In the course of doing so, one chanced upon the first population of *Scorzonera humilis* to be discovered in Britain outside – appropriately – Dorset (Hawkes & Phipps 1954). Secondly, it was the first major project to exploit the National Grid (the B.S.B.I.'s first Distribution Maps Scheme being then still at the planning stage). Ordnance Survey maps with the Grid printed on them had then just appeared on sale and Green, who had become familiar with gridded maps during his wartime army service, insisted on their being adopted as a basis (P. S. Green, pers. comm. 2002). The 1 km squares of the Grid were initially chosen as the mapping unit, but it was soon realised that Warwickshire was too big for that to be practicable, and the switch was accordingly made to just one square in every group of four, selected randomly. Thirdly, it was the first project of its type in Britain to be conceived with automatic data-processing ultimately in mind. The impetus for this came from one of the three eventual authors, R. C. Readett, who was fresh from revolutionising the accounting system of Birmingham City Council by introducing such methods. At the start that meant the use of punched cards, but by the end magnetic tape had arrived and the data were processed on the University's computer. Fourthly, special standard recording sheets were used. These were much more elaborate than the field cards devised for the B.S.B.I.'s concurrent Scheme. For each square the recorder had to write down the species found and against each one enter the coded abbreviation for the particular habitat type and an estimate of the frequency. Recorders were further expected to pay each of their squares at least three visits. Fifthly, the complexity of that recording system necessitated a major training effort. Several field meetings each summer were held primarily for that purpose, in different parts of the county in turn. The training proved so effective and the meetings so collegially stimulating that in some cases virtual tyros initially had turned into very competent field botanists by the time the project ended. Lastly, the finished work was taken on an out-and-out commercial basis by a leading scientific publisher, which saw it as a means of demonstrating the potential of the kind of advanced retrieval methods with which it was keen to become identified.

Well before that project ended, it was all too apparent that it had been over-ambitious. After fifteen years spent collecting the data and a further six before the resulting massive volume issued from the press the team was, not surprisingly, exhausted. Sadly, but very understandably, it was thereupon disbanded – and the neglected, next-door county of Worcestershire that could have so much benefited from its attentions unfortunately had to forgo them.

In the meantime, the B.S.B.I.'s first Distribution Maps Scheme had taken place and, while employing much simpler methods than the Warwickshire project, had introduced most of that field botany generation to grid-square recording. The immediate outcome was a flurry of county Floras embarked upon based on that new approach. Warwickshire's experience served as a warning against attempting the ideal of a 1 km square coverage and most Flora committees – for by its very nature this much more intensive type of work tended to be a more tightly collective undertaking than in the past – were content to settle for the less demanding tetrads. By a short head the Flora of Staffordshire of Edees (1972) led the field in adopting the latter as the basis on which distributions were to be mapped.

This account would not be complete without some mention of the important contribution to local Flora thinking made by the late John Dony. A teacher of economics by profession, he was to the fore in urging authors to pay more attention to that aspect and not be deterred from publication by exaggerating the difficulties. On this he spoke very much from personal experience. The first of the two Floras he wrote of Bedfordshire (Dony 1953) was the first work ever to be published at the expense of a local authority. He owed this to having acted for many years as unpaid curator of botany at Luton Museum, thereby saving the Borough Council the cost of employing an official. But that argument might not have had the desired effect, even so, had he not been close to the Council and had 'friends at court'. Apart from relieving him of any financial worry, municipal sponsorship was seemingly responsible for the exceptionally wide review coverage that Flora managed to achieve. Considering the book's purely British focus and its narrowly local one at that, it was remarkable that it attracted notices in areas overseas with vegetation that was entirely different, among them California. No doubt partly as a result of such an unusual amount of publicity, the book sold so well that it ended up by making what up to then had been considered an impossibly large profit for a local Flora. However, all of that went to the local authority, to Dony's

chagrin. The next Flora he wrote, he vowed, he would publish himself. As it turned out, that proved unnecessary, for a local authority again was willing to sponsor his *Flora of Hertfordshire* (Dony 1967). Nevertheless that did not stop him from doing his personal bit to maximise its sales, by acting as his own publisher's representative and calling on every likely outlet for books in the entire county.

Dony also thought hard about how to secure economies in printing, and had realised that a major saving was to be had by the simple expedient of having the non-narrative sections of the text set in double columns. A quarto format, instead of the long-traditional octavo, was another of his innovations that has been much copied since. Admittedly, though, Dony was an extremist: he *lived* county Floras, and was prepared to devote more time and energy to compiling, writing and then selling them than probably anyone else would be willing to contemplate. But the world needs extremists to demonstrate the true limits of what is possible.

Since the 1950s local Flora work has been in a golden age, and one that shows no sign of ending. Yet that boom is still, as ever, unevenly experienced geographically. The quantity of publications continues to be a reflection on the whole of where field botanists are present in greatest numbers. Many parts of Scotland have yet to be the subject of any published Flora at all, and barely one Irish county in five has ever had one either. How this chronic imbalance is to be overcome is one of the more important matters that has yet to receive its due share of discussion.

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The treatment of infraspecific taxa in local Floras

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ABSTRACT

One of the most valuable contributions a local Flora can make is to document the occurrence not only of subspecies but also of the currently unfashionable lower categories of varieties and forms. Their neglect in most recent identification works means that information on these taxa is difficult to find, a consistent approach to them is unavailable, and local Flora writers nowadays usually ignore them. Little information about them is therefore being collected, and there is a downward spiral of knowledge which needs reversing. Some remedies are suggested.

KEYWORDS: forms varieties, subspecies, infraspecific variation.

INTRODUCTION

The coverage of subspecies in recently published local Floras is very variable. Sometimes they are covered fully, and are even mapped like the species, but often they are either ignored or treated rather evasively. The coverage for Atlas 2000 also suggests that there is great variation in the way in which different recorders treat them and that in general we are not very good at recording subspecies, but I do not think there is any disagreement that we ought to treat them as seriously as we do species. Stace's *New Flora* (1997) certainly gives us no excuse for not doing so. We just need to try harder and do better. But infraspecific variation below the rank of subspecies, which is what I am mainly concerned with here, has been deeply unfashionable for fifty years or more and few of us nowadays take any notice of it. As enquiring field botanists we should surely wonder, when we see the obvious variation in so many species that is not described in Stace (1997) or in Clapham, Tutin & Moore (1987), what is going on. Is it geographical, is it ecological, is it entirely random, is it phenotypic or is it genetic? How can we find out about it? Should we record it, and, if so, how?

My own interest was heightened when in September 1994 Peter Sell and Gina Murrell paid a visit to my county of Cardiganshire. Among other sites, we visited the sea cliffs and coastal grassland at Gwbert where they demonstrated that what at a casual glance I would probably have recorded as a more or less uniform population of *Leontodon saxatilis* was in fact a mixture of *Hypochaeris radicata* subsp. *ericetorum*, *Leontodon autumnalis* var. *simplex* and *L. saxatilis* var. *arenarius*, familiar to them from other coasts of Britain. The first two seem to be widespread but the third is probably western in distribution. The distribution of all three in Wales was very poorly known, and none of them had been recorded before in the county. The same uncertainty held for *Cirsium arvense* var. *maritimum*, several of the varieties of *Lotus corniculatus*, the late-flowering prostrate and dwarf *Succisa pratensis* var. *maritima* and various other very distinctive taxa we found there. On the beach below my house at Aberystwyth they noticed *Galium aparine* var. *marinum*, a prostrate, condensed, late-flowering ecotype, growing with var. *aparine*, which ever since has bred true in my garden and which occurs, hitherto unrecorded, on several beaches in the county. Another variety of this species, late-flowering and dwarf, which is an arable weed forming globe clumps after harvesting, I have found only in the trial plots of the Welsh Agricultural College near Aberystwyth where it was probably introduced from what may be its main area of distribution in East Anglia. There are innumerable other examples of obvious but little known infraspecific taxa, and the problems and opportunities for extending our knowledge are endless.

The lack of practical coverage of infraspecific variation has been deplored for as long as it has existed. Druce (1928), in the introduction to the second edition of his *British Plant List*, writes: "Compiled, as this *List* is, especially for field botanists, the varieties inserted are numerous (about 2400). Some botanists may resent their inclusion, but there are advantages in citing them, and it will rest with the writers of a new British Flora (a work so much to be desired) to relegate them, if necessary, to their more correct status." Unfortunately, when the new Flora of Clapham, Tutin & Warburg (1952) did appear 34 years later, the vast majority of these variants were not even relegated, they were just ignored, and the preface says: "It does not attempt to describe all named varieties or to give other details which a specialist might reasonably desire". The same approach prevailed in the later editions, encouraged by *Flora Europaea's* (Tutin *et al.* 1964–1980) similar attitude to varieties, and continued with Stace's *New Flora* (which, although ostensibly only going down to subspecies, does in fact include about a hundred atypical varieties or forms and many cultivars). Sell & Murrell (1997) say: "It is unfortunate that many botanists tend to ignore variation completely, and they will certainly ignore it if it has no name at all ...", and Allen (1987) says: "under-recording is the stumbling block at present in seeking to interpret many easily recognised and recordable patterns of variation." As a result, there has for a very long time been no framework of infraspecific taxonomy for local Flora writers to follow and most of them, even if they would like to have included varieties, have, as Allen (1987) has observed, taken the easy option and followed their leaders in ignoring them. There has thus been a downward spiral of knowledge about much of the observable infraspecific variation. It is difficult to record it because we have no names or descriptions for it, and we cannot evaluate and name it because it is not being recorded.

On a national level there have been several attempts to bring the lower levels of variation back to our attention. In 1966 David Allen made a plea for better treatment of them at the local Flora writers' conference in Bristol (Allen 1967), and published in *Watsonia* (Allen 1966) a list giving details of all infraspecific taxa that had been tested in cultivation; this was an exemplary start that has, alas, not been followed up. Two B.S.B.I. Presidential addresses, by David Valentine (1979) and David Allen (1987), raised the standard but both failed to rally the troops. They make essential reading and provide much information on the significance of infraspecific variation. Tim Rich in the two versions of the *Plant Crib* (Rich & Rich 1988, Rich & Jermy 1998) brought together a great deal of comparatively up to date information, and did much to encourage botanists to record variation in more detail.

The one modern attempt to describe and evaluate the infraspecific variation of the British flora at all levels is Sell & Murrell's *Flora of Great Britain and Ireland* (1997–), of which only the monocot volume has so far been published. They say that "an attempt has been made to include all names used in British and Irish floras", although they admit that "No serious attempt has been made to decide on the correct infraspecific rank as taxa are often both ecological and geographical". As further volumes appear it should provide a very practical framework for recording. Because no-one has attempted this for at least the 75 years since Druce made his plea for a proper evaluation, there is bound to be controversy, but it is local Flora writers who are in the perfect position to try out Sell & Murrell's taxonomy. Local Floras ought to be one of the main ways in which information filters up to the national consensus of botanical knowledge. This still happens in matters of distribution and ecology, and the authors of species accounts in *Atlas 2000* constantly consulted and got much information from a number of recent county Floras in order to build up the general picture. Sell and Murrell, in contrast, have an extremely thin time of it, trying to get comparable information on variation from these Floras.

There have though been a few lone voices among local Flora writers. Webster (1978) in her *Flora of Moray, Nairn & East Inverness* went into admirable detail in a few cases, but it is Allen (1984) in his *Flora of the Isle of Man* who sets the modern standard and includes a vast amount of information on variation. Scott & Palmer (1987) in *The flowering plants and ferns of the Shetland Islands* are also very informative. Of other recent Floras, Bowen (2000) in *The flora of Dorset* and French, Murphy & Atkinson (1999) in their *Flora of Cornwall* have more on variation than most, and to some extent are exceptions to the general rule that there is a negative correlation between infraspecific detail and tetrad maps..

VALUE OF INFRASPECIFIC INFORMATION IN LOCAL FLORAS

Including information about variation makes a Flora vastly more interesting. Browsing through the Isle of Man or Shetland Floras gives one a much better impression of what makes these areas and their plants distinctive, and how they fit into the national pattern, than browsing through many other recent Floras. It inspires us to go out and see what this or that species is doing in our own patch. Intraspecific variation may often be the poor man's window onto genetic variation. Most of us are not in a position to study properly the genetic variation within populations – which is increasingly being recognised as a significant factor in conservation – but, as the morphological variation in many cases reflects the genetic variation, the recording of it as infraspecific variants should be a valuable exercise. For example, areas of coastal grassland with a large number of coastal ecotypes, to which we may be able to give varietal names, must surely be of considerable conservation interest; Valentine's (1979) comments on the variation in *Centaurea scabiosa* are very relevant here. Intraspecific variation may also be of great significance to those who study rusts, smuts, galls or phytophagous insects and may explain otherwise puzzling phenomena of distribution or partiality of these plant-related organisms. Cultivars are equally relevant here, and although, by definition, they are not going to be native plants they are often naturalised and very much part of the ecosystem, with their particular ecologies, diseases and resistances and differing abilities to survive in the wild.

A lot of infraspecific variation is probably not worth recording. It may be random, it may be unrelated to any meaningful geographical, ecological or other factor, or it may be a figment of a taxonomist's imagination, but in many cases we simply do not know. Only a small proportion of the observed variation has been properly investigated. By recording it, we can at least add to the information about it and help in the proper appraisal of its value. At the moment, most of us have little idea what is worth recording. Only what is in Stace? Surely not. Everything that will be in Sell & Murrell? Almost surely not. We just do not know. But nothing is lost by recording more than ultimately turns out to be worth while, and everything is lost by not recording it at all. Much of it will certainly be useful, and more useful than a lot of what we do spend our time recording. So how do we go about it?

SOURCES OF INFORMATION

I have mentioned some of the chief sources already. Sell & Murrell (1997–), in so far as it has been published, is of course the best available guide. Rich & Jermy (1998) is also essential. Every aspiring local Flora writer should look through the *Flora of the Isle of Man* (Allen 1984) at least once a year to be reminded of many of the things to look out for, and a few other recent Floras such as those of Dorset and Cornwall will provide useful snippets of information. Of the older national Floras by far the most useful is Druce's 1930 edition of *Hayward's botanist's pocket-book*; although out of date in its nomenclature and giving little or no evaluation of how worthwhile most of the infraspecific taxa are, it includes a vast number, especially in the often overlooked and unindexed appendices. The incomplete Williams's *Prodromus florae Britannicae* (1901–1912) and Moss's *Cambridge British Flora* (1914–1920) are also invaluable sources. A number of the older local Floras are useful and strongly recommended, especially those that give brief descriptions of the variants. Horwood & Noel's *The Flora of Leicestershire and Rutland* (1933) is one of the best, and Salmon's *Flora of Surrey* (1931), Keble Martin & Fraser's *Flora of Devon* (1939), White's *Flora of Bristol* (1912) and, though to a disappointingly lesser extent, Druce's county Floras, are also well worth consulting.

Many foreign Floras are very useful, with the ongoing *Flora Nordica* (Jonsell 2000–) being the most relevant up to date source; it is conveniently starting at the opposite end of the sequence of families to Sell & Murrell. Hegi's *Illustrierte Flora von Mittel-Europa* (1906–) and Rouy & Foucaud's *Flore de France* (1893–1913) contain vast numbers of variants that also occur in Britain. All these provide good descriptions of the variants. The 2400 variants in Druce (1928) are unfortunately not described, although many are in Druce (1930). Other useful lists include Akeroyd (1997) which covers infraspecific variants of European coastal species. Cultivars are notoriously difficult to identify, and the language and identification methods used by

horticulturalists are often quite different from what local Flora writers are used to; but a lot can be gleaned from the numerous Royal Horticultural Society publications, and various books by W. J. Bean, G. Krüssman, A. Rehder, Alan Mitchell, Roger Phillips and the like. An outstanding recent taxonomic account of cultivars is Kuitert (1999) on *Japanese flowering cherries* (street trees are considered fair game for Flora writers in many other parts of the world, but have not usually been covered in this country). Another is Bishop, Davis & Grimshaw (2001) on *Snowdrops*. Crawley (2002) has bravely begun to tackle the problems of identifying the more commonly naturalised of the myriad of daffodil cultivars, but as there are about 26,000 names in the latest RHS Register (Kington 1998) it is not going to be easy to decide which to cover.

Much of the information scattered in journals such as the *BEC Reports* and *Watsonia* is not easily traceable, although the appendices in Druce (1930) to some extent act as an index to the former; the latter is soon to have a cumulative index. Some time ago, David Allen assembled all the published and much unpublished information on infraspecific taxa in Britain. This treasure trove is now at the National Museum of Wales, Cardiff, and Tim Rich is hoping to use it as a basis for a list of infraspecific taxa with details of the sources (it would be especially valuable if this could again include information on the results of cultivation experiments). A project to update and evaluate all this information and make it available as some sort of infraspecific Flora remains a long term aim, but how this would relate to Sell & Murrell is uncertain. Meanwhile these files at Cardiff can be consulted by anyone interested. Many other sources are available. Mary Briggs (2000) in her Presidential address showed how an alert and energetic local botanist can both learn from and contribute to the work of botanists operating in a wider field, and this certainly applies to problems of infraspecific taxonomy. Experts are perhaps likely to be more interested in the variation of one's local plants than in tetrad maps of their distribution, and there are many opportunities for getting them involved.

Another great source of information is in herbaria, but these are no longer being added to as much as in the past and a lot of variation is inadequately represented in them. Valentine (1979) in his Presidential address said: "Certainly, indiscriminate collecting is not desirable, but intelligent collecting, in which the specimens are treated as samples of a population and collected with ecotypic variation, polymorphism, or hybridization in view, are doubly valuable in that so few series of this kind are to be found in our large herbaria." Specimens put into a major herbarium are of course most likely to be looked at by experts, who should in return help us by naming them more critically, so there is mutual benefit all round. Ideally, certain items of information in a local Flora should always be underpinned by specimens deposited in a local or national herbarium.

METHODS OF PRESENTATION

It is helpful to indicate to what extent one has tried to cover infraspecific variation, and it is surprising how rarely this is done. For all the authors tell us, the plants of the Isle of Man may really have ten times as much infraspecific variation as those of Flintshire, as the Flora of neither area tells us what their policy is for including or commenting on these variants. If a species is not in a county Flora, we can assume it is not there, but if a variety is not mentioned we usually do not know whether it is absent on the ground, or deliberately left out of the Flora, or perhaps just absent from the author's mind. In particular, it is helpful to cover the variation recognised in earlier local Floras of the same area. Do forms of *Anthyllis vulneraria* approaching var. *coccinea* still occur in Leicestershire, and does *Veronica scutellata* var. *villosa* still occur at Groby Pool, as Horwood & Noel (1933) recorded? What is the current status of the rayed form of *Senecio vulgaris* in the Bristol region, discussed at length by White (1912)? The more recent floras of these areas do not tell us, but it would surely be interesting and useful to know. A particularly poignant example of continuing lack of information is *Iris foetidissima* var. *citrina*, the yellow-flowered variant, for Allen (1987) in his Presidential address mentions it as his favourite among variants which "are so conspicuous that it is hard to believe that their distribution is not known with tolerable completeness"; he cites records from Bath and Devon through Dorset to the Isle of Wight. Yet, since then, I think only the Dorset and Somerset Floras mention it, although there is a specimen in **BM** from Kent and it is mentioned by Simpson (1982) from Suffolk. Sell & Murrell can give no information on its ecology and distribution and just say that they require further study.

There is an almost insurmountable problem in knowing how to indicate that variants do not occur in one's area. It is tedious to repeat under each species "no significant variation occurs". In selected cases it may be worth saying "all populations seen are of the glabrous form" or "only yellow-flowered plants occur" or whatever. The Shetland Flora often gives species in the form "*Sonchus asper* (L.) Hill subsp. *asper*," and since in the Explanatory Notes the authors say that for nomenclature they have in general followed *Flora Europaea*, we can assume that they mean they have not got subsp. *glaucescens*, which is the other subspecies recognised in *Flora Europaea*. This convention is of course not practicable for varieties when there is no standard work to follow (although it should become more possible as Sell & Murrell is completed or an annotated Allen/Rich list becomes available). Unless one makes clear in each case what standard one is following, it is impossible to know what one is including or excluding by the use of a name. For example, were one to list *Lotus corniculatus* var. *corniculatus*, if one is following Stace (1997) it means it is not var. *sativus*, but it might still be var. *crassifolius* or var. *incanus* in the sense of Druce (1930); if one is following Druce (1930) it means that it is not the latter two varieties, but might still be var. *sativus*. In many cases it will be obvious what one means, but the best solution may be to do what Horwood, Salmon and Allen do and make one's Flora interesting and helpful by including a little descriptive gloss, such as: "Most populations are var. *corniculatus*, fleshy-leaved plants (var. *crassifolius*) have not been seen, and plants with densely hairy leaves (var. *incanus* or var. *hirsutus*) are confined to the limestone and to dry, sandy banks; the robust, hollow-stemmed var. *sativus* is frequent on reseeded roadside verges." Varieties and forms, almost by definition, tend to be definable by a very few characters, so this is usually easy. It may be argued that this takes up too much room, but it is the sort of information that makes a local Flora worthwhile and readable. It is also essential to say if one cannot distinguish variants recognised in whatever standard one is following and has therefore deliberately ignored them. It is no disgrace to say that one has been unable to distinguish the subspecies of *Sedum telephium* or even of *Molinia*, and it is more honourable than saying nothing. It may also of course be genuinely useful to say that they are just not distinguishable in a particular area.

CONCLUSION

Druce had 2400 varieties in 1928, and there must be very many more by now; there is no available estimate, and still less any estimate of the number worth recording. No local Flora writer is going to be able to include more than a small proportion, but virtually any information on these infraspecific taxa is going to be a contribution to our knowledge of variation and will be worth the effort. So often when one goes out with colleagues in their own patch they show one fascinating features of the local plants, including all sorts of infraspecific variants, but when they come to write the county Flora most of this seems to get left out and what makes their county so interesting is lost. We should all try harder to write the sort of Flora that does justice both to the authors and the plants, and that contributes more information to botany in general.

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Perceptions of change in English county Floras, 1660–1960

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ABSTRACT

References to floristic change in county Floras have not hitherto received much attention, but they are a potential source of evidence for the extent of such change in the historical period. To explore this potential, references to change in the introductory sections of 68 English county Floras published between 1660 and 1960 are summarised and discussed. References to change are rare before 1860; after this date they are more frequent but few Floras published in any period have floristic change as a major theme. Notable exceptions are the Floras of Cambridgeshire (Babington 1860), Worcestershire (Lees 1867) and Middlesex (Trimen & Dyer 1869), all of which describe major changes in their areas. After 1890 many Floras included a list of extinct species. Several highlight change in coastal habitats, and some contain details of particular developments such as grassland improvement in Leicestershire and the effect of agricultural changes during the Second World War in a Gloucestershire parish. Most discussions of floristic change are based on subjective judgements, and the most vivid accounts are of changes experienced by the author. Few authors have made any detailed use of historical records, and it can be difficult to tell whether the absence of references to change indicates a relatively stable countryside or merely reflects an author's lack of interest in the subject. Quantitative measures of floristic change need to be developed and related to evidence of agricultural and other land-use history.

KEYWORDS: agricultural improvement, drainage, enclosure, extinction, floristic change, urbanisation, war.

INTRODUCTION

Several recent studies have used the data contained in local and county Floras to assess the nature and extent of historic floristic change. Some authors, notably McCollin *et al.* (2000), have assessed floristic change by a direct comparison of two Floras, and others have combined the records contained in Floras with those from other sources to examine such change (e.g. Dony 1977; James 1997; Greenwood 1999, 2003; Preston 2000). The potential use of county Floras to modern botanists interested in assessing change is explored in detail by Walker (2003b).

The degree to which the authors of county Floras themselves reported, and commented upon, floristic change has received less attention. In this paper I have attempted an initial exploration of this subject, in the hope that it might not only be of intrinsic historical interest but might also provide some evidence of the extent to which floristic change was occurring in the past. Contemporary field botanists tend to regard the period since 1950 as one of unprecedented change, and in particular consider that the changes in land-use brought about by modern agricultural methods have had a more damaging effect on our native flora than any other developments in recent centuries. Does an examination of the way in which Flora writers perceived floristic change in earlier times support this view, or is there always a tendency for people to regard the times in which they live as ones marked by dramatic change?

METHODS OF ASSESSING PERCEPTIONS OF CHANGE IN FLORAS

SCOPE OF THE STUDY

This study is restricted to the first editions of English county Floras published between 1660 and 1960 (Table 1, Fig. 1). I have examined 68 Floras, from the first accepted county Flora, John Ray's Cambridge Catalogue (1660), to Grose's *Flora of Wiltshire* (1957), the last Flora to appear before publication of the *Atlas of the British flora* (Perring & Walters 1962). These include Floras

TABLE 1. PRESENCE OF FOUR 'CHANGE FEATURES' (DEFINED IN THE TEXT) IN ENGLISH COUNTY FLORAS, 1660-1960.

Area	V.C. No.	Author(s)	Date	1	2	3	4
				Preface mentions change	Introductory material includes paragraph on change	Old/ extinct records marked	Extinct species listed
Cambs.	29	Ray	1660	No	No	No	No
Notts.	56	Deering	1738	No	N/A	No	No
Cambs.	29	Relhan	1785	No	No	No	No
Oxon	23	Sibthorp	1794	No	No	No	No
Beds.	30	Abbot	1798	No	No	No	No
Northumb. & Durham	66-68	Winch <i>et al.</i>	1805	Yes	No	No	No
Notts.	56	Ordoyno	1807	Yes	No	No	No
Midlands	37,38 etc.	Purton	1817	No	No	No	No
Devon	3,4	Jones & Kingston	1829	No	No	No	No
Northumb. & Durham	66-68	Winch	1831	N/A	No	No	No
Oxon	23	Walker	1833	No	No	No	No
W. Devon & Cornwall	1-4	Jacob	1836	N/A	N/A	No	N/A
Notts.	56	Howitt	1839	N/A	No	No	No
Yorks.	61-65	Baines	1840	No	No	No	No
Salop	40	Leighton	1841	No	No	No	No
Herts.	20	Webb & Coleman	1849	No	No	No	No
Leics.	55	Kirby	1850	Yes	No	No	No
Wight	10	Bromfield	1856	Yes	Yes	No	No
Cambs.	29	Babington	1860	No	Yes	Yes	Yes
Suffolk	25-26	Henslow & Skepper	1860	No	No	No	No
Essex	18-19	Gibson	1862	Yes	Yes	Yes	Yes
W. Yorks.	63-64	Miall & Carrington	1862	No	No	No	No
N. Yorks.	63-64	Baker	1863	No	No	No	No
Surrey	17	Brewer	1863	No	No	No	No
Devon & Cornwall	1-4	Keys	1866-1872	No	No	No	No
Norfolk	27-28	Trimmer	1866	No	Yes	No	No
Worcs.	37	Lees	1867	No	Yes	Yes	Yes
Northumb. & Durham	66-68	Baker & Tate	1868	N/A	No	Yes	No
Middlesex	21	Trimen & Dyer	1869	No	Yes	Yes	Yes
Dorset	9	Mansel-Pleydell	1874	No	Yes	Yes	No
London	21	De Crespigny	1877	Yes	No	Yes	No
Hants. & Wight	10-12	Townsend	1883	No	Yes	No	No
Lake District	69-70	Baker	1885	No	No	No	No
Oxon	23	Druce	1886	No	No	No	Yes
Leics.	55	Mott <i>et al.</i>	1886	Yes	No	Yes	Yes
Sussex	13-14	Arnold	1887	No	No	No	No
Herts.	20	Pryor	1887	No	Yes	No	No
W. Yorks.	63-64	Lees	1888	No	No	Yes	No
Wilts.	7-8	Preston	1888	No	No	No	No
Herefs.	36	Purchas & Ley	1889	No	No	No	No
Suffolk	25-26	Hind	1889	No	No	No	No
Derbys.	57	Painter	1889	No	No	No	No
Warks.	38	Bagnall	1891	No	No	No	No
Somerset	5-6	Murray	1896	No	No	No	Yes
Berks.	22	Druce	1897	No	No	No	Yes
Cumberland	70	Hodgson	1898	N/A	No	No	No
Cheshire	58	De Tabley	1899	No	Yes	No	No
Kent	15-16	Hanbury & Marshall	1899	No	No	No	Yes

TABLE 1. CONTINUED

Vice-county	V.C. No.	Author(s)	Date	1	2	3	4
				Preface mentions change	Introductory material includes paragraph on change	Old/ extinct records marked	Extinct species listed
Staffs.	39	Bagnall	1901	N/A	No	No	No
E. Yorks.	61	Robinson	1902	No	No	No	Yes
Derbys.	57	Linton	1903	No	No	No	Yes
W. Lancs.	60	Wheldon & Wilson	1907	No	Yes	No	Yes
Worcs.	37	Amphlett & Rea	1909	No	No	No	No
Cornwall	1-2	Davey	1909	No	No	Yes	Yes
Norfolk	27-28	Nicholson	1914	N/A	No	No	No
Bucks.	24	Druce	1926	No	Yes	No	Yes
Northants.	32	Druce	1930	No	Yes	No	Yes
Surrey	17	Salmon	1931	Yes	No	Yes	No
Leics.	55	Horwood & Noel	1933	No	Yes	No	No
Sussex	13-14	Wolley-Dod	1937	N/A	Yes	No	Yes
Westmorland	69	Wilson	1938	No	Yes	No	Yes
Cambs.	29	Evans	1939	No	Yes	Yes	Yes
Devon	3-4	Keble Martin & Fraser	1939	No	No	No	Yes
Dorset	9	Good	1948	No	No	No	Yes
Gloucs.	33-34	Riddelsdell <i>et al.</i>	1948	No	Yes	Yes	Yes
London	21	Kent & Lousley	1951-1957	Yes	No	No	No
Beds.	30	Dony	1953	No	No	No	Yes
Wilts.	7-8	Grose	1957	No	No	No	No

N/A denotes not applicable (e.g., if the Flora lacks a Preface, N/A is entered under 1). Full details of the Floras are cited in the bibliography.

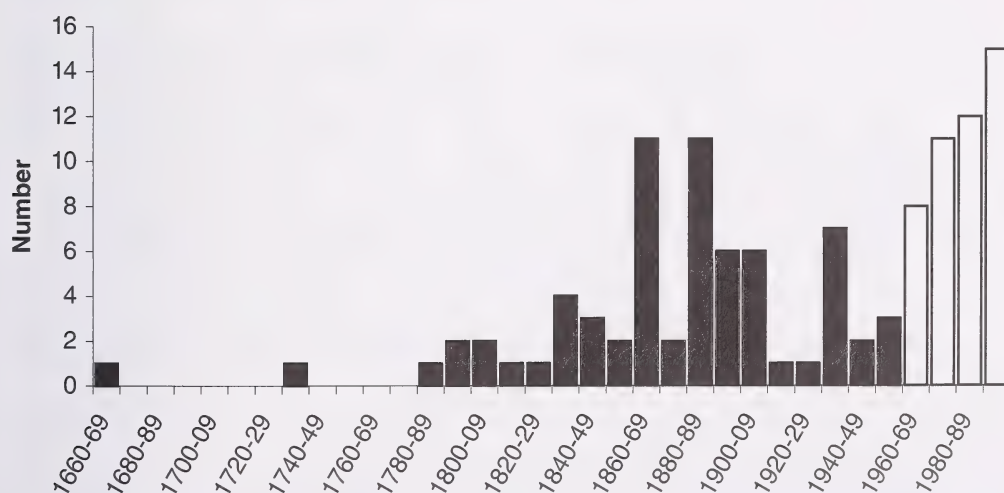


FIGURE 1. The number of county floras published per decade between 1660 and 1999. The diagram distinguishes those Floras published between 1660 and 1959, the subject of this paper.

of the Lake District and the London region, areas which are as large as some traditional counties. After 1962 there was a great revival of the county Flora tradition and this date can therefore be taken as marking the transition from the historical to the modern era of Flora-writing. I have restricted the coverage to England, as adding the other countries of the British Isles increases the heterogeneity of the study area without a proportional increase in the number of Floras. I have excluded check-lists, which are insufficiently detailed to be of any use in this context. More reluctantly, I have excluded 'local Floras', those covering smaller areas than vice-counties, simply to limit the size of the task. Finally, I have (with a few stated exceptions) only considered changes from the 16th century onwards to plants which are classified by Preston *et al.* (2002) as native species or archaeophytes. Archaeophytes are ancient introductions, defined as plants which are believed to have become established in the wild before AD 1500.

COMPARISON OF FLORAS

County Floras are remarkably varied. The *Flora of Essex* by S. T. Jermyn (1974, p. 3) excluded old (pre-1930) records on the grounds that "their inclusion only artificially inflates the number of county records; also, apart from following the slavish conventions of writing a county Flora, such records merely stimulate an idle curiosity for many, with a very limited interest for a few. I cannot see what is to be gained, either scientifically or historically, to include *Otanthus maritimus* which has not been refound in Essex since it was recorded from Mersea Island, by Gerard, in 1597....". In contrast, *The historical Flora of Middlesex*, published in the very next year (Kent 1975), lovingly details the county's historical records from 1548 onwards. Floras published in the three centuries from 1660 are even more varied in both format and content. As a consequence, the comparison of Floras, like the comparison of any dissimilar objects, is fraught with difficulties.

To compile a list of all references to change in all 68 Floras would be a mammoth task. After initial examination of some Floras, I recorded the following 'change features' for each one:

1. Is change in the native flora mentioned in Preface, e.g. as one of the reasons given for producing the Flora?

The reasons for writing a county Flora are often outlined in the Preface. These frequently include the accumulation of records since the last Flora of the county, but I have not treated this as a reference to floristic change.

2. Is there at least one paragraph in the introductory or concluding material (outside the Preface and the species accounts) devoted to floristic change affecting native species in the historic period (1500 onwards)?

The restriction of this criterion to the historic period excludes those Floras which discuss (in general terms) disafforestation and other land-use change since the Norman Conquest, for example.

3. Are old records, or sites where the species is extinct, clearly and obviously distinguished from new records in the species accounts?

This requires an explicit marking of old or extinct records. Many Floras list records chronologically or provide the readers with some evidence which enable them to date a record at least approximately (e.g. recorder's name, literature reference) but such Floras do not qualify under this criterion. The difference between old and current records must be immediately apparent. I have not counted under this criterion those Floras which indicate taxa which are extinct (the annotation must apply to individual records) nor have I included Floras which mark records as 'extinct or dubious'.

4. Is there a list of extinct species?

This also refers to extinctions in the historic period.

These four 'change features' do not provide a comprehensive picture of the references to change in each Flora: there are often, for example, brief references (less than a complete paragraph in length) in the introductory material and additional references in the individual species accounts. Nevertheless, the 'change features' do provide a broad indication of the extent to which the authors of particular Floras were concerned with floristic change.

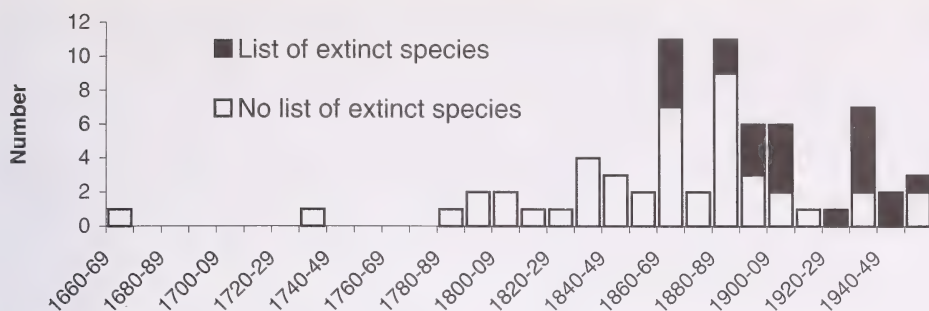


FIGURE 2. The number of county Floras published in each decade between 1660 and 1959 which contain (or do not contain) a list of extinct species.

REFERENCES TO CHANGE IN COUNTY FLORAS, 1660-1960

The occurrence of the four 'change features' listed above in Floras published between 1660 and 1960 is documented in Table 1. Very few Floras published before 1860 include any of the four features. Lists of extinct species appear in Floras from the 1860s onwards, and they are present in most 20th century Floras (Fig. 2). The other three change features occur sporadically in Floras from the 1860s, but these show little evidence for an increase in frequency with time. Only one of the five Floras published in the 1940s and 1950s, for example, devotes a paragraph in the introductory material to floristic change. The overall impression is that change is not an important consideration for many Flora writers in this period. Nevertheless, a general tendency for considerations of change to become more frequent from the 1860s is apparent from Fig. 3, which shows the proportion of Floras with at least one change feature in the decades since 1660.

As the Floras are so varied in their approach, it is more useful to discuss them individually than to generalise. I have divided them into chronological groups and, within the period when most Floras were written, 1860–1914, selected some areas where the contrast between different Floras is particularly informative.

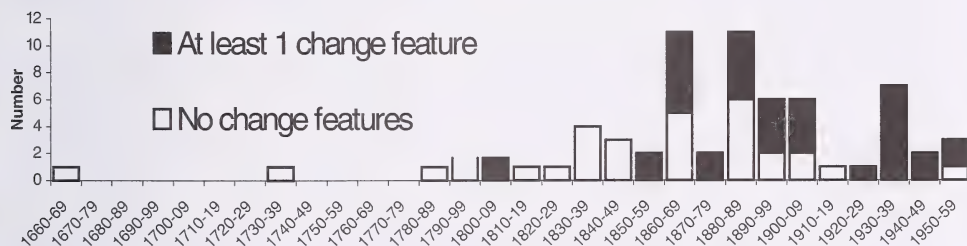


FIGURE 3. The number of county Floras published in each decade between 1660 and 1959 which contain (or do not contain) at least one of the four 'change features' defined in this paper.

THE PIONEER FLORAS, 1660-1859

There are very few 'change features' in the early Floras. The first example is found in the Preface to *The botanist's guide through the counties of Northumberland and Durham* (Winch *et al.* 1805), in which the authors explain the format of their Flora:

"As botanists however have been frequently misled by the insertion of plants in provincial Floras, which, by cultivation or some other cause, had been extirpated a long time previous to their habitats having been published, and the value of the following pages chiefly depending upon their accuracy in this particular, the Editors have thought it proper on that account, to state the authorities on which the catalogue rests".

This is at first sight a most surprising statement. Which Floras had misled botanists by including localities where plants were already extinct? Very few county Floras had been published before 1805, and although there were certainly other publications which might count as "provincial Floras", there were not very many (Henrey 1975). I have wondered whether the authors were thinking of Cambridgeshire. Floras of Cambridgeshire had been published by Ray (1660) and Relhan (1785, with a second edition in 1802), and other floristic works published before 1805 include those of Martyn (1727) and Martyn (1763). Babington (1860, p. x) could not tell whether many of the records in Relhan (1785, 1802, 1820) were repetitions of previously published records or whether Relhan had himself confirmed the occurrence of a species at a site, and the situation is no clearer to the modern reader. However, all the authors of *The botanist's guide* ... appear to have been firmly rooted in the Newcastle area, with no connections that I can detect to Cambridge. If they were referring to Cambridgeshire, they must presumably have heard about the problem from others.

A similar indication that floristic change was occurring in northern England in the early 19th century comes from grandiloquent prose in the Preface to Ordoyno's (1807) *Flora Nottinghamiensis*:

"nearly a century has elapsed, since Deering published his 'Catalogue of plants naturally growing about Nottingham;' and although the busy hand of human industry has, in the lapse of time, altered the face of nature, and expelled many of these inoffensive tribes from the habitations, which they formerly occupied, still they are not extirpated; they are, even at this day, to be discovered, by their diligent votaries, in those sheltered assylums, where cultivation has not invaded the privacy of their sequestered retreat."

Baines (1840, p. xii) refers briefly to the agricultural improvement of the "dark and wearisome moorlands" of N. E. Yorkshire. "It is gratifying to believe that some part of this poor country is under a course of gradual improvements by the beneficial operation of the Pickering and Whitby Railway, which from either end brings lime, the grand improver of moorland, at moderate cost."

In contrast to these references to change, Mary Kirby's comments in *A Flora of Leicestershire* (1850, p. v) on Pulteney's earlier lists of the plants of the county (1757, 1795) are indicative of stability:

"Antiquated as these catalogues may appear, the experience of each succeeding summer has tended to confirm their accuracy. *Aquilegia vulgaris*, and the two or three plants that may probably be extinct, are the exceptions, and not the rule."

The last Flora of the pioneer period, Bromfield's *Flora Vectensis* (1856, pp. xvi-xvii), gives a very different picture of change on the Isle of Wight. Justifying the inclusion of the dates of discovery of the rarer or more local species, which he feared might be thought to lack "practical use or interest to the collector", he argued:

"when it is considered how rapid are the changes which the surface of this island is yearly, monthly and daily undergoing, from the progress of building and its invariable attendant, increased cultivation; - low lands, but lately waste, now inclosed, and spots not long since free, and accessible to every wanderer in search of health or recreation, at this time dotted with tenements, their sites fenced from the intrusion of stranger footsteps with the jealous exclusiveness of individual appropriation; - it will be evident that the *first* recorded station for some rare or local plant may often be the *last* on record ..."

These comments have an urgency missing from the earlier references to change. They read as if they are based on personal experience, suggesting that Bromfield, as he is writing, has in his mind's eye a favourite place from which he is now excluded and where he fears that some species may face extirpation. By contrast, Ordoyno's observations on the "busy hand of human industry" seem theoretical and generalised. This may just be a reflection of their different prose styles, but Bromfield's remarks herald a concern about change that was to become evident in some of the Floras of the 1860-1914 period.

FLORAS OF THE EASTERN COUNTIES, 1860-1914 *Cambridgeshire*

Babington's *Flora of Cambridgeshire* (1860) dealt with floristic change to a much greater extent than any previous Flora, and the design of the book reflects this. One of Babington's aims was "to record not merely the present state of our Flora but also its condition before the great alterations

caused by modern enclosures and drainage: alterations still advancing so rapidly that probably many of the places in which I have myself gathered plants within the last few years do not now produce them. The localities given by the older Botanists, but which have not been confirmed by recent observers, are inserted on their authority and markedly separated from the rest by being printed in Italics, so as to point out their historical not modern character" (pp. xi–xii). The changes which had taken place since 1800 in the different areas of the county are discussed in the introduction, and for the first time in a county Flora there is a list of "lost plants".

Babington's comments (1860, pp. xiv–xxiii) on the changes which had taken place in the county are well known. The Chalk Country which "until recently (within 60 years)" was "open and covered with a beautiful coating of turf, profusely decorated with *Anemone Pulsatilla*, *Astragalus Hypoglottis* [*A. danicus*], and other interesting plants ... is now converted to arable land, and its peculiar plants mostly confined to small waste spots by road-sides, pits, and the very few banks which are too steep for the plough. Thus many species which were formerly abundant have become rare" and "even the tumuli, entrenchments, and other interesting works of the ancient inhabitants have seldom escaped the rapacity of the modern agriculturist, who too frequently looks upon the native plants of the country as weeds, and its antiquities as deformities". The plants of the Clayey District "have suffered nearly as much ... where they were once abundant they are now rarely to be found". The Fens "have undergone an equally if not more destructive change than the Chalk district" as steam drainage had rendered the whole level "a pattern in farming". "With the water many of the most interesting and characteristic plants have disappeared, or are become so exceedingly rare that the discovery of single individuals of them is a subject for wonder and congratulation. There is scarcely a spot remaining (I only know of one, near Wicken) in which the ancient vegetation continues undisturbed and the land is sufficiently wet to allow of its coming to perfection. Owing to the necessary existence of numerous ditches ... those plants which are absolutely aquatic have not suffered so greatly as the others; but they are fast decreasing, now that the steam-engine causes even many of the ditches to be dry in summer".

The marked changes discussed by Babington were the result of an extensive reorganisation of the agriculture of the county in the early 19th century. Two waves of parliamentary enclosure, followed by widespread agricultural improvement, had resulted in habitat destruction on a massive scale – the ploughing of chalk grassland and heathland, the drainage of wetlands in the south of the county and the use of steam drainage in the fens (Preston 2000). Babington was able to document these changes because of the long sequence of historical records available to him (Table 2). Thus Babington's Flora resulted from an unprecedented combination of circumstances – a long sequence of historical records followed by a period of very rapid floristic change.

TABLE 2. SOURCE'S OF BABINGTON'S (1860) RECORDS CITED "SOLELY UPON THE AUTHORITY OF THE OLDER BOTANISTS".

Source	Date of source	Percentage of older records from this source
J. Ray and contemporaries	1660–1685	18
J. Martyn	Active c. 1727–1735	18
T. Martyn	Least inactive 1762–1785	2
J. Lyons	1763	2
J. Fisher	c. 1770	3
R. Relhan and contemporaries	1785–1820	54
Others	Mostly late 18th and early 19th century	3

Dates indicate the period when the records were originally published, or when the botanist was active. For the dating of the botanical activity of J. & T. Martyn, see Walters (1981).

Other eastern counties

The historical record available to Kirby Trimmer for his *Flora of Norfolk* (1866) was less extensive than that which Babington had drawn upon for Cambridgeshire. Nevertheless, Trimmer thought that change was occurring at a similar rate in West Norfolk. In the early part of the reign of George III (1760 onwards) West Norfolk "consisted chiefly of dry heath lands, open sheep walks, and sandy warrens, wet marshes, bogs, and fens; but within the last half century the first three of these have been greatly reduced in number and extent by enclosure, and the greater portion of the other descriptions of soil, after drainage, subjected to the plough, or converted into meadows." By contrast, East Norfolk had by 1760 "long been enclosed" (pp. xiv–xv). One feature which Trimmer regarded as particularly characteristic of Norfolk was the system of 'Land Dressing', or importing soil from other districts to temper the local soils so "wet soils are rendered dry, and dry soils sufficiently moist, adhesive soil loose, and loose soils sufficiently adhesive". As a result, "plants which naturally prefer the sand, the chalk, and clay, are often found in proximity ..." (pp. xvi–xvii).

Authors of other Floras of the eastern counties presented a picture of much less dramatic change. Gibson's (1862) *Flora of Essex* was inspired by Babington's *Cambridgeshire* and is modelled upon it. Although Gibson recognised that "Essex is in some degree a new botanical field, since no separate Flora or list of its plants has as yet appeared", the older herbals and British Floras contained many Essex records and these provided "data on which we may endeavour to estimate how far our present Flora has been changed by the progress of cultivation, and by other causes" (pp. vi–vii). He concluded that "a certain amount of change seems to have been produced by the progress of cultivation, drainage, and enclosure, and by the felling of woods, though the effects are less evident than in Cambridgeshire. The plants supposed to have become extinct are not numerous; less than a dozen species altogether ... Several others are, however, fast becoming scarce ..." (pp. xvii).

Pryor's (1887, p. xxxvii–xxxviii) *Flora of Hertfordshire* also concluded that "the botany of the county within the historic period has undergone less change than that of Cambridgeshire from its fen-reclamation, or Middlesex from the encroachment of building". Admittedly, he uses this argument rather self-servingly to justify the absence from his Flora of the sort of detailed treatment of the lives of the older botanists provided by Trimen & Dyer (1869). Hind, in his *Flora of Suffolk* (1889, p. xxxiv), also commented that "a gradual change is taking place in the Flora of the County. Several plants of the early part of this century are now no longer to be found, and others are becoming rarer every day. To meet this, there is a constant succession of foreign plants becoming naturalised ... The change, however, is so slow, that there is no reason to fear that the distribution of plants in Britain will be greatly modified in the course of succeeding centuries".

Trimen & Dyer's *Flora of Middlesex* (1869) is a special case, as the London metropolis has come to dominate that county. Trimen & Dyer include a detailed discussion of the nature and extent of the changes brought about by the growth of London. In particular, they stress the destruction of heathland (especially the enclosure and cultivation of thousands of acres in the early 19th century), the grubbing up of the few remaining woodlands, the extraction of brick earth in numerous brickyards, the construction of canals and the New River set against the conversion of numerous streams to subterranean sewers, and the remorseless advance of the built-up area of London. Those localities where species are "certainly or very probably extinct" are marked, and a list of "probably extinct" species in the county as a whole is included in the Flora.

De Crespigny (1877) cited changes in the flora of the London area since the publication of Cooper's *Flora Metropolitana* (1836) as one of the main reasons why *A New London Flora* was required. "It is a well-known fact that vegetation everywhere alters to a certain extent with the lapse of time; it does so to a marked degree in the neighbourhood of London, where the disturbing elements of clearing, draining, building, enclosing, are perpetually at work".

In summary, writers of Floras of the eastern counties were prompted by Babington's *Flora of Cambridgeshire* to consider floristic change. Their comments suggest that there was considerable variation in the rate of change from county to county.

FLORAS OF THE WEST MIDLANDS, 1860–1914

Lees' account of 'The botany of Worcestershire'

Edwin Lees was singled out by John Gilmour as the Victorian author who, in his book *The*

botanical looker-out, plumbed the lowest depths of “ludicrous and pretentious sentimentality” (Gilmour & Walters 1954, p. 23). Nevertheless, Lees’ *The botany of Worcestershire* (1867) provides an account of floristic change which is, in its way, even more remarkable than that in Babington’s *Flora of Cambridgeshire*. *The botany of Worcestershire* is not without its defects, and it only just qualifies as a county Flora. Over 200 pages of repetitive and disorganised introduction precede the 36 pages devoted to the systematic catalogue. Lees confesses that he has covered not only Worcestershire but also Herefordshire and Warwickshire, it being “a relief not to be too closely confined to a comital boundary” (p. vi). Indeed, he “felt inclined to take in or enclose for botanical purposes, portions of the adjacent counties which really *geographically* belong to us” (p. 2), an attitude similar to that later taken by J. W. Heslop Harrison (Pearman & Preston 2000, pp. 11–12). This cavalier approach to the admittedly complex county boundary, and Lees’ botanical inconsistencies and inaccuracies, have left a corpus of ambiguous records to exasperate authors of later Floras. Yet, despite these faults, Lees produces a vivid picture of floristic change in his area, based on some earlier records and his forty years of personal observation. This reflects his strong personal interest in the subject. Even the book of poems he published in his old age (Lees 1880) begins with four on the theme ‘Landscape changes and rural transformations’.

Lees noted the mosses and fungi which colonised areas where charcoal was burnt in the Wyre Forest (p. lxxii) and the plants growing in places from which turf had been pared away at Rednall (p. 116), as well as the positive responses of *Campanula patula*, *Cephalanthera longifolia*, *Epipactis purpurata* and *Festuca altissima* to coppicing (pp. 18–20). However, most of his observations deal with change on a rather longer timescale. The effects of drainage are repeatedly referred to. “Before Moseley Wake Green was enclosed (which I remember in its integrity) and the bogs drained, this must have been a locality of surpassing interest, and even now, though the bogs are almost extinct, yet as several pools yet remain, a stroll along their margins may still discover the last relics of a banished race ... botanists must solace themselves, as Mr. Mathews says, ‘with the reflection that their place will be supplied by much more important and profitable vegetation’” (pp. 119–120). At Feckenham Bog, eight miles from Droitwich “in the early part of the present century ... dreary moors extended for some distance around. The cottagers of the vicinity dug the turf of the bog for fuel as is still done in Wales ... coal was a luxury unknown ... The site even of the bog is now found with difficulty, cultivated meadows and arable land alone presents itself to the view, and all the above mentioned plants [which included *Anagallis tenella*, *Baldellia ranunculoides*, *Cirsium dissectum*, *Cladium mariscus*, *Pinguicula vulgaris* and *Schoenus nigricans*] have disappeared from the locality” (p. 96). A rather different site, Longdon Marsh, “a waste of about 3,000 acres” was “a large lake in rainy seasons ... but a commission is at present engaged in the somewhat expensive project of draining it, with what results remains to be seen” (p. lxvi).

The enclosure of heathland, as in the eastern counties, is another marked change. Whinwood Heath, for example, “was a few years since a waste ... as rough and wild as any common left to Nature’s keeping; but its scattered birch trees have been cut down, it has been enclosed, and if more valuable to the farmer, it has ceased to possess any interest to the botanist” (p. 126). Near Bromsgrove in “the heathy part of Worcestershire”, “the bogs are mostly drained, and the hills cultivated, except on their very tops, or where the Windsor family owners of the soil have enclosed it, and planted firs and larches for the preservation of game” (p. 138). Although these conifer plantations contained interesting fungi, the “diligent Cryptogamous botanist” was warned that this area “requires to be furtively trodden” (p. 118).

In addition to the enclosure of common land, “recently too, hedges have been extensively stubbed up, and coppices cut down” (p. xxxiii). *Juniperus communis* “from being remorselessly cut down, has become almost extinct in the county” (pp. 137–8), both this species and *Sorbus torminalis* “being of slow growth, when cut down are not renewed” (p. xxxii–xxxiii). In the county as a whole “very few old trees can be said to exist, though there are many that from premature decay put on the appearance of ‘dry and bald antiquitie’” (p. xxxvii).

Water course management and pollution also had an impact on the flora. At Badsey, the ditches were “so deep that nothing can grow on their sides” (p. 95). At Worcester, the River Severn “under the direction of the Severn Navigation Commissioners, has by weirs and locks been raised, so that the waters have an uniform depth of five or six feet, the *Ranunculus* no longer flowers, not being

able to reach the surface, though yet existing below the water in an unflowering state" (p. xxxvi). The Stour, "pure and bright in its childhood, becomes dirty as a begrimed medicant in its progress through Kidderminster" (p. 124).

The destructive effects of building are sometimes mentioned. Yardley "abutting upon smoky Birmingham, whose polypoid arms have spread into its once lonely fields and woods ... has been so invaded and built upon of late years, that ... I have heard of nothing of importance recently gathered there" (p. 121). Industrial pollution was also noticeable. At Cradley "there is no resisting manufactures and smoke, and Flora retreats disgusted from the vicinity of iron works, and the dismalities that surround a nail-making population ... there are no plants ... worthy of notice to record. Even the Lichens ... will not grow upon the trees at Cradley" (pp. 129–130). (This observation was published only eight years after Grindon (1859) first reported the effects on industrial pollution on lichens.)

The effects of change on individual plant populations are also considered. The single *Sorbus domestica* in the Wyre Forest, for example, famously suffered "wanton destruction by ruffian hands" (p. xci). A unusual lowland population of *Asplenium viride* on Ham Bridge was destroyed by "an unfortunate renovation of the structure" (p. 87) while the population of the introduced umbellifer *Anthriscus cerefolium* was eliminated when "those Vandals (as respects botanists), the Road Surveyors, last year altered the course of the Bristol road, cut the bank away ... and not even a stray plant is now to be met with there" (p. lxxxix).

Some of Lees' observations correspond with those being made by modern botanists. "A few scraggy native Black Poplars (*P. nigra*) appear in various localities by brook sides, but this tree appears to be dying out" (p. xl) as "old gnarled stubs ... are not uncommon, but no young trees of this species now appear ..." (p. xxxiii). Lees also notes that *Brachypodium pinnatum* "which, useless as a grass, yet on the sides of Bredon Hill, left wild, or only occasionally stocked, spreads greatly, forming rounded patches yards in diameter, wholly untouched by cattle, and thus seeds unchecked, besides spreading by short rhizomes, until much of a pasture is usurped by this coarse and distasteful species" (p. lii). He also commented on the spread of *Urtica dioica*: "in the once undesecrated 'Winding Valley' ... the track of the subterranean water-course is marked by a line of Nettles that seem to have sprung up in the footsteps of the workmen, and show where their polluting influence extended". Indeed, he considered that this species "is seen to follow the footsteps of man with such dogged pertinacity" that he thought it probable enough that it was an alien (pp. 139–140).

Some species benefited, at least temporarily, from the changes to the countryside. "The year after the ground was excavated for the Severn Valley Railway between Stourport and Bewdley, the mass of scarlet poppies (*Papaver rhoeas*) that lined the embankment was wonderful to behold ... Yet, though probably many of the poppies seeded, this extraordinary profusion has not been maintained" (pp. xii–xiii). A more permanent expansion of range was shown by *Chamerion angustifolium* which "quite recently ... has become numerous in several parts of the Vale of Severn, and promises to spread, incited to take possession of new made roads and embankments" (p. 24). Lees thought that "agricultural weeds are upon the increase, in spite of the treatises written to destroy them" (p. 140). One such was *Legousia hybrida*, which "is now very plentiful in the arable fields on Broadway ... yet it must be remarked that this species must have been introduced on Broadway Hill since its enclosure and cultivation" (p. 103). Other plants, including *Hyoscyamus niger* and *Onopordium acanthium*, were often found on "deposits of manure or rubbish from gardens on roadsides" although "these wandering plants ... all prove fugacious, and are seldom seen in the following season" (p. 21).

Standard Floras of the West Midland counties

The impression one gets from *The botany of Worcestershire* of an ever-changing flora is at variance with the accounts in the standard Floras of Herefordshire (Purchas & Ley 1889), Worcestershire (Amphlett & Rea 1909) and Warwickshire (Bagnall 1891). None of these Floras contain any of the 'change features' defined earlier in this paper. Even the species accounts in Purchas & Ley (1889) reveals remarkably few references to change. They do mention the increase in the county of *Medicago arabica* and *M. polymorpha*, species which had been introduced to some gardens with river gravel, the similar spread of *Bromopsis erecta* with limestone road-mending materials, the increase of *Chamerion angustifolium* and *Pastinaca sativa* on railway

embankments, and an interesting reference to the deliberate sowing of *Trifolium micranthum* on lawns. The species lost from the county are *Sparganium natans*, as its only known site, a small pool, was drained, and a puzzling *Epipactis*, whose site was converted to a deer park. Single sites were lost for *Anagallis tenella*, *Apium nodiflorum*, *Drosera rotundifolia*, *Orobanchae rapumgenistae*, *Pinguicula vulgaris*, *Ranunculus circinatus*, *Sagina nodosa* and possibly *Phragmites australis*. The destruction of single trees of *Rhamnus cathartica* and *Salix alba* is noted. All in all, this seems remarkably little change considering that the authors' collective experience of the county extended back over 40 years.

An examination of the species accounts in Amphlett & Rea (1909) reveals rather more references to change in Worcestershire, especially in those parts of the county which border on the Birmingham conurbation. *Anagallis tenella*, *Baldellia ranunculoides*, *Drosera rotundifolia*, *Menyanthes trifoliata* and *Potentilla palustris* are identified as wetland species which are "steadily disappearing through the drainage of bogs and the advance of modern conditions" (p. 124) or "rapidly vanishing from the face of our county" (p. 149). *Juniperus communis* also "appears to be slowly vanishing". *Gymnocarpium dryopteris* "has to a great extent disappeared from the county, owing, it is to be feared, to the ravages of the fern-hunter" and both *Oreopteris limbosperma* and *Primula vulgaris* had suffered from collecting by gardeners or for sale in Birmingham. Although these and a few similar observations might be thought to indicate a changing Flora when they are gathered together, one has to read 441 closely printed pages to find them.

The absence of any general reference to change in Bagnall's (1891) *Flora of Warwickshire* is particularly surprising as Birmingham itself falls in this vice-county. By reading through the species accounts I have found some 15 species which were either thought to be extinct, possibly extinct or had not been refound recently (e.g. *Huperzia selago*, *Hypochaeris glabra*, *Mentha pulegium*, *Phyllitis scolopendrium*, *Vicia sylvatica*) or were in general decline (e.g. *Asplenium adiantum-nigrum*, *Calluna vulgaris*, *Menyanthes trifoliata*, *Narthecium ossifragum*, *Schoenoplectus tabernaemontani*). A further twenty species were declining or extinct at particular sites (e.g. *Botrychium lunaria*, *Ceratocarpus claviculata*, *Lactuca virosa*, *Nymphaea alba*, *Vaccinium vitis-idaea*). However, a more striking feature of the Flora is the number of old records which are cited without comment. These include many of William Withering's late 18th century records from the Birmingham area. The population of the Borough of Birmingham had doubled between 1760 and 1801 and then increased from 71,000 in 1801 to 401,000 in 1881. The suburbs outside the borough boundary also expanded greatly (Gill 1952; Sutcliffe & Smith 1974). In the course of this growth, all that remained of Birmingham Heath was enclosed and built on in 1799 (Gill 1952, p. 121). Nevertheless, Withering's records from this locality of species such as *Drosera rotundifolia*, *Eriophorum angustifolium*, *Hypericum elodes*, *Nardus stricta*, *Potamogeton polygonifolius*, *Rhynchospora alba* and *Utricularia vulgaris* are cited without any indication that they may have become extinct there. (Bagnall did refind *Calluna vulgaris* in this area, so some acidic habitat must have survived.) Other Withering records from suburbs of Birmingham such as Edgbaston and Winson Green are also cited. There are also species recorded outside the Birmingham area for which all the records appear to be old but which are merely described as 'very rare', without further comment (e.g. *Hottonia palustris*, *Pulicaria vulgaris*).

The contrast between Lees book and the standard Floras is instructive. It suggests that Purchas & Ley, Amphlett & Rea and Bagnall were not particularly concerned with change, and did not design the format of their Floras with this in mind.

FLORAS OF COASTAL COUNTIES, 1860-1914

Most of the scattered references to change in other county Floras published between 1860 and 1914 cover the same causes as those discussed in the preceding sections. One additional theme is that of changes in coastal habitats. Arnold (1887, p. xii) noted that in Sussex "owing to the encroachments of the sea ... many well-known localities for plants, as notably, Pilsey Island, are fast disappearing, and the coast line at Bognor, Brighton, Newhaven, and elsewhere, is undergoing considerable change". In the Isle of Wight and Hampshire development was also a threat. "The botanist may search in vain for many species entered in this Flora as growing on the Dover at Ryde. Even in Dr. Bromfield's time this ground was already being encroached on by building ... and since then the town has still further spread in this direction ... The same may be said of Royal Heath and the neighbourhood of Sandown; also of Portsea Island,

&c." (Townsend 1883, p. xxiii). In Kent, the botany of the northern portion of the long stretch of blown sand between Deal and the mouth of the River Stour "has been greatly interfered with by the extensive golf links near Sandwich" (Hanbury & Marshall 1899, p. xxxi).

An even greater degree of change affected the coasts of N.W. England. As in Sussex, erosion and building operations affected the coast of the Wirral in Cheshire, and although some of the erosion may have been natural, other stretches of coast were "readily undermined by the strong current now cast on this shore in consequence of the continuous line of works erected on the Liverpool side" (De Tabley 1899, p. lxix). In West Lancashire the coast from Blackpool to Lytham, until about 1875, "was truly a botanist's paradise ... The sand dunes were then practically undisturbed and, in the neighbourhood of where St. Annes now stands, extended a considerable distance inland. They formed a high belt rising along the shore ... On the land side of these dunes were flat stretches of boggy and sandy marsh, whilst inland again were more sand-hills and marshes succeeding one another and intermixed. The boggy hollows formed beautiful natural gardens, filled during the summer with a wealth of flowers delightful to behold; and in them also grew many rare plants and mosses, unnoticed by the ordinary passer-by, but of fascinating interest to the botanist. It is painful to think that many of these have now gone and none of the old marshy ground remains in its original condition! Where not already built upon it is 'improved' and drained and given over to crowds of excursionists or converted into golf links" (Wheldon & Wilson 1907, p. 34). Elsewhere on the West Lancashire coast the construction of the Ribble Docks had led to the loss of extensive salt-marshes. Even a stretch of sea-cliffs supporting *Asplenium marinum* was completely removed when a dock was constructed at Heysham near Morecambe, and "the district being much over-run by excursionists, very few interesting plants are left except such as are either inconspicuous or out of reach" (p. 25).

INTER-WAR AND POST-WAR FLORAS, 1914-1960

Only 13 Floras published between 1914 and 1960 are included in this study. They show, in general, a greater tendency to mention change in the introductory material, and usually include lists of extinct species (Table 1). Druce (1926, pp. xlv-lxviii), for example, refers to various developments which have affected the Buckinghamshire flora. These include disafforestation, the enclosure of commons, the drainage of marshland, the spread of the London suburbs and other building developments and the subsequent use of brickpits for what would now be called land-fill. In addition to such general comments, a few of the Floras provide a more detailed treatment of particular changes, and some of these are considered below.

Agricultural improvement of grassland in Leicestershire

The county of Leicestershire was predominantly pastoral in the inter-war years, and its grasslands are treated by A. R. Horwood, in Horwood & Noel (1933), from an agricultural as well as a botanical viewpoint (pp. xxvi-xxx). In reviewing a list of the weeds of grassland drawn up in the early 19th century, Horwood says that "the elimination of a large proportion of them including the beautiful Cowslip [*Primula veris*], Green Winged Orchid [*Orchis morio*], Moonwort [*Botrychium lunaria*], Adder's Tongue [*Ophioglossum vulgatum*], &c., has already been accomplished over a large proportion of the grasslands of Leicestershire by the free and repeated use of chemical concentrates, or fertilizers, such as basic slag, &c.". Most of the grassland was (agriculturally) excellent, and many upland meadows in S. and E. Leicestershire "were once covered with ant-hills, but they have gradually been improved". Nevertheless, "there are ... some pastures on heavy Lias Clays that have not been drained that need to be vastly improved, especially those with very marked ridge and furrow". In the more calcareous grassland on limestone and chalky boulder-clay "the aggressive and successful Tor Grass, *Brachypodium pinnatum*" was a problem for both farmers and botanists. "It is too hard and harsh for live stock ... Little else grows where Tor Grass is dominant. Such plants as *Anemone Pulsatilla*, *Asperula cynanchica*, *Astragalus danicus* are in danger of extinction where Tor Grass runs riot".

Development of the Sussex coast

Wolley-Dod (1937, pp. xii-xxiv) discusses change in Sussex with reference to the seven botanical divisions into which he divides the county. Change in the coastal habitats of the county is particularly apparent in his text. In the West Rother Division, "the changes in the flora ... are chiefly at its sea-edge and the maritime plain". "The steady erosion of the coastline which has been

going on for ages and is still taking place" was the most significant cause. In other divisions, building development, the increase in summer holiday-makers and the construction of holiday homes "of a slight and temporary nature" figure more prominently. In the Cuckmere Division, the "extension of Eastbourne, from the times of the earliest botanists, has been very great ... the large modern town covering many of the old botanical sites. ... Building is now extending on the Crumbles ... a celebrated spot for botanists. Most of its rarities still survive but appear doomed. Beyond this, almost as far as Pevensey Sluice, the littoral portion becomes yearly more overrun in late summer and autumn by tents and temporary dwellings of holiday-makers, so that even if they do not gather its flowers, they trample them out of recognition, and perhaps out of existence. *Crepis foetida* is disappearing from this cause. East of Bexhill building is now almost continuous to St. Leonards ...". The flora of Rye Harbour and Camber (East Rother) "has been celebrated for its rarities. Now, unfortunately, bungalow dwellers and their inevitable associations are rapidly destroying the whole of that area and part at least of its flora seems doomed. The Rye Golf Club have now enclosed a portion of the ground where several rare species grow; this it is hoped may preserve them." It is interesting that golf clubs were regarded as threats to the natural coastline by Hanbury & Marshall (1899) and Wheldon & Wilson (1907), but by 1937 a golf club appeared on Wolley-Dod to be the only hope of saving the Rye area from the greater threat of building development. The unplanned development of the Sussex coast, as described by Wolley-Dod, attracted national attention. Farmers were happy, during a period of agricultural depression, to sell land to development companies and this led to ribbon development along cliffs and highways. On the coast, "weekend residents from the 1890s erected any building that took their fancy, from disused railway carriages and tramcars to the more sophisticated structures resembling verandahed dwellings adopted by the English in India" (Brandon 1974, p. 262). Most of these beach shacks were cleared at the onset of the Second World War, but such unplanned developments attracted the strong disapproval of local authorities and were one of the factors leading to modern planning legislation (Hardy & Ward 1984).

In inland Sussex, Wolley-Dod cites road-widening as the chief modern change in the West Rother Division. "The construction, widening and 'improvement' of roads" is also cited in W. H. Pearsall's Preface to C. E. Salmon's posthumous *Flora of Surrey* (1931) as one cause of the loss of plants from their former localities.

Wartime changes in Ashchurch, Gloucestershire

Changes brought about by the Second World War were foreshadowed by Wolley-Dod (1937), who reported that "the island of Thorney, which is celebrated as the home of several rare species, is about to be taken over by the Royal Air Force, and will no doubt lose at least some of its rarities". After the War C. W. Bannister contributed to the *Flora of Gloucestershire* (Riddelsdell *et al.* 1948, pp. lxxxix–xciii) a detailed study of the impact of war-time changes on a small area in the north of the county. (There is little in the introductory material in this *Flora* dealing with changes in the county as a whole, perhaps because, as Allen (2003) relates, the flora took 71 years to complete.) "Before the War, arable land was practically non-existent" in Bannister's area, the parish of Ashchurch, "and most of the area consisted of rather rough, poor, ill-drained pasture. During the War years, however, very extensive ploughing took place, and now the area of arable is far greater than that of pasture. Also much draining was carried out, and waste and scrubland cleared." Not surprisingly, this led to the appearance of arable weeds previously unknown in the district. "Of these, the sudden appearance and extremely rapid spread of *Ranunculus arvensis* was most spectacular". Many other arable species "present before the War, have increased enormously and considerably extended their area"; these included *Kickxia elatine* and *K. spuria*. There had been a corresponding decline in grassland species, mostly "abundant plants, found also on roadsides and similar places ... A few more uncommon species, however, have been practically wiped out, notably *Genista tinctoria* and *Orchis morio*, both of which were abundant in several localities before the War." Summarising the changes, Bannister concluded that "it is good to know that, in this district at least, our native species, more beautiful than the majority of the 'weedy' newcomers, have not suffered more severely during such a period of upheaval".

DISCUSSION

SCOPE OF THE STUDY

Although the county Floras included in this survey provide a manageable group of books for study, they only represent a small proportion of the publications which might be examined for evidence of the way in which botanists have perceived floristic change. Local Floras might be well worth studying, and there may also be much relevant material in national and local journals. The more restricted scope of the local Floras, and the greater informality of papers in many journals, could provide insights that are missing from the county Floras. A study of the references to alien species in county Floras and other works would complement this paper, and might also be illuminating.

HOW HAVE AUTHORS RECOGNISED FLORISTIC CHANGE?

There are three lines of evidence which the author of a Flora might draw upon to assess change:

1. Extrapolation from current events

If certain species are characteristic of certain habitats and there are obvious changes in these habitats, an author might well conclude that floristic change was occurring. If, for example, pastures are being ploughed up to create arable fields he might conclude that grassland species are declining and that cornfield weeds may be increasing. He wouldn't, in this case, need any botanical records to do so.

2. Personal experience

An author, if long-resident in his county, might witness changes over his own lifetime. This evidence might be supplemented by the memories of botanical colleagues.

3. Evidence from botanical records

The third and most obvious source of data on floristic change is the botanical records of an author's predecessors.

These categories grade into each other, and it is particularly difficult in practice to separate the first category from the second. It is striking how many of the examples of floristic change discussed in county Floras are based on personal observations in these two categories. Lees' (1867) description of change in Worcestershire, Wolley-Dod's (1937) remarks on the despoliation of the Sussex coast and Bannister's (1948) Gloucestershire study are some of the most vivid descriptions of change, and draw to a large extent on their own experience. Although Lees and Wolley-Dod had historic records available to them, these only supplement their own observations. One of the more remarkable examples of the use of personal experience is Druce's (1926, p. xix) discussion of the disafforestation of Whittlebury Forest, in which he is able to draw on his very early memory of a visit to the area when it was newly cleared of trees, probably in the late 1850s.

Some discussions of change do make full use of historic botanical records. These include Babington's (1860) treatment of Cambridgeshire, as he witnessed only the latter part of the agricultural change he described. However, in general it is notable that the authors of Floras do not tend to use historic records to illustrate floristic change, especially in a quantitative or semi-quantitative way. This remains true of county Floras today (Walker 2003b).

Rapid changes are much more likely to be apparent during a single lifetime than more gradual developments. The effects of radical changes in land-use might, for example, be more apparent than those resulting from long-term climate change. Gradual changes might only become apparent when plant records collected over a longer timescale are analysed, and might therefore have been overlooked in the historic period by the authors of county Floras.

THE PROBLEM OF FLORAS THAT DON'T MENTION CHANGE

As change does not feature prominently in some of the standard county Floras published before 1914, it is easy to get the impression that our predecessors botanised in an almost unchanging countryside. However, there are numerous other reasons why an author might not mention floristic change, even if he was aware of it. He might simply lack the space to deal with it within the

physical constraints of his Flora. He might not be interested in the subject, or consider that it was not an appropriate one for a county Flora. Many authors model their Floras on an existing work, and an author might be following a model in which change was not considered. He might also exclude references to changes that were so familiar to him and his contemporaries that they did not need mentioning. Finally, some Floras are published posthumously and may not include introductory material which the author would have prepared if had he lived to complete the book.

In some cases it is clear that the lack of evidence of change in the Flora simply reflects the author's lack of interest in floristic change. The flora of Warwickshire *was* affected by the growth of Birmingham, however little attention was given to the subject by Bagnall (1891). In other cases it is unclear whether the absence of reference to change implies an absence of dramatic change. Was the flora of Worcestershire changing less drastically when Amphlett & Rea (1909) were active than in the days of Lees (1867)? Does the lack of reference to change in Herefordshire by Purchas & Ley (1889) indicate a stable countryside? These are difficult questions to answer. However, it is clear that the absence of reference to change should not be taken uncritically as implying an absence of change. Edwin Lees (1867, p. 120) may have been unusual amongst the authors of county Floras in thinking that "the changes continually taking place in local floras ... [form] one of the most interesting episodes in the science of botanical geography".

ASSESSING THE RATE OF FLORISTIC CHANGE

Sexual intercourse began
In nineteen sixty-three
(Which was rather late for me) –
Between the end of the *Chatterley* ban
And the Beatles' first LP.
(Larkin 1974)

This quotation brilliantly encapsulates the attitude of many contemporary botanists to floristic change. Even if on reflection they accept that change must have occurred in the past, they regard developments in recent decades as quantitatively if not qualitatively different. Jones (1980, p. 5), for example, in her biography of Edwin Lees, comments that "the coming of the railways gave the gentlemen of the field clubs a mobility to explore, before the acceleration of change caused by technology and dense population destroyed the glory of the English countryside, and diminished so greatly its native flora". Reading the descriptions of change in earlier Floras is a salutary reminder that dramatic changes did occur in earlier centuries. It is particularly interesting to see references to changes such as the loss of species-rich pastures, the spread of *Urtica dioica* and the decline of *Populus nigra*, all changes one might suppose had taken place (or, at least, first been recognised) in recent decades. There is little *prima facie* evidence to suggest that change has proceeded at an accelerating rate in all areas. The statistics on plant extinction in Cambridgeshire set out by Preston (2000), for example, do not appear to suggest a gradually accelerating process of floristic change over the last 250 years.

Little attempt has been made to devise direct measurements of the rate of floristic change in England during the historic period. Only recently have attempts been made to look critically at the way in which the rate of extinction of species in vice-counties has changed over time (Preston 2000; Walker 2003a). If further, preferably more detailed, measures could be devised, it might be possible to test whether change is an accelerating process. Are alternative models more appropriate? Might floristic change, at least in some areas, be an episodic phenomenon, with periods of rapid change followed by periods when the rate of change slowed?

There is also considerable scope for bringing together estimates of the extent of floristic change and data on agricultural and other land-use history such as those summarised by Collins (2000), Thirsk (1984) and Turner (1980). Are there reasons to believe that floristic change in 19th century Cambridgeshire was more marked than in Suffolk or Hertfordshire? Was Worcestershire changing more rapidly than Herefordshire in the same period? A consideration of other lines of evidence could do much to help interpret the valuable but fragmentary record of floristic change provided by the authors of county Floras.

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Using data from local floras to assess floristic change

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ABSTRACT

Local floras provide valuable baselines which have seldom been used to measure floristic change. This is largely due to the paucity of historical data for many counties but also because of changes in recording behaviour over the past 350 years. One of the simplest ways to assess change however, is to calculate extinction rates: in English counties at least, this method has shown an average loss of around one species every two years during the last century. In contrast, quantitative assessments of increase/decline have proven more difficult because of the nature (or lack) of historical data. In order to overcome this problem regression analyses have been used to calculate *relative* changes in species distributions. This approach is particularly useful because it takes into account differences in recorder behaviour between surveys. In contrast, *absolute* floristic changes have only been recorded from sample sites ("habitat studies") in two counties (Bedfordshire and Dorset).

KEYWORDS: baseline, extinction, habitat study, recorder behaviour, vice-county.

INTRODUCTION

Although seldom acknowledged, an important role of the local flora is to provide a baseline from which to measure change (Allen 1963). This has become increasingly feasible in recent years with the publication of floras for a number of counties which possess at least one earlier work (e.g. Beckett & Bull 1999; Bowen 2000; French *et al.* 1999; Killick *et al.* 1998). Yet, with a few notable exceptions, authors have seldom attempted to use these works in order to measure floristic change. In some areas this is understandable: many counties, particularly in the remoter parts of the British Isles, lack substantial earlier works. For example, the Scottish parish of Assynt, which has long been a mecca for British botanists, was not adequately recorded until after 1990 (Evans *et al.* 2002). Compare this with the rather unremarkable county of Nottinghamshire, which by 1900 already had three major floras (Deering 1738; Howitt 1839; Ordoyno 1807).

The ways in which botanists have recorded species distributions has also restricted the number of studies which have been carried out. Over the past 350 years these have changed from simple lists of localities (e.g. Ray 1660), to entries under botanical divisions (e.g. Babington 1860) and latterly to "dot" atlases based on grid systems of different sizes (e.g. Dony 1976; Gent & Wilson 1995). In many cases this shift to a more systematic approach, and the increase in recorder effort which it demands, has made modern authors reluctant to compare their datasets with those collected for earlier works (e.g. Jermyn 1974; Killick *et al.* 1998).

The object of this paper is to assess the extent to which local floras can be used to quantify the floristic changes which have taken place in the British Isles over the last 350 years. To this end I pose the following questions: to what extent do local floras provide adequate baselines from which to measure change and, secondly, how have these been used in floristic change studies? Some of the problems associated with these various approaches are discussed, specifically in relation to extinction and the detection of broad scale changes between surveys, and possible solutions suggested. Nomenclature for vice-counties and vascular plants follows Stace (1997).

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METHODS

For the purposes of this study I have attempted to include all local floras (including second editions, supplements and detailed checklists) which provide complete coverage for British or Irish vice-counties or works that cover parts of different vice-counties where there is at least some tradition of botanical recording (e.g. Baker 1863; Halliday 1997; King 1891; Lavin & Wilmore 1994). As a consequence, I exclude bare lists published in general studies (e.g. Victoria County Histories), book chapters or journal papers (e.g. Druce 1922), or works dealing with smaller geographical areas, such as individual parishes (e.g. Evans *et al.* 2002), islands (e.g. Campbell 1945) and cities (e.g. Bristol, London, Liverpool, Edinburgh). These were compiled by consulting earlier lists of local floras (e.g. McCosh 1988; Perring 1971), as well as those works listed in Simpson (1960) and are summarised in the Table 1 (a complete list of works is available from the author on request).

For each local flora the following details were noted:

Is the provision of a baseline mentioned as an aim in the introductory chapters?

How do the authors record the abundance and distribution of species (e.g. sites, parishes, botanical districts, grid-squares)?

Do the authors provide a list of extinct species with the year of the last record?

Are there detailed lists of species for individual sites (e.g. "habitat studies" *sensu* Dony (1953))?

Have these data been utilised to quantify floristic change?

RESULTS

LOCAL FLORAS AS HISTORICAL BASELINES

The publication of local floras, 1660–2002

The first local floras differed from earlier herbals (e.g. Gerarde 1597) in attempting to provide a comprehensive list of plants for their own sake and not their potential usefulness (Marren 1999). The earliest examples, which attempted to cover entire counties, included the works of Ray (1660) and Relhan (1785) in Cambridgeshire, Deering (1738) in Nottinghamshire, Abbott (1798) in Hertfordshire, and Sibthorp (1794) in Oxfordshire. In contrast the nineteenth century saw a dramatic increase in botanical activity culminating in the publication of 43 major floras in as many years (30 of which covered English vice-counties; Fig. 1). Of these the works of Babington (1860), Druce (1886, 1897) and Trimen & Dyer (1869) were particularly influential in both style and content. This peak in botanical activity was then followed by a gradual decline during the first half of the twentieth century and culminated in only six floras being published between 1940 and 1959 (Brunker 1951; Dony 1953; Good 1948; Grose 1957; Lloyd & Rutter 1957; Riddelsdell *et al.* 1948), the lowest number since the early 1800s. However, the publication of the *Atlas of the British flora* in 1962 (Perring & Walters 1962) led to renewed activity, and an unprecedented increase in the number of floras published (66 in 42 years).

The aims of local floras

The stated aims of local floras have changed dramatically since the seventeenth century when botany was viewed as a sobering pursuit intended to distract "...men of university standing..." from "...ball-games,...drinking, gambling, money-making, popularity-hunting" (Ray 1660). Although similar sentiments are expressed in a number of eighteenth (e.g. Deering 1738), nineteenth, and even some twentieth century floras (e.g. Perring *et al.* 1964), introductory statements became increasingly scientific after 1800 as authors rushed to provide their counties with a first comprehensive flora or to fill the gaps left by previous works (Gilmour 1963). At its height, in the late nineteenth century, this Dickensian quest for "facts" led to a number of very detailed floras, including Trimen and Dyer's (1869) *Flora of Middlesex* which was intended "...to give a complete and accurate catalogue of the plants which have at any time been recorded to grow in Middlesex". As a consequence the weight of introductory material increased dramatically. For example the introductions to each of Druce's (1886, 1897, 1926, 1930) Thames series of floras ran to over 150 pages and included chapters on the physical nature and land use of the county, mini-biographies of its most famous botanists (botanologia), as well as phytogeographic comparisons with adjoining counties.

TABLE 1. THE NUMBER OF LOCAL FLORAS (INCLUDING SECOND EDITIONS, SUPPLEMENTS AND CHECKLISTS) PUBLISHED FOR BRITISH AND IRISH VICE-COUNTIES SINCE 1660

	Local flora				2nd edition/supplement			
	England	Wales	Scotland	Ireland	England	Wales	Scotland	Ireland
1660–1800	5	–	–	–	–	–	–	–
1800–1860	14	–	3	–	–	–	–	–
1860–1900	30	3	7	3	3	–	–	–
1900–1960	21	3	10	3	8	1	3	1
1960–2002	42	7	11	6	13	–	–	4
Total	112	13	31	12	24	1	3	5

	Checklist				Total		
	England	Wales	Scotland	Ireland	Local flora	2nd eddn./suppl.	Check-list
1660–1800	–	–	–	–	5	–	–
1800–1860	–	–	–	–	17	–	–
1860–1900	–	–	–	–	43	3	–
1900–1960	–	1	1	–	37	13	2
1960–2002	6	3	16	2	66	17	27
Total	6	4	17	2	168	33	29

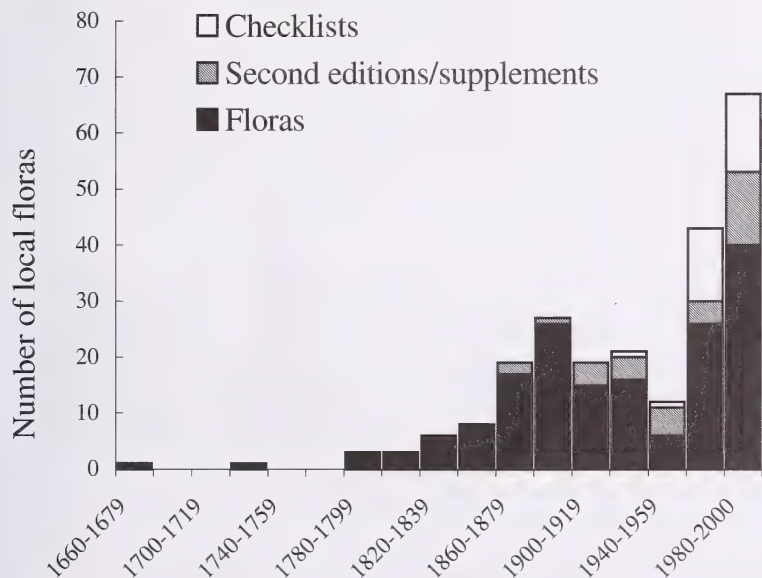


FIGURE 1. The number of local floras (including second editions, supplements and checklists) published for British and Irish vice-counties since 1660.

The potential use of the local flora to measure floristic change only became apparent after the publication of the 1962 *Atlas*. Edward Salisbury was probably the first to acknowledge this fact, suggesting that the maps produced in Dony's (1967) *Flora of Hertfordshire* "...should be regarded, not merely as a summary of past records, but as a basis for further observations on distribution and the process of never-ceasing change that the plant population evinces". Perring (1979) said as much in the Foreword to Trist's (1979) *Ecological Flora of Breckland*, whereas in Cornwall, Margetts & David (1981) acknowledged that their work would not only take stock of the work of the generation that succeeded them but also "...provide a baseline for the further investigations that are now likely to proceed vigorously". Almost without exception similar sentiments have been expressed in all subsequent local floras (e.g. Bellamy 2000; Killick *et al.* 1998; Mabey 1999; Stace 1990; Swan 1993).

Historical baselines

Our ability to measure floristic change depends primarily on the availability of historical data to which we can compare modern records. As Fig. 2 shows, this is unlikely to be a limiting factor for the majority of English vice-counties as all have at least one local flora or checklist, and 85% have two or more. Indeed, the most well recorded British county, Cambridgeshire, has five major floras as well as a recent checklist (Crompton & Whitehouse 1983). However, this is not the case for the majority of Scottish, Welsh and Irish vice-counties. Of these 14%, 20% and 61% respectively lack even a single flora or checklist and only 47%, 46% and 16% have more than one. In comparison to England no single Scottish, Welsh or Irish vice-county has more than three local floras.

The length of time since the first published flora for a vice-county will also influence our ability to measure change as counties with the longest tradition of recording will tend to be better studied. Once again English vice-counties are favoured in this respect as the majority of local floras were published between 1850 and 1899 (46%; Table 2). In contrast only 28%, 23% and 10% were published before 1900 in Scotland, Wales and Ireland respectively.

The methods used to record species distributions have changed dramatically over the past 350 years (Fig. 3). For example, the majority of early floras contain nothing more than bare lists of species for sites within easy reach of an urban centre (e.g. Ray 1660). With the development of road and rail links during the nineteenth century, however, botanists were able to visit the remoter corners of their counties. This led to the division of counties into "botanical districts" in order to ensure a more even coverage of recording effort. This approach, pioneered by Webb and Coleman (1849) in *Flora Hertfordiensis*, was adopted by many Victorian botanists and remained the preferred method until the advent of grid-based recording schemes during the 1960s (e.g. 10 × 10 km, Perring *et al.* (1964); 5 × 5 km, Bowen (1968); and 2 × 2 km, Dony (1967)). Subsequently over 60 grid-based floras have been published, over 40 of which have been for English vice-counties (Table 3).

ASSESSING FLORISTIC CHANGE

Perceptions of change

By far the simplest way to assess floristic change is to see how change has been recorded in the text of floras (e.g. Preston 2003). For example, Edward Salisbury provides a particularly revealing account of changes which took place in the flora of Hertfordshire during his lifetime (Dony 1967), in particular the "...decline or disappearance of many marsh plants such as Grass of Parnassus, *Triglochin palustris* and *Pulicaria vulgaris*..." due to "...the neglect of many ponds, upon which the watering of stock once depended...", and how on commons the abrasive effects of footwear "...have depressed or eliminated many of the smaller open habitat species" (Salisbury 1967). In some modern floras these personal accounts have been replaced by whole chapters dealing specifically with the effects of land use change (e.g. Best 1995; Bowen 1968, 2000; Killick *et al.* 1998; Lousley 1976) or accounts of the species which have increased or declined (e.g. Dony 1976; French *et al.* 1999; Primavesi & Evans 1988; Hall 1980; Halliday 1997; Kent 1975; Newton 1971). Despite their historical value, such statements are often highly selective and reliant on the author's perceptions of change. As a consequence I address the extent to which we can measure, in a more or less quantified way, the changes which have taken place.

TABLE 2. PUBLICATION DATES OF THE FIRST LOCAL FLORAS FOR BRITISH AND IRISH VICE-COUNTIES

Date of first flora	Number of vice-counties									
	England (v.cc. = 46 ^a)		Scotland (v.cc. = 36)		Wales (v.cc. = 13)		Ireland cc. = 31)		(v.	Total (v.cc. = 126)
	no.	%	no.	%	no.	%	no.	%	no.	%
1650–1699	1	2	–		–		–		1	0.8
1700–1749	1	2	–		–		–		1	0.8
1750–1799	2	4	–		–		–		2	1.6
1800–1849	6	13	3	8	–		–		9	7.1
1850–1899	21	46	7	19	3	23	3	10	34	27.0
1900–1949	9	19	8	22	2	15	2	6	21	16.7
1950–2002	6	13	13	36	6	46	7	23	32	24.4
Total v.cc.	46	100	31	86	11	85	12	39	100	79.4
Total pre-1900	31	67	10	28	3	23	3	10	47	37.3

^aThe total number of vice-counties for England, Scotland, Wales and Ireland are 58, 41, 13 and 40 respectively. The figures quoted here differ because a number of vice-counties have traditionally been combined within floras. These include vice-counties 1 & 2, 3 & 4, 5 & 6, 7 & 8, 11 & 12, 13 & 14, 15 & 16, 18 & 19, 25 & 26, 27 & 28, 33 & 34, 53 & 54, 62 & 65, 63 & 64, 67 & 68 and 69 & 70 in England, 79 & 80, 82–84, 87–89, 91 & 92 and 107 & 108 in Scotland, and H1 & H2, H3–5, H7 & H10, H15 & H17, H26 & H27, H34 & H35, H38–40 in Ireland. Four additional areas have also been included within the English figures: Scillies (1b), Jersey (S), Guernsey (S), Breckland (part 26 & 28).

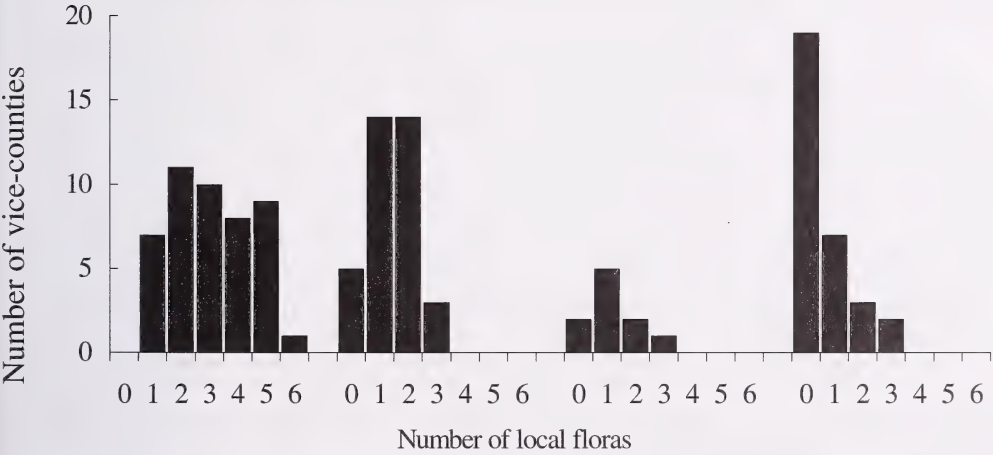


FIGURE 2. The number of local floras (including second editions, supplements and checklists) published for individual English, Scottish, Welsh and Irish vice-counties since 1660.

TABLE 3. THE WAYS IN WHICH SPECIES DISTRIBUTIONS HAVE BEEN RECORDED IN LOCAL FLORAS (INCLUDING SECOND EDITIONS, SUPPLEMENTS AND CHECKLISTS) SINCE 1780

	England		Scotland		Wales		Ireland		Total	
	no.	%	no.	%	no.	%	no.	%	no.	%
Sites	37	26	25	49	9	50	8	42	79	34
Districts	61	43	13	25	4	22	9	47	87	38
10 × 10 km	12	8	9	18	1	6	1	5	23	10
5 × 5 km	5	4	2	4	2	11	—	—	9	4
2 × 2 km	25	18	2	4	2	11	1	5	30	13
1 × 1 km	2	1	—	—	—	—	—	—	2	1
Total	142	—	51	—	18	—	19	—	230	—

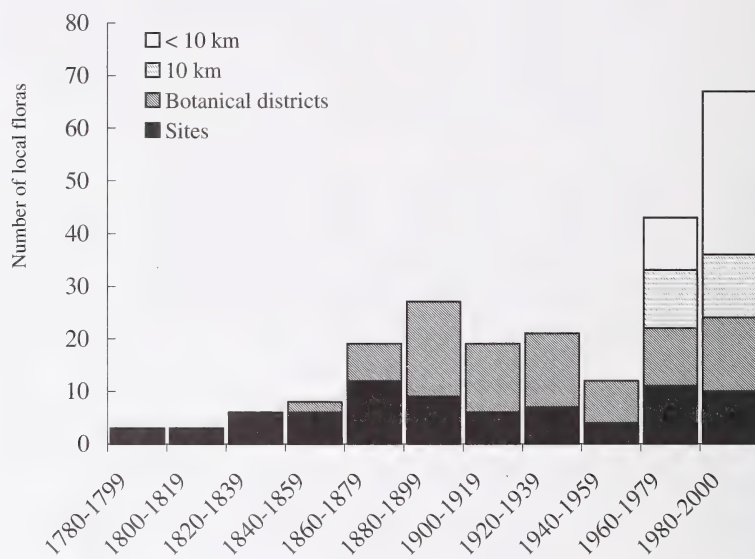


FIGURE 3. The ways in which distributions have been recorded in local floras since 1780.

County extinction

Over the last 40 years the number of floras which include lists of extinct species has risen markedly (Fig. 4). As a result there have been a number of attempts to use these data to calculate extinction rates for individual counties (e.g. Marren 2000, 2001; Preston 2000; Walker 2003). These suggest that British vice-counties have lost one species every two years since 1900, with, on average, southern and eastern counties having lost more (0.6 species a year) than those in the north and west (0.4 species a year; Walker 2003). In addition, these data have also been used to identify periods of heightened extinction. For example, in Cambridgeshire Preston (2000) showed that the peak periods of extinction coincided with the first main wave of parliamentary enclosure during the early part of the nineteenth century whereas in Middlesex they occurred soon after 1870 as a result of the spread of the London conurbation.

Information on county extinctions can also be used to identify which species have declined the most and thus the habitats which have suffered the greatest changes in recent decades. For example, Table 4 lists those species which have been lost from more than half the best recorded counties in south east England. Five of these species have a predominantly northern distribution in the British Isles but have undergone severe declines as a result of drainage and habitat loss (*Antennaria dioica*, *Carex dioica*, *Lycopodium clavatum*, *Parnassia palustris*, *Utricularia minor*),

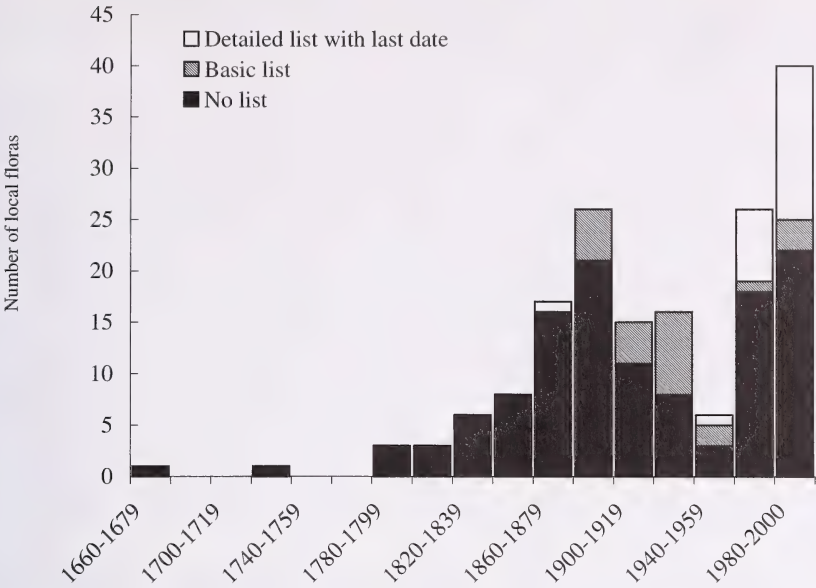


FIGURE 4. The number of British and Irish local floras which include lists of extinct species.

TABLE 4. EXTINCT SPECIES IN LOWLAND COUNTIES^a

Species	Status	Broad habitat	Number formerly		% extinct
			present	Number extinct	
<i>Arnoseris minima</i>	Extinct ^b	Arable	9	9	100
<i>Pulicaria vulgaris</i>	Red Data	Acid grassland	9	8	89
<i>Antennaria dioica</i>	Not scarce	Calcareous grassland	8	7	88
<i>Lycopodiella inundata</i>	Scarce	Bog/heath	9	7	78
<i>Melampyrum arvense</i>	Red Data	Arable	9	7	78
<i>Hammarbya paludosa</i>	Scarce	Fen, marsh, swamp	8	6	75
<i>Valerianella rimosa</i>	Red Data	Arable	11	8	73
<i>Carex dioica</i>	Not scarce	Fen, marsh, swamp	10	7	70
<i>Lythrum hyssopifolium</i>	Red Data	Arable	9	6	67
<i>Parnassia palustris</i>	Not scarce	Fen, marsh, swamp	9	6	67
<i>Anagallis minima</i>	Not scarce	Acid grassland	11	7	64
<i>Mentha pulegium</i>	Red Data	Standing water	11	7	64
<i>Utricularia minor</i>	Not scarce	Fen, marsh, swamp	10	6	60
<i>Hypochaeris glabra</i>	Scarce	Acid grassland	11	6	55
<i>Lycopodium clavatum</i>	Not scarce	Bog/heath	11	6	55

^aThe species listed are those which have been lost from over half of the following counties: Bedfordshire (v.c. 30), Cambridgeshire (v.c. 29), Dorset (v.c. 9), Kent (v.cc. 15 & 16), Lincolnshire (v.cc. 53 & 54), Middlesex (v.c. 21), Norfolk (v.cc. 27 & 28), Northamptonshire (v.c. 32), Oxfordshire (v.c. 23), Suffolk (v.c. 25 & 26) and Surrey (v.c. 17).

^bLast recorded in the British Isles in 1971.

four were formerly rare plants of cultivated land (*Arnoseris minima*, *Lythrum hyssopifolium*, *Melampyrum arvense*, *Valerianella rimosa*), and six were localised species of acid grasslands and bogs (*Anagallis minima*, *Hammarbya paludosa*, *Hypochaeris glabra*, *Lycopodiella inundata*, *Mentha pulegium*, *Pulicaria vulgaris*).

Comparisons between time-periods

Rather surprisingly there have only been a handful of attempts to quantify floristic changes using data collected for earlier floras. For most counties this is simply due to a lack of adequate historical data to which modern records can be compared. However, even where these data do exist, differences in the ways in which the data were originally collected has made comparisons with modern datasets difficult to interpret (Primavesi & Evans 1988). For example, even extremely thorough recorders, such as Druce and Gibson, did not always cover the various parts of the county with equal intensity (Killick *et al.* 1988; Jermyn 1974). As a consequence their qualitative statements of abundance are likely to be biased (Perring 1963; Rich & Smith 1996).

Given these caveats, however, there is no reason why qualitative datasets should not be used to provide some indication of the overall floristic changes which have taken place. To illustrate this I have plotted Druce's (1930) personal assessments of abundance for the Orchidaceae and Cyperaceae in Northamptonshire against those given in a recent flora of the county (Fig. 5; Gent & Wilson 1995). Although rather crude this approach shows that, despite the increase in recording activity since the turn of the century, 49 species (61%) appear to have become less common (e.g. *Orchis morio* and *Luzula pilosa* decreased by 5 and 4 categories respectively), whereas only eight species (10%) appear to have increased (e.g. *Carex remota*, *C. ovalis* and *Juncus compressus* increased by 3, 3 and 2 categories respectively).

Given the subjectivity involved in assigning species to abundance categories a more statistically rigorous approach is to compare quantitative measures between time periods. However, despite the fact that many counties have grid-based floras (Table 3), no repeat surveys have been published. An alternative approach is to compare earlier qualitative measures with modern grid-based data. For example, in a recent study of changes in the flora of Northamptonshire Druce's (1930) qualitative assessments (eight abundance categories) were plotted against modern pentad (5×5 km) distributions (Fig. 6; McCollin *et al.* 2000). Changes during the intervening period were then calculated as standardised residuals from the linear regression line for the whole dataset ($R^2 = 64.4\%$, $F_{680} = 1233$, $p < 0.0001$). Thus differences between the observed and predicted values (standardised residuals) provided an indication of the *relative change* in distribution since 1930: those species which deviated most from the predicted distribution were assumed to have changed the most and vice versa. Using this method species which had apparently declined the most (i.e. those with an observed value greater than two standard deviations below the regression line) included seven arable plant species (*Agrostemma githago*, *Anthemis cotula*, *Legousia hybrida*, *Ranunculus arvensis*, *Sison amomum*, *Torilis arvensis* and *Veronica polita*), five species associated with semi-natural grassland (*Astragalus danicus*, *Helianthemum nummularium*, *Orchis morio*, *Rhinanthus minor* and *Thymus polytrichus*) and three aquatics (*Hottonia palustris*, *Oenanthe fluviatilis* and *Spirodela polyrhiza*).

Recently, a similar approach has been developed in order to measure change in the distributions of species included in the *New Atlas of the British and Irish flora* (Telfer *et al.* 2002). As in the McCollin *et al.* (2000) study the measure of change for each species (the Change Index) was based on its standard deviation from the regression line for the entire dataset, i.e. the extent to which a species 10×10 km distribution has changed *relative* to the overall change in the British flora between 1930–1969 and 1987–1999. This is a particularly powerful technique because it takes into account recorder biases caused by differences in the geographical coverage and the greater intensity of recorder effort in the latter survey period.

Habitat studies

A small number of floras include detailed "habitat studies" which provide lists of species for individual sites as well as, in some cases, additional information on soil type, pH, aspect, topography etc. (Table 5). The pioneer of this approach was Ronald Good (1948) who, during the 1930s, recorded the vegetation and flora of 7500 sample sites in the Poole Basin in Dorset. Fortunately he marked the precise location of his study areas on Ordnance Survey maps, thus

TABLE 5. "HABITAT STUDIES" INCLUDED IN LOCAL FLORAS

County	Number	Sample area	Number re-surveyed	Source(s)
Dorset	7500	Various	390	Good (1948); Byfield & Pearman (1994)
Bedfordshire	86	5 yd radius	86	Dony (1953, 1977)
Wiltshire	5000	c.250–350 yd ²	0	Grose (1957)
Hertfordshire	109	5 yd radius	0	Dony (1967)
Derbyshire	84	Various	0	Clapham (1969)
Breckland	26	Various	0	Trist (1979)
Leicestershire	107	Whole site	0	Primavesi & Evans (1988)
Flintshire	49	2–20 m ²	0	Wynne (1993)

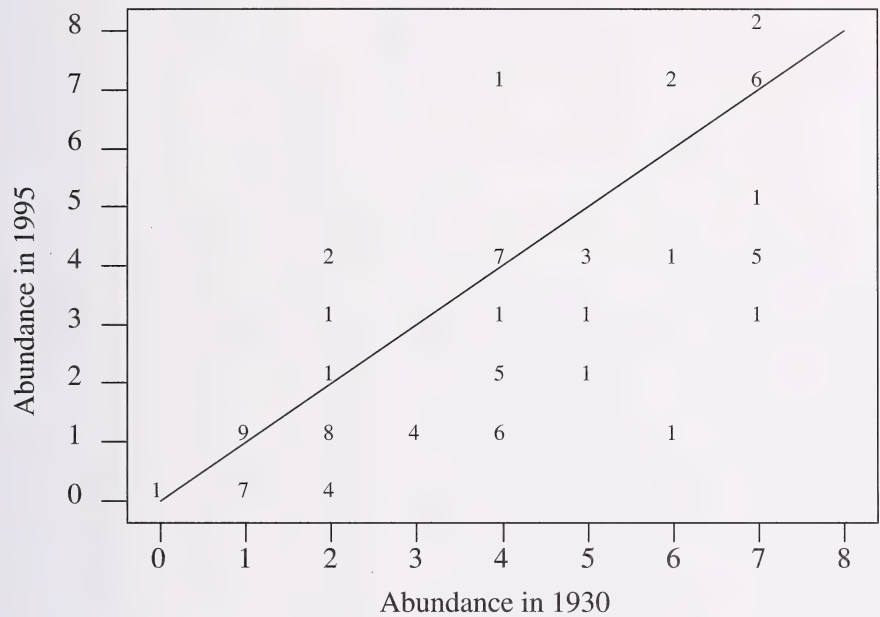


FIGURE 5. The relationship between the abundance of Cyperaceae ($n = 59$) and Orchidaceae ($n = 22$) in Northamptonshire in 1930 and 1995 ($R^2 = 63\%$, $F_{79} = 135$, $p < 0.001$). The number of species within each abundance category are shown in relation to a 1:1 line. Categories are as follows: 0 – ‘extinct’, 1 – ‘very rare’, 2 – ‘rare’, 3 – ‘very local’, 4 – ‘local’, 5 – ‘locally common’, 6 – ‘locally abundant’, 7 – ‘frequent/common’, 8 – ‘very common’ (see McCollin *et al.* 2000 for details). Abundance scores taken from Druce (1930) and Gent & Wilson (1995).

allowing modern workers to determine changes over the intervening years (Byfield & Pearman 1994). Over a decade later John Dony (1953) carried out a similar, albeit much more limited study in Bedfordshire and latterly Hertfordshire (Dony 1967). However, these were a marked improvement on the Good Survey surveys because the samples were of equal area (a circle of 5 yards radius) and were placed in representative stands of vegetation, and not just those of conservation interest. As a result all subsequent habitat studies have attempted to emulate Dony in some way (e.g. Clapham 1969, Primavesi & Evans 1988; Trist 1979, Wynne 1993), although surprisingly few have used his standardised sample area (Table 5).

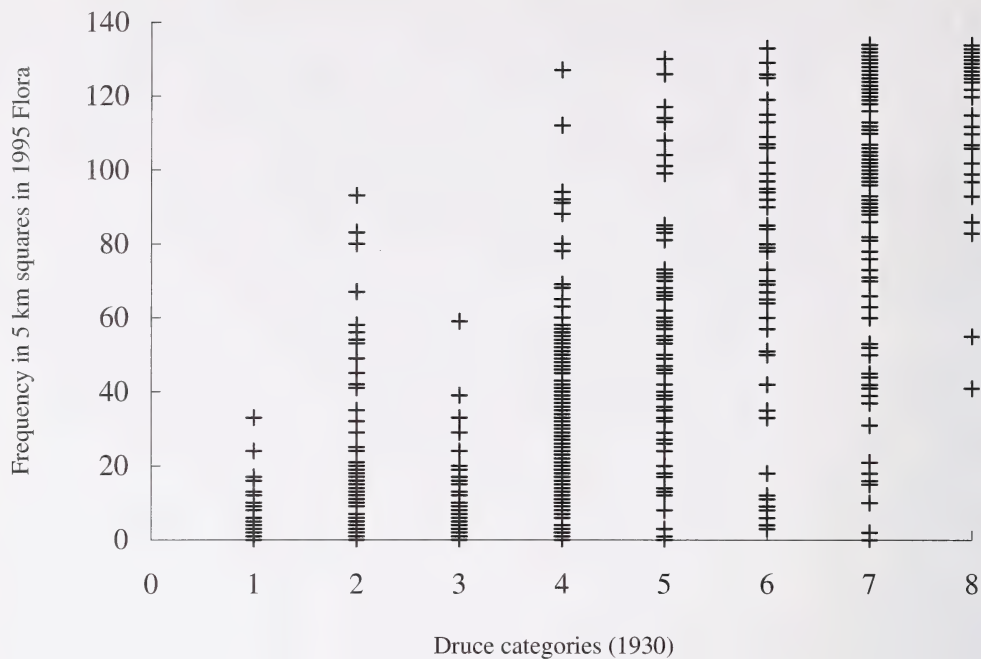


FIGURE 6. The relationship between the abundance of species in Northamptonshire in 1995 and 1930 ($R^2 = 64.4\%$, $F_{680} = 1233$, $p < 0.0001$; abundance categories are the same as for Fig. 4). Data for 1995 are pentads (5×5 km) and for 1930 abundance scores assigned to species by Druce (1930) in his flora of the county. Graph taken from McCollin *et al.* (2000) and reproduced by kind permission of the authors and Elsevier Press.

In 1976 Dony (1977) re-recorded the original Bedfordshire “habitat studies” in order to assess the changes which had taken place during the intervening 26 years. The results of this survey were extremely revealing (Table 6): overall c.13% of the sites had been converted to other land uses, whereas a further 28% had deteriorated to a greater or lesser extent. Some habitats had fared much worse than others: in particular, wet grasslands, heathlands and calcareous grasslands had seen the greatest losses whereas woodlands had remained largely unaffected. In addition, Dony was able to show that the percentage of recorded extinctions within his “habitat studies” were comparable to the losses for the county as a whole (Table 6).

TABLE 6. CHANGES IN THE FLORA OF BEDFORDSHIRE BETWEEN 1949/50 AND 1976 AS RECORDED BY DONY’S (1953, 1977) “HABITAT STUDIES”

Broad habitat	Number of “habitat studies”						Extinct species	
	“Lost”		Deteriorated		Unchanged		% lost	% lost since 1978
	no.	%	no.	%	no.	%		
Woodland	2	8	2	8	20	83	4.6	5.3
Calcareous grassland	1	13	3	38	4	50	4.3	6.1
Acid pasture and heath	1	9	4	36	6	55	16.2	19.0
Marshes and meadows	4	22	8	44	6	33	22.8	35.3
Total	8	13	17	28	36	59	–	–

For Dorset a more restricted re-survey of Good's plots was undertaken in order to assess the changes in the distribution of 41 rarer heathland species (Byfield & Pearman 1994). In this study 390 of the original stands were relocated, using Good's original OS maps, and the presence of target species noted. Of these 35% had been converted to agriculture (22%) or forestry (7%) (miscellaneous (6%)). More importantly, there had been a 75% decline in the number of populations of target species. For example, eleven species which were fairly widespread in Good's day (present in more than 20 sites) had declined by more than 50% (*Anagallis minima*, *Chamaemelum nobile*, *Filago vulgaris*, *Genista anglica*, *Lycopodiella inundata*, *Potentilla palustris*, *Pinguicula lusitanica*, *Radiola linoides*, *Rhynchospora fusca* and *Veronica scutellata*).

DISCUSSION

ASSESSING CHANGE USING DATA ON EXTINCTION

Although figures for extinction give an indication of the nature and scale of environmental changes over recent decades there are a number of problems associated with their use (Walker 2003). In many cases extinction at the local (county) scale is rarely forever: some species will be overlooked because they are taxonomically difficult, cryptic, or occur in habitats which are difficult to study (e.g. water bodies) or have been traditionally ignored by botanists (e.g. agricultural land). On the other hand some species may well reappear because they have unpredictable or transient life-histories (e.g. arable weeds). For example, in Hertfordshire over 20 "extinct" species which have reappeared since Salisbury's (1924) surveys in the 1920s (Dony 1974; James 1997). A similar rate of rediscovery has been found in Cheshire (14%; Newton 1971, 1990), Norfolk (12%; Beckett & Bull 1999; Petch & Swan 1968), Lincolnshire (8%; Gibbons 1975; Gibbons & Weston 1985) and Northamptonshire (5%; Walker 2003). Alternatively the ultimate demise of a species may take many years to be acknowledged, whereas some species believed extinct may well have survived unnoticed. As a consequence, the perceived number of extinctions may well be very different from the *actual* number within a given area.

Secondly, smaller areas tend to have higher extinction rates because the area of habitat available for a species is reduced (relative to larger areas), thus increasing the threat of localised extinction. As a consequence, smaller counties, such as Middlesex, have very high extinction rates, whereas for very large counties such as Cornwall or Norfolk rates are much lower (Walker 2003). A similar argument applies to the latitudinal position of a county: southern and eastern counties tend to have more species, and so are likely to lose more species regardless of the environmental changes which have taken place.

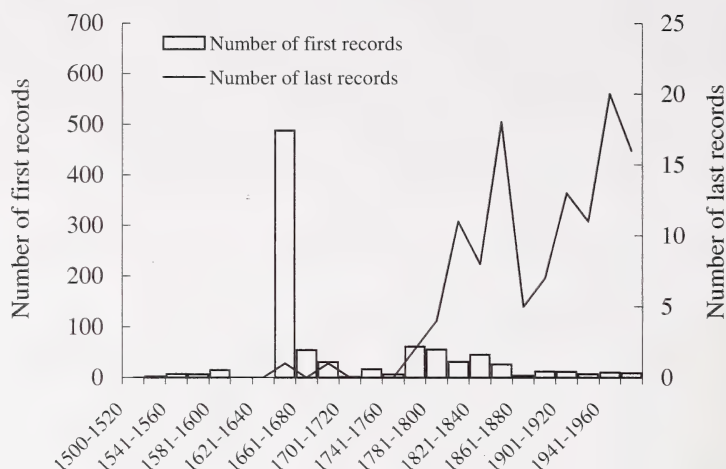
Finally, the rate of extinction may well be influenced by the history of plant recording in the county, with concentrations in periods of intensive recording (Preston 2000). For example, in both Northamptonshire (Walker 2003) and Bedfordshire (Fig. 7b) earlier peaks in extinction appear to coincide with the publication of major works (e.g. Abbott 1798; Morton 1712). Prior to this few extinctions had been recorded, not necessarily because environmental changes had been slight, but because so few species were known to sixteenth, seventeenth and eighteenth century botanists. In contrast, the peak periods of extinction in Cambridgeshire (Fig. 7a) appear unrelated to recording activity in the county, presumably because the majority of its species were first recorded well before the major agricultural changes of the eighteenth and nineteenth centuries (Preston 2000).

ASSESSING CHANGE USING HISTORICAL DATA

Despite the publication of over 200 local floras over the past 350 years very few attempts have been made to assess floristic changes. As the results of this study have shown this is primarily due to a lack of adequate historical data for many areas (Fig. 2). Whilst the majority of English counties possess at least one modern flora, much of Wales and Scotland has to make do with checklists, while most of Ireland has not even got that (Marren 1999). As Figure 3 shows this problem is compounded by the nature of historical data (Perring 1963; Rich & Smith 1996): due to changes in recording methods and behaviour, particularly the increased effort in later surveys, few counties are likely to possess historical datasets which are directly comparable to modern data. Furthermore, increasing knowledge of the taxonomy and biogeography of difficult, critical or cryptic taxa may mean that apparent changes in the distributions of some species are likely to be relative rather than absolute (Rich 1998; Rich & Smith 1996; Rich & Woodruff 1992).

Studies which focus on the nature, rate and scale of extinction avoid many of these problems because they are less influenced by problems of recording behaviour. However, such studies

a) Cambridgeshire



a) Bedfordshire

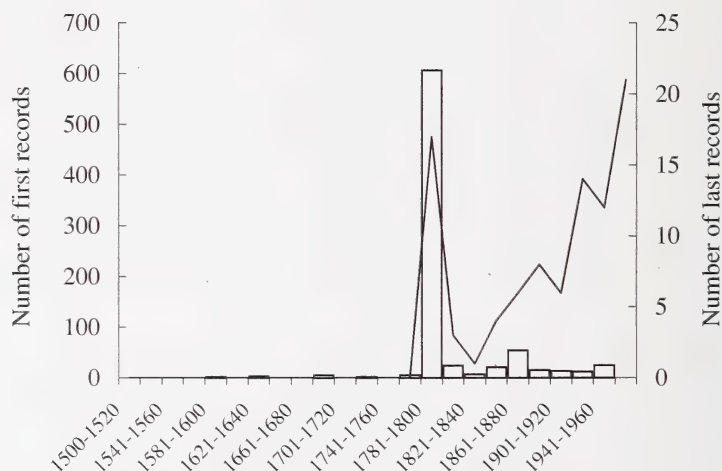


FIGURE 7. First and last records for species in a) Cambridgeshire and b) Bedfordshire (within 20 year intervals). For Cambridgeshire last dates were taken from Preston (2000) and first dates from Perring *et al.* (1964) and Crompton (2001). For Bedfordshire first dates were taken from Dony (1953, 1976) and figures for last records supplied by the vice-county recorder (C. Boon, pers. comm., 2001).

provide very *conservative* estimates of change for a small sample of rare or localised species. In comparison, quantitative assessments of change, which utilise earlier distribution data, allow us to take stock of *all* the species in an area and gauge the relative magnitude of the changes which have taken place during the intervening time period. As a consequence they often highlight changes in the distribution of formerly “common” species which may have become increasingly localised or threatened during the intervening period. Regression analyses, which provide a measure of *relative change* between surveys, are particularly useful in this respect because they take into account the differences in recorder effort between surveys. Similarly, the effects of recorder bias can be minimised in repeat habitat studies if there is precise information on how and where the original survey was carried out.

CONCLUSION

As the results of this brief study have shown, many counties in the British Isles lack adequate baselines from which to measure floristic change. As a consequence, a priority for botanists over the coming decade might be to "fill these gaps" with baseline florals, as well as repeat grid-based surveys for counties where detailed baselines already exist (in particular earlier tetrad surveys). With this in mind, recorders should attempt to collect their data in ways which will be of use to future botanists, who will inevitably look back at our florals, as we have done with Ray, Babington, Druce, and Dony, in order to assess the floristic changes which have taken place. Anyone currently embarking on a local flora project would do well to bear this in mind before they begin.

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Using data from local floras for ecological research

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ABSTRACT

Ecology has been variously defined ‘the scientific study of the interactions between organisms and their environment’ or ‘the scientific study of the interactions that determine the distribution and abundance of organisms’. Many local floras contain accounts of the environment; all give information on the distribution and abundance of plants. In spite of this, there is rather little flow of information between ecologists and flora writers. Among possible explanations are the disparity in the spatial scale of interest, the subtlety of plant life histories, the obscurity of key environmental factors, and the emphasis of floras on rarities rather than on the ‘ecosystem engineers’. Nevertheless, some interesting analysis of flora data is possible, both of spatial patterns and of temporal change.

KEYWORDS: biogeography, ecology, autecology, vegetation, life cycle

INTRODUCTION

ECOLOGY

We all have a vague idea of what we mean by ecology, but the word has acquired new significance in an age of environmentalism. Ecologists, so it is supposed, are people who want to save the planet. They have a green message. The reality is more mundane. The authors of a well known ecology textbook (Begon, Harper & Townsend 1986) give two definitions: ‘the scientific study of the interactions between organisms and their environment’ and ‘the scientific study of the interactions that determine the distribution and abundance of organisms’.

Definitions are not always the best way to find out what a subject is about. It is often prudent to see what subjects appear in a textbook. The most suitable for this purpose is *Plant Ecology*, edited and largely written by the BSBI vice-county recorder for Berkshire (Crawley 1997). Most of the topics are ‘plant-centred’ (Table 1), that is to say that they relate to how a plant can survive and reproduce in an often hostile world. The later topics in *Plant Ecology* shade into biogeography, the study of organisms at larger scales of time and space.

An aspect of ecology that is implicit but not prominent in *Plant Ecology* is autecology, the species-centred view of the world. Autecological accounts of species can be mini-monographs such as the Biological Flora of the British Isles (Table 2; e.g. Blackman & Rutter 1954; Carey & Farrell 2002), databases such as the Ecological Flora Database (Fitter & Peat 1994) or books combining a database with verbal accounts (Grime, Hodgson & Hunt 1988). Grime *et al.* (1988), for example, categorize *Hyacinthoides non-scripta* as a woodland bulb-forming monocotyledonous herb with a vernal phenology, pointing out that it is sensitive to grazing by cattle and sheep but avoided by rabbits. They describe how the bulbs are buried deeply by the action of contractile roots and how the species normally reproduces by seed, taking at least 5 years to reach flowering size. These facts tell us much about the life of *H. non-scripta* and together indicate where it should be expected to occur.

LOCAL FLORAS

Local floras differ among each other but there is a general pattern followed by many. I categorized the contents of 30 local floras dating from Deering (1738) through to Evans, Evans & Rothero (2002), dividing them into four headings (Table 3). In several floras, chapters categorized as ‘interpretation of distributions and change’ are basically a travelogue, giving the interesting features of sub-regions or catchments. Some of these travelogues are a complex blend of floristics

TABLE 1. TOPICS INCLUDED IN CRAWLEY'S *PLANT ECOLOGY* (1997)

General topic	Examples
Physiology	Photosynthesis, water relations, nutrient acquisition
Life history	Growth, longevity, reproduction, dispersal, seed dormancy
Interactions	Competition, herbivory, diseases, plant defences
Population biology	Genetics, population dynamics, plant-herbivore dynamics
Plant communities	Physiognomy, succession, diversity, species-area relations
Large-scale factors	Pollution, climate change
Biodiversity	Hotspots, islands, aliens

TABLE 2. HEADINGS IN BIOLOGICAL FLORA OF THE BRITISH ISLES

Main heading	Details
Geographical and altitudinal distribution	British, Irish, European and world range, altitudinal limits in Britain and Europe
Habitat	Climatic and topographic limitations, substratum
Communities	Nowadays classified by NVC types (Rodwell 1991–2000)
Response to biotic factors	Effects of disease, insects, mammalian grazing
Response to environment	Gregariousness, response to various factors, effect of frost, drought etc.
Structure and physiology	Morphology, mycorrhiza, perennation, reproduction, chromosomes, physiological data, biochemical data
Phenology	Timing of germination, flower and fruit production, tuber initiation etc.
Floral and seed characters	Floral biology, hybrids, seed production and dispersal, germination, seedling morphology
Herbivory and disease	Animal feeders, parasites, diseases
History	Quaternary and archaeological data, first records

TABLE 3. CHAPTERS IN AN AVERAGE LOCAL FLORA

No.	Chapter	No. of pages
1	Environmental background	18
2	Interpretation of distributions & change	27
3	History of recording	9
4	Flora enumerated by species	226
	Length of chapters 1 and 2 as a percentage of the total	16%

and physical background. Other floras, such as my own account of North Wales bryophytes (Hill 1988), enumerate the interesting plants mainly by habitat. The distinction in Table 3 between environmental description and interpretation is not sharp.

The earliest local floras lacked almost all information about the physical background, but by the late 19th century, they sometimes contained lengthy descriptions. These did not necessarily relate strongly to the accounts of individual species; Mansel-Pleydell's (1895) description of Dorset geology is gloriously irrelevant to his flora. Much the same applies to more recent floras where there are lengthy descriptions of the vegetation. For example, in the Natural History Museum's account of the Island of Mull (Jermy & Crabbe 1978), there is a chapter entitled 'Terrestrial Ecosystems', much of which is devoted to the vegetation. In this chapter, we learn that *Trichophorum cespitosum* is sometimes a dominant component of lowland bog vegetation and that the conditions for its dominance are quite specific. All of this detail is lost in the species account, which states merely 'In damp peaty areas, a common associate of *E. tetralix* on the Ross. Can withstand some grazing and burning. Frequent to abundant; widespread'.

Clearly, the two chapters, one on vegetation and another on flora, are aimed at describing the plants and their environment from different perspectives. The flora is plant-centred and brief. The account of vegetation is concerned mainly with the dominants, the big plants, 'ecosystem engineers' that help to define the environment as well as being merely a part of it.

INFORMATION FLOW BETWEEN LOCAL FLORAS AND ECOLOGISTS

Much early ecology was descriptive, showing how plants in general and vegetation in particular can be related to the environment. Ecologists (e.g. Aber & Melillo 1991; Walter 1979) have recently devoted much attention to the physiological factors that determine vegetation types, driven especially by the need to understand the potential response of ecosystems to climate change (Sykes *et al.* 2001; Woodward 1992). Such work is global and generic, though the factors determining the changes in individual species have also attracted some attention (Huntley *et al.* 1995; Walther 2000).

In these grand matters, the place of the local flora has not been large. Likewise, Tansley (1939) and Rodwell (1991–2000) made little use of information from local floras in describing the vegetation of our islands.

A glance at the accounts written for the Biological Flora of the British Isles shows that they make extensive use of descriptions of vegetation, but that local floras are little cited. For example, neither Blackman & Rutter (1954) nor Carey & Farrell (2002) cited local floras in their accounts of *Hyacinthoides non-scripta* and *Himantoglossum hircinum* (Carey & Farrell did, however, consult local floras as part of their study of *H. hircinum*). Gilbert (1995) cited Grose (1957) and Wolley-Dod (1937) for the habitat and spread of *Symphoricarpos albus*. Watkinson, Newsham & Forrester (1998) cited Hind (1889), Petch & Swann (1968) and Trist (1979) for the history of *Vulpia ciliata* ssp. *ambigua*; and Rose, Bannister & Chapman (1996) cited Brewis *et al.* (1996) and Mansel-Pleydell (1895) for the history of *Erica ciliaris*.

The reverse flow, of ecological information to local floras, is hugely variable. At one extreme, Burton (1983) gives a 12-page analysis of factors affecting the distribution of plant species in the London area but refers to only two published sources, both of them papers in the *London Naturalist* and neither of them ecological. The excellent flora of West Lancashire by Wheldon & Wilson (1907) includes a 61-page disquisition on the factors affecting plant distribution, including some material that would now be categorized as physiological plant ecology. The authors explicitly cite only six papers, of which two are physiological and one ecological; but then there was almost no British literature on plant ecology at the time. In Hertfordshire, there was also an early ecological influence, dating from 1910 when E.J. Salisbury was most active in the county (Dony 1967). Some of the grander modern floras, such as those of Cumbria (Halliday 1997), Oxfordshire (Killick, Perry & Woodell 1998) and Assynt (Evans *et al.* 2002), include extensive ecological and historical sections. They present a broad view of the environment and floristics of their regions but, unlike the West Lancashire flora, mainly ignore physiology.

In summary, local floras are used by ecologists to a small extent, mainly to provide information on distributional change, and ecological information is included as background in some local floras but not in others.

ECOLOGICAL ANALYSES OF LOCAL FLORA DATA

If local floras have limited use to ecologists, what about the distributional data that they contain? One of the most extensive analyses of distributional data in a local flora was that of Good (1948) for the English county of Dorset. Good was particularly interested in the effects of climate. Climate is by far the largest influence on flora at the global scale but becomes less significant than soil and topography at smaller scales (Cain 1944). According to Good (1948, p.52) 'Climate primarily determines what species constitute the flora of Dorset, but edaphic conditions chiefly determine how those species are distributed individually within the county, that is to say, which are widespread, which are abundant, which are local, and which are rare'.

Good recognized two types of climatically-determined distributions, the marginal type (species at the edge of their range) and the gradient type (species which are widespread in the county but

are more frequent in one climatic zone). Some species' ranges were determined by rainfall, others by proximity to the sea, which is a complex climatic response depending on temperature and humidity. In addition, he recognized 40 species for which Dorset offers optimal climatic conditions. In enumerating edaphic factors, he distinguished a variety of soil types, such as saline, calcareous, medium, acid, clayey and sandy. Additional important factors were the presence of special habitats, notably water and woodland.

Even when all these factors were taken into account, patterns of distribution were not simple. There were compound distributions such as that of *Iris foetidissima*, which was found in woods, hedges and undercliffs on the coast, but inland was more or less confined to woods on the north-eastern chalk and adjacent Tertiary clays. Good was completely unable to explain this pattern, though other complex patterns such as that of *Phragmites communis* could be understood as the sum of the coast and the larger rivers. Other species such as *Achillea ptarmica* and *Viola palustris* had strangely disjunct distributions within the county. Good called these simply 'anomalous distributions'.

Good was hampered in his statistical analysis by the magnitude of his dataset. He made many of his inferences by 'eyeballing' the distribution maps and applying his extensive knowledge of Dorset plants in the field. His dataset, based on 7,500 sampling stations, would be easy to analyse on a modern computer, but would have been a large computational problem as little as 10 years ago. Such an analysis may soon be forthcoming because, thanks to a grant from the Heritage Lottery Fund, all of his stand data have now been computerized, geo-referenced and checked. They are a valuable resource for the future.

With the advent of electronic computing came habitat-based distribution maps (Cadbury, Hawkes & Readett 1971). There was also the possibility of more organized analysis of plant distributions. Several methods were explored by the authors of the Shropshire flora (Sinker *et al.* 1985). These included classifications of quadrat data, composite maps ('coincidence maps') of groups of species, and attractive small distribution maps fitted into the text. For the adjacent county of Montgomeryshire (Trueman, Morton & Wainwright 1995), a wider range of figures and analyses was possible, including satellite images of land-cover types, a scatter diagram of species richness in relation to altitude, and ordination and classification of tetrads based on their species, using the programs DECORANA and TWINSpan (Hill 1979a; Hill 1979b). Particularly impressive is the agreement between the coincidence map for 23 ancient woodland species (Fig. 1) and a distribution map of ancient woodland sites (Fig. 2). The TWINSpan classification (Fig. 3) divides the tetrads into two (and then four and eight), separating tetrads with the moorland species *Erica tetralix*, *Juncus squarrosus*, *Molinia caerulea* and *Nardus stricta* from those with *Ribes uva-crispa*, which is frequent in hedgerows and woods, especially near human habitation.

An additional method of analysis, Canonical Correspondence Analysis (ter Braak 1986) explicitly seeks correlations between environmental attributes and species lists. Canonical Correspondence Analysis was used by Bates (1995a) to make an analysis of bryophyte distributions in 5 km squares of Berkshire (Bates 1995b). This demonstrated a major axis of variation distinguishing heathland and bogs on the one hand from eutrophic and calcareous countryside on the other. A secondary axis distinguished eutrophic lowlands with rivers from countryside containing specialists of nutrient-poor chalk. The other two axes of variation found by this method were hard to interpret, though one axis had some relation to ancient woodland.

Bates, like Good before him, contrasted the strongly edaphic basis of variation within the county with the climatic basis found when 10 km squares were analysed at the scale of Great Britain (Hill & Domínguez Lozano 1994). Overall, the result of the county analysis was a little disappointing, in that the gradients revealed were obvious without complex analysis or, if not obvious, were hard to interpret. Even those that were obvious did not necessarily reflect single controlling factors but instead showed complex patterns of variation, such as that between relatively upland parts of the county (with higher rainfall, lacking major watercourses, often well wooded) and the major river valleys (with lower rainfall, intensively agricultural, largely unwooded, with rich riparian floras). Interestingly, some specialists of tree bark and rotting wood showed strong correlations with soil acidity, even though they did not themselves grow on soil.

Using the same methods of analysis on 1 km square data from an intensively-recorded area of northern Finland, Heikkinen, Birks & Kalliola (1998) came to rather a similar conclusion. All numerical techniques revealed a major gradient from alpine areas at one extreme to lowland sites with rivers and rocky outcrops at the other; a secondary gradient was correlated with the



FIGURE 1: Coincidence map of ancient woodland species in Montgomeryshire (from Trueman *et al.* 1995).

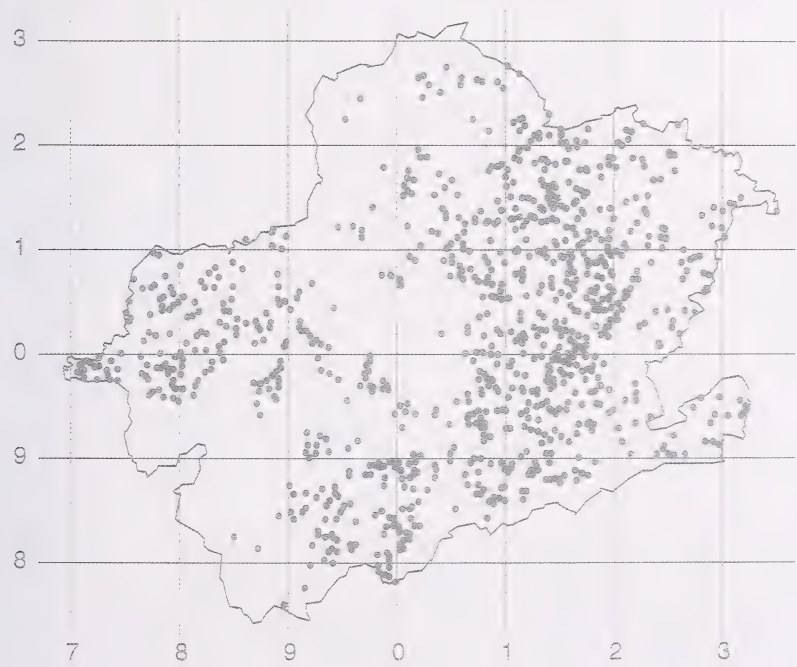


FIGURE 2: Distribution of ancient woodland sites in Montgomeryshire (from Trueman *et al.* 1995).

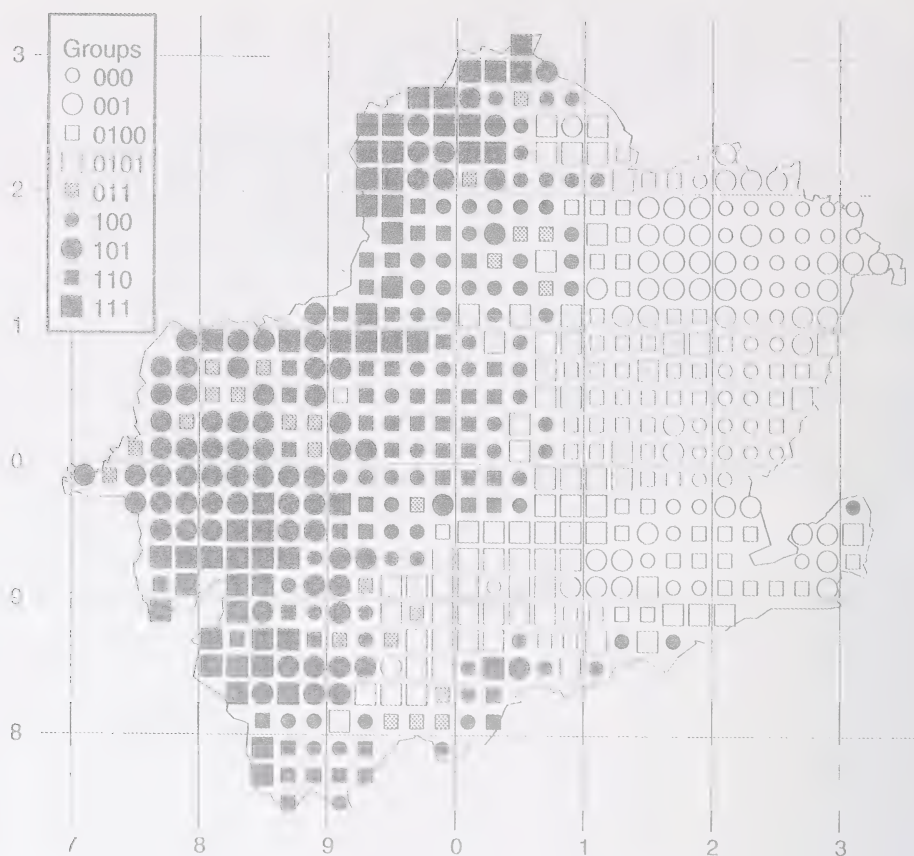


FIGURE 3: Tetrads of Montgomeryshire classified into groups on the basis of their flora (from Trueman *et al.* 1995).

abundance of mires. However, much of the floristic variation was determined mainly by small-scale factors, which were not readily detected at the 1 km square scale. Richness of rare species was likewise not easy to predict from environmental variables (Heikkinen 1998). Local hotspots were mainly in topographically heterogeneous grid squares, where high cliffs occur in deep gorges. Again, small-scale variation was important.

DISCUSSION AND CONCLUSIONS

It is clear that data from local floras are used rather little in ecological research. What are the reasons?

DISPARITY OF SCALE

Most ecological phenomena are studied at the ecosystem scale, which is smaller than the 1 km square scale or 2 km square scale used in many local floras. Ecological processes can of course be used to explain some of the phenomena that are observed. But it is the landscape scale that matters for local floras, with broader phenomena such as eutrophication, pasture abandonment, loss of burning, winter cropping of arable etc. acting as the great drivers of change. The ecological basis of calcium tolerance or of adaptation to high-nutrient or low-nutrient environments is fascinating for a plant ecologist but the ecology is just a little too detailed for understanding distributions. For a local flora, it is normally sufficient to know whether a plant thrives under particular conditions and where those conditions can be found.

A key factor that is often expressed at an inconveniently small scale for distribution maps is the topographic roughness of the terrain. Just as Heikkinen (1998) found small-scale terrain factors to be important in northern Finland, so may gullies and ravines be important as plant habitats in many parts of Britain. Likewise, the presence of grazed flushes with mineral enrichment of the ground water may be crucial for the survival of various marsh plants on extensive moorland, but small flushes are not mapped by cartographers nor are they easily recognized in satellite images.

The timescales of ecological phenomena, especially those of soil processes such as peat formation, may also be incompatible with those of a local flora; but this is less common. Many plants live for decades or even as clones for hundreds of years. Most, however, complete their life cycles within a human generation.

OBSCURITY OF KEY ENVIRONMENTAL FACTORS

Recurrent patterns of distribution are apparent when the key factors controlling the presence of species are similar. However, key factors for particular species may not be correlated with those for others, at least at the scale of recording, so that an appearance of randomness results. One formerly obscure factor is the presence of ancient woodland. Since the pioneering work of Peterken (1974) and Rackham (1976), the importance of ancient woodland has been well understood. Its presence can now be mapped as an environmental factor to aid interpretation of distribution patterns (Spencer & Kirby 1992).

Biotic factors such as susceptibility to slug grazing (Bruehlheide & Scheidel 1999) are much more troublesome. Slug densities depend on a variety of factors, including the moisture of the season and the abundance of predators that eat them. Deer grazing and its effect on woods is often all too obvious (Crampton *et al.* 1998), but the effects of herbivory by many invertebrates, especially those that eat roots, are still largely unknown even to ecologists.

Equally unknown for many species is the extent to which they depend on dispersal vectors. Poschlod *et al.* (1998) were of the opinion that, in former times, sheep movements between and around farms transported propagules between patches of calcareous grassland. Thus species could become locally extinct for a few years and then be reintroduced. Modern farming prevents such reintroductions. If this theory is true, then long-term declines of calcareous grassland plants could be expected even if the physical condition of the habitat is maintained.

SUBTLETY OF PLANT LIFE HISTORIES

The dependence of some species such as *Lobelia urens* on intermittent disturbance (Dinsdale, Dale & Kent 1997) cannot be appreciated without a detailed ecological understanding of its life cycle. At the present time, many of these peculiarities are being discovered in the process of devising species action plans (UK Biodiversity Group 1998). There are many such peculiarities. Plants that depend on rare events such as occasional fires or droughts may seem to be particularly unpredictable. Sometimes the key life-history factor may no longer be operative. *Tilia cordata* survives in Cumbria without effective reproduction; it is a relict of warmer times in the past (Halliday 1997).

EMPHASIS OF FLORAS ON RARE SPECIES

Much ecological study is devoted to finding out how the commoner species perform in the landscape. Large, abundant plants determine how most ecosystems work. They are the ecosystem engineers. Likewise, most types of vegetation are defined by common and widespread species. Plants such as *Paris quadrifolia* that were found in less than 10% of samples of any vegetation type were not even mentioned by Rodwell (1991–2000). Writers of local floras all take pleasure in the unusual, even if, like Good (1948), their species accounts do not show it. Good's frontispiece shows *Himantoglossum hircinum*, extremely rare in Dorset, where only two isolated plants had at that time been found.

Large numbers of ecologists are in fact concerned with rare species, as well as with common ones. Rarity is the subject of a well known ecological textbook (Gaston 1994). Most local floras say little of interest about their common plants. *Galium aparine*, for example, receives a dull notice in almost all floras. Even the authors of the excellent Shropshire flora (Sinker *et al.* 1985), cannot say much for it. Their most notable comment is 'Difficult to clear when brushing hedges'. Maybe *G. aparine* is just too much part of the furniture (or dross, depending on one's point of view) of our everyday lives.

CONCLUSIONS

In extreme cases, the authors of local floras provide distributional data almost without interpretation. At the other extreme, some ecologists are fixated on life cycles and physiological responses and ignore distributions. In the centre, there is much common ground. To write a local flora is inspiring for an ecologically-minded botanist, who is thereby forced to think about the distribution and abundance of plants in the locality. Ecological studies can feed into local floras where they help to explain remarkable phenomena such as the survival of *Tilia cordata* in Cumbria. But the fact remains that distributional data from local floras remain rather intractable and difficult to use. Probably this is because the standard methods of analysis seek general patterns. Plant distributions are interesting at all scales, from the continent to patches in a field. At the scale of the local flora, distributional data are often hard to interpret, being the result of diverse historical processes and biotic factors, which produce complex patterns. It is to be hoped that improved methods of analysis will in future allow ecologists to solve some of the problems that Good (1948) found so intractable. Present methods of numerical analysis are inadequate. Much remains to be done.

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Swedish provincial Floras – a survey of their history and present status

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ABSTRACT

Swedish provincial floras have a history dating back to the 17th century. During the Linnaean era very few were written, but there was an upgrowth in the early 19th Century with Göran Wahlenberg. Towards the middle and end of the 19th Century many provincial Floras were written because of the needs of the secondary schools. A new upgrowth took place in the 1920s to 1940s largely by academic botanists in Uppsala. From the 1970s provincial Floras have been published or are under work for most of the 24 Swedish provinces, now largely based upon a broad amateur floristic interest.

PRE-LINNAEAN FLORAS

The history of Flora writing in Sweden starts before Linnaeus. In the 17th Century the great polymath Olof Rudbeck the elder was the dominant figure at Uppsala university. Amongst many other things, he was the founder of the botanic garden and the author of the massively ambitious botanical work *Campus Elysii*, most of which was destroyed in the Uppsala fire in 1702. Rudbeck fostered a particular interest and knowledge in botany in a number of medical students, which subsequently led to some botanical activity in the Swedish provinces. After Rudbeck the elder died in 1702, the botanical interest he stimulated lived on with his son Olof Rudbeck the younger and the medical professor Lars Roberg. This was an essential precondition for Linnaeus' botanical development. The younger Rudbeck had reported on and illustrated the flora of Lapland in 1695, and Roberg made observations on the flora of parts of Uppland, the province in which Uppsala is centrally placed.

The earliest example, however, of what can be called a provincial Flora is from 1694, *Chloris gothica* by Olof Bromelius (1694), an enumeration of the plants Bromelius knew from his home town of Gothenburgh and its nearest surroundings.

Another fine example of a pre-Linnaean Flora is the "Flora wiksbergensis" by a physician Johan Linder from 1716. It is, in fact, of a very restricted area, but unusually complete and accurate. A modern edition with detailed annotations has been produced by Clemedson (1972).

LINNAEUS AND HIS DISCIPLES

During the first decades of the 18th Century the dean of Uppsala Cathedral, Olof Celsius, took a profound interest in the flora of the province of Uppland. He collected a large herbarium, two sets of which still exist, but he did not bring all his knowledge together in published form, except for a brief catalogue (Celsius 1732). He is, however, known as the man who "discovered" Linnaeus in Uppsala. Freshly arrived as a student, Linnaeus encountered Celsius in the Botanic Garden and made such an impression that he was immediately taken under Celsius' wing. They made trips together and collected in Uppland, and Linnaeus prepared a small manuscript with a provincial theme, "*Adonis uplandicus*", which, however, was not printed in his lifetime (Linnaeus 1888).

There is among all Linnaeus' works only one that may be reckoned as a provincial Flora, *Flora lapponica* (Linnaeus 1737). This is, however, not restricted to Lapland but includes the plants Linnaeus found along his whole journey from Uppsala to the north and back. But plants from northern Sweden dominate by far and the mountain flora is well represented, thanks to the lucky circumstance that the areas Linnaeus visited are, as it later appeared, among the richest that we have. The geographical information given in the Flora is scarce, and the specimens collected,

forming the Lapland herbarium (now in Institut de France, Paris), lack locality annotations. You have to compare the book with his diary to try to locate his findings. Besides that Flora from his young days – during the Lapland tour in 1732 he was just 25 – his works are on a national or mostly a general scale. Among the many theses defended by Linnaeus' disciples, but usually written by the professor himself, there are but a few floristic pieces, which just enumerate the plants from a place. Linnaeus did not directly inspire floristics, though within the Linnaean botanical tradition, which grew strong during the 19th Century, local and provincial Floras obtained a prominent place.

It is with Göran Wahlenberg, first demonstrator and then professor of botany in Uppsala from 1828 to his death in 1850, that provincial Floras in a proper sense were produced. Wahlenberg was an ardent Linnaean for whom the Linnaean system was nearly sacrosanct and for him only Latin was imaginable as the language of botany, even in Floras of Sweden which others decades before had written in Swedish. But Wahlenberg was an innovator in his understanding of plant geography and the inclusion of locality information in Floras. A masterpiece in that respect is his *Flora upsaliensis* (Wahlenberg 1820), covering the area within approximately 20 km of the city of Uppsala. This Flora is detailed enough to allow a fruitful comparison with present conditions and an estimation of the environmental and floristic changes. Like Linnaeus, Wahlenberg (1812) wrote a *Flora lapponica*, very unlike his master's except for the sexual system and the Latin language used. Wahlenberg was the leading expert on the Scandinavian mountain flora of his time and gives rich and exact information on plant localities and habitats, founded upon his experience from four journeys to various parts of northern Scandinavia.

Flora Nordica provinces in Sweden (S)

BhG	Göteborg and Bohuslän
Bl	Blekinge
Dlr	Dalarna
Dls	Dalsland
Gst	Gästrikland
Gtl	Gotland
Hl	Halland
Hls	Hälsingland
Hrj	Härjedalen
Jmt	Jämtland
Klm	Östra Småland
LL	Lule lappmark
LyL	Lycksele lappmark
Mpd	Medelpad
Nb	Norrbottn
Nrk	Närke
PL	Pite lappmark
Sk	Skåne
Sml	Inre Småland
Srm	Södermanland
TL	Torne lappmark
Upl	Uppland
Vb	Västerbotten
Vg	Västergötland
Vrm	Värmland
Vsm	Västmanland
Ång	Ångermanland
ÅsL	Åsele lappmark
Ög	Östergötland
Öl	Öland

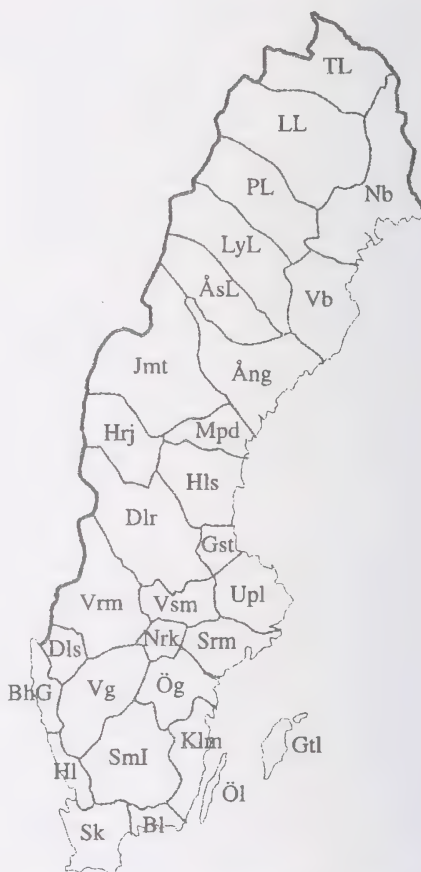


FIGURE. 1. Map of the Swedish floristic provinces, corresponding to the historical provinces, "landskap", with few exceptions. The most important are that "Sml and Klm" form the historical province of Småland, and that "ÅsL, LyL, PL, LL, TL" form that of Lapland.

NINETEENTH CENTURY 'SCHOOL FLORAS'

After Wahlenberg, who can be said still to represent the Linnaean period, there were few more ambitious provincial Floras published until the middle of the century. When they did reappear, they were no longer academic pieces of work, but grew up from the needs of the reform of secondary schools which took place about 1850. Now natural sciences and not least natural history obtained a comparatively prominent place in the teaching plan. Botany became in many places particularly favoured owing to teachers inspired by the Linnaean tradition. The pupils had to collect an admittedly modest number of plants during the summer holidays, as was still the case in the 1940s, but quite a few brought together imposing collections and maintained a lifelong botanical interest (Jonsell & Hultgård 1999). For those activities a number of provincial Floras were written, with the emphasis on keys and short descriptions rather than detailed locality information. The authors were, as a rule, teachers who had their education from the universities in Uppsala or Lund, often ending in a doctoral degree and the acquisition of a position in one of the provincial "gymnasias". The need for such Floras became much reduced when in 1883 a national Swedish school Flora appeared (Krok & Almquist 1883), the 28th edition of which was published in 2001. In Sweden there is no parallel to the Victorian heyday of county Flora writing we hear about from Britain (Preston 2003).

Floristic interest remained high, however, resulting in intense plant collecting during the decades around 1900. The leading amateurs were often physicians, apothecaries, priests and teachers with varying academic backgrounds. On the whole the flora was considered as static and inexhaustible as concerns plant collecting, which was regarded as an innocent occupation in the sunny countryside. Numerous reports on new finds and compilations about the flora of a parish were published, but no major provincial works were seen for many years.

TWENTIETH CENTURY REVIVAL AND TWENTY FIRST CENTURY PROSPECTS

A revival of interest took place in the 1920s, and again arose from the academic sphere. The Swedish Phytogeographical Society was founded in Uppsala in the 1920s, and reflected amongst other things an ambition to analyse the floristic elements and floristic history of Sweden, which gave rise to some academic theses. The earliest one is a monumental work about the flora and vegetation of Uppland (Almquist 1929), not really esteemed as an academic work in its day but the more appreciated today for its wealth of accurate information which, unusually enough, makes possible quite detailed comparisons with our time. The Baltic island of Öland (Sterner 1938), so famous for its rich and peculiar flora, and parts of Lapland (Arwidsson 1943, Selander 1950) also received detailed and scholarly presentations. For a few other provinces Floras were written without the academic connection. Those for Jämtland (Lange 1938), Bohuslän (Fries 1945, 1971) and Dalarna (Almquist 1949) are good examples.

The modern time for provincial Floras does not start, however, until about 1970, and initiatives came from people in the provinces, no longer from university institutions. A forerunner is a Flora of the southernmost and botanically very rich province of Skåne (Weimarck 1963), which is, however, focused on keys and descriptions and has only short pieces of locality information. The geographical units for this kind of Flora have in Sweden with few exceptions been the historical provinces (in Swedish "landskap"; Fig. 1), the folk lands rooted in early mediaeval times but for more than 350 years of no official standing. In tradition and in spirit they are in high degree alive, and have their well defined borders which have the great advantage of being stable in contrast to those of the administrative counties. In contrast to the British vice-counties our old provinces are well known to everybody – people regard themselves as coming from, say, Uppland, Öland or Småland, which are only historical entities today. There are 24 of those provinces, which means that most of them are of considerable size, many times larger than an average vice-county. In Figure 2 a few provinces are superimposed upon a map of Britain. The northern province of Norrbotten covers in length the most of Scotland, Småland, Linnaeus' birth province, the whole of the Midlands and a part of Wales, and Uppland corresponds to Yorkshire. The smallest Swedish province, Närke, covers a little more than the Greater London area.



FIGURE. 2. Map of Britain with four Swedish provinces superimposed.

At present, practically all the Swedish provinces have their Flora projects, some of them completed during the last 10-15 years, some of them close to completion within a few years time, others still in the inventory phase. There is no central initiative behind this series of Flora projects. The earliest ones, now all completed, were one-man projects with limited assistance from others even in the inventory phase and with no formal organization behind them – examples are the Floras of Östergötland (Genberg 1977, new ed. 1992), Dalsland (Andersson 1981), Västmanland (Malmgren 1982), Öland (Sterner & Lundqvist 1986), Ångermanland (Mascher 1990), Härjedalen (Danielsson 1994). Two of them were in fact accepted as academic theses, and the one for Öland is a thoroughly revised and amended edition of Sterner (1938). These enterprises of course

challenged other provinces to launch Flora projects, usually starting with the formation of a provincial botanical society to take responsibility for the work. A very important stimulus for these initiatives was and is the growing concern for conservation of the flora, alongside the profound transformation of the agricultural landscape, in particular, but also of forests, lakes, coasts, etc. This concern has made many more interested in and prepared to learn about the flora, and floristic activities are now much more widespread in society, far outside the academically educated to which they used to be restricted. In the current projects a few people are still the driving forces, of course, and there are still only marginal grants available, some obtained by selling information to nature conservancy authorities and the like. The inventory builds, however, upon a large team of amateurs and includes as a rule a measure of training in floristics on inventory camps. Some professional botanists are usually involved as well, and there are also links to the university institutions and botanical museums. Some of these team-work Floras have recently appeared: Halland (Georgson *et al.* 1997), Södermanland (Rydberg & Wanntorp 2001) and Västergötland (Bertilsson *et al.* 2002).

The Floras published in this "generation" have generally a high typographical standard, with colour plates of habitats and selected species. The "species part" indicating localities and often with maps takes the major share of the pages, but there are usually comprehensive chapters about the history of exploration, geology and climate, vegetation and habitats, and often a guide to places where visitors can get acquainted with the flora of the province.

Traditionally the church parish, which used to be the smallest unit in the Swedish administrative hierarchy, was also the unit under which localities were sorted in the Floras. It had the advantage of stable borders and historical continuity, so that all older records in herbaria and literature could be properly included. The earlier among the Floras mentioned above still use that system. Now a 5 × 5 km square, corresponding to the sheets of the "Economic map of Sweden", is almost universally accepted as the base. This grid system, combined with coordinates for localities, of course allows storing and handling in databases in a way not possible before. The number of squares in a province amounts to 1350 in a large one such as Norrbotten in the very north, to more than 750 in the medium-sized central Swedish province of Uppland, and to c. 300 in a small south Swedish one such as Blekinge. The square is usually the main unit for records, but in more densely populated provinces and where the number of recorders is high the four "subsquares" of 2.5 × 2.5 km are in many cases taken as the record unit.

The conditions for the projects vary considerably. In a northern province like Norrbotten most squares were not previously visited by any botanist, and at the same time many of them are difficult to reach and the number of field workers is low. The eastern floristic element is well represented and may cause surprises, not only as to species found but also in the way in which familiar species vary. There are many habitats practically unknown in Sweden outside this province and there are some unregulated major rivers, which is now very rare. In such a province the research for the Flora entails a kind of basic exploration, which may well change the distributional picture for a number of species, not to mention the known frequency.

By contrast stand the provinces of Uppland and Skåne, with the old university cities of Uppsala and Lund, for which there were Floras of a sort by the 18th Century and where detailed works have appeared repeatedly into the 20th century. For Uppland Celsius (1732), Wahlenberg (1820) and Almquist (1929) have been mentioned. An extremely detailed new *Flora upsaliensis* (Almquist 1965) covers exactly the same area as that of Wahlenberg. For Skåne an early small Flora is Leche (1744), bigger and more detailed are Lilja (1838) and Areschoug (1882). There is also an atlas (Weimarck & Weimarck 1985) largely building upon numerous parish inventories during the preceding 60 or more years. All this makes it possible to present for many species documented comparisons of floristic changes, to which in addition a wealth of historical information from herbaria and literature contributes considerably. A good share of the project labour has to be devoted to compiling this kind of information.

The time needed for a provincial Flora project, from the start of inventories to the publication of a book, is generally 10–20 years, and that if no period of dormancy comes in between. It is a challenge for project leaders to keep up the spirits of a team for such long periods. The publication of provincial floristic journals reporting news and finds, and *ad hoc* reports of progress, are measures undertaken to achieve this. The Swedish botanical society arranges a yearly gathering for project leaders to discuss chosen topics and exchange their experiences. The prospects are promising that in about 10–15 years nearly every Swedish provinces will have its modern Flora.

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Understanding change: a Lancashire perspective

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ABSTRACT

Changes in the vascular flora of West Lancaster (v.c. 60), were analysed over 100 years and over a more recent period of 30 years through site studies of roadsides, arable fields and the Lancaster Canal. Whilst 4% of the native flora was believed extinct nearly 700 species not native to the area were recorded, at least casually, and comprised 43% of the total flora of 1617 species excluding hybrids, and the critical genera of *Hieracium*, *Rubus* and *Taraxacum*. An assessment of native species showing changes in frequency of occurrence (23% of native species), extinct/decreasing and new/increasing, over 100 years was correlated with habitats and, using phytogeographic relationships of British plants, climate changes. The changing flora was also analysed using Ellenberg indicator values. Using data from a selection of different sites similar analyses were carried out with species showing change over the last 30 years. These analyses demonstrated that species showing change in their frequency of occurrence in v.c. 60 correlated with habitat changes and with increasing nutrient and base status of soils whilst a possible correlation with climate warming was also noted.

KEYWORDS: Ellenberg values, phytogeography, soil nutrient and base status, climate.

INTRODUCTION

The Watsonian vice-county of West Lancaster (v.c. 60) is situated in the centre of the British Isles on the western coast of England. Historically, its vascular flora is one of the least well known in England (Watson 1883; Perring & Walters 1962), yet the vice-county encompasses a wide range of habitats with a diverse flora. Nevertheless, Wheldon & Wilson (1907) published a Flora in 1907 following many years of fieldwork. Although they searched the literature and herbaria they were unaware of the work of Samuel Simpson (1802–1881) (most of his plants are at **K** and **OXF** but his main herbarium seems to be lost) and Henry Borron Fielding (1805–1851) in the first half of the 19th Century. The acquisition by the Bodleian Library, Oxford in 2000 of an 'English Flora' (MS. Eng. D. 3357) comprising six volumes of paintings, many of Lancashire plants by Mrs Fielding (1804–1895) with a commentary provided by her husband, H. B. Fielding, makes a valuable contribution to an understanding of the Lancashire flora prior to 1850.

Following Wheldon & Wilson's Flora, little further work was done in the vice-county until the late 1960s. The flora was then surveyed on a tetrad basis but detailed survey work more-or-less ceased with the publication of *The flowering plants and ferns of North Lancashire* (Livermore & Livermore 1987). The B.S.B.I. 'Atlas 2000' project provided an impetus to update pre-1987 records, but intensive fieldwork was not possible until 1998. As a consequence of these relatively distinct phases of study it was thought it might be possible to analyse the flora to assess change over more than 200 years and to seek possible reasons for change. In this latter respect two recent publications (Preston & Hill 1997; Hill *et al.* 1999) provide new tools to aid analysis.

CHANGING COMPOSITION OF THE FLORA

Using the status assigned to species by Stace (1997) an attempt was made to analyse the composition of the flora (hybrids, subspecies and the critical genera of *Hieracium*, *Rubus* and *Taraxacum* were excluded). An initial analysis was published (Greenwood 1999) and in the light of more recent fieldwork the opportunity was taken to revise these figures.

Table 1 shows that prior to 1840 over 40% of the currently known v.c. 60 flora was discovered. However, these figures rely on what recorders prior to that date considered to be species and what they thought were noteworthy. Particularly noticeable was the absence of many species found commonly today. Nevertheless, they already recognised that a number of introduced species had become part of the 'wild' flora.

TABLE 1. CHANGES IN FLORISTIC COMPOSITION

	Pre 1840	1907	1992	2001
No. of native species recorded	387	797	922	925
No. of introduced species (% of recorded flora)	24 (6)	205 (21)	657 (42)	692 (43)
No. of extinct native species (% of native flora)	19	27	37	39 (4)

By 1907 86% of the native flora was recorded, but 21% of the total number of species was introduced. In 1992 the flora comprised 1579 species of which 42% was introduced. Since then further, but mainly introduced species have been discovered.

Perhaps the most surprising figure is the low level of extinctions (species not recorded for a substantial time, say 30 years, or where the last established locality is known to have been lost) despite the growth of towns and general urbanisation, mineral extraction and intensification of agricultural practices. At 4% this compares with figures for Northumberland (v.cc. 67 & 68) of 2.4%, Durham (v.c. 66) of 9.6% and Cumbria of 10.5% (Graham 1988; Halliday 1997; Swan 1993). For south-eastern England, Preston (2000) noted that 18% of the Middlesex (v.c. 21) and 13% of the Cambridgeshire (v.c. 29) floras were extinct. Preston also defined the rate of extinction but for West Lancaster, where records were made unevenly over time, meaningful analysis is not possible.

However, by comparing the work of Wheldon & Wilson (1907) with the current status of the flora it is possible to define those species that have been added to the known flora but, perhaps more importantly, it is possible to identify species that appear to have decreased or increased in abundance. Although Wheldon & Wilson did not systematically survey the vice-county on a grid square basis, fieldwork over the last 30 years suggests that they covered the area well.

Table 2 summarises the changes estimated in 1996 (Greenwood 1999) and as revised in the light of fieldwork in the period 1998–2000. The main effects of this revision are to reduce the number of taxa that appeared to be increasing in abundance and increase the number of decreasing species. However, out of 925 native species recorded in v.c. 60 only 215 or 23% seemed to have changed their status since 1907. Of these the discovery of new species (4.9%) more than matches those lost (4.2%), but only a very small number of the newly discovered species are likely to be real immigrants. Perhaps more surprising is the slightly larger number of species (12.7%) that seem to be increasing in frequency as compared with those that are decreasing (6.5%). Nevertheless, those that are decreasing include some species that 100 years ago were too common for localities to be recorded, but may now be on the verge of extinction. Examples include *Platanthera chlorantha*, reduced to two nearby colonies with a total of under ten plants or *Pinguicula vulgaris*, which declined from numerous sites to 17 recorded between 1965–1987 and to six sites in 2000.

TABLE 2. DECREASING / INCREASING SPECIES 1907–2001

	1996	2001	1996	2001
	Original (Nos.)	Revised (Nos.)	Original (% of native species)	Revised (% of native species)
New taxa	43	45	4.7	4.9
Increasing taxa	114	71	12.4	7.7
Total	157	116	17.1	12.7
Decreasing taxa	48	60	5.2	6.5
Extinct taxa	37	39	4.0	4.2
Total	85	99	9.2	10.7

Total number of species: original 922; revised 925. Changes include switches between categories and an additional three species.

HABITAT CHANGES

There have been major changes to the Lancashire landscape since 1800. The agricultural changes prior to 1850 were as significant as the later 19th Century industrial changes and urbanisation and later 20th Century agricultural intensification (Simmons 2001). Apart from ancient woodlands, where a net loss of perhaps 10% for Lancashire as a whole was recorded between 1945 and 1986, (Morries 1986) there are no quantitative measurements for habitat change over 100 or 200 years. However, Table 3 attempts to summarise the main changes qualitatively.

TABLE 3. HABITAT CHANGES

Loss/ Reduction	Gain/Increase
Lowland raised bog / heath	Fens
Sand dunes	Salt marshes
Mesotrophic grassland	Gravel pits & reservoirs
Ponds	Planted broad-leaved & coniferous woods
Hedges	Marshes & scrub
Ancient broad-leaved woods	Townscape
Nutrient-poor wetlands	Nutrient-rich wetlands
	Eutrophic grasslands

Lowland wet heaths, commonly called 'moor', were mostly common grazing and were enclosed with agricultural improvement during the late 18th and early 19th centuries. Fragments survived until the early 20th Century as at Ribbleton, Preston but none has survived to the present day. Similarly, lowland raised bogs or 'mosses' were drained from the 18th Century onwards, a process that continues today in the Bowland fringe. Two much modified fragments of lowland bog survive at Heysham and Cockerham but even in the Bowland fringe only a few surviving remnants remain.

Sand dunes were mostly converted into golf courses or built on to form the Fylde coast towns extending from Lytham and through Blackpool to Fleetwood.

Many ponds or marl pits, dug mostly in the 18th Century (Day *et al.* 1982), have been filled in during recent years (Boothby & Hill 1999), whilst it is believed some hedges were also removed as part of agricultural improvements. However, in Lancashire west of the M6, many hedges, along with broad-leaved copses, were planted as part of agricultural improvements and as cover for game during the early 19th Century.

Overall, these changes increased both the base (liming) and nutrient (fertilizers) status of the land and freshwaters of the area from the 18th Century onwards. To balance the losses, at least to some extent, there was an increase in some habitats. Until the later years of the 20th Century there was an increase in the extent of salt marshes over the previous 100 years despite the enclosure of some of the highest parts of the marshes. In Morecambe Bay the accretion/erosion sequence of salt marshes seems to be cyclical (Marshall 1967; Gray 1972). This has allowed the development of some *Phragmites*-dominated fen to develop. More significantly, the reclaimed Leighton Moss (formerly Warton and Storrs Moss) flooded when the steam pump required to keep the Moss drained failed due a fuel shortage in 1917 (Peter 1994). Leighton Moss then reverted to a large *Phragmites*-dominated fen, as did the nearby Hawes Water Moss where, however, drainage was never entirely successful. In addition to these newly created wetlands a number of reservoirs were built in the late 19th Century, creating new open waters but often destroying ancient broad-leaved woodlands, heaths or bogs. The building of motorways from the 1960s created a demand for gravel that was met by digging gravel pits along the M6 corridor through the vice-county. These subsequently flooded forming several new wetlands. New pits are still being created so that overall open water areas have significantly increased.

Table 4 demonstrates that species showing change correlate well with the known habitat changes. Interestingly, the loss of sand dunes has not caused a significant loss of species and, overall, there is an increase of coastal species. However, the large increase of open habitats provided by the greatly enlarged towns is reflected by greater numbers of increasing and new species in these habitats.

TABLE 4. HABITAT CHANGES
(HABITAT CATEGORIES BASED ON RODWELL 1991–2000)

	Decreasing & Extinct (No.)	Increasing & New (No.)	-Loss +Gain (No.)
Woodland & scrub	13	9	-4
Grassland & montane screes	18	19	+1
Mires & heaths	34	7	-27
Aquatic (Ellenberg values 9–12)	15	18	+3
Maritime (Sand dunes & salt marshes)	8	24	+16
Open habitats	11	38	+27

CLIMATE

At the present time the consequences of climate change are constantly in the news. Yet ever since the substantial warming following the last ice age there were many relatively minor climatic fluctuations. However, the present debate is given added impetus because it is believed that the present warming is due, in part, to human activity.

Table 5 illustrates the observed warming that has taken place in Central England (Hulme & Barrow 1997). This shows a significant warming in autumn and winter and, more recently, in summer as well. Precipitation is variable, but it is possibly getting wetter, at least in winter.

TABLE 5. TEMPERATURE CHANGES IN CENTRAL ENGLAND
(FROM HULME & BARROW 1997)

	1753–1995 (Change in degrees C)	1901–1995 (Change in degrees C)
Winter (DJF)	1.10*	-0.11
Spring (MAM)	0.39	0.42
Summer (JJA)	0.02	0.63*
Autumn (SON)	0.96*	0.93*
Annual	0.62*	0.47*

*Significant at 95% level

Note warmest decade was at the end of the 20th Century.

Central England Temperature Record = average daily max. & min. temperature. Northern station in Lancashire & one in west and one in east of south midlands, latterly Rothamsted, Malvern & average of Blackpool and Manchester.

Preston & Hill (1997) provided tools for analysing change. They assigned each British and Irish vascular plant to a floristic element based on their climatic preferences in the Northern Hemisphere. Their classification allocated species to major biomes (Arctic, Boreal, Temperate and Southern) and their longitudinal distribution (Oceanic, Suboceanic, European, Eurosiberian, Eurasian and Circumpolar).

Table 6 indicates the number of species showing change in each biome and for each biome whether or not there is a net loss or gain in the decreasing/extinct or increasing/new categories. The results show that species favouring a northern European distribution and therefore generally cooler climate are tending to decrease, whilst species favouring a more southern European distribution and therefore warmer climate are increasing.

TABLE 6. ANALYSIS OF CHANGE IN FLORISTIC ELEMENTS: MAJOR BIOMES
(ELEMENTS BASED ON PRESTON & HILL 1997)

Major biome	Decreasing & Extinct (Nos.)	Increasing & New (Nos.)	-Loss +Gain (Nos.)
Arctic-montane	1	1	0
Boreo-arctic montane	4	1	-3
Wide-boreal	1	0	-1
Boreal-montane	18	5	-13
Boreo-temperate	24	14	-10
Wide-temperate	1	2	+1
Temperate	33	49	+16
Southern-temperate	14	35	+21
Mediterranean	3	8	+5

Berry (2000) pointed out that the whole of the British Isles has a very oceanic climate. On a world scale of 0 for maximum oceanicity to 100 for maximum continentality the range within the British Isles is from less than 4 to 12.5 with Lancashire at 8. It is therefore not surprising that most species showing a net gain in Lancashire fall within Preston & Hill's middle or European group, although the circumpolar group, reflecting species characteristic of a colder climate, showed a net decrease. (Table 7).

TABLE 7. ANALYSIS OF CHANGE IN FLORISTIC ELEMENTS: LONGITUDINAL
DISTRIBUTION
(ELEMENTS BASED ON PRESTON & HILL 1997)

Eastern limit	Decreasing + Extinct (Nos.)	Increasing + New (Nos.)	-Loss +Gain (Nos.)
Oceanic	13	11	-2
Sub-oceanic	8	15	+7
European	32	45	+13
Euro-siberian	14	20	+6
Eurasian	7	11	+4
Circumpolar	25	13	-12

Overall the analysis of Lancashire species showing change correlates well with a slightly warmer climate but it is inconclusive in respect of continentality/oceanicity gradients.

ELLENBERG VALUES

Hill *et al.* (1999) re-worked Ellenberg's indicator values for vascular plants of Central Europe for plants found in Britain. The basis of indicator values is the realised ecological niche. Plants have a certain ecological tolerance and Ellenberg defined seven major scales. Temperature and continentality are considered above under Preston & Hill's classification of floristic elements. The other scales were for light (L) where 1 is for plants in deep shade and 9 for plants in full light; moisture (F) where 1 indicates extreme dryness and 12 a permanently submerged plant; reaction (R) where 1 indicates extreme acidity and 9 indicates basic reaction (although the scale reflects soil and water pH it is not a pH scale) nitrogen (N) a general indicator of soil fertility where 1 indicates extremely infertile sites and 9 indicates extremely rich situations and salt (S) where 0 represents plants absent from saline situations and 9 indicates species of very saline places.

Of these values analysis of the Lancashire flora for salt tolerance, with a few exceptions, was of little value, but the other values, i.e. light, moisture, reaction and nitrogen, were used to assess those species that showed change. The analysis of species for light and moisture was inconclusive but significant (where $p = 0.001$) differences were revealed for reaction and nitrogen. Table 8 shows these changes together with the average height of the species in each category. It shows that extinct species have the lowest reaction and nitrogen values, followed by decreasing and increasing species, and that increasing species are generally taller than extinct and decreasing species.

TABLE 8. ELLENBERG VALUES: ANALYSIS OF CHANGE 1700–2001

	Nos. of species	R Average	N Average	Height (Average in cm)
Extinct	39	4.9	3.1	58.1
Decreasing	60	5.8	3.7	56.3
Increasing	71	6.8	5.9	101.7
New	45	6.2	4.7	*140
New (natural spread)	9	6.9	4.7	48.6

*76 if *S. torminalis* is excluded

The figures for new species are apparently anomalous. The height of new species is skewed by the presence of a tree, *Sorbus torminalis*, which is an example of a species that although only discovered since 1900 at Silverdale in v.c. 60, is undoubtedly native. It was known from Cumbria much earlier (Wilson 1938), but it was also not discovered until the 20th Century in similar habitats to those in Lancashire at nearby Arnsdale. Of the new species, only nine could claim to have spread naturally into the vice-county. Whilst these species generally favour base rich sites they have often colonised open habitats of relatively low nutrient status and are usually low growing.

This analysis of species showing change over the last 100–200 years suggests that species preferring a warmer climate and richer soils with a higher base status were favoured. This is in accordance with the climate records and with agricultural improvements since at least 1800 that have increased soil fertility and base status.

CHANGES SINCE 1970

In the early years of the present survey of the flora of v.c. 60, a number of habitats were examined with the aim of describing their floristic composition. These included arable fields and roadside verges (including the hedge or wall separating the road from the adjacent field). Later, Livermore & Livermore (1989) carried out a systematic survey of the Lancaster Canal in Lancaster District. The existence of these data provided the opportunity for the same sites to be re-surveyed in the period 1998–2000 and any observed changes assessed.

ARABLE FIELDS

In 1971/2, 50 fields in the west of the vice-county were surveyed. They were on a variety of soils ranging from ones derived from boulder clay to ones derived from reclaimed mosses (raised bogs). Although only 21 fields were sampled in 1998 a species/area curve showed that their flora was a representative sample. However as crops vary from year to year and often include grassland in the rotation the fields surveyed in 1971/2 were not necessarily re-surveyed in 1998 although they were all located within the same general area. In both surveys, species lists were compiled for each field and the process of recording ceased when no further species could be added to the list. Recording took place within the ploughed area and not in any verge left between the ploughed area and the field boundary. In practice, most weeds were found within a few metres of the ploughed edge in cereal crops with few if any weeds in the main crop area. With root crops, especially potatoes, some fields became full of weeds after the main growth of the crop ceased and before harvesting.

Cereal crops included wheat, barley, oats (in 1972 only) and maize (in 1998 only). Other crops were potatoes, beans and swede (in 1998 only). In neither year was oil seed rape grown. Also no distinction was noted between winter and spring sown crops. In both years surveys took place in late July or August. This meant that wheat, barley and oat crops were surveyed just before or immediately after harvesting.

Table 9 shows that both the total number of species recorded and the number of weeds per field appear to have decreased. However, the species composition also changed with 42 species recorded in 1971/2 not being seen in 1998 yet 15 species were newly recorded in 1998. The species that were not recorded in 1998 along with the newly recorded ones were analysed according to their Ellenberg values. Little or no change was discernable in respect of light and moisture preferences and whilst new species showed some preference for more base rich soils there was a much greater preference for more nutrient rich soils.

TABLE 9. ARABLE FIELD FLORAS: ELLENBERG VALUES

	Species present 1971/2, absent 1998 (average for 42 species)	Species present 1998, absent 1971/2 (average for 15 species)
Reaction (R)	5.9	6.3
Light (L)	7.0	7.0
Nitrogen (N)	4.9	6.0
Moisture (F)	5.2	5.7

NUMBER OF SPECIES RECORDED

	1971/2(50 fields)	1998(21 fields)
Total number of species	113	75
Average/field	20.5	15.7

ROADSIDE VERGE FLORAS

In 1977 a number of 100 km-long roadside verges were surveyed to reflect their floristic composition in different parts of the vice-county. Some were selected because they were known to be floristically rich. In general, the richer verges were found in areas typical of ancient countryside (Rackham 1999) situated in the Bowland fringe in the east of the vice-county. The verge was defined as the area between the made-up road surface to the field side of the boundary fence or hedge. Besides the hedge the verge often comprised a ditch and a strip of grassland, of which a metre width adjacent to the road was mown several times during the growing season, whilst the remainder was mown once, usually in July. Hedge clipping and ditch cleaning (if done at all) took place in the winter months. In places, however, the grassland was replaced by scrubby woodland. It is believed that management remained unchanged through the years although it was noted that one hedge had been re-laid.

In 2000/1 ten of the richest verges identified in 1977 were re-surveyed but one was found to be essentially a semi-natural woodland and, as such, highly atypical of verges as a whole. As a consequence the analysis shown in Table 10 is for nine verges only.

Verges were surveyed by recording species present in the survey lengths once at the end of May or early June. In 2000 and 2001 a second visit was made at the end of June or early July before the whole verge was cut for maintenance purposes.

Table 10 shows that whilst verges might have become less species rich this is not significant. On the other hand the species composition had often changed markedly. Whereas 42 species recorded in 1977 were not seen in 2000/1, 24 species were newly recorded in 2000/1. Analysis of these species in terms of their Ellenberg values showed clear preferences. Notably there was a significant change for species preferring more nutrient rich soils and this corresponded with an increase in the average height of species. The values for reaction, light and moisture were not or little changed although there was a tendency for species to favour less light and soils with higher base status.

TABLE 10. ROADSIDE VERGE FLORAS: ELLENBERG VALUES

	Species present 1977, absent 2000/1 (average for 42 species)	Species present 2000/1, absent 1977 (average for 24 species)
Reaction (R)	5.8	6.2
Light (L)	6.6	6.3
Nitrogen (N)	4.6	5.9
Moisture (F)	5.9	5.9
Height (average in cm)	71.3	99.1

NUMBER OF SPECIES RECORDED

	1977	2000/1
Total number of species	156	146
Average/verge	65.3	61.8

The verges selected for re-survey in 2000/2001 also contained species with a more localised distribution in v.c. 60 when they were surveyed in 1977. Each species occurred in one or more of the surveyed verges in 1977 and were *Dactylorhiza fuchsii*, *Helictotrichon pubescens*, *Listera ovata*, *Ophioglossum vulgatum*, *Ranunculus bulbosus*, *Salix pentandra*, *Oreopteris limbosperma*, *Triglochin palustris* and *Valeriana dioica*. However, in 2000/2001 none were re-found in any of the verges. Whilst their average Ellenberg Reaction value was 6.3, slightly above the average for species as a whole not seen in 2000/2001, the Ellenberg Nitrogen value was only 3.3. Furthermore, two other localised species, *Baldellia ranunculoides* and *Hottonia palustris*, were found formerly in roadside ditches in the west of the vice-county and although these verges were not re-surveyed in 2000/2001, the ditches were searched in 1998 but neither species was re-found. They had Ellenberg N values of 2 and 5 respectively.

Overall, there is compelling evidence that eutrophication is a major reason for the changing species composition of roadside verges.

THE LANCASTER CANAL

The Lancaster Canal is entirely man-made and, like other 18th Century canals, was a major feat of civil engineering when first built. Today it is an attractive waterway and it is difficult to envisage the scar on the landscape that it created when being built. The canal from Preston to Tewitfield (on the Cumbrian border north of Lancaster) was opened in 1797 and, unusually, has no locks. The cut was lined with puddled clay, with a towpath on the western side that is separated from adjacent fields by a hedge. Until the 1970s, when an iron plate was fitted, there was no hard boundary between the towpath and the canal. There is usually no boundary fence on the other side of the canal but both banks are often lined with a marsh or reed bed zone. This initial stretch of the canal was watered by a number of intakes from nearby streams. Later the canal, with a flight of locks at Tewitfield, was extended to Kendal (currently abandoned but with plans for re-instatement). A branch from Galgate, via a flight of locks to the sea at Glasson Dock, was also built. To maintain water levels in the extended system, a reservoir at Killington in the Howgill Fells near Tebay was constructed. The original plans included an aqueduct across the R. Ribble to connect the canal to the rest of the canal system but this was never built (Hadfield & Biddle 1970). However, a link involving a short sea passage across the estuary of the R. Ribble was built in 2002. Thus from 1795 until 2002, the canal was isolated from the rest of the canal system and so far as is known any deliberate planting was limited. Accordingly, it is believed plants have colonised the waterway by natural processes and accidentally through human activities. However, as there are several non-native species characteristic of the waterway, e.g. *Acorus calamus*, it is believed that accidental introductions were unusually significant.

Following changes in the flora since it was built are difficult. Although Mr and Mrs Fielding lived within a few hundred metres of the canal none of the wetland species illustrated in their 'English Flora', compiled in the 1830s, were from the canal, yet they illustrated a few ruderal species from its banks. Perhaps at that time there were few aquatic and marsh plants present, although in **OXF** there is a specimen of *Groenlandia densa* collected from the canal at Lancaster in 1816 but the collector is unknown. Any significant records of plants found in and by the canal was not noted until the 1850s (Ashfield 1858, 1860, 1862, 1864). These were consolidated by Wheldon & Wilson (1907) in their Flora, which together with a few other records made subsequently, provide the basis of an account of the more noteworthy aquatic species (plants with an Ellenberg M value of 10 or more) recorded before 1940. Subsequently there were few observations made until the 1960s.

If the pre- and post-1940 aquatic floras are compared (Table 11), eleven species were seen prior to 1940 but not later and five new species were recorded after 1940. If the Ellenberg values for N and R are compared for these two groups there is an apparently significant change for species favouring waters of both higher nutrient and base status.

TABLE 11. LANCASTER CANAL: ELLENBERG VALUES FOR AQUATIC SPECIES
WHOLE CANAL

	Present pre-1940 Absent 2000	Species present 2000 Absent pre-1940
Number of species	11	5
Mean Ellenberg N value	4.8	6.6
Mean Ellenberg R value	6.3	7.2

Livermore & Livermore (1989) carried out a detailed survey of the canal in Lancaster District by noting species present within the curtilage of the canal along defined lengths of the canal (a length was the distance between two bridges and was therefore a variable distance). They carried out their survey by walking up and down the towpath in each length three times between May and September noting the species observed. In 2000 five of the richest lengths surveyed by the Livermores were re-surveyed using their methodology. It was found that 25 species recorded in the five survey lengths by the Livermores were not seen in 2000. On the other hand 34 new species were recorded in 2000. Analysis of their Ellenberg N and R values showed some eutrophication but little change in base status (Table 12).

TABLE 12. LANCASTER CANAL: ELLENBERG VALUES FOR ALL SPECIES
(FIVE SURVEY LENGTHS)

	Present 1987 Absent 2000	Present 2000 Absent 1987
Number of species	25	34
Mean Ellenberg N value	4.6	5.1
Mean Ellenberg R value	6.0	6.1

Note run-off from fields to towpath negligible? But run-off from fields into canal considerable with several minor feeders in addition to main feeder from Killington.

However, if the analysis is confined to aquatic species (Ellenberg M values of 10 and above) there appears to be a marked eutrophication of the waters and some increase in base status (Table 13). Another factor known to adversely affect macrophytic plant growth is boat traffic intensity (Murphy & Eaton 1983). It is also believed that boat traffic affects species diversity (Willby *et al.* 2001) but the significance of these issues for the Lancaster Canal is not considered here.

TABLE 13. LANCASTER CANAL: ELLENBERG VALUES FOR AQUATIC SPECIES (FIVE SURVEY LENGTHS)

	Species showing net loss 1987–2000	Species showing net gain 1987–2000
Number of species	13	12
Mean Ellenberg N value	5.4	6.3
Mean Ellenberg R value	6.3	6.8

DISCUSSION

It was pointed out previously that farming practices in the first half of the 19th Century were highly significant in causing a general increase in the base and nutrient status of agricultural land. However, agricultural depression followed and whilst continued progress was made in the development of new farming methods changes were not so dramatic as earlier. Nevertheless, from the middle of the 19th Century new manures and fertilizers became available and it is believed that some in particular may have significantly raised phosphate levels. These fertilizers were possibly significant in reducing the floristic diversity of many meadows and pastures.

The individual habitat studies over the last 30 years suggest that further increases in base and nutrient status have occurred and it is generally acknowledged that this coincides with a considerable intensification of agricultural practices (Simmons 2001).

Figure 1 suggests that farmers considerably increased their fertilizer applications in the period 1973–1991 and that the direct affects of this would be noted in arable fields and indirectly through run-off from fields into the Lancaster Canal. In addition to feeder inlets many fields slope down to the canal on its eastern side, and the odd open drain from farm buildings has also been seen although they may not now be active. It is less easy to see how run-off could affect roadsides except, perhaps, where a ditch receives drainage from the adjacent field. Generally, however, the ditch is designed to drain the verge and not the field. On the other hand, verges might receive significant nutrient enrichment from motor vehicles. NEGTA 2001 (2001) demonstrated that significant nitrogen pollution is associated with motorways although in this study all the verges were on minor roads where it is presumed nutrient enrichment from motor vehicles was minimal.

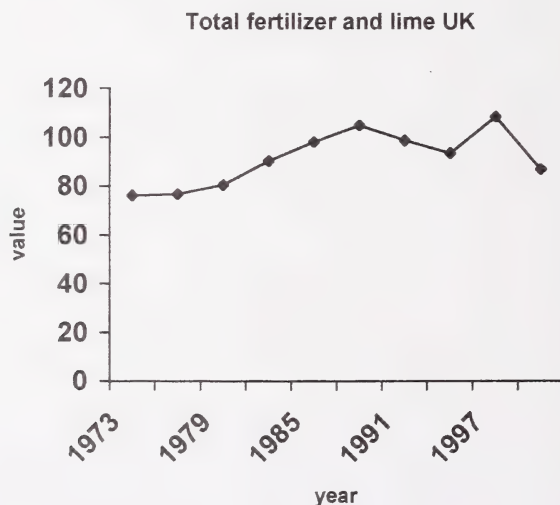


FIGURE 1. Relative values for the volume of lime and fertilizers consumed in the UK where the value for 1995 = 100. Figures taken from *Agriculture in the United Kingdom* on the DEFRA website.

TABLE 14. DEPOSITION OF ATMOSPHERIC NITROGEN
FROM KIRKHAM (2001)

Area	Amount deposited in Kg N/ha/pa
N. Pennines	18.6
Wales	24.8
N. Yorks Moors	25.4
Exmoor	25.8
Cumbria	26.1
Dartmoor	30.9
S. Pennines	31.0
Bowland	33.2
Upland England	26
England	19

The effects on plants of sulphur dioxide and solid carbon born through atmospheric pollution are well known but much less is known about other atmospheric pollutants. Nevertheless in recent years there has been considerable research into the affects of atmospheric nitrogen pollution. Unfortunately measurements of the amount of atmospheric nitrogen deposition have only been made relatively recently. Table 14 shows that Bowland has possibly the highest deposition rate in the country and well above levels that will change lowland heaths to grasslands. According to Kirkham (2001) at least two thirds of the nitrogen deposited may be in the form of reduced nitrogen (as NH_3 and NH_4^+) whilst the remainder is derived from nitrogen oxides. NEGTA 2001 (2001) confirmed these findings and suggested that reduced nitrogen was largely derived from farm animals and slurry. The early springtime application of slurry in pastoral Lancashire is a feature of the farming calendar. The present high levels of atmospheric deposition are probably recent, but work cited by NEGTA 2001 suggests atmospheric nitrogen pollution has been an increasing problem for over 100 years.

Lowland heaths change to grasslands where deposition rates are $>15\text{--}20$ Kg/ha/pa (NETGAP 2001). The changes noted here in the composition of the Lancashire flora are mostly in line with the wider Countryside Surveys (Firbank *et al.* 2000, Haines-Young *et al.* 2000). These show that acidification was not a problem as Wigginton (1995) has pointed out despite wet deposited acidity being amongst the highest in the country. The Countryside Surveys also suggested that there was general eutrophication making long-term conservation of low nutrient status sites difficult to maintain in some upland areas. However, the somewhat less diverse weed flora of Lancashire arable fields is contrary to their findings.

This analysis of the changing flora of West Lancaster, v.c. 60, indicates that, whether change to the whole flora over 100 years or the flora of selected habitats over a more recent timescale of less than 30 years are analysed, a similar picture emerges. These changes are consistent with climatic warming and of increasing base and nutrient status of soils and water systems.

It is important to appreciate that whilst correlations have been drawn with farming methods and atmospheric pollution it is unsafe to draw conclusions as to cause and effect. Clearly there are direct affects of habitat destruction, but often the building of towns, motorways etc. create new habitats. If there is a continuing source of seeds and propegules and the new habitats are suitable, plants readily colonise them. Whilst the new habitats are initially open and, perhaps, nutrient poor, they are often base rich. In time a closed and less diverse community develops and no doubt the nutrient status increases.

Many processes lead to nutrient enrichment, few lead in the opposite direction and then possibly for only a short period.

The difficulty of assigning cause and effect is illustrated by the extinction of *Antennaria dioica*. Formerly it occurred in several localities in three different areas of v.c. 60. Whilst the habitats were all probably open they varied from sea-level on the sand dunes at St Annes, on limestone rocks at Silverdale and to higher levels inland on neutral or possibly slightly acidic rocks at Leck. The last record was in 1909 on coastal limestone rocks at Silverdale but more interesting was the

loss from a nearby limestone hill. One hundred years ago the top of the limestone hill was largely free of trees and shrubs, presumably through grazing animals, but gradually scrub encroached over almost the whole hill until recently when the National Trust introduced a programme of scrub clearance. Was extinction caused by a lack of grazing and consequent woodland development? Insufficient is known about the other Silverdale sites to discuss possible causes of extinction. However, at St Annes the site was simply eradicated through building development.

It is difficult to know why the Leck colonies became extinct, although it is believed to have occurred in moorland areas grazed mainly by sheep. The last record was reported by Wheldon & Wilson (1907). The Ministry of Agriculture, Fisheries and Food carried out annual Parish surveys (Public Record Office: MAFF 68) from the second half of the 19th Century and these show that for Leck there were 1481 sheep in 1870 but by 1890 the numbers had risen to 3287 and by 1910 to 3536. Unfortunately it is not possible to accurately convert these figures to number of animals for a specific area, but a more than doubling of sheep numbers would no doubt cause problems for grazing-sensitive species. Similar increases in sheep numbers occurred at Silverdale and increased grazing at other sites in the Parish may have been responsible for the extinction of *Antennaria dioica* at these sites. As a popular area for tourists public pressure may also have been a contributing factor.

These observations suggest that changes in grazing pressure may be the limiting factor for the extinction or reduced frequency of some species. However, NEGAP 2001 pointed out that there is a complicated relationship between grazing levels and eutrophication. Furthermore, calculations of critical loads of atmospheric nitrogen for different habitats vary and are subject to further refinement. Despite these uncertainties it is suggested that ombrotrophic bogs are most sensitive and calcareous grasslands least sensitive to atmospheric nitrogen. Nevertheless using current figures it appears that nutrient nitrogen levels are exceeded for most if not all habitats in Lancashire and are expected to remain so until at least 2010.

Whilst climatic warming is taking place and has been for 100 years it is not necessarily the cause of the extinction or decline of more northerly species. It so happens that most of the species involved prefer soils of low nutrient status.

Rubus chamaemorus is confined today to undisturbed bog surfaces near the tops of the Lancashire fells. It requires long periods of low temperature (eight months at 4–5°C) for seed to germinate (Taylor 1971). Temperatures of this kind are unlikely to occur today. However, Conolly & Dahl (1970) pointed out that the southernmost localities in England, which includes Lancashire, correlates well with 26°C average maximum isotherm. It may not be temperature that limits the reproductive capacity of *Rubus chamaemorus* as it rarely flowers or produces fruit in Lancashire. Instead, for the northern Pennines at least, Taylor (1971) showed that the level of grazing was the limiting factor.

Similarly, the species that appear to be increasing also seem to be ones that prefer more base and nutrient rich soils. In particular, Pigott & Huntley (1978, 1980, 1981) showed that for *Tilia cordata* to reproduce, regular periods of high summer temperatures are required; something that must have occurred in the past 10,000 years to have allowed the species to spread to the Morecambe Bay area of Lancashire and Cumbria, its northern limit of distribution in the British Isles. These temperatures have not yet been reached regularly. Nevertheless, both *Tilia cordata* and *Rubus chamaemorus* are able to survive vegetatively for long periods.

The results reported here did not find a link between changing rainfall patterns and changing species composition. However, the discovery of gametophytes of the highly oceanic *Trichomanes speciosum* in Bowland and the western Pennines suggests that the climate was once more oceanic. The oceanic *Hymenophyllum* spp. also occurred more commonly. These observations indicate that whilst rainfall may have increased the overall evapo-transpiration rates may also have increased, at least locally. It is possible that some of the floristic changes do not reflect climate changes but were caused by increased grazing, removal of tree cover by what ever means or other environmental changes.

Therefore climatic changes or global warming may not be significant at the present time. However, if predictions prove correct (Table 15, Hulme & Jenkins 1998) it may well be an important factor in changing the composition of the flora in future. This will be limited if the warming is mostly in the winter months as whilst frost sensitive plants may survive they must also tolerate low light levels. Relative to other parts of the world with a similar climate it must be

TABLE 15. CLIMATE AND SEA LEVEL PREDICTIONS

	2020	2050	2080
Temperature (with respect to 1961–90 mean)	+0.5–1.2 C	+0.8–2.0 C	+1.0–2.8 C
Annual rainfall (% change from 1961–90 mean)	+3–6	+3–5	+3–15
Net sea level rise in cm		c. 15–70	

remembered Lancashire is a long way north in the Northern Hemisphere (54°N) - on the same latitude as southern parts of Hudson Bay in Canada. Without a substantial increase in summer temperatures it will not be possible for plants requiring sustained high summer temperatures to produce seed to reproduce sexually although they may survive and propagate vegetatively. These temperatures may nevertheless be reached towards the end of the 21st Century. Other predictions include increasing numbers and severity of storms and increasing incidence of hot summers. Thus unless there are substantial changes in human behaviour to alter the present environmental trends the Lancashire flora will appear lush and plants tolerating low light levels will grow throughout the winter. Plants requiring low winter temperatures and favouring low nutrient levels will continue to retreat. On the other hand, species favouring high nutrient levels will flourish, especially if they can grow in the cool but perhaps frost free and dark winter months but plants requiring sustained high summer temperatures will not spread northwards unless the prediction of substantially warmer summers is realised. Overall the flora will continue to become more diverse as yet more species escape from cultivation and humans continue to grow an ever more diverse range of plants from all over the world in their passion for gardening.

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A New Flora of v. c. 59 (South Lancashire): a progress report

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ABSTRACT

There has only been one previous Flora that covers the whole of v.c. 59 (South Lancashire) and this was published in 1963. A new Flora is in preparation with several seasons of fieldwork already undertaken. The Flora will cover vascular and non-vascular plants and fungi. The proposed format of the Flora is described, along with potential uses of the data and problems with interpretation. The publication date is likely to be 2004 or 2005.

INTRODUCTION TO V.C 59 (SOUTH LANCASHIRE)

Vice-county 59 (S. Lancs.) covers an area of approximately 3000 km². The area is bounded by the Rivers Ribble and Mersey to the north and south respectively, the Pennines to the east and the Irish Sea to the west. It combines some of the most densely populated areas within Great Britain within the Manchester and Liverpool conurbations, with distinctly rural areas in the north-eastern and north-western parts of the vice-county. Hence its major habitats include coastal, urban, lowland and upland areas.

The most significant botanical habitat within the area, on a national and international scale, is the Sefton coast. This stretches from Bootle, just north of Liverpool, to Southport (a distance of 24 km). In addition to the high floristic diversity of the area, several nationally rare and scarce species are found here (e.g. *Juncus balticus*, *Corynephorus canescens*). The extensive saltmarshes at the mouth of the Ribble also provide an important habitat for the specialised taxa that inhabit these areas.

In keeping with the rest of the country, within the lowland area agricultural intensification of the last 50 years has caused a drastic decline in species abundance. Only a few, small areas of traditional meadow survive amongst the extensive arable and grazing land. Those that do remain are generally afforded statutory protection (e.g. the Lancashire Wildlife Trust reserve at Charnock Richard pasture). Similarly the increased drainage of the uplands, the effect of acidification and the degradation caused by intense grazing have reduced the diversity of the uplands. For instance, the first British record for *Listera cordata* (Merrett 1666), a species now absent from the vice county, is from Pendle Hill. However, the uplands do support large expanses of the commoner upland species of base-poor areas (e.g. *Eriophorum vaginatum*, *Deschampsia flexuosa* etc.).

Lancashire is one of the least densely wooded counties (Spencer & Kirby 1992) in Great Britain with 4% woodland cover within Merseyside and Greater Manchester. The ancient woodland that does remain contributes to the plant diversity of the area. Such surviving woodlands are typically narrow, sinuous and in steep-sided valleys (e.g. Dean Wood, Wigan). The paucity of woodlands is partly due to their extensive clearance, primarily since 3000 BP (late Bronze age/early Iron age, Cowell, 1998) and partly by the extensive lowland mires that dominated the western plain of the county and the Mersey valley. The vast majority of these mosslands have been converted to arable land via drainage or peat extraction although odd relicts survive within the Mersey valley (e.g., Risley Moss) which are undergoing restoration.

Urban areas provide the usual habitats for ruderal species, such as *Linaria purpurea* and *Senecio squalidus*. In addition, the heavy industrialisation of the last 200 years has left a legacy of sites which are often floristically rich. This is due to the combination of nutrient-poor, extreme-pH substrate and lack of development. In addition, within many of these sites, there is high degree of habitat diversity. The importance of these locations is increasingly recognised, with some now being afforded statutory protection (e.g. Rixton Clay Pits, Warrington and Wigan Flashes).

THE NECESSITY FOR A NEW FLORA

Although there has been a tradition of producing local Floras (*Flora of Liverpool*, (Hall 1839) and *Flora Mancuniensis*) (Wood 1840)), there was no attempt at a Flora for the complete vice-county until Travis's *Flora of Lancashire* (Savidge *et al.* 1963). Fieldwork for this commenced following the formation of the Liverpool Botanical Society in 1906 and the work was close to completion in the early 1920s. However, financial constraints prevented completion from being achieved. Consequently W. G. Travis continued the fieldwork largely alone, until his death in 1958 when his manuscript was revised and completed by members of the Liverpool Botanical Society, with eventual publication in 1963. This remains the only treatment for the whole of the vice-county. Since it is almost 40 years since this work was published, with a great deal of the fieldwork incorporated into this Flora of a much greater vintage, a modern treatment of the vice-county based on new field records is appropriate.

Despite the advice generally given to Flora writers elsewhere at the conference, the work is being undertaken by a committee, chaired by Dr John Lowell. The anticipated breadth of the flora is beyond any individual on the committee. Moreover, within the group there is a wide range of expertise and knowledge which will allow the proposed treatment to reach fruition.

THE CONTENT AND EXTENT OF THE FLORA

In addition to the species details the Flora will include introductory chapters. The introductory chapters proposed will cover the following areas:

1. Method and duration of data collection and the extent of coverage of the Flora;
2. The history of recording within the vice-county;
3. The habitats and ecology of the area;
4. Important botanical sites in the vice county;
5. Biogeography.

While the proposed sections largely mirror those found in recent Floras, the aspirations of the committee are that it will reflect the special features of the area and hence give a distinct flavour of the locale. This is self-evident within the descriptions of important botanical sites. However, it is also the aim of the authors that this will inform other sections. For instance, the historical section will incorporate a description of the important role played by the artisan botanists of the 19th Century.

The habitats and ecology section will include details on soils, geology, climate and history as a means of explaining the current distribution of plants in the area rather than as separate sections in their own right. Biogeography was well covered in the previous Flora and a new discussion will be able to make comparison with the previous account.

The ability to draw future comparisons is also the rationale underpinning the proposed first section of the Flora. A largely overlooked area is the scientific value of Floras and the potential for detecting change in plant distribution and abundance (Hill 2003; Walker 2003). However, this will only be possible if precise details on how data was collected is clearly described.

The species details will cover the following taxonomic groups:

1. Vascular plants;
2. Bryophytes;
3. Marine and freshwater algae;
4. Fungi.

Initially it was hoped that lichens would also be covered but at the time of writing this seems unlikely. The groups that are included will be given different levels of coverage. Vascular plants and bryophytes will be dot-mapped at the tetrad level. Given the number of vascular plants (approximately 2200 species) and bryophytes (approximately 500) including casuals and extinct species, mapping all species will be precluded by space limitations. Therefore it is proposed to map only species which are present in six or more tetrads. This will reduce the maps required by

50%. Both the locations and the tetrad references will be given for those species which are not mapped.

There are around 1500 species of fungi recorded for the vice-county. However, the majority of fungi are detectable only when fruiting bodies are present. Such a sporadic appearance renders dot maps less meaningful for this kingdom. Therefore fungi will only be listed plus their special features and habitats. Lists will also be provided for the algal groups.

Of the microspecies aggregates, the *Rubi* have been extensively surveyed by local batologist Dave Earl. These will be presented as an Appendix to the vascular plants using the same criteria for mapping as the other vascular species, though with mapping at the 1 km square level. This will result in around 70 microspecies being dealt with. Such detailed coverage will be a highlight of the Flora.

The other critical groups (e.g. *Taraxacum*, *Hieracium*) will also be presented in an appendix to the main vascular plant section but in a much less detailed manner than for *Rubus*, with a simple listing of the taxa recorded. This detail will reflect the level of knowledge of these groups. Aliens and casuals will be treated in the appropriate main account following Stace (1997).

A distinction between old and new records will be made on the dot maps or records. However, this raises the question of what constitutes an old record, as there are a number of possible cut-off points; pre-1958, the last field season of the Travis Flora (Savidge *et al.* 1963); pre-1987, to correspond to the 'old' records presented in Atlas 2000 (Preston *et al.* 2002), or pre-1995, the onset of recording for the current Flora. This criterion is still to be decided upon.

USES AND PROBLEMS OF THE DATA

Analysis of six years of records has started to reveal patterns and problems. Despite the problem in delineating old records it is apparent that some species are spreading. This is demonstrated by the distribution of two bryophyte species, *Ulota phyllantha* (Fig. 1) and *Orthotrichum pulchellum* (Fig. 2). These were both absent in 1963 (Savidge *et al.* 1963), never having been recorded within the vice-county. Hill *et al.* (1994), based on surveys undertaken from 1950, also considered both to be absent. Given the distinct appearance of these two species (most notably the large epiphyte *U. phyllantha*), it appears that this is a true spread rather than a product of recording intensity and reflects increasing air quality and availability of habitat. These two species are notable in their sensitivity to atmospheric pollution (Smith 1978).

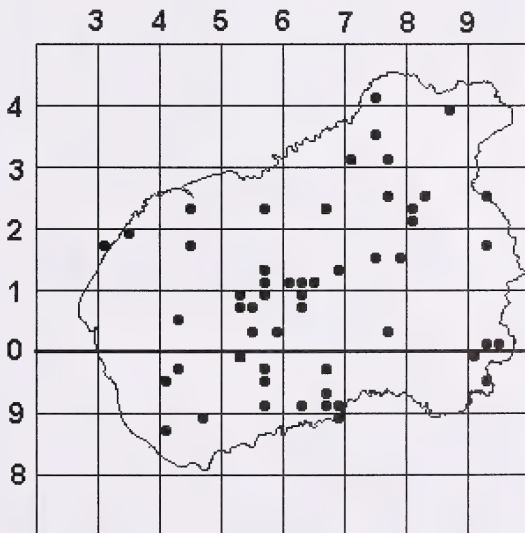


FIGURE 1. Distribution of *Ulota phyllantha* Brid. in v.c. 59 from surveys undertaken since 1995.

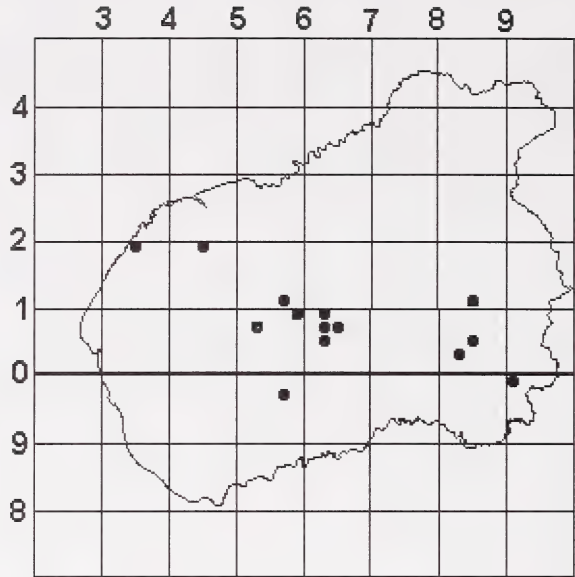


FIGURE 2. Distribution of *Orthotrichum pulchellum* Brunton in v.c. 59 from surveys undertaken since 1995.

Sufficient records now exist to compare the relative biodiversity within the vice-county. Unsurprisingly, vascular plant records show the tetrads covering the coastal dunes to possess most species, with those in intensive agricultural areas the least. Several urban areas also have high vascular plant diversity. Interestingly, this pattern is not completely repeated when bryophyte diversity is considered (Fig. 3). Here the coast is as poor as the agricultural areas, with the richest sites being in the highly populated ex-industrial areas.

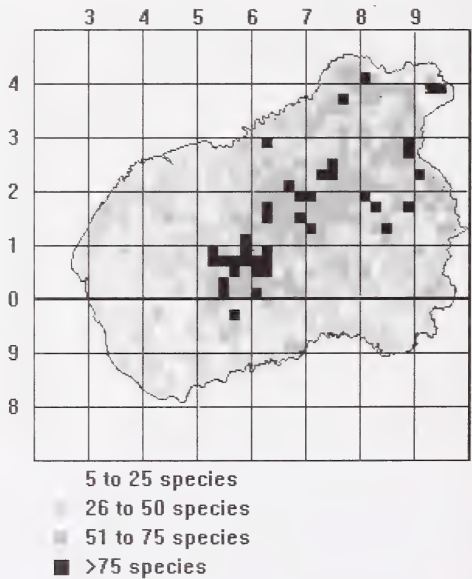


FIGURE 3. Bryophyte diversity in v.c. 59 revealed from surveys undertaken since 1995.

The presence of such variations in biodiversity may be due to the intensity of recorder activity rather than a reflection of the true pattern. Here, two approaches are briefly considered.

1. The distribution of ubiquitous species;
2. The relationship between cumulative species number and number of recorder visits.

It may be anticipated that certain conspicuous species will be found throughout the vice-county. Moreover, their obvious appearance means that they are unlikely to be overlooked. Within the vascular plants *Bellis perennis* and *Urtica dioica* may be considered to fall into this category. Similarly, the bryophyte *Brachythecium rutabulum* is extremely widespread and this is reflected in the distribution map in Fig. 4.

The few gaps in the distribution of this species may identify tetrads that have not been sufficiently visited. Alternatively, they may be areas that have been visited where the species is absent. As several bryophyte visits have been made to the appropriate tetrads in this case, a genuine absence of the species is suggested.

Such an approach will identify areas that have not received anything above a basic survey. However, once the common, easily identified species are recorded, a more sophisticated consideration of a tetrad can be made by considering the relationship between the number of visits or record cards from a tetrad and the cumulative number of species (see Fig. 5).



FIGURE 4. Distribution of *Brachythecium rutabulum* (Hedw.) B., S. & G. in v.c. 59 from surveys undertaken since 1995.

Initial visits to an area will rapidly increase the total number of species recorded in a tetrad. As the number of visits increases it becomes increasingly difficult to find new species. Therefore the graph begins to level off. Species-rich tetrads will have a higher final cumulative number of species than species-poor ones. Theoretically sufficient visits will identify all the species in a tetrad. However, given the dynamic nature of vegetative change this is likely to be a large number. More pragmatically, tetrads analysed in this manner, which reveal an ascending cumulative species number curve, are worthy of more intense future sampling than those whose curve gradient has started to flatten.

Once recording within a tetrad is complete the status of individual species may also require careful consideration. In particular, the distinction between native and introduced species can be confusing.

Consideration has been given to native status (e.g. Webb 1985) but on a national scale. Within v. c. 59 some species exist which are native in some areas and introduced elsewhere. This problem is most pronounced in trees. For example, *Acer campestre* is native within the small limestone area in the north-eastern part of the vice-county around Clitheroe. Elsewhere it is almost certainly planted. Such a clear geographic distinction is impossible with *Tilia cordata*. This is a rare native component of ancient woodlands in Lancashire but is increasingly incorporated into woodland creation schemes. Such problems will be addressed on an individual basis by the knowledge of the authors. Where such decisions have been made this will be explicit within the text.

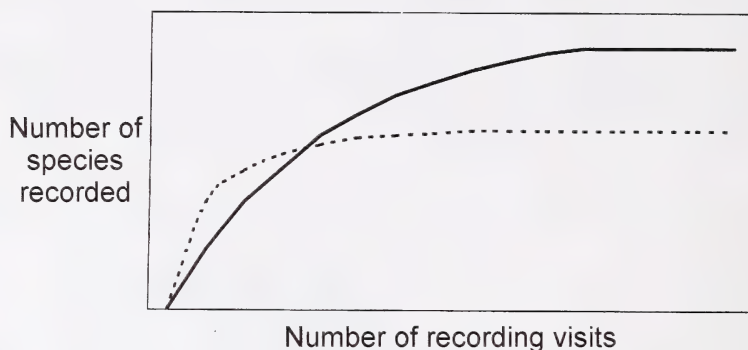


FIGURE 5. Effect of increasing the number of visits to a given area on cumulative number of species recorded. Key: (----) species-poor area, (—) species-rich area.

COMPLETION OF THE FLORA

The final field season for the Flora will be in 2003, the culmination of eight years fieldwork, with publication in 2004 or 2005. While it is recognised that the data are likely to leave many questions unanswered, it is important that publication is achieved as rapidly as possible. Otherwise the aim of producing a picture of the flora around the turn of the millennium within its historical context will not have been achieved. The questions still to be answered may act as a focus for future investigations.

ACKNOWLEDGMENTS

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One species lost every year? An evaluation of plant extinctions in selected British vice-counties since 1900

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ABSTRACT

A review of extinction since 1900 has been carried out in 25 British counties. Previous rates of extinction have been revised to exclude species which went extinct before 1900 and non-native species. For British counties as a whole the average rate is c.0.5 species a year with northern and western counties having lost fewer species (0.4 species a year) than those in the south and east (0.6 species a year). These losses suggest a period of heightened extinction during the 20th Century as a result of major environmental changes. However, they should be treated with caution for a number of reasons: extinction rates may also be influenced by the size of the county under investigation, its history of botanical recording and the reliability with which certain species can be recorded as extinct.

KEYWORDS: county Floras, environmental change, conservation.

INTRODUCTION

Peter Marren's study on county extinctions provides a startling account of the loss of species in England over the last century (Marren 2000, 2001). Using lists of extinct species published in local Floras, as well as Preston's (2000) study for Middlesex (v.c. 21) and Cambridgeshire (v.c. 29), he calculated an average loss of 0.7 species per year since 1900, with figures ranging from 0.3 in Norfolk (v.c. 28 & 27) to 1.4 in Northamptonshire (v.c. 32). His "league table of extinctions" also indicated geographical variation in rates of decline: southern and eastern counties, which occupy the top ten positions, have suffered the worst, with an annual rate of 0.76 species extinctions per year, as opposed to 0.57 in the north and west (Fig. 1).

These figures, which suggest a loss of almost "one species every year" in the worst counties (Frankland 2001), are being publicised by conservationists to highlight declines and presumably lobby government departments (Vines 2000). However, they present a number of intriguing irregularities. Most surprisingly, twice as many species appear to have gone extinct in Northamptonshire (v.c. 32), which tops the "league table", than in rural Cambridgeshire or suburban Middlesex. This is surprising given the rather unexceptional nature of v.c. 32. Due to its rather uniform geology (Sutherland 1995) the flora of the county is not unduly rich and lacks many of the more localised heathland and grassland species which are present in adjacent counties. In addition, recent environmental changes appear to have been comparatively slight. For example, the area of cultivation increased by just 25% between 1928 and the 1990s (661–1214 km²) to around half the area of the county (McCollin *et al.* 2000). Furthermore, it is not unduly urban with only 22% of land classified as "non-agricultural".

The aim of this paper is to re-examine the rate of extinction for a selection of British counties using a standardised approach which excludes introduced species and those lost before 1900. This has allowed comparisons to be made between counties and regions, as well as providing an overall extinction rate for British counties as a whole. Additionally, due to its comparatively high rate of extinction, a detailed re-evaluation of extinction in Northamptonshire is presented which takes into account the recent rediscovery of "extinct" species. Factors likely to have influenced these figures are suggested and the implications for conservation discussed. Nomenclature for vascular plants follows Stace (1997).

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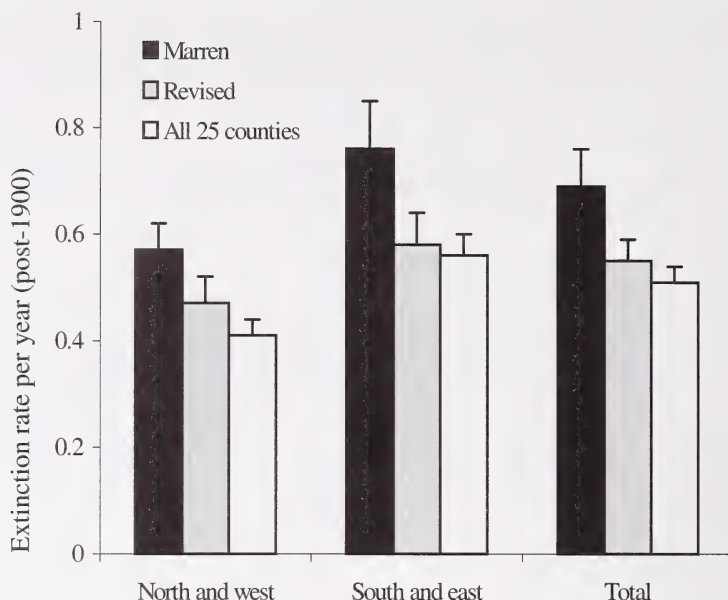


FIGURE 1. Annual extinction rates for British vice-counties since 1900. The graph displays the average rate (± 1 standard error) for Marren's original vice-counties ("Marren"; $n = 15$), the revised data given in Table 2 ("Revised"; $n = 15$), and for all 25 counties included in this study. These data are also summarised by region: "north and west" ($n = 9$) includes Durham, Cheshire, Westmorland, Cumberland, South Lancashire, Shropshire, Radnor, Cornwall, Northumberland; "south and east" ($n = 16$) includes Dorset, Surrey, Middlesex, Oxfordshire, Cambridgeshire, Bedfordshire, Northamptonshire, Leicestershire, Sussex, Kent, Essex, Suffolk, Norfolk, Gloucestershire, Lincolnshire and Bristol region. The regional differences are significant for all the vice-counties ($p < 0.05$) but not for the "Marren" and "Revised" figures.

TABLE 1. SUMMARY OF REVISIONS TO THE GENT & WILSON (1995) LIST OF EXTINCT SPECIES IN NORTHAMPTONSHIRE (V.C. 32)

	Notes	Extinctions in v.c. 32				Total
		Before 1900	1900–1930	1930–1970	After 1970	
Number of extinctions in the 1995 Flora	a	35	16	36	9	96
Species excluded:						
– rediscovered since 1970	b	–	–	–	5	5
– subspecies (species extant)		–	1	–	–	1
– not native	c	1	–	–	2	3
– dubious record or error	d	4	–	–	–	4
– British natives but introduced into v.c. 32	e	3	2	4	2	11
Total number excluded in this analysis		8	3	4	9	24
Additional extinctions	f	2	6	10	13	31
Revised number		29	19	42	13	103

Notes: a. Some dates have been re-determined as a result of historical research and are therefore different from those given in Gent & Wilson (1995). b. Rediscovered as a result of fieldwork for the New Atlas. c. Native status follows Preston & Hill (1997). Two species excluded on this basis (*Centaurea cyanus* and *Prunus cerasus*) have been rediscovered in recent years. d. This figure does not include *Eriophorum gracile* which has recently been confirmed for the county. e. Not considered native in v.c. 32 given their native distribution and habitats elsewhere in the UK. f. These figures are based on recent recording data, herbarium material and correspondence with local botanists.

METHODS

SOURCES OF DATA

Twenty-five counties are included in this study, including 15 which were originally analysed by Marren (2001) (Table 2), plus an additional ten for which there is a recent Flora and/or a list of extinctions (Table 3). Eighteen of these Floras (including Northamptonshire) provide a list of presumed extinctions with an indication of the year in which species were last recorded. For the remaining counties this information was compiled from species accounts (Cornwall, Dorset and Oxfordshire) or taken directly, without revision, from lists published in county studies of change for Bedfordshire (Boon 1998), Cambridgeshire (Preston 2000), Middlesex (Preston 2000) and South Lancashire (Greenwood 1999).

Because of its comparatively high rate of extinction Northamptonshire was treated in greater detail. Initially the list of extinctions was taken from the most recent Flora of the county (Gent & Wilson 1995; hereafter referred to as the 1995 Flora). This includes 96 species which were last recorded before the publication of George Claridge Druce's (1930) Flora of the county (hereafter referred to as the 1930 Flora), or between 1930 and 1970, but not since, despite deliberate searching at former sites (Gent & Wilson 1995). This list was subsequently revised in the light of more recent survey data collected in preparation for the New Atlas of the British and Irish flora (Preston *et al.* 2002).

ASSESSMENT OF NATIVE/ALIEN STATUS

In calculating extinction rates Marren accepted taxa as native in a county if the author of the Flora had done so, as well as non-native species so well-established in wild places that they can be categorised as permanent members of semi-natural communities (Marren 2000). The approach taken in this study differs in excluding species which are not considered native by Preston & Hill (1997), or British native species (*sensu* Preston & Hill) which have obviously been introduced to the county in question. As a result, for Northamptonshire it excludes many species classified in the 1930 Flora as "denizen", "colonist", "alien" or "exotic" and in the 1995 Flora as "British", "adventive" or "introduction". In addition, it also excludes a number of long-established introductions with naturalised ranges in the British Isles, such as *Centaurea cyanus*, which is considered to be native by some authorities (e.g. Stace 1997).

For all counties, where there is doubt about whether a British native species is native or not, the species is accepted as native if its habitat, history and distribution in the county are similar to those areas of Britain where it is assumed to be native. In this study a number of atlases (e.g. Perring & Walters 1962; Preston & Croft 1997; Stewart *et al.* 1994; Wigginton 1999) and monographs (e.g. Graham & Primavesi 1993; Page 1997) were particularly helpful in this respect.

ASSESSMENT OF DATES OF EXTINCTION

The year in which a species was last recorded was taken from the most recent published work for the county. Consequently, the accuracy of some of the figures presented, particularly those for counties with older Floras (e.g. Essex, Lincolnshire, Suffolk), could well be revised in the light of more up-to-date information. However, for Northamptonshire last dates were taken from data files collated for the New Atlas of the British and Irish flora (Preston *et al.* 2002). This allowed species which have been rediscovered since the 1995 Flora to be included.

For 20 species recorded in the 1930 Flora but not since, no last date is given, presumably because Druce considered the species to be extant or because no date was known to him. For these species approximate dates were derived from herbarium sheets in OXF, and/or plant records published by Druce in preparation for the 1930 Flora (Druce 1880–81 *et seq.*). For six species (*Eleogiton fluitans*, *Galium tricornutum*, *Mentha suaveolens*, *Oenanthe lachenalii*, *Thelypteris palustris* and *Valerianella carinata*) no last date could be traced. As a consequence these are treated as having been last seen in 1930. Similarly, for species which were known to Morton (1712) and Notcutt (1843) but no later authors the dates of extinction are given as 1712 and 1843 respectively.

TABLE 2. MARREN'S (2001) "LEAGUE TABLE" OF EXTINCTIONS. THE REVISED FIGURES EXCLUDE INTRODUCTIONS (TO THE UK OR VICE-COUNTY), HYBRIDS AND SPECIES WHICH WERE LAST RECORDED BEFORE 1900

	Number extinct		Extinction rate per year			Recording period		Source
	Marren	Revised	Marren	Revised	Change	Marren	Revised	
Northamptonshire (v.c. 32)	93	74	1.43	0.82	-0.61	1930-1995	1900-1990	This paper
Lincolnshire (v.cc. 53, 54)	77	38	0.91	0.45	-0.46	1900-1985	1900-1985	Gibbons (1975); Gibbons & Weston (1985)
Gloucestershire (v.cc. 33, 34)	78	45	0.91	0.52	-0.39	1900-1986	1900-1986	Holland <i>et al.</i> (1986)
Middlesex (v.c. 21)	76	76	0.84	0.84	0	1900-1990	1900-1990	Preston (2000)
Durham (v.c. 66)	68	55	0.77	0.63	-0.14	1900-1988	1900-1988	Graham (1988)
Cambridgeshire (v.c. 29)	66	66	0.73	0.73	0	1900-1990	1900-1990	Preston (2000)
Leicestershire (v.c. 55)	59	60	0.67	0.68	0.01	1900-1988	1900-1988	Primavesi & Evans (1988)
Surrey (v.c. 17)	51	29	0.67	0.34	-0.33	1900-1976	1900-1986	Lousley (1976); Leslie (1987)
Essex (v.cc. 18, 19)	68	68	0.61	0.61	0	1862-1974	1862-1974	Jermyn (1974)
Suffolk (v.cc. 25, 26)	50	46	0.61	0.56	-0.05	1900-1982	1900-1982	Simpson (1982)
Cheshire (v.c. 58)	49	41	0.54	0.46	-0.08	1900-1990	1900-1990	Newton (1971, 1990)
Westmorland (v.c. 69)	56	37	0.58	0.38	-0.20	1900-1997	1900-1997	Halliday (1997)
Cumberland (v.c. 70)	48	36	0.49	0.37	-0.12	1900-1997	1900-1997	Halliday (1997)
South Lancashire (v.c. 59)	50	48	0.49	0.50	0.01	1860-1963	1900-1996	Greenwood (1999)
Norfolk (v.cc. 27, 28)	33	37	0.33	0.37	0.04	1900-1999	1900-1999	Beckett & Bull (1999)

TABLE 3. EXTINCTION IN A SELECTION OF BRITISH VICE-COUNTIES, FIGURES EXCLUDE INTRODUCTIONS (TO THE UK OR VICE-COUNTY), HYBRIDS AND SPECIES

	Number extinct	Extinction rate per year	Recording period	Source
Dorset (v.c. 9)	32	0.32	1900–2000	Bowen (2000)
Oxfordshire (v.c. 23)	39	0.40	1900–1998	Killick <i>et al.</i> (1998)
Bedfordshire (v.c. 30)	55	0.61	1900–1990	Boon (1998) with amendments (C. Boon, pers. comm., 2001)
Shropshire (v.c. 40)	33	0.37	1900–1990	Sinker <i>et al.</i> (1985) with amendments (A. Lockton, pers. comm., 2001)
Radnor (v.c. 43)	38	0.41	1900–1993	Woods (1993)
Cornwall (v.c.c. 1 & 2)	36	0.36	1900–1999	French <i>et al.</i> (1999)
Sussex (v.c.c. 13 & 14)	69	0.78	1900–1988	Hall (1980); Briggs (1990)
Kent (v.c.c. 15 & 16)	28	0.34	1900–1982	Philp (1982)
Northumberland (v.c.c. 67 & 68)	23	0.25	1900–1993	Swan (1993)
Bristol Region (v.c.c. 6 & pt 34)	64	0.64	1900–2000	Green <i>et al.</i> (2000)

TABLE 4. REVISIONS TO THE FIGURES FOR COUNTY EXTINCTION GIVEN IN TABLE 2

Reason for exclusion from revised list									
Critical/ hybrids	Extinct before 1900	GB non- native	GB native- introduced	Never confirmed	Re-found	Total number excluded	Species added (extinct after 1900)	Number listed as extinct in flora	Number extinct (revised)
Lincolnshire	31	2	1		6	40	4	74	38
Gloucestershire	14	3		17		34		79 ^a	45
Durham		5	1	1		13		68	55
Surrey	14	3		1	4	22		51	29
Suffolk		3				3		49 ^b	46
Cheshire		2			6	8		49	41
Westmorland	17					17		54 ^c	37
Cumberland	10					10		46 ^d	36
Norfolk						0	4	33	37

Notes: ^{a,d} For these counties Marren quotes the following figures: ^a 78, ^b 50, ^c 56, ^d 48.

SELECTION OF SPECIES

In this paper the lists of extinctions used to calculate rates for British counties exclude the following species: those species last recorded before 1900, critical species and hybrids, species not considered to be British natives by Preston & Hill (1997), British native species which had obviously been introduced, species of dubious county status and those which had subsequently been refound since the publication of the Flora.

RESULTS

EXTINCT SPECIES IN NORTHAMPTONSHIRE

For Northamptonshire the changes to the list of "presumed extinctions" given in the 1995 Flora are summarised in Table 1. Of the original 96 species included in the 1995 Flora, 24 have been excluded from the current analysis because they are either obvious errors, introductions to Britain or v.c. 32, or have subsequently been rediscovered. Conversely, 32 species have been added to this list as a result of subsequent fieldwork and historical research. Overall this shows that 103 species have apparently become extinct in Northamptonshire since records began, representing 13% of the 810 species recorded in the county. The revised list of extinctions is given in Appendix 1 with the date of the last known record. The full list of changes to the Gent & Wilson list is given in Appendix 2.

Changes to the Gent & Wilson (1995) list of "presumed extinctions"

Five native species have been refound since the publication of the 1995 Flora and so are excluded from the revised list. In addition, *Polygala vulgaris* subsp. *collina* is excluded because subsp. *vulgaris* is still extant in the county and *Filago gallica*, which was last recorded near King's Cliffe in 1838, *Centaurea cyanus* and *Prunus cerasus* (both of which have been refound since the 1995 Flora) are all excluded as they are not considered native by Preston & Hill (1997).

Four species recorded as extinct in the 1995 Flora are likely to have been recorded in error. These include *Scleranthus perennis* subsp. *perennis* which was recorded by Morton sometime before 1712 (Druce 1930), and possibly on a wall near Wellingborough in 1974 (Gent & Wilson 1995). These records seem very doubtful given the rarity of *S. perennis* in Britain: subsp. *perennis* has only ever been confirmed from Doloritic rocks at one site in Radnorshire (Slater 1999) and subsp. *prostratus* is confined to a handful of sandy heaths in East Anglia (Leonard 1999). The Northamptonshire plants are more likely to be referable to over-wintering or biennial forms of *S. annuus* which occurs on sandy ground in the county or possibly subsp. *polycarpus* which appears to be more widespread than previously thought (Preston *et al.* 2002). Similarly, Morton's record for *Crepis foetida*, which is now a very rare native plant in the British Isles, is more likely to have been an early record for *Crepis vesicaria* subsp. *taraxacifolia*, which was first recorded in Britain in 1713 (Clapham *et al.* 1987). Other doubtful species include *Galium sternerii*, which has its most southerly English station in the Peak District (Lusby & Slack 1994), and *Sagina subulata*, which has a predominantly northern and western distribution in England (Perring & Walters 1962). Given the absence of herbarium material for these species it would seem unwise to accept them for the county. In contrast, *Eriophorum gracile*, which was collected by Druce from Hornstocks Wood near Wittering in 1878, has recently been confirmed from herbarium specimens (OXF) (Walker in press.).

Eleven British native species are considered to have been introduced into Northamptonshire. All these species occur outside their native range in the county (e.g. *Impatiens noli-tangere*, *Gymnocarpium robertianum*) or were recorded from artificial or disturbed habitats which suggest accidental introduction. In addition, both *Eryngium campestre* (grassland adjacent to garden) and *Daphne mezereum* (copse) were recorded in semi-natural habitats where they were presumably planted.

Thirty-one native species which were not included in the list of "presumed extinctions" in the 1995 Flora are considered extinct in this paper. Twenty-three of these have not been recorded since 1989, despite fieldwork for the New Atlas, and so are assumed to be extinct. However, a number of these are likely to have been overlooked and may well re-appear in future years (e.g. *Anagallis minima*, *Aphanes australis*, *Rosa* spp.). Of the remaining eight species six were classified as extinct in the main text of the 1995 Flora but not in the main list, and two are critical segregates (*Erophila majuscula* and *Euphrasia arctica*).

Extinction rate

Marren's extinction rate for Northamptonshire is based on the list of "presumed extinct" species given in the 1995 Flora, and is calculated by dividing the number of extinctions (96, excluding doubtfully present species) by 65, the number of years between the 1930 and 1995 Floras. This gives an average loss of 1.4 species per year, or 14 species a decade, since 1900. However, this is a significant overestimate because it assumes that all the species on this list were last recorded *after* 1930. As a result Marren includes 52 species, italicised in the Gent & Wilson list, which were last recorded *before* 1930, and in many cases before 1900. When these pre-1900 extinctions are removed from the analysis then this gives a loss of 74 species since 1900, or 0.82 species a year (Table 2).

EXTINCTION IN OTHER BRITISH VICE-COUNTIES

The revisions presented in this study show that Marren over-estimates the rate of extinction for at least nine other vice-counties (Table 4). The figure of 0.91 species a year for Lincolnshire (v.cc. 53 & 54), in particular, appears to be significantly higher than the revised rate because he includes 31 which were last recorded before 1900 within his 20th Century calculations. If non-native and rediscovered species listed in the supplement to the county Flora (Gibbons & Weston 1985) are excluded from the list given in the 1975 Flora (Gibbons 1975) then 64 native species have presumably become extinct in Lincolnshire, 38 of which were last recorded after 1900. This gives a probable rate of extinction of around 0.45 species per year since 1900, which, interestingly, is comparable to counties of similar size, such as Norfolk (v.cc. 27 & 28) and Cornwall (v.cc. 1 & 2).

The rate for Gloucestershire (v.cc. 33 & 34) is also different because he includes all 79 (Marren actually cites 78) species listed as probably extinct in the supplement to the Flora of the county (Holland *et al.* 1986). However, this figure includes 17 species which have never been satisfactorily confirmed for the county (all recorded before 1948), three ancient introductions not considered as native by Preston & Hill (1997) and 14 species which were last recorded before 1900. When these figures are taken into account the overall rate declines from 0.91 to 0.52 species per year since 1900.

Similarly, for Surrey Marren includes all 51 species listed as extinct in Lousley's Flora of the county (Lousley 1976) despite the fact that 14 of these species were last recorded before 1900. In addition, he includes three species which are not considered native by Preston & Hill (1997), four species which subsequently have been rediscovered and one species (*Carex diandra*) which has never been satisfactorily confirmed (Leslie 1987). When these figures are taken into account 43 native species are considered to have disappeared, of which 29 were last recorded after 1900. As a result the rate of extinction declines from 0.67 to 0.34 species a year (Table 2).

For a further six vice-counties, the revised figures presented in this paper are different to those given by Marren due to the exclusion of 13 non-native, critical and doubtful species in Durham (Graham 1988), 17 and ten hybrids in Westmorland and Cumberland respectively (Halliday 1997), six recently discovered species and two aliens in Cheshire (Newton 1971, 1990) and three non-native species in Suffolk (Simpson 1982). Norfolk is the only county for which the Marren estimate is lower than the one presented in this paper due to his exclusion of four species which were last recorded between 1900 and 1914 (*Epipactis purpurata*, *Herminium monorchis*, *Huperzia selago* and *Hypochaeris maculata*) (Beckett & Bull 1999). As a consequence Marren's figure of 0.33 species per year increases to 0.37 when these species are included.

ONE SPECIES LOST EVERY YEAR?

Marren's study was admittedly based on a small and geographically biased sample of counties. However, the revisions presented in this paper suggest that vice-counties in Britain have lost just over half a species a year during the last century (0.55), and not "one species a year" as the Marren "league table" suggests (Fig. 1). Not surprisingly, this figure is further reduced, to 0.51 species per year, when the sample size is increased to include more vice-counties (Fig. 1).

Figure 1 also shows the uneven geographical distribution of extinction. Counties to the north and west of the Tees-Exe line have, on average, lost fewer species and thus have a lower rate of extinction (0.41 species per year) than those in the south and east, which have lost 0.56. Although there is a great deal of variation within this dataset the overall regional differences are statistically significant when all the counties shown in Fig. 1 are included ($p < 0.05$).

Although these data suggest a much lower level of extinction than was first thought, they do support Marren's original assertion that Northamptonshire has suffered more than most other counties during the 20th Century (0.82 species per year) (Marren 2000, 2001). Indeed, even when the revisions presented in this paper are taken into account the overall loss of species in v.c. 32 is comparable to suburban Middlesex (0.84), and is higher than Cambridgeshire (0.73) and Sussex (0.78). The reason for this may be related to the timing of peak periods of extinction in Northamptonshire, which appears to have occurred much later than in some other counties (Fig. 2). For example, in Cambridgeshire the first wave of extinction coincided with habitat destruction caused as a result of parliamentary enclosure during the early part of the 19th Century (Preston 2000). However, in Northamptonshire 20th Century losses were much higher than in the preceding century, presumably because the majority of semi-natural grasslands were ploughed up after 1920.

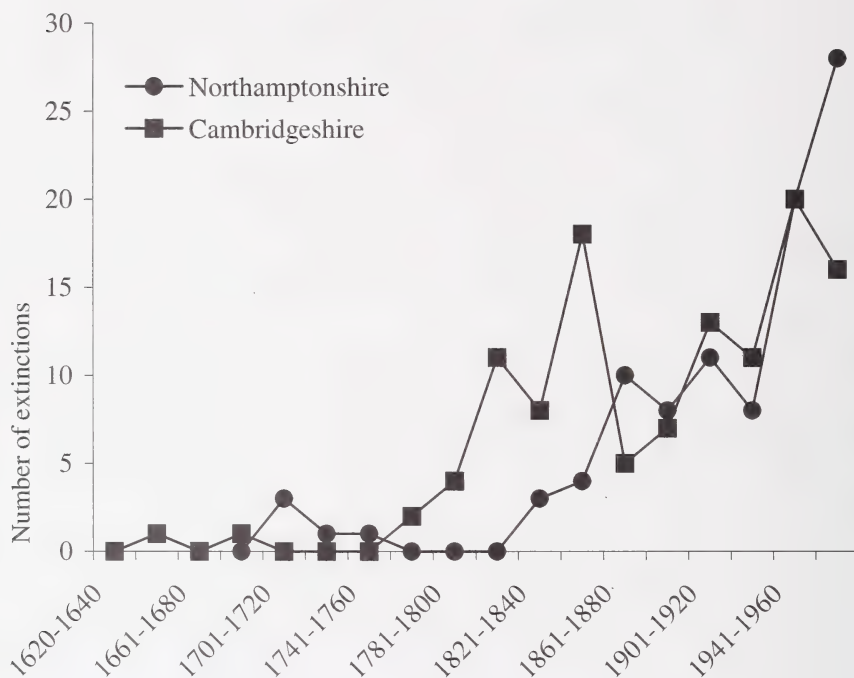


FIGURE 2. The number of extinct species in Cambridgeshire (v.c. 29) and Northamptonshire (v.c. 32) since 1620. The number of extinctions are plotted for 20 year intervals, using the assumption that a species became extinct in the period in which it was last recorded.

DISCUSSION

FACTORS INFLUENCING EXTINCTION RATE

The figures for plant extinction presented in this paper reflect the pace and scale of major environmental changes which have occurred within individual counties during the 20th Century. However, they may have also been influenced by a number of other factors (e.g. recording bias, county area, etc.) which may have led to the *actual* rate of extinction being over- or underestimated. Such problems are rarely acknowledged in studies of floristic change, despite the effects they are likely to have on the overall findings and conclusions.

Definition of native taxa

The revised figures for extinction presented in this paper are lower than in the Marren study, partly because of the exclusion of non-native British species (*sensu* Preston & Hill 1997) or British native species which have obviously been introduced outside their native range. For a sizeable proportion of these species there may be good grounds for exclusion. For Northamptonshire obvious examples include casuals imported into the county in rubble and sand (e.g. *Medicago minima*, *Potentilla argentea*, *Trifolium scabrum*) and colonists introduced by other means (e.g. *Impatiens noli-tangere*, *Gymnocarpium robertianum*). However, the exclusion of a number of long-established alien species, such as *Centaurea cyanus*, which were probably introduced by early farmers after the Neolithic, is more problematic. Many of these species, which were fully naturalised by the 15th Century, are important indicators of environmental change because they have undergone dramatic declines in recent years as a result of modern farming practices (Sutcliffe & Kay 2000). Conversely, many more recent introductions are becoming increasingly widespread on highly fertile, disturbed soils associated with human activities (Thompson *et al.* 1995).

Reliability of last date

In the absence of more detailed information the extent to which the date of last record actually reflects the timing of extinction can vary from species to species. For example, Druce provides precise dates for the loss of only two species in Northamptonshire; *Diplotaxis tenuifolia* which was “formerly on the south-west bastion of Northampton Castle, where it was plentiful until the castle was destroyed in 1879” (Druce 1930, p. 22) and *Daphne mezereum* which was “destroyed in 1909 by someone digging up the large shrub” (Druce 1930, p. 202). For most species, however, the date of the loss is not known. Two notable examples are given in the 1930 Flora; the loss of *Stachys germanica*, from “some old quarries between Fineshade and Wakerley” which “have since been filled up, and the plant destroyed” (Druce 1930, p. 184), and *Ophrys sphegodes* for which “the large planting of larch appears to have been responsible for its destruction” (Druce 1930, p. 225). As is more frequently the case, extinction usually follows a long period of decline during which successional or man-made changes render a site increasingly unsuitable for a particular species. In Northamptonshire, this presumably accounts for the loss of a number of heathland species (e.g. *Lycopodium clavatum*, *Juncus squarrosus* and *Moenchia erecta*) which declined as a result of piecemeal drainage, afforestation with conifers and housing development. Similar losses must have gone unnoticed during major periods of agricultural innovation. Indeed, Druce gives the example of *Ajuga chamaepitys*, which disappeared well before his day, presumably as a result of the “extensive enclosures” which took place in the early part of the 19th Century (Druce 1930).

These discrepancies between the date of the last record and the actual “extinction” are compounded by the nature of the recorders themselves. Botanists tend to be reluctant to classify a species as extinct, even if has not been seen for many years, and prefer to use terms such as “presumably extinct” or “almost certainly extirpated”, rather than to write it off completely (Marren 2001). Given the arbitrary nature of this decision then it would seem sensible to accept Preston’s (2000) cut-off: a species should not be considered extinct if it has been seen in the preceding decade unless there is good evidence to the contrary.

Is extinction forever?

As Preston (2000) quite rightly stated “at the vice-county level the slogan of ‘extinction is forever’ is manifestly false” as, occasionally, apparently extinct species reappear. This is often the case for species which form persistent seed banks. For example, in Northamptonshire *Genista anglica* was refound “springing up in newly cleared ground” at Harlestone Heath (Druce 1930, p. 50) following the removal of a plantation and more recently *Agrostemma githago* flowered following ground disturbance associated with the planting of a new hedge (Gent & Wilson 1995).

However, it is more common for species to reappear because they have been overlooked, either in places where they have not been previously sought or in old sites where they were formerly recorded. For most species this is because their ecology or taxonomy makes them difficult to record. For example, of the five species which have been rediscovered in Northamptonshire, two are very closely related to more common taxa (*Ulex minor* and *Pedicularis sylvatica*), one is an inconspicuous aquatic (*Potamogeton alpinus*) and one is a cornfield weed with a tendency to appear sporadically (*Papaver hybridum*).

Some species tend to be overlooked because they are inconspicuous, difficult to identify or occur in habitats which are poorly recorded. As a result there may be an argument for excluding such taxa from lists of extinct species because they are unlikely to have been recorded consistently in the past. For example, the historical distributions of *Erophila* taxa have only recently been understood through the use of herbarium material (Rich & Lewis 1999). Furthermore, the distribution of critical segregates of *Rosa*, *Rubus*, *Hieracium* and *Euphrasia* often reflect the areas where taxonomists have worked rather than the actual distribution of the individual species. As a result, for these species "rediscovery" or "extinction" may well represent nothing more than a change in the intensity of recording.

Aquatic species, in particular, pose a number of problems for the study of extinction. Traditionally they have been poorly recorded, largely because they occur in habitats which are difficult to examine and the major genera are taxonomically difficult (Preston & Croft 1997). Furthermore, the life histories of some species make them hard to study: most species are highly mobile, being adapted to the highly unstable conditions of water bodies. Some species are also susceptible to competition with alien waterweeds, such as *Elodea* spp. and *Azolla filiculoides*, which spread rapidly throughout Britain in the 20th Century. All these factors have meant a "kaleidoscopic pattern of change" in the distribution of some species (Preston & Croft 1998) making an assessment of their apparent extinction and colonisation difficult to interpret. The most obvious example in Northamptonshire is *Luronium natans*, which was last recorded in the county in 1986. In Britain the extent of its distribution has only recently been fully appreciated, following the discovery that the majority of its populations occur as inconspicuous, submerged plants, with rosettes of unremarkable grass-like leaves (Ferguson *et al.* 1998). The variability in growth-forms of other aquatic species, such as pondweeds and water-starworts, pose similar problems for the study of extinction.

Thus for Northamptonshire the rate of extinction presented in this paper may well be an overestimate, as some species may be rediscovered, especially amongst the 23 species not recorded since 1989. For example are *Anagallis minima*, *Aphanes australis*, *Rosa obtusifolia* and *R. rubiginosa* really extinct in v.c. 32 or have they just been overlooked?

County area

As with species richness the number of extinctions recorded in an area will be scale-dependent, with smaller areas tending to lose more species (Fig. 3). For example, twice as many species have gone extinct in the tiny suburban county of Middlesex (724 km²) than in rural Lincolnshire which is almost ten times as big (7200 km²). The underlying cause of this relationship is habitat availability: in smaller areas a species is more likely to become extinct because the extent of its habitat is more restricted. However, this relationship is likely to be strongly influenced by a number of other factors, not least regional differences in the scale of habitat destruction, climate, species-pool and habitat diversity. For example, since 1900 the Shetland Islands, which are comparable in area to Bedfordshire, have only lost two species (Scott & Palmer 1987). As a consequence, the overall relationship between extinction and area is relatively weak ($R^2 = 14.6\%$; $p = 0.059$).

The history of botanical recording

The rate of extinction may well be influenced by the history of plant recording in the county, with concentrations in periods of intensive recording (Preston 2000). This was certainly the case in Northamptonshire, where the first major period of botanical activity in the county, between 1800–1900, was immediately followed by a pronounced peak in plant extinction (Fig. 4). Prior to this few extinctions had been recorded, not necessarily because the environmental changes had been slight, but because so few species were known to 16th, 17th and 18th Century botanists. For example, only around 200 species were known to Morton in 1700, whereas, by 1900, Druce had recorded over 700 species in the county. As a result the number of extinctions increased markedly towards the end of the 19th Century. Given that most species had been discovered by the time of the 1930 Flora, the second peak in extinction after 1920 is presumably a more realistic reflection of the environmental changes which were taking place in the county around that time.

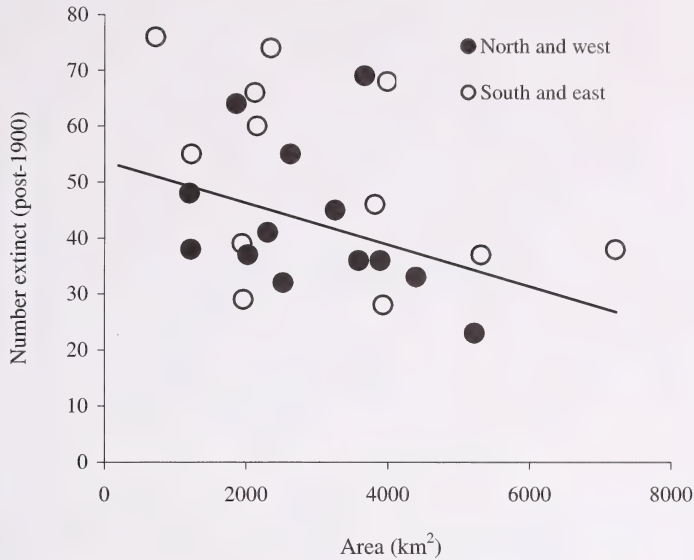


FIGURE 3. The relationship between county extinction since 1900 and area ($R^2 = 14\%$, $p = 0.059$).

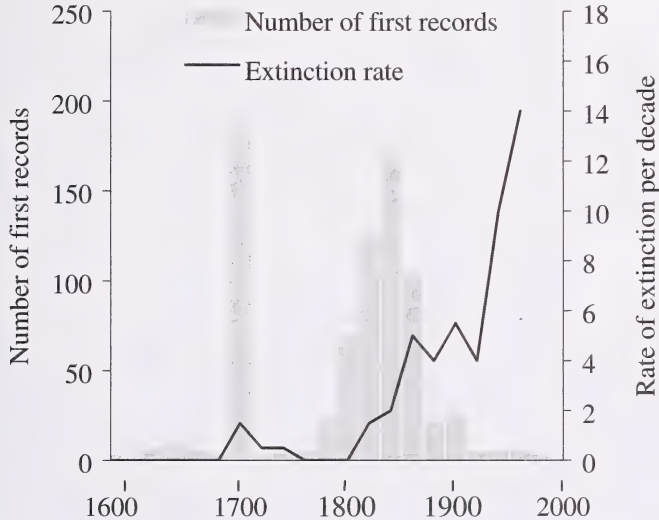


FIGURE 4. The discovery of new species in Northamptonshire (v.c. 32) (within 20 year categories) in relation to extinction rate (calculated for 20 year categories up to 1980). First dates are taken from the Gent & Wilson (1995) Flora (for 35 species no first date is given). Notable botanical works, which included new plant records for the county, are: Gerarde (1597), How (1650), Morton (1712), Notcutt (1843), Druce's early published plant records (1880–81 *et seq.*), and Druce (1930).

EXTINCTION AND CONSERVATION

Given the inherent problems in the study of extinction at the county scale, the figures presented in this paper should not be regarded as very precise: some species listed as extinct may well reappear, whereas others will be missing because insufficient time has elapsed for their loss to be noted or a judgement to be made as to their status. Moreover, not everyone will agree with the exclusion of non-native species, or indeed Preston & Hill's conclusions as to the native status of some species. Although this treatment is certainly the most credible for most species, it could well be refined, particularly with regard to some long-established introductions. Furthermore, the accuracy of some of the revised figures presented in this paper could be revised in light of more up to date information, particularly with respect to the rediscoveries since the publication of the last Flora.

Despite these caveats the overall figures suggest a period of heightened extinction at the county scale in Britain during the 20th Century, of which Northamptonshire appears to be a particularly illustrative example. Although the pace and scale of change may not be as bad as first thought, in lowland counties at least, we still appear to be "losing what is natural, particular and special" (Marren 2000). However, if these figures are to be used to highlight changes which have taken place in our native flora then we must ensure the correct use of the available data and acknowledge the inherent problems that the study of extinction inevitably presents.

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APPENDIX 1. EXTINCT NATIVE SPECIES IN NORTHAMPTONSHIRE (V.C. 32) WITH
DATE OF LAST RECORD

Ajuga chamaepitys, 1712; *Allium oleraceum*, 1873; *Anagallis minima*, 1956; *Aphanes australis*, 1950; *Arabis glabra*, 1960; *Arnoseris minima*, 1879; *Botrychium lunaria*, 1954; *Bromus interruptus*, 1907; *Bupleurum tenuissimum*, 1965; *Callitriche hamulata*, 1987; *Carduus tenuiflorus*, 1950; *Carex binervis*, 1979; *Carex dioica*, 1974; *Carex echinata*, 1950; *Carex laevigata*, 1905; *Carex muricata*, 1980; *Cerastium pumilum*, 1965; *Ceratophyllum submersum*, 1878; *Cirsium dissectum*, 1950; *Cladium mariscus*, 1950; *Clinopodium calamintha*, 1957; *Cochlearia officinalis*, 1950; *Colchicum autumnale*, 1980; *Cynoglossum germanicum*, 1883; *Drosera rotundifolia*, 1822; *Eleocharis multicaulis*, 1915; *Eleocharis quinqueflora*, 1971; *Eleocharis uniglumis*, 1956; *Eleogiton fluitans*, 1930; *Epipactis palustris*, 1956; *Erica tetralix*, 1980; *Eriophorum gracile*, 1878; *Eriophorum latifolium*, 1965; *Erophila majuscula*, 1905; *Euphrasia arctica*, 1935; *Euphrasia pseudokernerii*, 1969; *Festuca filiformis*, 1878; *Filago minima*, 1953; *Fritillaria meleagris*, 1822; *Galeopsis angustifolia*, 1969; *Galium parisiense*, 1926; *Galium pumilum*, 1914; *Galium tricornutum*, 1930; *Gentianella anglica*, 1965; *Gentianella campestris*, 1882; *Gymnocarpium dryopteris*, 1973; *Hypericum montanum*, 1980; *Hypochaeris glabra*, 1878; *Jasione montana*, 1965; *Juncus squarrosus*, 1880; *Juniperus communis*, 1712; *Linum perenne*, 1978; *Luronium natans*, 1986; *Lycopodium clavatum*, 1885; *Lythrum hyssopifolium*, 1912; *Lythrum portula*, 1880; *Marrubium vulgare*, 1975; *Mentha suaveolens*, 1930; *Misopates orontium*, 1951; *Moenchia erecta*, 1877; *Montia fontana*, 1965; *Myosurus minimus*, 1979; *Myriophyllum alterniflorum*, 1987; *Nardus stricta*, 1950; *Oenanthe crocata*, 1976; *Oenanthe lachenalii*, 1930; *Ophrys sphegodes*, 1852; *Orchis ustulata*, 1956; *Oreopteris limbosperma*, 1889; *Osmunda regalis*, 1822; *Parnassia palustris*, 1970; *Persicaria minor*, 1851; *Persicaria mitis*, 1965; *Pilularia globulifera*, 1746; *Platanthera bifolia*, 1960; *Polygonatum multiflorum*, 1907; *Potamogeton acutifolius*, 1910; *Potamogeton friesii*, 1948; *Potamogeton gramineus*, 1910; *Potamogeton obtusifolius*, 1984; *Potamogeton trichoides*, 1900; *Potentilla palustris*, 1950; *Rosa obtusifolia*, 1970; *Rosa rubiginosa*, 1987; *Rosa stylosa*, 1911; *Salvia pratensis*, 1884; *Silene gallica*, 1843; *Solidago virgaurea*, 1960; *Sparganium natans*, 1910; *Spiranthes spiralis*, 1847; *Stachys germanica*, 1870; *Stellaria neglecta*, 1972; *Teesdalia nudicaulis*, 1712; *Tephrosia integrifolia*, 1726; *Teucrium scordium*, 1884; *Thelypteris palustris*, 1930; *Thymus pulegioides*, 1975; *Torilis arvensis*, 1974; *Utricularia minor*, 1965; *Utricularia vulgaris*, 1989; *Valerianella carinata*, 1930; *Valerianella dentata*, 1975; *Valerianella rimosa*, 1882.

APPENDIX 2. REVISIONS TO THE GENT & WILSON (1995)
LIST OF EXTINCTIONS FOR NORTHAMPTONSHIRE

Species excluded	Additional extinctions
Rediscovered since 1970:	Not recorded since 1989
<i>Papaver hybridum</i>	<i>Anagallis minima</i>
<i>Pedicularis sylvatica</i>	<i>Aphanes australis</i>
<i>Potamogeton alpinus</i>	<i>Arabis glabra</i>
<i>Stratiotes aloides</i>	<i>Callitriche hamulata</i>
<i>Ulex minor</i>	<i>Carex binervis</i>
	<i>Carex muricata</i>
Subspecies (taxa still extant):	<i>Cerastium pumilum</i>
<i>Polygala vulgaris</i> subsp. <i>collina</i>	<i>Cochlearia officinalis</i>
	<i>Erica tetralix</i>
Not native:	<i>Euphrasia psuedokerneri</i>
<i>Centaurea cyanus</i>	<i>Galium parisiense</i>
<i>Filago gallica</i>	<i>Luronium natans</i>
<i>Prunus cerasus</i>	<i>Myosurus minimus</i>
	<i>Myriophyllum alterniflorum</i>
	<i>Potamogeton obtusifolius</i>
Never confirmed, probably recorded in error:	<i>Rosa obtusifolia</i>
<i>Crepis foetida</i>	<i>Rosa rubiginosa</i>
<i>Galium sternerii</i>	<i>Rosa stylosa</i>
<i>Sagina subulata</i>	<i>Spiranthes spiralis</i>
<i>Scleranthus perennis</i>	<i>Stellaria neglecta</i>
	<i>Thymus pulegioides</i>
	<i>Torilis arvensis</i>
	<i>Valerianella dentata</i>
British natives but probably introduced in Northamptonshire:	
<i>Cardamine impatiens</i>	Not included in the Gent & Wilson list
<i>Chamaemelum nobile</i>	<i>Bromus interruptus</i>
<i>Chenopodium vulvaria</i>	<i>Cladium mariscus</i>
<i>Cystopteris fragilis</i>	<i>Eleocharis uniglumis</i>
<i>Daphne mezereum</i>	<i>Galium tricornutum</i>
<i>Erodium moschatum</i>	<i>Lythrum hyssopifolium</i>
<i>Eryngium campestre</i>	<i>Silene gallica</i>
<i>Gymnocarpium robertianum</i>	
<i>Impatiens noli-tangere</i>	Critical segregates
<i>Plantago coronopus</i>	<i>Erophila majuscula</i>
<i>Trifolium scabrum</i>	<i>Euphrasia arctica</i>

A new British species, *Senecio eboracensis* (Asteraceae), another hybrid derivative of *S. vulgaris* L. and *S. squalidus* L.

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ABSTRACT

A new species of *Senecio* from York, England, is described and named as *Senecio eboracensis*. Evidence is reviewed that this fully fertile, tetraploid species ($2n = 40$), which was first discovered in 1979, is a hybrid product of *S. vulgaris* ($2n = 40$) and *S. squalidus* ($2n = 20$), and is distinct from another tetraploid hybrid product, the stabilized introgressant, *S. vulgaris* var. *hibernicus*, and also from the hexaploid hybrid product, *S. cambrensis*. Other studies have shown that *S. eboracensis* is reproductively isolated from its parents due to a high level of selfing, phenological separation, sterility of products of back crosses to *S. squalidus* and reduced fertility of products of back-crosses to *S. vulgaris*. The morphological similarity of *S. eboracensis* to partially fertile, intermediate hybrid plants collected from other locations in the British Isles is discussed, and would indicate that it could arise polytopically following hybridisation between the two parent species. However, other such intermediate hybrid products do not appear to have persisted at their site of origin.

KEYWORDS: hybrid evolution, speciation, *Senecio*, Asteraceae, allopolyploidy, introgression.

INTRODUCTION

Since the introduction of *Senecio squalidus* L. ($2n = 2x = 20$) to Britain from Sicily in the early part of the 18th Century (Harris 2002), and its subsequent spread to many parts of the British Isles (Kent 1954–5; 1956; 1960; 1962–4; 1963; 1964a; 1964b; 1964c; 1964d and 1966; Crisp 1972), there have been several notable instances of hybridisation with native *Senecio*, leading to the establishment of hybrid taxa and hybrid derivatives (Crisp 1972; Abbott & Lowe 1996). Some of the most prolific hybridisation events, and the only ones to generate fertile taxa in the wild, have been those with the common groundsel, *S. vulgaris* L. var. *vulgaris* ($2n = 4x = 40$). The triploid hybrid between the two species, *S. × baxteri* Druce ($2n = 3x = 30$) (Druce, 1893, 1907), has been recorded periodically when the parent species occur in large mixed populations (Crisp 1972; Benoit, Crisp & Jones 1975; Marshall & Abbott, 1980), and is almost completely sterile. The first fertile hybrid derivative to be reported was a radiate variant of common groundsel, *S. vulgaris* var. *hibernicus* Syme, which was initially found in Oxford in 1832 (Crisp 1972). However, Syme's (1875) description of this taxon was made on material from Cork, in Ireland, collected in 1866. This variant, of known introgressive origin (Ingram, Weir & Abbott 1980; Abbott, Ashton & Forbes, 1992), is now a common component of town and wasteland floras in many parts of the British Isles (Stace 1991).

A second fertile hybrid *Senecio* taxon that arose last century in the British Isles is the allohexaploid *S. cambrensis* Rosser. It was first discovered in 1948 by H. E. Green at Cefn-y-Bedd, North Wales (Rosser 1955), and is now commonly found in Wrexham and the surrounding area. *S. cambrensis* has also been reported from Leith, Edinburgh, Scotland, (Abbott, Ingram & Noltie 1983) and there is good molecular evidence for independent origins of this new hybrid species at these two locations (Ashton & Abbott 1992; Harris & Ingram 1992; Lowe & Abbott 1996). However, the Edinburgh lineage is now believed to be extinct (Abbott & Forbes, 2002).

A third fertile hybrid derivative was first recorded near York railway station (OS105 594 516) by R. J. Abbott and D. F. Marshall in 1979. The overall morphology of individuals in the population was intermediate between *S. squalidus* and *S. vulgaris* and plants were highly fertile (Fig. 1). Subsequent investigation of material raised in a glasshouse showed that this hybrid possessed 'showy capitula', had long achenes (3.0–3.5 mm), exhibited large leaves which were highly dissected with many lobes and had large, four-pored pollen (Irwin & Abbott 1992). Progeny of the hybrid bred true to type over several generations of cultivation under self and open-pollination conditions (Lowe 1996; Lowe & Abbott 2000). Cytological examination revealed that plants were tetraploid ($2n = 4x = 40$) and formed bivalents at meiosis (Irwin & Abbott 1992). Since 1979, this hybrid radiate groundsel has expanded its range in York to new sites located adjacent to Lendal Bridge (OS105 601 518) and at Dalton Terrace (OS105 593 512), and in 1991, York populations were estimated to contain some 250 individuals. Morphometric and isozyme analysis (Irwin & Abbott 1992) clearly demonstrated that the York plants were hybrid derivatives of *S. vulgaris* and *S. squalidus* and were distinct from the common inland radiate groundsel, *S. vulgaris* var. *hibernicus*. However, no formal description was made of the new taxon and it was referred to as 'York radiate groundsel'.

Recent work by Lowe and Abbott (2000) has indicated that 'York radiate groundsel' is not likely to be a first generation tetraploid hybrid of *S. vulgaris* and *S. squalidus*, but is probably the product of backcrossing an F1 hybrid to *S. vulgaris*. Analysis of random amplified polymorphic DNA (RAPD) variation (Lowe 1996; James 1999) has shown that it contains significantly more genetic material derived from *S. squalidus* than does *S. vulgaris* var. *hibernicus*. In regard to



FIGURE 1. Pressed specimen of *Senecio eboracensis* collected from the south embankment of the River Ouse, adjacent to Lendal Bridge, York, in May 1991 (K: holotype).

reproductive isolation, *S. vulgaris* var. *hibernicus* and 'York radiate groundsel' are both tetraploid and generate highly sterile triploid progeny when crossed with the diploid *S. squalidus* (mean pollen stainability of 36.6% and mean seed set of 0.63% for crosses involving 'York radiate groundsel' and mean pollen stainability of 33% and mean seed set of less than 0.01% for crosses involving var. *hibernicus*, Lowe and Abbott 2000). However, while *S. vulgaris* var. *hibernicus* is completely interfertile with var. *vulgaris* (Trow 1912), second generation offspring of crosses between 'York radiate groundsel' and var. *vulgaris* exhibit a significant reduction in seed set (F₂ progeny set on average 58.8% seed compared to mean seed set for parental taxa which were over 80%, $P < 0.01$, Lowe 1996; Lowe and Abbott, in review). The cause of this lowered fertility has not yet been fully established; however, the formation of univalents at meiosis in some F₂ progeny suggests that mispairing between chromosomes may contribute to the observed reduction in fertility (Lowe 1996; Lowe & Abbott, in review). There are also some prezygotic breeding barriers between York radiate groundsel and *S. vulgaris* that reduce the frequency of inter-taxon crossing at field sites to well below 1.5% (percentage of seed arising from intertaxon crosses relative to total number of seed collected; Lowe 1996; Lowe and Abbott, in review). These prezygotic isolating mechanisms include predominant autogamy of both taxa and substantial differences in flowering time at field sites. All of these mechanisms have been shown to drastically reduce intertaxon crossing at sympatric sites and in common garden experiments (Lowe 1996, Lowe and Abbott, in review). This contrasts with the higher levels of inter-varietal crossing that have been recorded between *S. vulgaris* var. *vulgaris* and var. *hibernicus* (up to 35% of total open pollinated seed set at a field site, Marshall & Abbott 1984).

Taken overall, we consider that the tetraploid hybrid derivative found in York, which has been loosely termed 'York radiate groundsel', should be described as a new species. Therefore, we have taken the classical name of York, *Eboracum*, to derive the species name *eboracensis*; and a formal description of *Senecio eboracensis* Abbott & Lowe follows.

Senecio eboracensis R. J. Abbott & A. J. Lowe, **sp. nov.**

DIAGNOSIS

A *S. vulgari* L. var. *hibernico* Syme acheniis longioribus (2.5–3.5 mm longis, potius quam brevioribus quam 2.3 mm), foliis longioribus magisque lobatis et papillis stigmaticis 10–30 praesentibus (in var. *hibernico* absentibus vel brevissimis); a *S. squalido* L. et *S. vernali* Waldst. & Kit. acheniis longioribus rectis (2.5–3.5 mm, potius quam brevioribus quam 2.3 mm, neque curvatis), ligulis paulo brevioribus (5.0–6.0 mm longis potius quam longioribus quam 7.0 mm) et paulo angustioribus (1.2–1.7 mm latis, potius quam latioribus quam 1.8 mm); a *S. cambrensi* Rosser ligulis 8 (potius quam pluribus quam 10), capitulis angustioribus (3.5–4.2 mm, nec latioribus quam 5.0 mm) et ligulis angustioribus (in *S. cambrensi* c. 2.0 mm latis); a *S. × baxteri* Druce et *S. × helwingii* Berger ex Hegi acheniis longioribus ample formatis (potius quam sterillimis, seminibus fertilibus paene nullis evolutis) differt.

DESCRIPTION

An annual herb, up to 40 cm high (Fig. 2). Stem erect to ascending, occasionally with horizontal base section (up to 5 cm) and adventitious roots at base. Lower and upper leaves petiolate. Leaves up to 8 × 3 cm with oval outline, widest around the midpoint, irregularly pinnatifid with lobes reaching (0.125–)0.25–0.5(–0.75) of the way to the midrib (Fig. 3), with upper leaves generally the more deeply lobed, lobe pairs (3–)5–7(–8); on fertile soils and under glasshouse cultivation, leaves may be much more luxurious and highly dissected, up to 17 × 8.5 cm with lobes reaching (0.5–)0.75–0.875(–0.92) of the way to the midrib (Fig. 2); lobes making between a 90 degree and a 45 degree angle with the midrib, lanceolate to linear, (1–)3–5(–8) times as long as wide, with apex usually acute with a very small tooth; leaf margin throughout dentate or sometimes lobulate. Apical inflorescence comprises 3–7 florets in a grouped corymb, at first dense and leafy, but later laxer with peduncles 0.5–2.0 cm; peduncles elongating further when fruiting (up to 2.5 cm). Capitula broadly cylindrical (c. 10.0 × 4.0 mm), becoming slightly campanulate when ray florets

open. Involucral bracts sparse (4–8), elongated (c. 3.5–4.0 mm), usually without black tips. Ray florets (6) 8 (9), bright yellow, with ligules narrow and long (c. 5.0–6.0 mm long and 1.5 mm broad), occasionally becoming revolute. Stigmatic papillae 10–30. Pollen grains in polar view c. 30–35 μm when fully expanded, mostly four-pored. Achenes 2.5–3.5 mm long, straight, shallowly grooved, with ribs glabrous and grooves hirtellous; pappus white, silky, readily becoming detached from the fruit. Fl. 4–10. Occurs on disturbed ground, car park perimeters, pavement cracks and other urban/industrial sites. $2n = 40$.



FIGURE 2. *Senecio eboraensis* raised under glass from seed collected at site adjacent to Lendal Bridge, York, in May 1991. Note the luxuriance of the leaves under high nutrient conditions.

FIRST RECORD

R. J. Abbott and D. F. Marshall 1979, waste ground near railway station, York (v.c. 64; OS105 594 516).

Type: England, York, v.c. 64, South embankment of River Ouse adjacent to Lendal Bridge (OS105 601 518) May, 1991, R. J. Abbott (*sine numero*; Fig. 1a) (holo. **K**, iso. **BM**, **E**, **LTR**, **OXF**, **RNG**).

DISTINCTNESS FROM CLOSELY RELATED *SENECIO* TAXA

Senecio eboracensis possesses a number of morphological features that distinguish it from several closely related *Senecio* taxa found in the British Isles. These are summarised in Table 1 and Fig. 3.

1. Common inland radiate groundsel, *S. vulgaris* L. var. *hibernicus* Syme. *S. eboracensis* may be distinguished in the field from inland forms of radiate groundsel by its longer achenes (<2.5 mm in *S. vulgaris*), and longer, more lobate and lanceolate shaped leaves (usually around 12 lobes in *S. vulgaris*). Primary peduncles are well developed and tend to be clustered at stem apex in *S. eboracensis* and are longer than those of *S. vulgaris*. Comparison of pollen grains (three-pored and 20–25 µm in diameter in *S. vulgaris*) and presence of stigmatic papillae (absent in *S. vulgaris*) may also be used in determination of herbarium material or fresh material in the laboratory. These characters, in addition to the presence of ray florets, may also be used to distinguish *S. eboracensis* from the eligulate *S. vulgaris* var. *vulgaris*.



FIGURE 3. Leaf silhouettes of *S. vulgaris* and *S. squalidus* together with their hybrid derivatives: a. *S. vulgaris* var. *vulgaris*; b. *S. vulgaris* var. *hibernicus*; c. *S. eboracensis*; d. *S. squalidus*; e. *S. cambrensis*. Each taxon is represented by two leaves to give an indication of the range of variation expected in the field and a scale is shown in cm. Plants from which leaves were harvested were raised together under glass from seed collected from plants in the field in 1993. All field plants were sampled from York, except those of *S. vulgaris* var. *hibernicus*, which were from Edinburgh.

TABLE 1. LIST OF MAIN DIAGNOSTIC FEATURES THAT DIFFERENTIATE *S. EBORACENSIS* FROM ITS PARENTAL TAXA, *S. VULGARIS* AND *S. SQUALIDUS*, AND OTHER CLOSELY RELATED TAXA
(DATA FROM ALLEN 1967; STACE 1991; LOWE 1996; LOWE & ABBOTT 1996; LOWE & ABBOTT 2000)

Character	<i>S. eboracensis</i>	<i>S. squalidus</i>	<i>S. vulgaris</i> var. <i>vulgaris</i>	<i>S. vulgaris</i> var. <i>hibernicus</i>	<i>S. vulgaris</i> ssp. <i>denticulatus</i>	<i>S. cambrensis</i>	<i>S. × baxteri</i>
Ray floret no. (length, mm)	8 (5-6)	12-15 (8-10)	0	7-13 (5)	7-13 (2-3)	8-15 (4-7)	8-13 (4-10)
Capitulum dimensions (mm)	10 × 4	10 × 5	10 × 3-5	10 × 3-5-4	11-13 × 3-5-4	11-13 × 4-5	10 × 2-3
Involucral bracts no. (length mm)	4-8 (3-5-4)	4-8 (3)	10-12 (3)	10-12 (3)	10-12 (3)	10-12 (4-5)	variable 4-12 (3-4)
Number of leaf lobes	13-19	9-13	9-13	9-13	9-13	9-13	9-13
Leaf length (cm)	8-13	5-9	7-11	7-11	5-10	10-15	5-11
Leaf shape	dissected	highly dissected to almost entire	spathulate	spathulate	spathulate, very hairy	dissected	highly dissected
Achene length (mm)	2-5-3-5	2-0-2-5	2-0-2-5	2-0-2-5	2-5-3-5	2-5-3-5	usually sterile (2-0-2-5)
Pollen grain diameter (µm)	30-35	20-25	20-25	20-25	20-25	30-35	very variable (10-40)
Number of pollen pores	4	3	3	3	3	4	2-6
Stigmatic papillae	10-30	40-60	0	0	0	30-50	0-30
Chromosomes (ploidy)	2n = 40 (4x)	2n = 20 (2x)	2n = 40 (4x)	2n = 40 (4x)	2n = 40 (4x)	2n = 60 (6x)	2n = 30 (3x)
Life history	ephemeral	annual, short-lived	ephemeral	ephemeral	annual	ephemeral	ephemeral
Ecology/habitat	ruderal	perennial ruderal	ruderal	ruderal	sand dunes and sea cliffs	ruderal	ruderal
Location	York	throughout British Isles	throughout British Isles	British Isles, with <i>S. vulgaris</i>	western coast	North Wales and Edinburgh	British Isles (infrequently)
Frequency	small populations	large populations	large populations	inter-mixed with <i>S. vulgaris</i>	small populations	small populations	isolated individuals

2. Coastal radiate groundsel, *S. vulgaris* L. ssp. *denticulatus* (O. F. Mueller) P. D. Sell. *S. eboracensis* may be distinguished in the field from coastal forms of radiate groundsel by its longer ray florets and longer, more lobate and lanceolate shaped leaves (usually around 12 lobes in *S. vulgaris*); the leaves are spatulate and covered in an arachnoid indumentum in ssp. *denticulatus*. Primary peduncles tend to be clustered at the stem apex in *S. eboracensis* and are longer and more numerous than those of *S. vulgaris* ssp. *denticulatus*. Comparison of pollen grains (three-pored and 20–25 µm in diameter in *S. vulgaris*) may also be used in determination of herbarium material or fresh material in the laboratory. In addition, *S. vulgaris* ssp. *denticulatus* is only found in Britain on dunes and sandy cliffs in the west and south-west and in the Channel Islands (Allen 1967).

3. Oxford ragwort, *S. squalidus* L.

Its longer, straight achenes (achenes, slightly curved and <2.5 mm in *S. squalidus*), more entire and lobate leaf and shorter ligules distinguish *S. eboracensis* from *S. squalidus*. As in *S. vulgaris*, pollen grains of *S. squalidus* are smaller and only three pored (20–25 µm).

4. Welsh groundsel, *S. cambrensis* Rosser

Both *S. cambrensis* and *S. eboracensis* are relatively robust, radiate plants, with large achenes (2.5–3.5 mm) and large (30–35 µm), mainly four-pored pollen grains. *S. eboracensis* possesses shorter involucre bracts (>11 mm in *S. cambrensis*), narrower capitula (4.0–5.0 mm diameter in *S. cambrensis*) and usually eight rather than the 13 ray florets typical for *S. cambrensis*. *S. eboracensis* also has fewer, shorter involucre bracts (less than 8 and less than 4 mm long) than *S. cambrensis* (more than 10 and greater than 4 mm long). Generally *S. eboracensis* exhibits narrower, less dissected and more lobate leaves than *S. cambrensis*, although there may be some variation in this character for both taxa under heterogeneous environmental conditions. Chromosome counts may be used for anomalous individuals, but the geographic location of a specimen is also a significant factor, as their ranges are not known to overlap.

5. *S. squalidus* × *S. vulgaris* = *S. × baxteri* Druce

Probably the best character to differentiate *S. × baxteri* from *S. eboracensis* is the high percentage of abortive fruit set by the former. However, at the end of the season, *S. eboracensis* may also set low numbers of seed, as is the case with other *Senecio* species (e.g. *S. sylvaticus*, *S. viscosus* and *S. cambrensis*, Rosser 1955). The low seed set of *S. × baxteri* is also manifest in the narrowness of its capitula (<3.0 mm), compared to *S. eboracensis* (typically 4.0 mm). Any full seed produced by *S. × baxteri* tends to be small (<2.5 mm) and is often deformed (straight achenes, 2.3–3.5 mm, in *S. eboracensis*). Also, the pollen of *S. × baxteri* has low acetocarmine stainability (less than 10%) and grains are highly irregular in size and pore number (10–45 µm and 2 to 6 pored), which is in contrast to the near 100% stainability and uniformly four-pored nature of *S. eboracensis* pollen. The leaf dimensions of *S. × baxteri* are generally smaller than those of *S. eboracensis* (typical length 8–3 cm), although some specimens of *S. × baxteri* may exhibit unusual leaf morphology. However, in a morphometric examination of *S. eboracensis* and *S. × baxteri* plants, the two taxa were easily distinguished using several leaf and capitulum characters (Lowe and Abbott 2000). Chromosome counts are also a good method for distinguishing the taxa. In addition, *S. × baxteri* usually occurs as a single ephemeral plant amongst its parent taxa (*S. vulgaris* and *S. squalidus*) and never as a population of morphologically similar individuals as does *S. eboracensis*.

6. Eastern groundsel, *S. vernalis* Waldst. & Kit. and *S. vulgaris* × *S. vernalis* = *S. × helwingii* Berger ex Hegi.

Another taxon which may be confused with *S. eboracensis* is *S. vernalis* Waldst. & Kit. This species is extending its range from the Continent into the British Isles (Kadereit, 1983). Diploid *S. vernalis* ($2n = 2x = 20$) can be distinguished from *S. eboracensis* by the possession of longer ray florets, smaller achenes and small, three-pored pollen. However, *S. vernalis* also hybridises with *S. vulgaris*, producing the sterile triploid *S. × helwingii* Berger ex Hegi ($2n = 3x = 30$). Although this hybrid has been recorded only rarely in the British Isles, it is likely to increase in abundance in the future if *S. vernalis* becomes more widespread. As with *S. × baxteri*, *S. × helwingii* sets practically no fertile fruit, its pollen is irregular and stainability is very low. The ray florets of *S. × helwingii* are also shorter (3.0 mm) than those of *S. eboracensis*.

A dichotomous key separating *S. vulgaris*, *S. squalidus*, and their hybrid derivatives (adapted from *Senecio* key presented in Stace, 1991) follows:

- 1 Ligules <8 mm or 0; capitula (excluding ligules) cylindrical in flower, twice as long as wide..... 2
- 1 Ligules usually ≥ 8 mm, rarely shorter or 0; capitula (excl. ligules) campanulate in flower,
 <1.5 times as long as wide 5
- 2 Achenes ≤ 2.5 mm; pollen grains 20–25 microns across, 3 pored 3
- 2 Achenes >3 mm; pollen grains 30–36 microns across, mostly 4 pored 4
- 3 Ligules absent *S. vulgaris* var. *vulgaris*
- 3 Ligules present (7–13) *S. vulgaris* var. *hibernicus*
- 4 Involucral bracts > 9, usually >4 mm in length, ligules ≥ 8 , leaf lobes <12 *S. cambrensis*
- 4 Involucral bracts < 9, usually <4 mm in length, ligules 8, leaf lobes >12.....*S. eboracensis*
- 5 Leaves usually flat, with lateral lobes much longer than width of central undivided
 portion, usually glabrous or nearly so *S. squalidus*
- 5 Leaves usually undulate, with lateral lobes approximately as long as width of
 central undivided portion, usually conspicuously pubescent*S. vernalis*

RECORDS OF INTERMEDIATE HYBRIDS FROM AROUND YORK

It is not certain how long *S. eboracensis* has occurred in York. There are early reports of radiate groundsel from York, e.g. an individual was found under a beech hedge on the banks of the Ouse, South West of Lendal Bridge by T. Medd in 1958 (T. Medd, pers. comm., 1996) and a population of rayed groundsel was also seen by T. Medd on a building site at Acomb Road in 1960. However, detailed description of these specimens is lacking, and so it is not possible to determine whether these reports refer to var. *hibernicus* or *S. eboracensis*. The first record of *S. squalidus* near the city of York was made by E. J. Payne at Acomb on 2. 5. 1938 (T. Medd, pers. comm., 1996). It was not recorded again until 1948 when it was seen by K.G. Payne at Tadcaster Road (T. Medd, pers. comm., 1996), but by 1957 it had become widespread in York (Kent, 1964c). It is most probable that *S. eboracensis* did not arise much before 1979, when it was first noted, as no other individuals with its distinctive morphology were recorded previously by local botanists. It cannot be ruled out, however, that *S. eboracensis* may have originated soon after the arrival of *S. squalidus* in York (around 1948) or was introduced from another locality elsewhere.

York radiate groundsel *Senecio eboracensis* was first noted as different from var. *hibernicus* (which also occurs around York but seldom in sympatry), when it was collected in 1979 from the edge of a car park near York railway station (OS105 595 517) by R. J. Abbott and D. F. Marshall (Fig. 1). Since then, this hybrid derivative has been recorded at several sites in and around York. During the 1980s, populations of the plant were discovered along the River Ouse East, downstream of Lendal Bridge (OS105 606 513, J. Warren, University of York), on the river bank around Lendal Bridge (OS105 601 518, R. J. Abbott), around the Barbican centre (OS105 618 513, J. Warren), in the grounds of Lawrence St Church (OS105 613 513, T. Crawford, University of York) and at the site of the construction of the Bishophthorpe Road roundabout (OS105 602 509, T. Crawford). During the early 1990s, in addition to sites around Lendal Bridge, the species spread to the car park of the Dalton Terrace church (OS105 593 512, R. J. Abbott) and along Tanner Row (OS105 599 517, A. J. Lowe). At some of these sites population sizes were quite large (up to 100 individuals at Lendal Bridge and Dalton Terrace). However, city redevelopments and increased weeding appears to have lead to a more recent decline. The species' current distribution is limited (a census in 1999 found small populations of plants persisting around Lendal Bridge and along Tanner Row) and it needs to expand rapidly in number and size of populations to avoid the risk of extinction caused by stochastic environmental and demographic perturbations (see Levin 2000).

Over the past century, specimens of putative, semi-fertile hybrids between *S. vulgaris* and *S. squalidus* have been recorded from various locations throughout the British Isles (see Appendix 1, which lists reliable reports of such intermediate, semi-fertile hybrids that are probably tetraploid). According to Benoit *et al.* (1975), hybrid swarms that are distinct from *S. vulgaris* var. *hibernicus* have been recorded in at least 20 English and Welsh vice-counties and in three Irish vice-counties; these hybrid swarms were viewed as tetraploid and described as exhibiting “..lower seed- and pollen-fertility than the parent species, but fertile achenes are often larger, and stainable pollen-grains often have four rather than three pores.” Crisp (1972) and Lowe (1996) have listed nearly 50 herbarium specimens/botanical reports from the British Isles of fertile intermediates between *S. vulgaris* and *S. squalidus*, and noted that such hybrid specimens have tended to be found in four main geographic areas: Cork, Cardiff/Bristol, North Wales/Cheshire/Merseyside and Oxford. Both workers used similar morphological criteria to identify hybrids, including: partial or full seed infertility, possession of ray florets, large capitula, long achenes (>2.5 mm) and a ragged or highly dissected leaf shape. Crisp also discovered a single fertile, tetraploid hybrid in London in November 1966 (Crisp & Jones 1970; referred to as S602 by Crisp, 1972). Progeny of this plant segregated for a wide range of morphological characters and fertility, but Crisp (1972) recommended that if a true breeding population of such intermediate hybrids were found in the future, these hybrids might warrant taxonomic recognition.

In more recent times, other workers, experienced in the taxonomy of the group, have also found what might be considered to be fertile hybrid individuals; for example, near Temple Meads railway station, Bristol, in 1986 (Warren 1987), at Avonmouth in 1991 (R. Milne, pers. comm., 1994), at Turnham Green, London in July 1992 (S. Harris, pers. comm., 1993) and at Passage West, Cork in 1991 (R. J. Abbott, unpub., 1993; Lowe, 1996). However, to our knowledge no other tetraploid hybrid individuals, apart from those at York, have become established as populations and bred true to type. From visits to sites where hybrid individuals have been recorded in the past, it would appear that many sites where large mixed populations had previously been abundant (Second World War bomb sites and industrial waste land) have since been redeveloped, and habitat loss may be one reason for the absence of these individuals at these and adjacent sites. Another possible explanation, favoured by Crisp (1972), is that, following the generation of fertile tetraploid hybrids, the genetic character of later generation progeny is diluted due to backcrossing to *S. vulgaris*, until only a few or single characters remain as evidence of past hybridisation, e.g. the ligule character of *S. vulgaris* var. *hibernicus*. Certainly the role of backcrossing in the origin of *S. eboracensis* is strongly suggested by resynthesis experiments (Lowe and Abbott 2000). Further evidence in favour of this hypothesis comes from the observation of herbarium specimens and botanical journal reports that show ‘introgression sequences’ at certain sites containing plants ranging from hybrid individuals intermediate in morphology between *S. vulgaris* and *S. squalidus* to those apparently differing from *S. vulgaris* only by the possession of ray florets (Crisp 1972; Lowe 1996). For example the following comments were made by Crisp on specimens from Bristol, Jamaica St/St James collected in July 1948 by I. W. Evans (506/4, **BRISTM**!): ‘In view of their ‘squalidus’ type leaves, largish heads, large seeds (many of which are unset) and slight laxity of flowering habit, I would suggest that this plant is one of the intermediate stages referred to above. As such, it has no strict taxonomic name, being intermediate between *S. vulgaris* × *S. squalidus* (= *S. × baxteri* Druce) and *S. vulgaris* var. *hibernicus* Syme. Probably the best one could do is refer to them as segregating tetraploid *S. × baxteri* progeny. I am assuming them to be tetraploid from my experience of similar plants’.

Although no formal name has been used to describe any fertile, tetraploid intermediate hybrid specimens found previously, (i.e. of a type resembling ‘York radiate groundsel’), G. C. Druce recognized that some of them were sufficiently distinct to warrant a new name, and loosely attached the name *Senecio advena* to them (Fig. 4; Crisp 1972). However, the name was never validly published and no type specimen exists (*Index Kewensis*). It is difficult to compare the various hybrid specimens that have arisen in the past directly to individuals of *S. eboracensis* from York. Many specimens share a number of morphological characters with *S. eboracensis* which differentiate them from other recognised hybrid derivatives. The route of origin of these other hybrid specimens is unknown; some may be tetraploid F1 hybrids between *S. vulgaris* and



FIGURE 4. Herbarium specimen collected by G. C. Druce from Burton-on-Trent in July 1930, and described by the *nomen nudum*, *Senecio advena* (RNG). This specimen is a fertile intermediate hybrid of *S. vulgaris* and *S. squalidus* and possesses a number of morphological features in common with *S. eboracensis*, including ray florets, long achenes and dissected leaves – but see text for discussion.

S. squalidus and others may be segregating elements in a hybrid swarm or introgression sequence (Lowe and Abbott 2000). Certainly, not all herbarium specimens and botanical journal reports of hybrid individuals (including those labelled as *S. advena* by Druce) should be classified as *S. eboracensis*. However, it should be acknowledged that hybrids similar in morphology to *S. eboracensis* arise periodically when the two parent species occur together, and thus a polytopic origin for *S. eboracensis* would be feasible.

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APPENDIX 1

The following specimens are fertile hybrids between *S. vulgaris* and *S. squalidus* and similar in morphology to *S. eboracensis*.

FROM AROUND OXFORD

- Oxford (v.c. 23) 3.10.1867, W. J. Dyer '*Senecio squalidus* L.'; 'The dried specimens have very much the appearance of the rayed form of *S. vulgaris* L. M. J. Dyer proposes the name *parviflorus* for this variety. It grew sparingly amongst thousands of the normal form' *Rep. Bot. Exch. Club Brit. I.* 1867:9. **BM!** **K** (Crisp 1972). This plant appears to be sterile, it could also be *S. × baxteri*.
- Oxford (v.c. 23) June 1886, G. C. Druce '*Senecio crassifolius* Willd'; 'resembles S602, but near to *S. vulgaris* var. *hibernicus*; pollen regular' Crisp, 1972. **BM!** **MANCH** (Crisp 1972).
- Oxford (v.c. 23) 1887 'On waste ground (but rarely about Oxford)' G. C. Druce, *Rep. Bot. Exch. Club Brit. I.* 1887:184; Crisp 1972.
- Oxford (v.c. 23) 1891 '*S. crassifolius* – J. G. Baker, *S. × baxteri* – G. C. Druce' *Rep. Bot. Exch. Club Brit. I.* 1891:337; Crisp 1972.
- Burton-on-Trent (v.c. 39) July 1930, Herb. J. E. Lousley, Coll. G. C. Druce '*Senecio advena* Druce n.p.; Det. H. J. M. Bowen '*Senecio vulgaris* L.'; An S602 type' Crisp, 1972. **RNG!**
- Didcot (v.c. 22) 1929 '*Senecio advena* Druce (a name used loosely by Druce to refer to plants of an intermediate nature); resembles S602' Crisp, 1972. **BM** (Crisp 1972).

FROM BRISTOL/CARDIFF

- Bristol, University Rd. (v.c. 34) 2.3.1945, Herb. Gibbons & Bell 960 '*Senecio*, long spreading ray'; 'Rather strongly ribbed glabrescent achenes. I believe *S. squalidus × vulgaris*' N.J.S., 1946. **LTR!**
- Bristol, Jamaica St. (v.c. 34) 19.3.1945, Herb. Gibbons & Bell 960 '*Senecio*, short tubular ray'; 'Too young for examination of achenes, but may be *S. squalidus × vulgaris* L.' N.J.S., 1946. **LTR!**
- Bristol, University Rd. (v.c. 34) 23.4.1945, Herb. Gibbons & Bell 960 '*Senecio*, long strap ray'; 'Thick-ribbed glabrous or glabrescent achenes. *S. squalidus* L. $×$ *vulgaris* L.' N.J.S., 1946. **LTR!**
- Bristol, Jamaica St. (v.c. 34) 20.4.1946, Herb. Gibbons & Bell 956 '*Senecio*, short tubular ray'; '*S. vulgaris* var. *radiatus*, I believe. The achenes seem to be those of *vulgaris*' N.H.S., 1946. **LTR!**
- Bristol, Jamaica St/St James (v.c. 34) July 1948, Herb. I. W. Evans 506/4 '*Senecio squalidus × vulgaris*' P. Crisp, March, 1968. **BRISTM!**
- Cardiff, Docks (v.c. 41) June, 1905, Ex Herb. H. J. Riddelsdell '*Senecio* Sp. B.' see *Rep. Bot. Exch. Club Brit. I.* 1906: 228; 'Pollen large, some 4 pored, low stainability; ligules short and broad; leaves resemble *squalidus* type. Definitely S602 type' Crisp, 1972. **MANCH**, **CGE** (Crisp 1972).
- Cardiff, Docks (v.c. 41) 15.5.1906, Ex Herb. H. J. Riddelsdell '*Senecio* sp. A.'; 'I believe this to be very near *S. vernalis*, Waldst. And Kit.' H. J. Riddelsdell 1906. *Rep. Bot. Exch. Club Brit. I.*:227–228. 'Heads large, with small ligules; leaves resemble *S. squalidus*; heads clustered, and the general growth form resembles that of *S. vulgaris*' Crisp, 1972. **BM!** **LIVU!** **CGE** (Crisp 1972).
- Llanduff (v.c. 41) 1.7.1910, Herb. H. J. Riddelsdell '*Senecio vulgaris*, L. Rayed-very short rays'. **BM!**
- Llanduff (v.c. 41) 9.8.1912, Herb. H. J. Riddelsdell '*Senecio vulgaris* Linn. Rays ½ length'. **BM!**
- Brigend, Glamorgan (v.c. 410) 10.8.1946, Coll. R. P. Libbey 1391/2 '*Senecio vulgaris* L. var. *radiatus* Koch'; 'This is a hybrid; *S. vulgaris × squalidus*'. **LTR!**

FROM AROUND CORK

- Cork, Boreenmana Rd. (v.c. H4) June 1895, Ex Herb. & Leg. R. A. Phillips 413 '*Senecio hibernica* Syme = *S. vulgaris × S. squalidus*'. **DBN!**
- Cork, near Blackrock (v.c. H4) Dec. 1896, Herb. N. Colgan, Leg. R. A. Phillips 413 '*S. vulgaris × squalidus*'; 'a small, hirsute, erect S602 type with large heads' Crisp 1972. **DBN!**
- Cork (v.c. H4) 1903, Coll. N. Colgan 413 '*Senecio vulgaris* var. *radiatus*, grown in garden from seed gathered in Cork'. **DBN!**

Passage West (v.c. H6) 1907, M. Persse 6 '*Senecio vulgaris* rayed f.'; 'An intermediate in the *S. vulgaris* × *squalidus* to *S. vulgaris* var. *hibernicus* Syme introgression sequence' P. Crisp, April, 1969; 'Large plant with large broad ligules, large heads, leaves resembling *vulgaris* type, seed set and of medium length' Crisp 1972. **DBN!**

OTHER LOCATIONS

Denbigh (v.c. 50) 12.6.1948, Leg. E. P. A. Jones, Conf. S. E. Chandler & J. E. Lousley '*Senecio squalidus*'. **BM!** Could also be *S. cambrensis*.

Ewloe Green/Alltami, Flintshire (v.c. 50) 1.5.1977, L. D. Wallace, *sin numero* 'very robust plant'. **LIV** (S. Harris!)

Ffrith, Cefn-y-Bedd Rd. (v.c. 50) 12.6.1948, Leg. E. M. J. ones, Det. J. E. Lousley 2660 '*Senecio vulgaris* × *squalidus* tetraploid'; 'yes a form with longer ray florets than previously seen' J.E.G. 30.9.1948. **BM!** Could also be *S. cambrensis*.

Glasgow, Strathclyde Univeristy (v.c. 77) 6.7.1974, R. P. Libbey 3243 '*Senecio vulgaris/squalidus* introgressant (long ligulate), garden grown from seed supplied by P. Hull. See P. Hull. 1974. *Watsonia*. 10(1): 69–75. **LTR!**

Kings Lynn, Coddeshell Walk (v.c. 28) 16.6.1972, Coll. R. P. Libbey 2269, Det. G. Jones '*Senecio squalidus* × *vulgaris*'. **LTR!**

Kings Lynn, Hospital (v.c. 28) 30.4.1973, Coll. R. P. Libbey 2640 '*Senecio squalidus* × *vulgaris* (fertile hybrid), see sheet 2641 of putative parents'; 'The papillae on the stigmas are intermediate between those of *vulgaris* and *squalidus*, a few long, a few short on a partly swollen stigmatic head'. **LTR!**

Liverpool (v.c. 59) Aug. 1976, Coll. A. J. Coombes '*Senecio squalidus* × *vulgaris*?' **LIVU!** Small specimen, could also be *S. cambrensis*.

Oldham, Failworth (v.c. 59) 9.10.1962, Coll. C. E. Shaw '*Senecio vulgaris* L. × *Senecio squalidus* L. (= *S. × baxteri* Druce)'; 'N.B. this specimen is fertile'; 'ach[enes] 2.7 mm'. **K!**

Parkstone, Dorset (v.c. 9) 6.9.1945, Ex. Herb. J. E. Lousley '*Senecio vulgaris* L. × *S. squalidus* L.'; '*S. × baxteri*' Crisp, 1972. **BM!**

Plymouth, Devon (v.c. 3) 17.5.1945, Herb. J. E. Lousley, Leg. E. M. Phillips '*Senecio squalidus* L. × *vulgaris* L?' **RNG!**

Unstone, Derbys. (v.c. 57) 1956, '*Senecio vulgaris* × *S. squalidus*'. **LIVU!**

Identification of British species of *Callitriche* by means of isozymes

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ABSTRACT

Isozyme variation was investigated among the eight species of *Callitriche* L. (Callitrichaceae) native to Britain. By this means, nearly all the species could be distinguished, particularly by the enzyme systems GPI and PGD. Although *C. brutia* Petagna and *C. hamulata* Kütz ex W. D. J. Koch could be separated from the other species they were not separable from each other. A case study involving a survey of four Norfolk rivers revealed only three species: *C. stagnalis* Scop., *C. obtusangula* Le Gall and *C. platycarpa* Kütz., of which the latter two were by far the most frequent.

KEYWORDS: allozymes, Callitrichaceae, distribution, taxonomy.

INTRODUCTION

Most British species of *Callitriche* L. are capable of living either submerged in water or on land in damp mud. This amphibious behaviour is associated with considerable phenotypic plasticity, particularly of vegetative features. Reproductive parts, especially ripe fruits and pollen, are required before material can be determined with any great confidence, and even then *C. brutia* Petagna and *C. hamulata* Kütz ex W. D. J. Koch cannot always be distinguished in the field (Schotsman 1972). Furthermore, when growing completely submerged, species such as *C. stagnalis* Scop., *C. obtusangula* Le Gall. and *C. platycarpa* Kütz., do not flower and, as a result, cannot be identified. In very many cases, therefore, it has proved impossible to make firm identifications. In Britain numerous papers and communications at botanical meetings have highlighted the confusions and disagreements among botanists (Pearsall 1935; Jones 1955; Meikle & Sandwith 1956; David 1958; Savidge 1960, 1967; Preston & Croft 1997).

One consequence of this has been uncertainty over which species are to be found in the British Isles. Even over the last 50 years, for example, *C. cophocarpa* Sendtn. or *C. palustris* L. have been credited to our flora by some authors but not by others (Clapham *et al.* 1952, 1962; Schotsman 1972; Haslam *et al.* 1982; Lansdown 1998; Kent 1992; Preston & Croft 1997; Stace 1991, 1997). These uncertainties were partly based on taxonomic problems regarding the distinction of *C. cophocarpa* from *C. platycarpa* (Savidge 1958; Schotsman 1967) and *C. lenisulca* Clavaud (Schotsman & Andreas 1974; Schotsman & Haldimann 1981). Another root of the problem has been the lack of authenticated voucher material, so it is of some interest, therefore, to note that *C. palustris* was discovered recently in Ireland (Lansdown & Bruinsma 1999) and then also in Scotland (by R. V. Lansdown) during the course of fieldwork for the present study. *Callitriche cophocarpa*, in contrast, is less likely to occur in Britain because of its primarily eastern European distribution (Savidge 1958; Schotsman & Haldimann 1981). Eight species of *Callitriche* are currently recognised as members of the British flora (Table 1).

A second consequence of not being able to identify species properly has been the difficulty in preparing reliable distribution maps (Preston & Croft 1997). Not only have there been frequent misidentifications, but also many fieldworkers have been unwilling to venture identifications at all, with the result that some species are probably under-recorded (Preston & Croft 1997; Lansdown 1998).

Although of no use in the field or herbarium, inter-specific variation in chromosome number (Table 1) has helped considerably with problems of identification, although one sometimes suspects an element of circular reasoning in some of the reports. A good example of a study that

TABLE 1. BRITISH SPECIES OF *CALLITRICHE* AND THEIR PUBLISHED CHROMOSOME COUNTS. ALL COUNTS BASED ON BRITISH MATERIAL EXCEPT FOR *C. PALUSTRIS*

Species	2n
<i>Callitriche hermaphroditica</i> L.	6
<i>Callitriche truncata</i> Guss.	6
<i>Callitriche stagnalis</i> Scop.	10
<i>Callitriche obtusangula</i> Le Gall	10
<i>Callitriche platycarpa</i> Kütz.	20
<i>Callitriche palustris</i> L.	20
<i>Callitriche brutia</i> Petagna	28
<i>Callitriche hamulata</i> Kütz.	38

has used chromosome number to help document the distribution of *Callitriche* species is that by Lewis-Jones & Kay (1977) who surveyed localities in Glamorgan. Nevertheless, with the exceptions of *C. brutia* and *C. hamulata*, no British species has a unique chromosome number and so this evidence cannot be used alone to determine identity.

The primary aim of the present study is to describe another method, using isozymes, by which vegetative material of *Callitriche* can be identified (Demars & Gornall 2001). Although equally inapplicable in the field or herbarium, the method does at least allow for the screening of large numbers of plants so that the true extent of morphological variation within each species can be assessed; this may then allow better descriptions to be drawn up and allow potentially diagnostic morphological characters to be described more precisely.

A secondary aim of the present study is to use the findings to help survey the distribution of *Callitriche* species in four Norfolk rivers (R. Wensum, Nar, Wissey and Bure). This survey forms part of a biodiversity inventory and biomonitoring scheme led by the Environment Agency (forthcoming R&D report P2-127).

MATERIALS & METHODS

PLANT MATERIAL

Reference material in fruiting and/or flowering condition was collected throughout Britain, mostly during summer 2000. Chromosome counts were made on certain plants in order to provide supporting evidence for identifications made on diagnostic morphological characteristics. Table 2 provides a summary of the reference populations sampled. Voucher specimens of most collections are preserved in **NMW** or **LTR** (Table 2). In many cases only a single plant was gathered per population, and our results must therefore be interpreted cautiously. Nevertheless, we have sampled a wide range of populations and furthermore, since most species are predominantly self-fertilising (Philbrick & Anderson 1992), we assume there is unlikely to be much intra-population variability. In Norfolk, collections were made from four river basins: those of the Rivers Wensum, Wissey, Nar and Bure, in 1999 and 2000. Details of these collections are given in Table 3.

CHROMOSOME COUNTS

Actively growing root-tips were pre-treated with 0.002M 8-hydroxyquinoline for ca20h in the field and fixed later using 3:1 absolute ethanol: glacial acetic acid. Root-tips were hydrolysed at room temperature in 5M HCl for 10 minutes before squashing, flaming and staining in aceto-orcein.

ISOZYME ELECTROPHORESIS

After collection, samples were kept cool (4–10°C) and processed usually within 5 days. Standard horizontal electrophoresis, on 12% starch gels, of isozymes from extracts of young, actively growing shoot apices was carried out as described by Wendel & Weeden (1989) using the extraction buffer of Hollingsworth *et al.* (1995). Two gel/electrode buffer systems were used: tris-borate-EDTA (TBE) (Wendel & Weeden 1989) and morpholine citrate (MC8) (Hollingsworth *et al.* 1995). Eight enzyme systems were studied: glucose-6-phosphate isomerase (GPI), malate

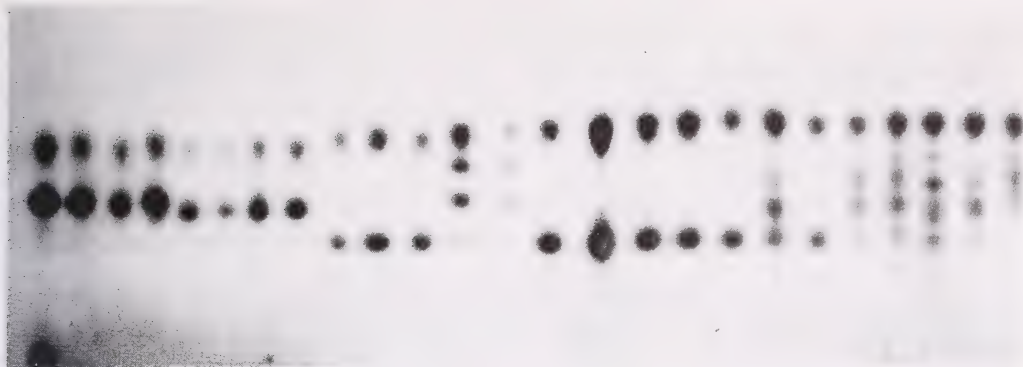


FIGURE 1. Glucose-6-phosphate isomerase (GPI) phenotypes in *Callitriche* species. (Figures in parentheses refer to the population reference numbers in Table 2.) Lanes 1–4, *C. hermaphroditica* (1, 2, 3, 4). Lanes 5–8, *C. truncata* (13, 12, 10, 11). Lanes 9–11, *C. stagnalis* (15, 16, 17). Lanes 12–13, *C. platycarpa* (33, 35). Lanes 14–18, *C. obtusangula* (31, 25, 22, 23, 26). Lane 19, *C. brutia* (41). Lane 20, *C. obtusangula* (27). Lanes 21–25, *C. hamulata* (48, 49, 50, 53, 54).

dehydrogenase (MDH), phosphogluconate dehydrogenase (PGD), phosphoglucomutase (PGM), aspartate aminotransferase (AAT), fructose-bisphosphate aldolase (FBA), isocitrate dehydrogenase (IDH) and malic enzyme (ME). AAT, GPI, FBA, IDH, ME and PGM were assayed using the TBE system, the others (MDH, PGD) using the MC8 system. Staining protocols followed Hollingsworth *et al.* (1995) for all enzymes except MDH, ME and FBA for which the recipes in Wendel & Weeden (1989) were used.

Preliminary interpretation of enzyme banding patterns in terms of alleles and loci was based on their conserved subunit structure and subcellular compartmentalization (Gottlieb 1981, 1982; Weeden & Wendel 1989) and a knowledge of the ploidy level of the species.

RESULTS

CHROMOSOME NUMBERS

Results of the chromosome number determinations are shown in Table 2. The counts obtained for the species examined, viz. *C. stagnalis* ($2n=10$), *C. obtusangula* ($2n=10$), *C. platycarpa* ($2n=20$), *C. brutia* ($2n=28$) and *C. hamulata* ($2n=38$), agreed with previous reports (Table 1).

ISOZYME PHENOTYPES

Variation within and between the species was such that species-specific isozyme phenotypes were identified only in GPI (Fig. 1), MDH and PGD. These are summarised in Fig. 2. As expected, diploid species (*C. hermaphroditica*, *C. truncata*, *C. stagnalis* and *C. obtusangula*) have the simplest phenotypes, consistent with the presence of two loci coding for each of the enzyme systems studied. Phenotypes indicative of heterozygotes were rare, as might be expected from the predominantly self-fertilizing nature of the species (Philbrick & Anderson 1992). The polyploid species (*C. platycarpa*, *C. palustris*, *C. brutia* and *C. hamulata*) usually have more complicated phenotypes, and showed evidence of heterozygosity in all samples studied.

Inspection of Fig. 2 shows that the variation allows identification of all species except *C. brutia* and *C. hamulata*, which cannot yet be distinguished from each other. Intraspecific variation in GPI or PGD occurred in *C. hermaphroditica*, *C. stagnalis*, *C. obtusangula*, *C. brutia* and *C. hamulata* (Fig. 2, Table 2). In the case of *C. hermaphroditica*, both large-fruited and small-fruited variants were sampled, but their respective isozyme phenotypes showed uncorrelated variation. In one of the cases where reference populations were sampled in some detail, variation between individuals was discovered, viz. *C. obtusangula* in the Grand Union Canal, Leicester (Table 2).

TABLE 2. DETAILS OF POPULATION LOCALITIES, SAMPLE SIZES (Ni), CHROMOSOME NUMBERS (2n) AND INFRA-SPECIFIC ISOZYME VARIATION IN GPI OR PGD (SEE FIG. 2 FOR PHENOTYPES)

Ref no.	Species/population	Voucher ^a	Ni	2n	Infra-specific variation
	<i>C. hermaphroditica</i>				GPI PGD
1	Worcs., v.c. 37, Chadwich Manor, SO975761	RL 750 & BD, 19 Jul 2000	1S ^b		B
2	Salop, v.c. 40, Colemere Mere, SJ435330	RL 751 & BD, 19 Jul 2000 (NMW)	1		A
3	Monts., v.c. 47, Montgomery Canal, SJ255197	RL 752 & BD, 19 Jul 2000 (NMW)	1		A
4	Monts., v.c. 47, Montgomery Canal, SJ237083	RL 753 & BD, 19 Jul 2000 (NMW)	1S		A
5	Lincs., v.c. 53, Swanholme lakes, SK945685	RL 766 & BD, 8 Aug 2000 (NMW)	1L ^b		B
6	W. Perth, v.c. 87, Lake of Menteith, NN583011	RL 771, BD & NW, 9 Aug 2000 (NMW)	1L		A
7	W. Perth, v.c. 87, Doune ponds, NN724023	RL 767 & BD, 9 Aug 2000	1L		B
8	E. Perth, v.c. 89, Loch Clunie, NO115437	RL 773 & BD, 10 Aug 2000 (NMW)	1L		A
9	E. Perth, v.c. 89, Fingask Loch, NO175428	RL 774 & BD, 10 Aug 2000	1L		B
	<i>C. truncata</i>				
10	S. Devon, v.c. 3, River Dart, Totnes, SX802611	RL 740 & BD, 18 Jul 2000 (NMW)	1		
11	S. Devon, v.c. 3, River Axe, SY290982	RL 742 & BD, 18 Jul 2000 (NMW)	1		
12	S. Somerset, v.c. 5, Bridgewater & Taunton canal, Creech St Michael, ST275256	RL 736 & BD, 17 Jul 2000	1		
13	Leics., v.c. 55, Groby Pool, SK522083	BD (RL763), 21 Sep 1999 (NMW)	1		
	<i>C. stagnalis</i>				
14	W. Cornwall, v.c. 1, SE of Grochall, SW699142	NS, 9 Mar 1996	3	10	D
15	S. Devon, v.c. 3, East Bovey Head, SX686824	RL 738 & BD, 17 Jul 2000 (NMW)	1		D
16	S. Devon, v.c. 3, River Dart, Totnes, SX803611	RL 741 & BD, 18 Jul 2000 (NMW)	1		D
17	S. Hants., v.c. 11, Ober Water, SU250039	RL 749 & BD, 18 Jul 2000 (NMW)	1		D
18	W. Norfolk, v.c. 28, River Tat, TF836312	BD, 27 Jul 1999 (LTR)	5		C
19	Cards., v.c. 46, Brynllynan, SN184482	AOC, 1997	4		D
20	Cards., v.c. 46, Pen-y-Graig, SN223519	AOC, 1997	2		D
21	Dunbarton, v.c. 99, Wards pond, NS443876	RL 769, BD & NW, 9 Aug 2000	2		C
	<i>C. obtusangula</i>				
22	N. Somerset, v.c. 6, Gordano Valley, ST442733	RL 735 & BD, 17 Jul 2000 (NMW)	1		D
23	S. Hants., v.c. 11, Ober Water, SU258038	RL 746 & BD, 18 Jul 2000 (NMW)	1		D
24	E. Norfolk, v.c. 27, River Bure, Ingworth, TG193291	BD (RL 783), 15 Aug 2000	2		D
25	W. Norfolk, v.c. 28, Wendling Beck, TF966152	BD, 9 Jul 2000 (LTR)	1		D
26	W. Gloucs., v.c. 34, Over Pools, SO818194	RL 758 & BD, 20 Jul 2000 (NMW)	1		D
27	Cards., v.c. 46, Glan Rheidol, SN662793	RL & BD, 20 Jul 2000 (LTR)	1	10	D
28	Leics., v.c. 55, Grand Union Canal, Leicester, SK5702	RG, 1996	80	10	12D 68E
29	Leics., v.c. 55, Aylestone Meadows, SK5600	RG, 1996	37	10	E
30	Leics., v.c. 55, Saddington Brook, SP6691	RG, 1996	40	10	E
31	France, Deux-Sèvre, River Auxances, D59 bridge	BD (D59), 21 Jun 2000	1		D
	<i>C. palustris</i>				
32	Dunbarton, v.c. 99, Wards pond, NS443876	RL 768, BD & NW, 9 Aug 2000 (NMW)	2		

TABLE 2. CONTINUED

Ref Species/population No.	Voucher ^a	Ni	2n	Infra-specific variation	
<i>C. platycarpa</i>				GPI	PGD
33 Dorset, v.c. 9, Stoborough, SY929867	RL 743 & BD, 18 Jul 2000 (NMW)	1			
34 E. Norfolk, v.c. 27, Saxthorpe, TG107306	BD (RL 784), 15 Aug 2000 (LTR)	1			
35 W. Gloucs., v.c. 34, Over Pools, SO818194	RL 757 & BD, 20 Jul 2000 (NMW)	1			
36 Leics., v.c. 55, Kilby Brook, Kilby, SP6294	RG, 6 Mar 1996	24	20		
37 Leics., v.c. 55, Kilby Brook, SP617954	BD, 25 Jul 1999 (LTR)	1			
38 Leics., v.c. 55, Knighton, Knighton Hall, SK599014	RG, 15 Sep 2000	25	20		
39 Leics., v.c. 55, River Sence, Little Stretton, SK6600	RG, 6 Mar 1996	4	20		
40 Leics., v.c. 55, Stonton Wyville, SP7394	RG, Mar 1996	30	20		
<i>C. brutia</i>				G	G
41 S. Somerset, v.c. 5, Wimbleball Lake, SS977317	RL 737 & BD, 17 Jul 2000 (NMW)	1			
42 Carm's., v.c. 44, Afon Teifi, SN256422	AOC, 1997	4		I	G
43 Cards, v.c. 46, Brynllynan, SN184482	AOC, 1997	2		I	G
44 Cards., v.c. 46, Pen-y-Graig, SN223519	AOC, 1997	1		I	G
45 Monts., v.c. 47, Machynlleth, SH742013	BD (RL785), 23 Aug 2000 (NMW)	2		I	G
46 Merioneth, v.c. 48, Dolgellau, SH71	APC, 1996	2	28	H	H
47 Caerns., v.c. 49, N. of Aberdaron, Methlem Pond, SH174301	APC, 9 Mar 1996	6	28 ^c	I	G
<i>C. hamulata</i>				G	H
48 S. Devon, v.c. 3, East Dart River, SX647790	RL 739 & BD, 17 Jul 2000 (NMW)	1	38		
49 S. Hants., v.c. 11, Oberwater floodplain, SU265029	RL 748 & BD, 18 Jul 2000 (NMW)	1		G	H
50 S. Hants., v.c. 11, Oberwater floodplain, SU260034	RL 745 & BD, 18 Jul 2000 (NMW)	1	38	G	H
51 Worcs., v.c. 37, Swanhurst Park, SP08	JP, 1996	2	38	G	H
52 Warks., v.c. 38, Rookery Brook, SP1866	JP, 1996	2	38	G	G
53 Monts., v.c. 7, Montgomery Canal, Newton Powys, SO172970	RL 754 & BD, 19 Jul 2000 (NMW)	1	ca38	G	H
54 Monts., v.c. 47, River Wye, Llangurig, SN908797	RL 755 & BD, 19 Jul 2000 (NMW)	3	38	H	H
55 Dunbarton, v.c. 99, Wards pond, NS443876	RL 770, BD & NW, 9 Aug 2000 (NMW)	1		G	H

^a AOC, Arthur Chater; APC, Ann Conolly; BD, Benoît Demars; JP, James Partridge; NW, Nigel Willby; NS, Nick Stewart; RG, Richard Gornall; RL, Richard Lansdown. Collection numbers, where given, form part of codes assigned by RL

^b L – broad-winged fruits; S – narrow-winged fruits.

^c Count by Wentworth *et al.* (1991).

NORFOLK RIVER SURVEY

Callitriche is a very common genus in the rivers of Norfolk. Three species were identified using the isozyme phenotypes described above, supplemented by diagnostic pollen features in a few cases (Table 3). Without exception, the diagnostic characters supported the determination based on isozyme phenotype. *Callitriche obtusangula* (Fig. 3A) and *C. platycarpa* (Fig. 3B) were the most frequent species and were often found growing together, sometimes inter-mixed. *Callitriche stagnalis* appears to be restricted to the upper River Tat, a tributary of the River Wensum (Fig. 3A).

TABLE 3. OCCURRENCE OF *CALLITRICHE* SPECIES IN THE RIVERS WENSUM, WISSEY, NAR AND BURE IN NORFOLK

Locality (all v.c. 28 except where noted)	Grid Ref.	Collection	No. individuals assayed	
			<i>C. obtusangula</i>	<i>C. platycarpa</i>
<i>River Wensum</i>				
Whissonsett	TF913238	10–11 Apr 1999		5
Pear Tree Corner	TF898237	10–11 Apr 1999		6
Southmill Farm	TF882283	10–11 Apr 1999	2	2
Doughton	TF882290	10–11 Apr 1999	1	4
Sculthorpe Mill	TF894303	10–11 Apr 1999	1	1
Sculthorpe Fen	TF902297	10–11 Apr 1999		5
Fakenham – upstream STW	TF921293	10–11 Apr 1999	2	3
Fakenham – downstream STW	TF936292	10–11 Apr 1999	2	5
Pensthorpe Water Fowl Park	TF943288	10–11 Apr 1999	2	3
Pensthorpe Gravel Pit Bridge	TF953287	10–11 Apr 1999		4
Lyng, v.c. 27	TG073181	17 Aug 2000		1
Taverham, v.c. 27	TG157137	17 Aug 2000		1
Taverham, v.c. 27	TG159136	17 Aug 2000	1	1
<i>River Wensum tributaries</i>				
South Raynham Brook	TF879241	10–11 Apr 1999		5
Helhoughton Brook	TF868267	10–11 Apr 1999		5
Fakenham (ditch)	TF936293	10–11 Apr 1999		5
Langor drain	TF961291	10–11 Apr 1999	5	
River Ainsie, v.c. 27	TG094213	28 Jun 2001	pollen	
River Tat, Coxford	TF846294	18 Aug 2000		3*
River Tat, Broomsthorpe	TF852284	10–11 Apr 1999	4	2
River Tat, Tatterford Common	TF867280	10–11 Apr 1999	1	2
tributary of River Tat	TF845289	10–11 Apr 1999		5
East Rudham Brook	TF845287	10–11 Apr 1999	1	4
<i>River Wissey</i>				
Hilborough	TF833008	1 Aug 2000		1
Gooderstone Common stream	TF753006	2 Aug 2000		2
Beachamwell stream	TF717005	2 Aug 2000	1	2 + pollen
Bodney	TL828988	1 Aug 2000	1	1
Ickburgh	TL808944	1 Aug 2000	2	1
Didlington	TL769968	1 Aug 2000	1	
Stoke Ferry	TL710995	3 Aug 2000	1	
Stoke Ferry Fen	TL676975	31 Jul 2000		1
<i>River Nar</i>				
Mileham	TF905186	24 Jul 2000	pollen	
Litcham	TF883172	24 Jul 2000	pollen	
Lexham Hall (pond)	TF869175	24 Jul 2000	pollen	
West Lexham	TF840170	24 Jul 2000		1*
West Acre	TF833008	25 Jul 2000	1 + pollen	
Newton	TF828154	25 Jul 2000	1	1
Newton	TF827154	25 Jul 2000		1
Narborough	TF745132	27 Jul 2000	1 + pollen	pollen*
Marham	TF723120	25 Jul 2000	pollen	
<i>River Bure (all v.c. 27)</i>				
Saxthorpe	TG123296	15–18/08/00	3*	
Buxton	TG242232	16 Aug 2000	1	
Costishall	TG266201	16 Aug 2000	1	

Plants were identified by isozyme assay (no. individuals tested) and/or pollen characters. These records are additional to the reference collections from Norfolk listed in Table 2.

* Voucher specimen in LTR.

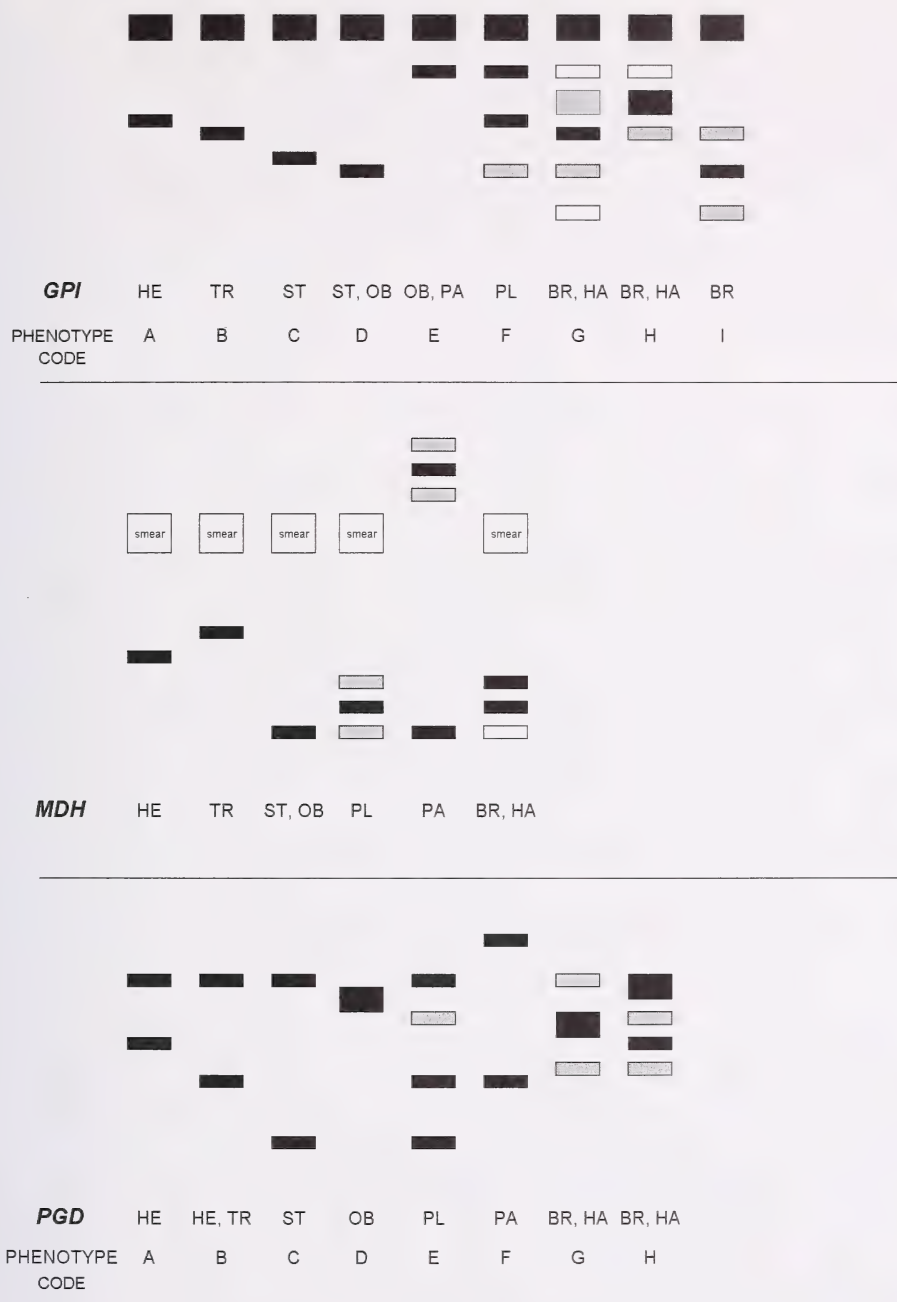


FIGURE 2. Schematic single-enzyme phenotypes recovered from *Callitriche hermaphroditica* (HE), *C. truncata* (TR), *C. stagnalis* (ST), *C. obtusangula* (OB), *C. platycarpa* (PL), *C. palustris* (PA), *C. brutia* (BR) and *C. hamulata* (HA). Differential shading is approximately proportional to allozyme band intensity. Anode towards top of figure.

DISCUSSION

IDENTIFICATION

The only previously published study of isozymes in the genus was by Gil Pinilla (1992) who compared 28 populations of *C. obtusangula* and *C. stagnalis* from Dorset and Wales in ten enzyme systems (AAT, ADH, G6PDH, EST, IDH, MDH, ME, PGI, SKD and SOD). She found little variation and concluded that isozymes were unlikely to provide a basis for species identification. We could not distinguish *C. stagnalis* from *C. obtusangula* using AAT, IDH, MDH or ME either. We did, however, find abundant variation, some of it apparently species-specific or nearly so, in GPI, MDH and PGD sufficient to allow separation of all taxa except *C. hamulata* and *C. brutia*. It is of course possible that further collections may well reveal additional alleles and thereby extend the range of variation such that our observed differences will become less clear. Nevertheless, we believe that the provenance of our material is sufficiently wide that this is unlikely to happen to any great extent. Thus, in earlier, preliminary studies, material assayed from a wider range of localities throughout Britain revealed only limited additional variation, and insufficient to disrupt the correlation with species identity (RJG, unpublished data).

It is perhaps no surprise that our isozyme assay could not distinguish *C. brutia* from *C. hamulata*. The morphological features of the two taxa are extremely close, so much so that they can be virtually impossible to separate at some stages of their development (Schotsman 1967, p.93) or when growing submerged (Schotsman 1967, p.88; 1972). Diagnostic characters relating to leaf shape are prone to phenotypic plasticity, and those involving hairs or fruit morphology (Schotsman 1967, p.88) are very subtle at best. Even the most commonly used character, peduncle length, may not be constant (Schotsman 1954 pl. 13a; Schotsman 1967, p. 88). The two species are clearly very closely related genetically, and this is further borne out by the fact that they share identical *rbcL* sequences in their chloroplast genome (Philbrick & Les 2000). We suggest that one explanation for this close relationship is that *C. hamulata* ($2n = 38$) could be an allopolyploid, with *C. brutia* ($2n = 28$) as one of its parents and a species with $2n = 10$ as the other. Until additional evidence can be supplied the only reliable ways of separating the two species are by cytological means or electron microscopy of the pollen (Cooper *et al.* 2000). The difference in chromosome number is mirrored also by a difference in the amount of DNA per chromosome (Pijnacker & Schotsman 1988).

Variation in fruit size among British populations of *C. hermaphroditica* was not accompanied by any correlated variation in isozyme phenotypes. Martinsson (1991a) examined Nordic populations of the two variants and concluded from multi-variate analyses that the pattern of variation in fruit morphology is complex and involves other characters as well as size. The extent and nature of the genetic difference between the large-fruited and the small-fruited variants remains to be established, although Savidge (1958, p. 55) observed that under similar experimental cultural conditions they retained their respective phenotypes.

POLYPLOIDY

Although apparently rare, hybridisation is not unknown in *Callitriche* (e.g. Martinsson 1991b). It seems to occur chiefly among species capable of wind-pollination, hence with an increased chance of outcrossing (Schotsman 1982). In this regard, Savidge (1958, 1960) suggested that *C. platycarpa* ($2n=20$) may have had an allotetraploid origin from *C. stagnalis* and *C. cophocarpa* (both $2n=10$). The evidence for this hypothesis rests on the morphological intermediacy of *C. platycarpa* and on the cytological behaviour of the hybrid *C. platycarpa* $\times$ *cophocarpa*. The two putative parents are also sympatric in eastern Europe (Schotsman 1967). Savidge (1958, p.114), however, did not rule out a possible autotetraploid ancestry, owing to the partial sterility often seen in *C. platycarpa*. This alternative view was taken up by Schotsman (1967), who concluded that *C. platycarpa* was more likely to be an autotetraploid of *C. cophocarpa*. Evidence from chromosome number and DNA amount per chromosome is consistent with either hypothesis (Pijnacker & Schotsman 1988). Our findings would support Savidge's contention of an allopolyploid origin, assuming that the constant heterozygosity seen in *C. platycarpa* at three loci (GPI-2, MDH-2 and PGD-2) turns out to be fixed and is due neither to clonal growth nor to a sampling artefact caused by tetrasomic inheritance. Consideration of shared alleles indicates also that *C. stagnalis* is a likely candidate for one of the parents.

The other three polyploid species, *C. palustris*, *C. brutia* and *C. hamulata*, also showed complex isozyme phenotypes, consistent with heterozygosity. The implications of this remain to be demonstrated, although we have earlier speculated on a possible hybrid origin for *C. hamulata*.

DISTRIBUTION IN NORFOLK

The findings from our survey of the four Norfolk rivers indicate that both *C. platycarpa* and *C. obtusangula* are common, supporting the statements made by Petch & Swann (1968). In contrast, *C. stagnalis* is scarcely to be found in the rivers surveyed. The distribution maps provided by Beckett & Bull (1999) in their account of the flora of Norfolk, based on a survey 1985–1999, show very few records of either *C. platycarpa* or *C. obtusangula*, presumably owing to difficulties in determining non-flowering material or to a different sampling strategy. Their map of *C. stagnalis*, in contrast, shows a widespread distribution but its apparent avoidance of rivers is not clear. Our experience, therefore, is that isozyme data can provide a reliable basis for the study of the distribution and ecology of *Callitriche* species.

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***Galeopsis segetum* Neck. (Lamiaceae), Downy Hemp-nettle: native or introduced in Britain?**

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ABSTRACT

Galeopsis segetum is an extinct species in Britain whose distribution status is unclear. Ten criteria have been used to assess whether it is likely to be native or introduced using data compiled from the literature, herbaria and other sources. The unique geographical distribution and its general morphological uniformity in Britain fit within its European context and provide strong support for a native status. Evidence against a native status is given mainly by its occurrence as an arable weed (not a natural habitat) and its occasional naturalisation elsewhere. Evidence from other criteria are more equivocal. On balance, we place greater emphasis on the geographical and morphological evidence, and accept it as native in Britain in north Wales and eastern England. There is insufficient information to be certain of its status in a number of other areas.

KEYWORDS: Distribution, ecology, extinct species.

INTRODUCTION

Galeopsis segetum Neck. (*G. ochroleuca* Lam., *G. dubia* Leers, *G. villosa* Huds.), Downy Hemp-nettle, is currently listed as one of 20 extinct native British plants (Wigginton 1999). It was first recorded by Ray (1670) from three sites in Yorkshire, and was last seen in Caernarvonshire in 1975 on the edge of an arable field.

Opinions on the status of *Galeopsis segetum* as a native or introduced species have varied. Many authors have accepted it as native, e.g. Bentham & Hooker (1858) and Clapham *et al.* (1952). Some authors have suggested it is introduced, e.g. Watson (1849) and Dunn (1905), while other authors are equivocal, e.g. Druce (1932) and Rich (2001). The status is important as we are considering a re-introduction program for the species in Britain.

In this paper we use the eight criteria of Webb (1985) and one of Preston (1986) to analyse whether *G. segetum* is likely to be native or introduced in Britain. In addition we introduce a tenth criterion which may help decide if plants are native or introduced: usage by man. Many different plants have been used over thousands of years for food, clothing, medicine, building, raw materials etc., and those that are useful are more likely to have been introduced to areas outside their native ranges than those which have not. For instance, *Triticum aestivum* L. and *Linum usitatissimum* L. have been widely grown in the British Isles for centuries and are clearly introductions. It is likely that herbs such as *Artemisia vulgaris* L. and *Tanacetum parthenium* (L.) Sch. Bip., of long-known medicinal value (e.g. Gerard 1633), are also widely introduced. Plants with no known use are less likely to have been moved outside their native ranges. As with the previously used criteria, this criterion cannot give a definitive answer in isolation. For example, *Chamaemelum nobile* (L.) All. has also been used as a medicinal plant (Gerard 1633) but is widely accepted as native.

METHODS

Data have been compiled from the literature, herbaria (**BEL, BIRA, BM, BRISTM, CGE, CMM, DBN, E, HAMU, HDD, HLU, K, LDS, LES, MANCH, MBH, NMW, NOT, OXF, RNG** and **RTE**; no material traced in **DCR, DHM, LCN, SFD, SUN, SWN** or **TBY**; herbaria abbreviations follow Kent & Allen 1984), the Biological Records Centre and the Threatened Plants Database, and correspondence with botanists.

On original specimens or photocopies of herbarium sheets from throughout its range, the following measurements were made:

1. Height from base of stem (excluding roots) to top of inflorescence or leaves (excluding flowers).
2. Number of nodes/pairs of leaves on main stem. It was sometimes difficult to discern separate nodes in the terminal inflorescences.
3. Number of nodes with branches. Typically the plants are branched below the middle, or after damage.
4. Length and width of largest leaf. This was usually selected from the middle of the main stem but sometimes in the lower inflorescence when stem leaves were not available.
5. Number of inflorescences. It was sometimes difficult to discern this for terminal inflorescence groups. Young, immature inflorescences were included.
6. Pressed corolla length. These are likely to be distorted by pressing, and sometime immature flowers may have opened during pressing.

Partial measurements were made for incomplete or damaged plants. Notes were also made on leaf tootingh, pubescence and flower colour. Cultivated material was ignored.

COMPARISON AGAINST NATIVE/INTRODUCED CRITERIA

FOSSIL EVIDENCE

There are no fossil records of *Galeopsis segetum* in Britain (Godwin 1975). However, it is insect pollinated so there are unlikely to be pollen records, and it is also unlikely that, being a species of dry open habitats, its seeds would have fallen in places where they could have been preserved in places such as peat bogs.

HISTORICAL EVIDENCE

The historical records date from Ray (1670), which is of equivalent date to the first records for many native British species.

HABITAT

Galeopsis segetum is almost universally stated to be an arable weed in Britain. Table 1 lists the number of times it has been recorded for each habitat in Britain, which supports its occurrence as an arable weed. It is usually noted from light sandy soils (e.g. Yorkshire) or plateau gravels (e.g. Berechurch).

In Europe, it is also recorded as an arable weed and from waste ground, but also occurs in the summer-warm, Hemp-nettle silicate screes (*Galeopsietalia segetum*) with *Anarrhinum bellidifolium* (L.) Willd., *Epilobium lanceolatum* Sebast. & Mauri and *Senecio viscosus* L. (Ellenberg 1988). Presumably these screes were its natural habitat before it moved into open ground created by arable farming. Hegi (1975) recorded it from scree, gravel, sand, boulders, scrubby woods, paths, edges and quarries, exclusively on lime-deficient soils. Hess *et al.* (1972) noted it from montane, rarely subalpine, fields on rather damp, stony, lime-deficient ground in warmer, sheltered locations in Switzerland. Ellenberg (1988) categorised it as an Oceanic therophyte occurring in generally well lit places but also in partial shade, in generally warmer, sheltered situations, in dry to damp soils which are usually acidic (but also sometimes more neutral) and nitrogen-deficient.

TABLE 1. HABITATS OF *GALEOPSIS SEGETUM* IN BRITAIN COMPILED FROM HISTORICAL LITERATURE AND HERBARIUM RECORDS. REPEAT RECORDS FOR THE SAME HABITAT AND SAME SITE ARE NOT INCLUDED

Habitat	Number of records
Cornfields	12
Other fields (excluding cornfields)	5
Beach	1
Hedgebank	1
Gravel pit	1
Not stated	21

There are no records from equivalent natural siliceous scree/rock natural habitats in Britain, the nearest possible one being the beach. Prehistorically, it could have colonised arable land from native colonies on open ground, such as sands and gravels associated with major river catchments. On balance, its absence from natural habitats suggests an introduced status.

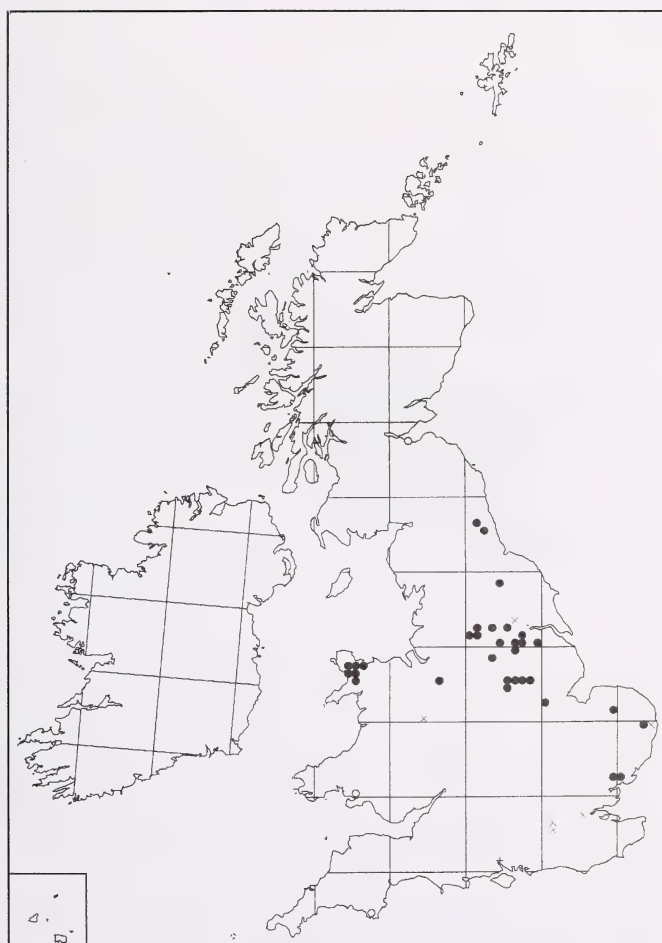


FIGURE 1. Distribution of *Galeopsis segetum* in Britain. ● native, ○ native status uncertain, + introduced, × error or probable error.

GEOGRAPHICAL DISTRIBUTION

Data on its distribution and occurrence in Britain have been compiled (Appendix 1) and are mapped in Figure 1. The distribution pattern is unlike that of any other species in Britain, and quite different to those of species normally regarded as introduced arable weeds such as *Ranunculus arvensis* L. or *Agrostemma githago* L. It is characteristic of arable areas with sandy soils in eastern England, with scattered records elsewhere.

In a wider context, *G. segetum* is a western European endemic and the British localities are certainly within the range over which it could be expected to be native from its distribution in Europe (Fig. 2). Townsend (1972) listed it as native in Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain and Switzerland, and introduced to Austria, Croatia, Czech Republic, Hungary and Rumania. Hegi (1975) noted that, like *Scutellaria minor*, it is one of the few purely Atlantic and, at the same time, strictly calcifuge Labiates.

The unique distribution pattern which fits within the European context provides support for its native status.



FIGURE 2. Distribution of *Galeopsis segetum* in Europe, redrawn from Meusel & Jager (1992). ● native. ○ introduced.

TABLE 2. COMPARISON OF MORPHOLOGY OF ENGLISH, WELSH AND CONTINENTAL MATERIAL OF *GALEOPSIS SEGETUM*

	England	Wales	Continent	T-test comparison of British vs Continental material
Height, cm	26.9 ± 0.9 (n = 64)	19.9 ± 0.72 (n = 75)	24.7 ± 1.04 (n = 97)	P > 0.19
No. nodes	6.2 ± 0.14 (n = 63)	6.4 ± 0.14 (n = 76)	8.1 ± 0.16 (n = 97)	P << 0.001
No. pairs branches	1.8 ± 0.15 (n = 71)	1.3 ± 0.15 (n = 80)	3.0 ± 0.16 (n = 96)	P << 0.001
Leaf length, mm	35.0 ± 1.17 (n = 79)	27.1 ± 1.24 (n = 83)	30.4 ± 1.01 (n = 99)	P > 0.5
Leaf width, mm	15.6 ± 0.66 (n = 79)	13.6 ± 0.91 (n = 83)	11.6 ± 0.53 (n = 99)	P < 0.001
Leaf l:w ratio	2.31 ± 0.04 (n = 79)	2.19 ± 0.05 (n = 83)	2.8 ± 0.07 (n = 99)	P << 0.001
No. inflorescences	5.2 ± 0.66 (n = 76)	4.75 ± 0.52 (n = 83)	8.9 ± 0.87 (n = 51)	P << 0.001
Flower size, mm	28.1 ± 0.39 (n = 69)	27.6 ± 0.29 (n = 82)	28.1 ± 0.51 (n = 21)	P > 0.5

Figures are means ± standard error (number of samples). The significance of differences between British (i.e. England and Wales) and continental material was assessed using a two-tailed T-test with variances not assumed to be equal.

GENETIC DIVERSITY

Genetic diversity has been assessed from comparative morphology.

The British material is morphologically fairly uniform in leaf shape, leaf toothings and general pubescence, with the exception of material from a gravel pit in Southampton which is considered to be an introduction. Specimens are variable in size, and consequently in development of lateral branches. The Welsh material measured included a large number of small specimens collected for the Botanical Exchange Club by J. E. Griffith, which has rather biased the sample. If these smaller plants are excluded, there are no significant size differences between English and Welsh material. The flower colour is usually yellow, though in many specimens the flowers have faded and without colour notes it is impossible to be certain. Baker & Nowell (1854) noted that at Cantley it varied with white- and purple-tipped flowers. Windsor (1873) noted it with reddish flowers at Llanfairfechan.

To judge from the European material in British herbaria, *G. segetum* is generally more variable on the continent than in Britain, though Hegi (1975) regarded it as varying very little. Comparative morphological data for Britain and Europe are given in Table 2. European material has more nodes and more lateral branches, and although often taller, the mean sizes are similar. The larger number of lateral branches results in more inflorescences. The pubescence is more variable, some plants being fairly densely hairy on the leaves and other being less so. The leaves vary from being strongly toothed to almost entire, and they are often significantly narrower than in British material. There is one especially striking infraspecific variant noted from France, Italy and Switzerland, var. *nepetifolia* (Timb.) Briq., which has smaller, roundly-toothed leaves. Many specimens from Switzerland are shorter, with many branches. The flower colour is also more variable, though the corolla mean sizes are identical to British material. A few specimens from France were noted with white corollas, and sometimes the corollas are reddish (var. *varians* (Desv.) Thell.).

Some European plants, especially from France, are morphologically similar to British material, and the British plants fit with the general pattern of variation observed in the species. The relative uniformity of British populations is also not indicative of repeated introductions.

FREQUENCY OF KNOWN NATURALISATION

Galeopsis segetum appears to be a persistent casual introduction in eastern Europe, but it is not a species which appears to have readily naturalised either in Britain or elsewhere in the world.

REPRODUCTIVE PATTERN

Galeopsis segetum is probably predominantly a summer annual in Britain and Europe. It is not known whether it is self-pollinated or self-compatible, but most herbarium sheets have ripe seed suggesting it is probably so. Thus if an isolated seed was introduced, it is likely to produce a plant which has the potential to regenerate itself.

POSSIBLE MEANS OF INTRODUCTION

Given that it is often an arable weed, its seeds could have been introduced as a contaminant of imported grain, though as stated above, the distribution pattern is not indicative of this. The seeds are significantly smaller than those of cereals, but like many other Labiate species could have been introduced accidentally. Alternatively, it could have colonised Britain naturally from seed washed down the major European rivers such as the Rhine (it is abundant in parts of the catchment in Germany) whilst there was open sands and gravels for it to colonise earlier in this interglacial.

ASSOCIATED INSECTS

There is no information available on insects specifically associated with it which could indicate native status, and the chance to investigate this in Britain has long since passed.

USAGE BY MAN

Galeopsis segetum is not listed in the main British herbals (e.g. Gerard 1633) or noted by Ray (1670) to have been used as a medicinal herb, but it has been more widely used on the continent for various illnesses (e.g. lung complaints, spleen illnesses, etc.; Hegi 1975). However, there is no clinical or pharmacological evidence to support its usage (Wichtl 1994). It is possible that it could have been introduced as a medicinal herb but there is no evidence to support it.

DISCUSSION

Strong support for native status is given by the unique geographical distribution in Britain which fits within its context of a western European endemic, and the genetic uniformity (with one exception) which also fits within the European pattern. The early date of introduction is also supportive of native status.

Evidence against native status is given mainly by its occurrence as an arable weed and presumed naturalisation in eastern Europe. Its seeds could have been introduced with grain, or possibly as a medicinal herb as it has been used in Europe. No conclusions can be drawn from the absence of fossil evidence, its reproductive pattern, or associated insects.

On balance, we place greater emphasis on the geographical and genetic pattern, and accept it as native in north Wales and eastern England. There is no strong evidence against native status. However, there is no definitive answer and there will always be an element of doubt for many such species. We differ from the interpretation of its natural range as stated in Clapham *et al.* (1987) and Stace (1997), who regard it as native in Caernarvonshire and introduced elsewhere in Great Britain. Their interpretation may result from the slightly ambiguous legend for the map in Perring & Walters (1962) which, in addition to extinct native and casual post-1930 records, indicates records 'before 1930' only without qualification as native or introduced (by implication they should have been accepted as native). The lack of herbarium material or other information do not allow decisions about its status in a number of other sites (e.g. Loddiswell).

Its acceptance as native in north Wales now establishes a firm basis for a reintroduction programme.

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APPENDIX 1. RECORDS OF *GALEOPSIS SEGETUM* IN BRITAIN.

The records are listed in alphabetical order within vice-counties. Erroneous, unconfirmed or rejected records where published or in databases are listed in square brackets.

V.C. 3, SOUTH DEVON

Loddiswell (Blackdown Camp), 1931, W. C Bennett, T. Edmonds & D. A. (?) (Martin & Fraser 1939; no specimen traced).

V.C. 9, DORSET

[Bowen (2001) regarded old reports as errors for *G. angustifolia*; two specimens in **HLU** purporting to be *G. segetum* are both wrongly identified.]

V.C. 11, SOUTH HANTS

Southampton, in a gravel pit on Portswood Road near Belle Vue House, July 1837, R. Bligh (**E**). This specimen differs in leaf tothing and pubescence from other British collections.

V.C. 16, WEST KENT

[There are records for a small chalk pit out of Darenth Wood, and roadside from Dartford Heath to Green Street Green, 1833–1835, D. Cooper (Cooper 1836) which were accepted by Hanbury & Marshall (1899) but have never been verified by other botanists and for which no specimens have been traced in **RTE** or **WAR**.]

V.C. 17, SURREY

[Thames Ditton?, *H. C. Watson* (**E**); this specimen was probably sent by H. C. Watson from Thames Ditton where he lived and were not collected there wild.

High bank just before you reach Mickleham, on the left, and, Dorking chalk pit, 1833–1835, D. Cooper (Cooper 1836); like the Kent records without vouchers cited above, these are rejected, as they were by Salmon 1931.]

V.C. 19, NORTH ESSEX

Alresford, cornfield, 25 July 1873, 27 September 1873, 25 July 1874 and 16 August 1879, *E. G. Varenne* (**BIRM, BM, CGE, MANCH, OXF**).

Berechurch, in considerable abundance in one cornfield, 1846, and cornfields, 1851, *E. G. Varenne* (**BIRM, BM, E, HAMU, LIV, NMW**; Benthall 1848, Gibson 1862). Much if this material is short and damaged, presumably during harvesting the crops.

Elmstead, Villa Ponds, 1862, W. L. P. Gamons (Gibson 1862, no specimen in **SWN**).

V.C. 25, EAST SUFFOLK

[St Olaves, 'among a very luxuriant growth of rushes there grew, to us, a very unusual state of *Galeopsis* not yet determined. It was quite as tall as *G. tetrahit* but differs from that species in the stem and flowers. It comes nearer to what we raised from seeds sent to us by a Continental correspondent, who gave them the name *G. villosa*. The flowers were pure white in dense whorls, and the stem was hairy rather than prickly, and not swollen above the joints', Anon. (1862); accepted as *G. segetum* by Hind (1889) but the height, flowers and habitat are incorrect and the record is rejected.]

V.C. 27, EAST NORFOLK

Geldeston, undated, *Anon.* (**BM**).

V.C. 36, HEREFORD

[Specimens in many herbaria from Sedbury and variously dated c. 1903 onwards were cultivated by S. H. Bickham from material he collected near Bangor 1902 and 1903, and have not been consistently labelled as cultivated.]

V.C. 38, WARWICK

[Cited by Watson (1849) as probably an error of one of his correspondents.]

V.C. 40, SHROPSHIRE

[Casual in Botanical Division VIII, no other details (Lloyd & Rutter 1957); there are insufficient grounds on which to accept this record.]

V.C. 44, CARMARTHEN

Llangennech (Vale of the Lougher), 1912, D. Hamer (no specimen traced; Hamer 1912 states most species were confirmed by A. Bennett, though whether this one was or not is not known).

V.C. 49, CAERNARVON

Abergwyngregyn [Aber], beach near, undated but pre-1821, H. Davies (**BM**). Near Aber, July 1823 and August 1830, W. Wilson (**BM**, **CGE**, **NMW**).

'Bangor'. This area has numerous collections, but most are simply labelled as Bangor or near Bangor and there is no confirmation it actually occurred at Bangor itself. Griffith (1895) cites 'F[V]odal Ucha, F[V]odal Ganol, Goetra, etc.' and the records traced which may relate to these are as follows:

Fodol Farm: In a cornfield at Fodol Farm, near Bangor, 8 August 1888, J. E. Griffith (**BM**, **BEL**, **BRISTM**, **CBN**, **HLU**, **MANCH**, **NMW**, **OXF**). Near Fodol, July 1900, G. C. Druce & J. E. Griffith (**OXF**). Near Vodal, August 1900, J. E. Griffith (**BIRM**, **BM**, **BEL**, **BRISTM**, **DBN**, **E**, **OXF**, **RNG**). Near Vodal, 30 August 1901, J. E. Griffith (**BEL**, **BIRM**, **BM**, **CGE**, **LIV**, **MANCH**, **NMW**, **OXF**). Vodal Lecha/Habodel, fair plenty in corn, August 1926, Miss E. Vachell, Mrs E. Knowling, Lady J. C. Davy & Ms A. M. David (**NMW**; there is also a detailed account of the search in E. Vachell's diaries). Fodol Farm, 20 July 1957, Mrs W. B. Watt (Biological Records Centre, cited as Port Dinorwic by Ellis 1983). Fodol Farm, south of Hafodol Farm, 1975, J. H. Fremlin (Biological Records Centre).

Fodol Ganol: Fodol Ganol, 6 August 1916, M. L. Wedgwood (**MBH**). Fodol Ganol, Dinorwic, 29 August 1926, T. J. Foggitt (**BM**, **CMM**, **HDD**, **LDS**).

Goetre: In the cornfields and on the earth walls about 2 miles from Bangor on the road to Llanberis, August 1773, Anon. (**BM**). Potato field 2 miles from Bangor on the Caernarvon road, 22 August 1830, J. E. Bowman (**BM**). In a cornfield on the right hand, two and a half miles from Bangor on the new road to Caernarvon, 6 August 1840, J. B. Wood (**BM**, **MANCH**, **TBY**). About 1 mile east of railway between Treborth and Caernarvon, Port Dinorwic, 14 August 1905, A. O. Hume (**RNG**).

Hafodol-uchaf. Upper Vodal Farm, in plenty in a cornfield, 12 August 1927, E. M. Reynolds (**BIRA**). Hafodol Farm, Bangor, 8 August 1936, H. S. Redgrove (**BM**). Hafodol Uchaf, 4 September 1948, C. E. Raven (**RNG**). This farm is next door to Fodol Farm and the records could be from the same place.

Menai Bridge: Near Menai Bridge, July 1852, H. S. Fisher (**LIV**). Near Menai Bridge/corn field near Bangor, 23 & 24 August 1852, W. S. Skellon (**LIV**, **MANCH**). Near Menai, Carnarvon, August 1919, G. C. Druce (**OXF**).

Llanfairfechan: I have met with a form of it at Llanfairfechan ... the flowers however being reddish, 1868, J. Windsor (Windsor 1873); this record is accepted as he obviously knew both *G. segetum* and *G. angustifolia* in Yorkshire.

Other material which it has not been possible to ascribe to any of these localities is as follows: Bangor, near, 1802, H. Davies (**K**). Bangor, 1806, D. Turner (**E**, **HAMU**, **K**). Bangor, August 1826, W. Wilson (**CGE**). Bangor, September 1840, J. Ralfs (**MANCH**). Bangor, 1843, Anon. (**LIV**). Near Bangor, 1850, W. R. Crotch (**BM**, **CGE**, **CMM**, **E**, **MANCH**). Bangor, June 1888, Anon. (**LIV**). Near Bangor, 1890, August 1893, August 1895, J. E. Griffith (**BEL**, **BIRM**, **BM**, **BRISTM**, **CGE**, **DBN**, **E**, **HDD**, **LIV**, **K**, **OXF**, **MANCH**, **NMW**, **NOT**). Bangor, undated, Miss E. Potts (**LIV**). Bangor, August 1901, H. J. Riddelsdell (**BM**). Cultivated ground/arable lands, Bangor, 4 August 1902, 4 August 1903 and September 1903, S. H. Bickham (**BM**, **CGE**, **E**, **LDS**). Bangor, August 1904, E. Drabble (**BM**).

V.C. 52, ANGLESEY

Anglesey, 1814, D. Turner (**CGE**). Anglesey, August 1852, W. S. Skellon (**BIRM**).

V.C. 53, SOUTH LINCOLN

Bourne, 28 July 1838, J. Dodsworth (Gibbons 1975 cites a specimen in **LLN** but it could not be traced in 2001, Mrs R. Weston, pers. comm.)

V.C. 54, NORTH LINCOLN

Carrhouse, 1899, S. Hudson (Gibbons 1975; no specimen traced).

Twigmoor, sandy field near, Oolite, July 1877, *W. Fowler* (**BM**, **CGE**, **CMM**; Gibbons 1975).
 [A record for Tetley Hall, variously dated 1981–1988 and by various apparent recorders though originally V. Wilkin in at least three databases, is a data-processing error for *G. tetrahit* which was the species recorded originally; pers. comm. Mrs R. Weston and V. Wilkin, 2001].

V.C. 56, NOTTINGHAM

Annesley, near, undated, B. Eddison (Howitt & Howitt 1963, citing contribution to Eddison's Flora 1839, not seen). A rare plant only once found by us between Kirkby and Linby, 1880, Mrs A. Gilbert (Gilbert 1880).

Balderton, cornfields (Ordoyno 1807).

Barnby in the Willows, cornfields (Ordoyno 1807).

Coddington, cornfields (Ordoyno 1807).

Everton Carr, sandy cornfield, 30 August 1918, *Mrs C. I. Sandwith & N. Y. Sandwith* (**LDS**, **K**; Howitt & Howitt 1963). They revisited the site on 9 August 1939 but this time found a form of *G. speciosa* without any coloration on the lip (**BM**).

Farnsfield, cornfields (Ordoyno 1807).

Newark-on-Trent, near. W. Hudson (Turner & Dillwyn 1805). Near Newark, August 1860, *H. Ibbotson* (**NOT**).

Nottingham, undated, *J. Dickson* (**E**).

Oxton Forest, 1839, G. Howitt (Howitt 1839).

[High Park, Blidworth, September 1862 in **CGE** = *G. tetrahit*]

V.C. 58, CHESHIRE

Acton Grange, September 1905, *E. Drabble* (**BM**).

V.CC. 59 AND 60, SOUTH AND WEST LANCASTER

[Cited for Lancashire by Hudson (1798) but not accepted subsequently (e.g. Watson 1849). Druce (1932) cited an erroneous record for v.c. 59 but the original reference has not been traced.]

V.C. 61–65, YORKSHIRE

Yorkshire, cornfields, undated, *G. Don* (**E**). Yorkshire, 1820, *W. J. Blake* (**OXF**). Yorkshire, undated, *A. Bloxham* (**CGE**).

V.C. 61, SOUTH-EAST YORK

On the Wolds (Baines 1840; no further details or specimens traced).

V.C.62, NORTH-EAST YORK

Thirsk, near (Baines 1840; no further details or specimens traced).

V.C. 63 SOUTH-WEST YORK

Barnby Dun, in a sandy field, July 1885, *H. Johnson* (**CMM**, Lees 1888).

Bawtry, in a cornfield near, July 1803, J. Salt (Lees 1888; specimen supposed to be in **SFD** but not traced in 2001).

Beacon Hill, Halifax, 1820, herb. R. Leyland ('long since disappeared' Baines 1840). Beacon Hill near Halifax, sparingly, undated but pre-1867, *Anon.* (**K**). [Lees 1888 erroneously cites this for 1775, J. Bolton].

Cantley, abundant in cornfields, varying with white- and purple-tipped flowers, undated, G. E. Smith (Baker & Nowell 1840).

Near Castle Hill, Huddersfield (Hobkirk 1859).

Darfield (Ray 1670).

'In cultivated fields about Fixby, near Rastrick. It is found amongst oats, peas, potatoes, etc.' (Anon. (?J. Bolton) 1775; Lees 1888, Crump & Crossland 1904).

Hall Bower, Huddersfield (Hobkirk 1859).

Huddersfield, 1876, P. Inchbald (Lees 1888).

[Records cited for 'Selby' refer to the Gateforth-Brayton record in v.c. 64.]

Sheffield (Ray 1670).

Wakefield (Ray 1670).

V.C. 64, MID-WEST YORK

Between Gateforth and Brayton near Selby, undated, probably collected by *J. Backhouse* (**E**; Lees 1888). Gateforth, near Selby (Baines 1840). Gateforth, undated, C. H. Middleton (Lees 1888). Selby, undated, *E. Drabble* (**BM**).

V.C. 66, DURHAM

Birtley, two or three examples on the edge of a cornfield, 1917, J. W. H. Harrison (Graham 1988). Ryton/Winlaton/ Crawcrook/Stephen's Hall: the various combinations of these laolcites seem to belong to the same area, which are now part of the outskirts of Gateshead (L. Jessop, pers. comm. 2001). Near Ryton, 1829, *W. C. Telyan* (**HAMU**, not in **WAR** as cited by Graham 1988). Between Ryton and Winlaton, corn fields, 1832, July 1833 and July 1839, and near Stephen's Hall, 15 October 1833, *R. B. Bowman* (**BIRM**, **BM**, **CGE**, **DBN**, **HAMU**, **OXF**). 1833, *W. Christy* (**CGE**). Ryton, 1833, herb. *C. Conway* (**NMW**). Ryton, 1839, *J. E. Bowman* (**BEL**, **BM**, **CGE**, **E**, **RNG**). Ryton, 1855, *Anon.* (**NMW**). Cornfield, June 1870, *M. A. Johnson* (**LES**). Ryton, undated, *W. A. Stables* (?). Ryton, Crawcrook, Darlington, undated, *N. J. Winch* (**E**).

V.C. 71 ISLE OF MAN

[Rejected as an error for *G. speciosa* by Allen (1984).]

V.C. 83, EDINBURGH

Field at Lochend(s) near Edinburgh, July 1836, *G. McNab* (**K**). This is the first record for Scotland, though there is an element of doubt as the specimen is mixed with another of *G. speciosa* and the collectors' surname is written 'Macnab' though the soil on the roots of the specimens looks similar. Lochend is a small district in Edinburgh noted for other rarities, and for a small area of serpentine rock (D. McKean, pers. comm. 2001).

NOTE ADDED IN PRESS

There are two records for *Galeopsis segetum* in the recently published *New atlas of the British and Irish flora* (Preston *et al.* 2002) which require comment:

The record for v.c. 37 in SO75 is based on a record by Gaut (1918) where it appeared in the second year following clearance of a part of Long Coppice on sandy and stony soil (J. Day, pers. comm., 2002). R. G. Gaut was a careful, reliable observer with an excellent reputation, and the soil type is correct. This is the only record for the vice-county which has not been reported again, and it is not a species of woodland (*Galeopsis tetrahit* is more likely). No herbarium material is known, and the record is best regarded as unconfirmed.

The record for v.c. 92 in NJ60 is now thought to be an error (K. Fallowfield, pers. comm., 2002).

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Performance of *Festuca arundinacea* Schreb. (Poaceae) populations in England

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ABSTRACT

The native grass *Festuca arundinacea* Schreb. is widespread in grasslands across the United Kingdom, and is considered to be highly variable and represented by a number of strains and ecotypes. A field survey of 151 individuals from 16 populations in England in which eight morphological traits, canopy cover, and the number of vegetative and flowering tillers was measured confirmed this variability. Principal Components Analysis showed a strong principal gradient of variability reflecting a continuum of mean individual size among populations. Among-population variability in size exceeded within-population variability supporting the view of extreme variability in native habitats. Populations in the most productive habitats had the largest individuals (e.g., mesotrophic grasslands and roadside verges with >100 vegetative tillers and >40 flowering tillers per individual) while stressful habitats supported relatively small individuals (for example an individual growing in coastal strand with eleven vegetative and three flowering tillers). There was no evidence of geographic structuring of populations with respect to morphological variability or any relationship to associate species composition among sites. Detrended Correspondence Analysis of associate species abundance indicated three types of community reflecting coastal, inland, and limestone substrate sites. Fungal endophyte infection was uncorrelated with plant size, but was significantly related to the plant communities in which *F. arundinacea* populations occurred. Inland populations had low endophyte infection frequencies (five of six < 20%), whereas coastal populations and populations growing over limestone often had 100% of individuals endophyte infected.

KEYWORDS: endophytes, morphological measurement, ordination, phenotypic variation, tall fescue.

INTRODUCTION

The grass *Festuca arundinacea* Schreb. is native to Great Britain and Europe (Gibson & Newman 2001). It is also cultivated worldwide as a forage and turf grass (Sleper & West 1996). In the United States alone some 14 million ha of *F. arundinacea* have been planted. In Great Britain, *F. arundinacea* is widespread, occurring as a component of 19 National Vegetation Classification (NVC) communities ranging between mesotrophic and calcareous grasslands, mires and swamps, and maritime communities, as well as weedy open habitats (Gibson & Newman 2001). Taxonomic descriptions of *F. arundinacea* describe the grass as being variable with different strains occupying distinct habitats (Hubbard 1984). Whilst there are a number of published reviews of the species (e.g. Sleper & West 1996), including a recent Biological Flora account (Gibson & Newman 2001), an account quantifying morphological variation among and within native habitats is not available. To date, studies have concentrated on ecotypic variation in morphology expressed in common-garden experiments (Chatterjee 1961; Robson 1968; Grynia 1980; Ueyama *et al.* 1992; Ueyama & Sato 1994). Other studies have concentrated on physiological comparisons among ecotypes of *F. arundinacea* (e.g., Stoddart 1995) and its agronomic importance (Buckner & Bush 1979).

Members of the grass family frequently exhibit substantial morphological variation that can be an expression of phenotypic plasticity or ecotypic variation. Much of this variation, including the potential range of phenotypic plasticity, is genetically based reflecting relatively high levels of genetic diversity and divergence among grass populations compared with other plant groups (Godt & Hamrick 1998). Grime *et al.* (1986) suggest that plants from highly productive habitats will exhibit higher morphological plasticity than plants of the same species from unproductive habitats.

Although genetic diversity levels in some populations of *F. arundinacea* are known (e.g. Sugiyama *et al.* 1980; Ceccarelli *et al.* 1992), the relationship to morphological diversity in native habitats is poorly understood (Ueyama & Sato 1994). Morphological development of *F. arundinacea* plants is likely to reflect the response of different genotypes to local environmental conditions (Sugiyama 1995), especially soil moisture (Grynja 1980). Indeed, Trist (1991) suggested that *F. arundinacea* var. *stricta* (Hack.) K. Richt was, in fact, an environmentally-induced variant and not a genetically distinct variety.

The objective of this study was to quantify the level of morphological variability of *F. arundinacea* within and among populations from sites representing a wide variety of native habitats across southern England. In view of the known ecotypic variation in *Festuca arundinacea* and its widespread distribution in many habitats, we hypothesised the occurrence of habitat-related morphological variation in this species. In common with other grasses (Godt & Hamrick 1998), we expected within-population variation to exceed among-population variation.

MATERIALS AND METHODS

FIELD WORK

Native populations from England were surveyed in June and July, 1999. Sites were chosen to represent the diversity of vegetation types in which *F. arundinacea* occurs naturally (Table 1). The sites were unimproved and ungrazed except by rabbits, and by sheep at Bolton Le Sands. The site at Cressbrook Dale was formerly stock-grazed. A number of the sites are mown at least once seasonally (Bibury Verges, Little Dartmouth 1, Drayton, Paiges Meadow, Wineham Lane, and probably Polegate Trail). Eight to ten individuals were randomly selected at each of the 16 sites. Morphological measurements were made upon each selected individual. These were (1) the number of flowering and vegetative stems per individual, (2) the length and width of the longest leaf on 5–8 vegetative tillers, and (3) on five reproductive tillers, the length of the flowering panicle, length and width of the uppermost culm leaf, culm height, and number of spikelets per panicle. Gregariousness was estimated for each individual on a 1 to 5 scale reflecting plants growing in a turf (1) to compact clumps (5). The canopy cover over bare ground of *F. arundinacea*, other grasses, herbs, and woody plants were estimated in a 0.75 m² circular quadrat centred around each individual. The abundance of associated species including *F. arundinacea* across each site were estimated using the DAFOR scale (D = dominant, A = abundant, F = frequent, O = occasional, and R = rare). The species abundance data were used to assign each site to a National Vegetation Classification (NVC) community type (Rodwell 1991a, b, 1992, 1995, 2000). Leaf sheath samples were collected and preserved in alcohol for later investigation of fungal endophyte status and are reported elsewhere (Spyreas *et al.* 2001a). Voucher specimens of a representative plant of *F. arundinacea* from each site are deposited in the herbarium at Southern Illinois University Carbondale. Nomenclature follows Stace (1997).

DATA ANALYSIS

Principal Components Analysis (PCA) was used to summarize variation of individuals within and among populations. The PCA was based upon the correlation matrix from values of ten morphological variables from 151 individuals sampled at 15 of the 16 sites (the Salisbury Plain site was excluded because of incomplete data). Significance of PCA components and loadings on significant components were tested using parallel analysis (Franklin *et al.* 1995). Correlations between independent variables, the PCA components, and DCA axes (see below) were tested using Spearman's Rank correlation incorporating a Bonferroni adjustment to avoid Type I errors. The first component of an initial PCA (referred to hereafter as PCA₁) was strongly related to plant size (see results). Subsequent components were non-significant and uninformative because of this

overriding size effect. To explore further variation among individuals, the value for each morphological variable was regressed against the PCA₁ first component scores (all regressions were significant at $P < 0.05$). The correlation matrix of the residuals from these regressions were used in a second PCA (i.e., PCA₂). PCA₂ was thus based upon data in which the strong size effect had been removed.

Within- and among-population variability was assessed by comparing variance component estimates with separate one-way ANOVAs of morphological variables and the PCA₁ and PCA₂ component scores. In this analysis, the site in which a population occurred was treated as a random effect. With one treatment (i.e. site), two variance components were estimated, site and residual variance, with the former providing an estimate of among-population variability and the latter (technically the variance of the site means), estimating within-population variability.

Analyses were conducted using SAS-PC Ver 8.0 and JMP Ver 4.0.2 running under Windows 2000.

The relationship between sites based upon the abundance of *F. arundinacea* and associated species was assessed using Detrended Correspondence Analysis using PC-ORD (McCune & Mefford 1999). Species occurring at fewer than two sites were excluded from the analysis leaving a matrix of 79 species. The option to downweight rare species was employed. The correlation between DCA axes and morphological variables associated with *F. arundinacea* from each site, PCA component scores, and associated species diversity was tested using Spearman Rank correlation at a Bonferroni adjusted significance level.

Geographic substructuring of the populations based upon associate species abundance and morphological variation of *F. arundinacea* was evaluated by calculating Mantel z-test statistics (in PC-ORD, McCune & Mefford 1999) between Sorenson's Distances among sites for the species abundance or morphological character matrices, and a matrix of inter-site geographic distances.

RESULTS

MORPHOLOGICAL VARIABILITY

Morphological data from the 16 populations are shown in Table 2. Individuals of *F. arundinacea* ranged in size from a plant with only two tillers growing in an arable field margin (Wytham; mean of 5.8 tillers per plant) to a plant with 386 tillers growing on waste ground alongside a footpath (Polegate; mean of 194 tillers per plant). Similarly, the mean height of flowering tillers ranged from 62 cm at coastal strand (Mill Bay) to 1.6 m in individuals at a disused rail track (Harrington) (the tallest flowering tiller was 2.3 m, also at this site).

Fecundity was calculated as the product of flowering tiller number times mean number of spikelets per panicle, and ranged from a mean of 37 spikelets per plant in the field margin at Wytham to 5,779 spikelets per plant at Berrow saltmarsh. Across all sites, the plant with lowest fecundity had 25 spikelets (Wytham), compared with the largest value (16,466 spikelets at Berrow). Fecundity was highly correlated with the morphological variables (all $P < 0.0001$), and also with *F. arundinacea* cover ($r = 0.50$, $df = 141$, $P < 0.0001$), and cover of herbs and woody plants ($r = 0.21$ and 0.33 , $P = 0.01$ and $P < 0.0001$, respectively). Fecundity was negatively correlated with cover of grass and bare ground ($r = -0.44$ and -0.30 , $P < 0.0001$ and $P = 0.0003$, respectively).

The morphological variables, including fecundity, were highly correlated with each other (Spearman's Rank correlation, all $P < 0.05$) indicating that the largest plants not only had larger leaves, more vegetative tillers and taller flowering stems, but had more flowering stems with more spikelets.

PCA₁ extracted one significant component (eigenvalue = 5.30, variance accounted for = 53%); other components were not significant according to cut offs for eigenvalues established using parallel analysis. The first component of PCA₁ had high positive loadings for all of the morphological variables (significantly so for leaf length, culm leaf length, height, panicle length and spikelet number), reflecting the high correlation among the morphological variables. The component scores were subsequently used as an integrated measure of plant size allowing a ranking of populations (Fig. 1). There was a continuum in size from one population to another.

TABLE 1. CANOPY COVER OF PLANTS, NUMBER OF SPECIES, NVC VEGETATION TYPE, AND DOMINANT SPECIES AT SITES IN WHICH *F. ARUNDINACEA* WAS SURVEYED (SEE FOOTNOTE FOR LOCATIONS). THE CHALK GRASSLAND (A CG3 DOMINATED BY *BROMOPSIS ERECTA*) SHOWN IN TABLE 2 IS NOT INCLUDED BECAUSE OF INCOMPLETE DATA

Variable	Habitat				
	Arable field hedgerow ¹	Arable field margin ²	Carboniferous limestone grassland ³	Cliff-top grassland ¹⁴	Cliff-top grassland ²⁵
Canopy cover (%) [*]					
<i>F. arundinacea</i>	33.8	5.0	9.0	14.5	6.0
Herbs	2.8	3.1	**	50.5	27.8
Other grasses	63.1	85.9	82.0	31.0	52.0
Woody plants	0.4	0	8.5	16.0	31.5
Bare ground	0	6.8	0.5	0	1.5
Total cover	100.1	94.0	95.5	112.0	117.3
No. of species	16	10	21	16	24
Dominant species (plus other characteristic species)	<i>Dactylis glomerata</i> , <i>Holcus lanatus</i>	<i>Lolium perenne</i> , <i>Poa trivialis</i>	No dominant species. Abundant species included <i>Arrhenatherum elatius</i>	<i>Festuca arundinacea</i> , <i>Pteridium aquilinum</i>	<i>Festuca rubra</i> subsp. <i>rubra</i> , <i>Anthoxanthum odoratum</i>
N.V.C. vegetation type	MG1	MG7a	MG1e	MC9	MC9
Variable	Habitat				
	Hay meadow ⁶	Roadside hedge ⁷	Roadside verge ¹⁸	Roadside verge ²⁹	Salt marsh ¹¹⁰
Canopy cover (%) [*]					
<i>F. arundinacea</i>	26.5	22.5	35.0	45.9	60.6
Herbs	16.0	49.5	22.5	28.6	15.7
Other grasses	65.5	17.5	26	42.7	17.1
Woody plants	0.5	19	0	0	18.8
Bare ground	0.2	0	28	0.9	0
Total cover	108.5	108.5	83.5	117.2	112.2
No. of species	24	26	22	23	22
Dominant species (plus other characteristic species)	<i>Dactylis glomerata</i> , <i>Holcus lanatus</i> , <i>Rumex obtusifolius</i>	<i>Festuca arundinacea</i> , <i>Rubus fruticosus</i> agg.	<i>Arrhenatherum elatius</i> , <i>Heracleum sphondylium</i>	<i>Arrhenatherum elatius</i> , <i>Festuca arundinacea</i>	<i>Festuca rubra</i> subsp. <i>rubra</i> , <i>Phragmites australis</i> , <i>Rubus fruticosus</i> agg.
N.V.C. vegetation type	MG7b	MG1b	MG1b	MG1b	S26b/MG12b

TABLE 1. CONTINUED

Variable	Habitat				
	Salt marsh ² ¹¹	Strandline 1 ¹²	Strandline 2 ¹³	Waste ground 1 ¹⁴	Waste ground 2 ¹⁵
Canopy cover (%) [*]					
<i>F. arundinacea</i>					
Herbs	11.0	13.5	16.5	41.5	46.0
	**	16.5	29.5	**	5.0
Other grasses	68.5	32	17.2	47.0	34.0
Woody plants	0	26	0.5	6.5	14.0
Bare ground	20.5	11.5	39.3	5.0	0.5
Total cover	78.5	88.0	63.7	94.5	99.0
No. of species	21	25	11	32	21
Dominant species (plus other characteristic species)	No dominant species. Abundant species included <i>Agrostis stolonifera</i> , <i>Festuca rubra</i> , subsp. <i>rubra</i> , <i>Glaux maritima</i> & <i>Trifolium repens</i>	<i>Carex pendula</i> , <i>Festuca arundinacea</i>	<i>Festuca rubra</i> subsp. <i>rubra</i> , <i>Lolium perenne</i> (with <i>Elytrigia juncea</i> ssp. <i>boreoatlantica</i>)	<i>Festuca arundinacea</i>	<i>Deschampsia caespitosa</i> , <i>Festuca arundinacea</i> , <i>Rubus fruticosus</i> agg.
N.V.C. vegetation type	MG12	W2	SD2/SD4	MG1	MG9b

* Estimated in 0.75 m² circular plots centered around each individual.

** Cover of herbs included in grass category.

Site locations: 1. Drayton, Warwickshire (SP165550), 2. Wytham Woods, Oxfordshire (SP461081), 3. Cressbrook Dale, Derbyshire (SK172744), 4. Little Dartmouth 3, Devon (SX874492), 5. Little Dartmouth 5, Devon (SX874492), 6. Paiges Meadow, West Sussex (TQ315245), 7. Little Dartmouth 1, Devon (SX874492), 8. Bibury Verges, Gloucestershire (SP119048), 9. Wineham Lane, Bolney, West Sussex (TQ238215), 10. Berrow Marsh, Somerset (ST290518), 11. Bolton-le-Sands, Lancashire (SD479693), 12. Fairlight Glen, East Sussex (TQ853107), 13. Mill Bay, Devon (SX742383), 14. Disused railway trackside, Harrington, Cumbria (NX998248), 15. Cuckoo Trail footpath, Polegate, East Sussex (TQ584056). Data for canopy cover and morphological data in Table 2 for Paiges Meadow, Polegate, Little Dartmouth 3, Wytham, Berrow, and Fairlight Glen were published previously in Gibson & Newman (2001).

TABLE 2. MEAN (± 1 SE) MORPHOLOGICAL MEASUREMENTS AND COUNTS FROM DIFFERENT HABITATS FOR *FESTUCA ARUNDINACEA*. THREE MEASUREMENTS WERE MADE ON EACH OF 10–12 PLANTS PER HABITAT

Variable	Habitat			
	Arable field hedgerow	Arable field margin	Carboniferous Limestone grassland	Chalk grassland†
Canopy cover (%)	33.8 $\pm$ 6.2	5.0 $\pm$ 0.0	9.0 $\pm$ 1.2	—
Panicle length (cm)	19.2 $\pm$ 0.9	14.0 $\pm$ 1.2	30.1 $\pm$ 1.4	25.6 $\pm$ 1.1
Spikelets per panicle	43.0 $\pm$ 6.2	30.6 $\pm$ 3.0	100.2 $\pm$ 8.7	95.2 $\pm$ 7.9
Leaf length (cm)	54.6 $\pm$ 2.1	26.9 $\pm$ 2.8	69.1 $\pm$ 3.2	35.3 $\pm$ 3.7
Leaf width (mm)	6.0 $\pm$ 0.3	4.3 $\pm$ 0.3	7.4 $\pm$ 0.3	3.9 $\pm$ 0.5
Upper culm leaf	Length (cm)	11.7 $\pm$ 1.5	15.7 $\pm$ 2.3	11.3 $\pm$ 3.6
	Width (mm)	4.9 $\pm$ 0.5	4.3 $\pm$ 0.4	4.0 $\pm$ 1.1
Culm height (cm)	117.7 $\pm$ 3.8	93.9 $\pm$ 4.2	155.2 $\pm$ 4.8	110.3 $\pm$ 5.5
Flowering/vegetative tillers per individual	5.5/30.6	1.3/4.5	5.5/13.1	9.4/11.8
Gregariousness*	4.3 $\pm$ 0.1	5.0 $\pm$ 0.0	3.7 $\pm$ 0.3	—

Variable	Habitat			
	Cliff-top grassland 1	Cliff-top grassland 2	Hay meadow	Roadside hedge
Canopy cover (%)	14.5 $\pm$ 1.4	6.0 $\pm$ 0.7	26.5 $\pm$ 5.1	22.5 $\pm$ 3.1
Panicle length (cm)	23.1 $\pm$ 1.5	22.3 $\pm$ 2.2	19.5 $\pm$ 1.7	32.4 $\pm$ 1.7
Spikelets per panicle	90.1 $\pm$ 9.4	79.8 $\pm$ 19.2	56.0 $\pm$ 7.3	133.9 $\pm$ 9.7
Leaf length (cm)	53.5 $\pm$ 4.2	43.2 $\pm$ 3.0	38.5 $\pm$ 2.6	66.2 $\pm$ 3.8
Leaf width (mm)	6.3 $\pm$ 0.2	5.4 $\pm$ 0.4	6.0 $\pm$ 0.3	6.9 $\pm$ 0.4
Upper culm leaf	Length (cm)	13.0 $\pm$ 1.8	14.2 $\pm$ 3.1	12.4 $\pm$ 1.5
	Width (mm)	5.0 $\pm$ 0.5	4.2 $\pm$ 0.5	5.4 $\pm$ 0.5
Culm height (cm)	127.7 $\pm$ 4.9	109.7 $\pm$ 5.6	97.0 $\pm$ 6.3	139.1 $\pm$ 7.5
Flowering/vegetative tillers per individual	6.6/22.3	2.3/3.6	20.5/68.4	12.7/27.2
Gregariousness*	4.7 $\pm$ 0.2	5.0 $\pm$ 0.0	4.3 $\pm$ 0.3	5.0 $\pm$ 0.0

Some populations consisted of smaller individuals (low component scores) than in other populations (e.g., the saltmarsh population from Bolton-le-Sands compared with the populations at Berrow salt marsh and Polegate trail: see Fig. 1 and Table 2). The scores from this component were positively correlated with the canopy cover and fecundity of *F. arundinacea* (Spearman's $r = 0.40$ and 0.74 , $df = 139$, $P < 0.0001$, respectively), woody plant cover ($r = 0.53$, $P < 0.0001$), and negatively correlated with the combined cover of herbs and other grasses ($r = -0.31$, $P = 0.0002$) and cover of bare ground ($r = -0.47$, $P < 0.0001$).

To address Grime *et al.*'s (1986) hypothesis relating morphological plasticity to productivity, the regression was calculated between variance of PCA₁ component scores (as a measure of plasticity), and total plant cover per site (habitat productivity). Estimated in this manner, morphological plasticity was positively, albeit poorly related to productivity, when data from the Harrington site is excluded as an outlier (PCA₁ variance = $-0.10 + 0.0035$ (total cover), adjusted $R^2 = 0.18$, $P = 0.07$).

Three significant PCA₂ components were extracted, of which components 1 and 2 had significant loadings (eigenvalues = 2.57 and 2.03, variance accounted for = 26% and 20%, for components 1 and 2, respectively). There were no significant variable loadings on component 3, and it was not considered for further interpretation. Parallel analysis showed that Component 1 was significantly negatively related to the number of vegetative tillers, and positively related to panicle length. Component 2 was negatively related to the length and width of the youngest, fully expanded culm leaf. There was considerable overlap in the distribution of populations with respect

TABLE 2. CONTINUED

Variable	Habitat			
	Roadside verge 1	Roadside verge 2	Salt marsh 1	Salt marsh 2
Canopy cover (%)	35.0 ± 5.6	45.9 ± 5.3	60.6 ± 11.1	11.0 ± 2.2
Panicle length (cm)	20.5 ± 1.3	18.8 ± 1.1	30.9 ± 1.6	12.1 ± 0.9
Spikelet number	57.9 ± 7.4	41.6 ± 3.1	131.3 ± 14.2	39.6 ± 2.7
Leaf length (cm)	57.7 ± 6.5	34.6 ± 2.4	63.3 ± 6.7	23.8 ± 4.0
Leaf width (mm)	6.0 ± 0.4	4.8 ± 0.2	6.6 ± 0.3	3.7 ± 0.3
Upper culm leaf Length (cm)	15.1 ± 1.4	10.2 ± 0.9	18.6 ± 1.7	4.6 ± 1.0
Width (mm)	6.0 ± 0.3	4.0 ± 0.3	6.0 ± 0.4	1.8 ± 0.1
Culm height (cm)	119.9 ± 6.6	102.6 ± 7.4	147.8 ± 8.7	77.5 ± 6.4
Flowering/vegetative tillers per individual	2.6/44.6	4.1/8.3	31.9/172.2	8.1/10.3
Gregariousness*	2.9 ± 0.3	4.5 ± 0.2	4.8 ± 0.1	2.7 ± 0.3

Variable	Habitat			
	Strandline 1	Strandline 2	Waste ground 1	Waste ground 2
Canopy cover (%)	13.5 ± 5.7	16.5 ± 2.2	41.5 ± 4.6	46.0 ± 8.8
Panicle length (cm)	20.9 ± 1.8	17.2 ± 1.4	32.1 ± 2.3	27.2 ± 1.7
Spikelet number	68.2 ± 9.9	60.1 ± 5.9	139.0 ± 11.8	85.5 ± 14.7
Leaf length (cm)	29.2 ± 3.1	24.9 ± 2.4	74.5 ± 6.8	73.0 ± 4.9
Leaf width (mm)	5.7 ± 0.3	6.5 ± 0.3	9.4 ± 0.6	7.4 ± 0.3
Upper culm leaf Length (cm)	8.1 ± 1.2	8.5 ± 1.3	13.3 ± 2.0	21.6 ± 1.5
Width (mm)	2.6 ± 0.2	4.5 ± 0.4	4.5 ± 0.6	6.3 ± 0.5
Culm height (cm)	106.0 ± 10.0	61.5 ± 4.2	163.7 ± 9.6	151.6 ± 5.4
Flowering/vegetative tillers per individual	4.8/8.9	3.3/11.1	33.2/55.6	40.2/153.8
Gregariousness*	4.9 ± 0.1	4.4 ± 0.2	4.7 ± 0.1	4.7 ± 0.2

†CG3 Salisbury Plain, Wiltshire (ST918468).

*Estimated on a 1 to 5 scale reflecting plants growing as a turf (1) to highly clumped (5).

to components 1 and 2 (Fig. 2). Two of the northern populations, i.e., those from Harrington and Cressbrook Dale were relatively distinct from the other populations by having high component 1 and 2 values corresponding to low loadings for culm leaf length and width, and high loadings for panicle length. Some populations such as Mill Bay and Wineham Lane showed minimal variation with respect to the integrated response of these characters, whereas others such as Polegate and Berrow were highly variable. The first component of PCA₂ was positively correlated with canopy cover of herbs and other grasses (Spearman's $r = 0.27$, $df = 141$, $P = 0.001$), woody plant cover ($r = 0.29$, $P = 0.0006$), and the ratio of the number of flowering to vegetative tillers per individual ($r = 0.30$, $P = 0.0003$). It was negatively correlated with *F. arundinacea* canopy cover ($r = -0.39$, $P < 0.0001$) and the total number of tillers per individual ($r = 0.46$, $P < 0.0001$). The second component of PCA₂ was positively correlated with herb cover ($r = 0.23$, $P = 0.006$) and negatively correlated with other grass cover ($r = -0.36$, $P < 0.0001$).

There was no significant correlation between species richness per site or endophyte infection levels, and the component scores for either PCA₁, PCA₂, or fecundity.

Among-population variability exceeded within-population variability for eight of the ten morphological variables. Among-population variability ranged 56–70 % of the total variance for these eight variables. The two variables in which within-population variability exceeded among-population variability were culm leaf length and width (among-population variance of 54 and 58%, respectively). Among-population variability of overall plant size (i.e., PCA₁ axis 1 scores) was 74% of total variance, exceeding within-population variance (Fig 3). When overall plant size reflected in PCA₁ was accounted for in the analysis (i.e., PCA₂), within-population variability exceeded among-population variability (within-population variance of 59 and 61% for PCA₂ components 1 and 2, respectively; Fig 3).

PLANT COMMUNITY RELATIONSHIPS

The 16 populations occurred in a wide range of habitats ranging from established grasslands (e.g., carboniferous limestone, cliff-top grassland, chalk grassland) and coastal habitats (e.g., saltmarshes and strandline) to disturbed habitats (e.g., roadside hedges and verges, arable field margins) (Table 1). Nine N.V.C. communities were represented, with mesotrophic grasslands (i.e., MG1, MG7, MG9, and MG12) being the most frequent. *Festuca arundinacea* ranged in abundance from occasional to dominant in these sites with a canopy cover ranging from nine to 61%. It was a dominant species at six sites including a cliff-top grassland, roadside hedge and verge, strandline and waste ground. Among the 16 sites, 201 associated vascular plant taxa were recorded. The most common associated species were grasses, notably *Festuca rubra* ssp. *rubra* (nine sites, dominant in three), *Dactylis glomerata* (14 sites, dominant in one), *Arrhenatherum elatius* (12 sites, dominant in two), *Holcus lanatus* (eleven sites, dominant in one), and *Agrostis stolonifera* (eleven sites, none dominant), plus the shrub *Rubus fruticosus* agg. (eleven sites, none dominant), and herb *Plantago lanceolata* (eight sites, none dominant) were also common.

Two axes (eigenvalues of 0.43 and 0.27 for axes 1 and 2, respectively) were retained for interpretation following a Detrended Correspondence Analysis of associate species abundance. The distribution of sites with respect to these two axes allowed the discrimination of three main groups; two limestone-based sites, six inland sites, and eight coastal sites (Fig 4). A suite of species were limited in their distribution to the two limestone-based sites. These were *Anthyllis vulneraria*, *Carex flacca*, *Centaurea scabiosa*, *Filipendula vulgaris*, *Helianthemum nummularium*, *Linum catharticum*, *Polygala vulgaris*, *Primula veris*, *Sanguisorba minor*, *Scabiosa columbaria*, *Succisa pratensis*, *Trisetum flavescens*, and *Valeriana officinalis*. Other species with high abundance at these sites and also present elsewhere included *Briza media*, *Crataegus monogyna*, *Festuca ovina*, *Pimpinella saxifraga*, and *Viola hirta* (Pearson Correlation with DCA axis 1 all > 0.8, $P < 0.01$). Discrimination of associate species among the inland and coastal sites was less clear, but *Festuca rubra* was clearly associated with the coastal sites (Pearson Correlation with DCA axis 2 = 0.78, $P < 0.01$), and *Dactylis glomerata* and *Poa trivialis* were associated with the inland sites (Pearson Correlation with DCA axis 2 = -0.71 and -0.75, respectively, $P < 0.01$). To a lesser extent, *Agrostis capillaris*, *Cynosurus cristatus*, *Elytrigia repens*, *Holcus lanatus*, *Lolium perenne*, *Phleum pratense*, and *Ranunculus acris* were associated with the inland sites (Pearson Correlations all -0.5 to -0.7, $P < 0.01$). *Festuca arundinacea* was not significantly correlated with either axis but was most abundant in the coastal and inland sites compared with the limestone-based sites. Widespread species such as *Rubus fruticosus* agg., and *Plantago lanceolata* were not particularly associated with any specific type of vegetation or the DCA axes.

The first DCA axis was correlated with endophyte infection frequency (Spearman's $r = 0.78$, $df = 14$, $p = 0.0009$). Populations in which endophyte infection frequency was less than 60% were restricted to inland sites, all of which had low axis 1 and axis 2 values. No other variables, including those related to morphology of *F. arundinacea*, met the Bonferoni corrected level of significance ($p = 0.0013$ for a set of 38 correlations) for correlation with either DCA axis.

Mantel tests revealed no significant geographic substructuring of the populations based upon either the abundance of associate species or morphological variation in *F. arundinacea* (standardized Mantel statistics = 0.052 and 0.124 for associate species and morphological variables, respectively; $P > 0.05$ in both cases).

DISCUSSION

The data presented here support the hypothesis for genotype x environment morphological variation in populations of *Festuca arundinacea*. Contrary to our expectations (Godt & Hamrick 1998), within-population variation was not greater than among-population variation, except after removal of a size effect).

Results confirm the extreme variability of *F. arundinacea* across native habitats in England. The habitats themselves were varied, ranging from field margins, beach fronts, and the margins of saltmarshes, to mesophytic and calcareous grassland. However, in no case was *F. arundinacea* observed directly under a woody canopy. The plant communities in which *Festuca arundinacea*

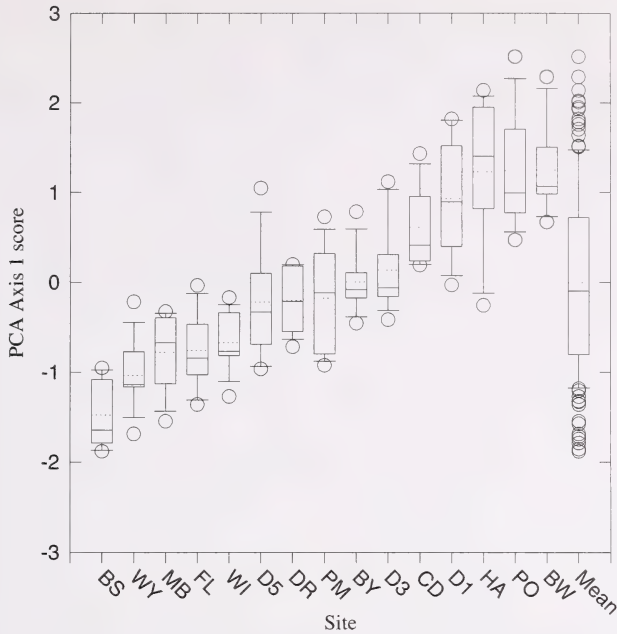


FIGURE 1. Tukey box plot of PCA₁ component one scores. Populations are ranked by mean (dashed line) score. BS = Bolton-le-Sands, Lancashire; BW = Berrow marsh, Somerset; BY = Bibury verges, Gloucestershire; CD = Cressbrook Dale, Derbyshire; D1 = Little Dartmouth hedge row, Devon; D3 = Little Dartmouth upper cliff, Devon; D5 = Little Dartmouth lower cliff, Devon; DR = Drayton, Warwickshire; FL = Fairlight Glen, East Sussex; HA = Harrington, Cumbria; MB = Mill Bay, Devon; PM = Paiges Meadow, West Sussex; PO = Polegate, East Sussex; WI = Wineham Lane, West Sussex; WY = Wytham Woods, Oxfordshire.

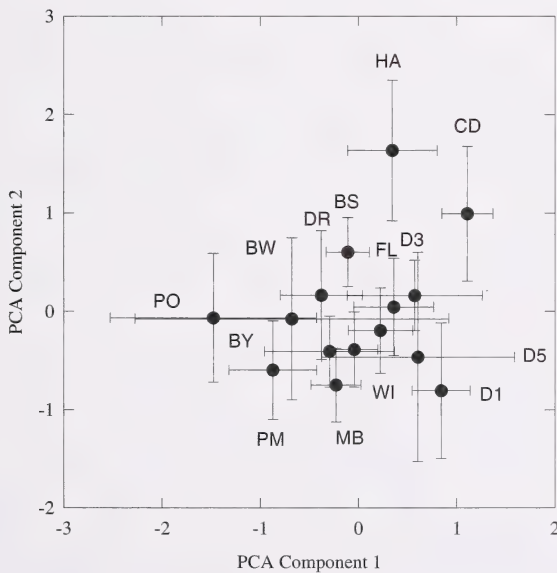


FIGURE 2. Principal components analysis (PCA₂) of 110 *Festuca arundinacea* individuals from 15 sites. The centroid of the location of individuals from each site is shown (solid circle) $\pm$ 1 SE bar. Sites identified according to codes in Figure 1. Component 1 was significantly negatively related to the number of vegetative tillers per individual and positively to panicle length. Component 2 was negatively related to length and width of the youngest, fully expanded culm leaf.

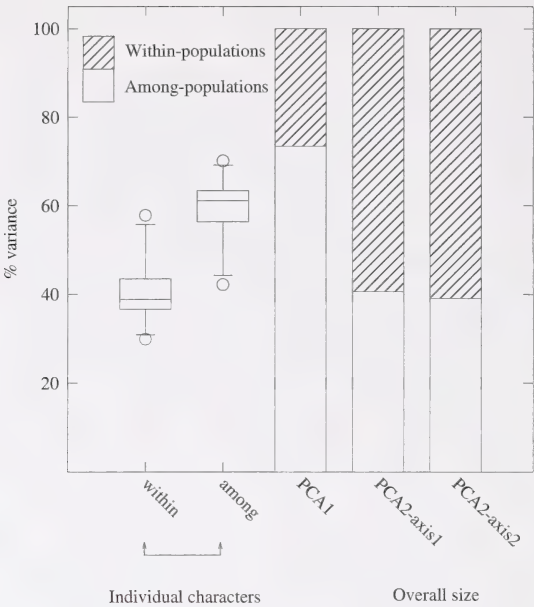


FIGURE 3. Variance components estimates for within- and among-population variability in *Festuca arundinacea*.

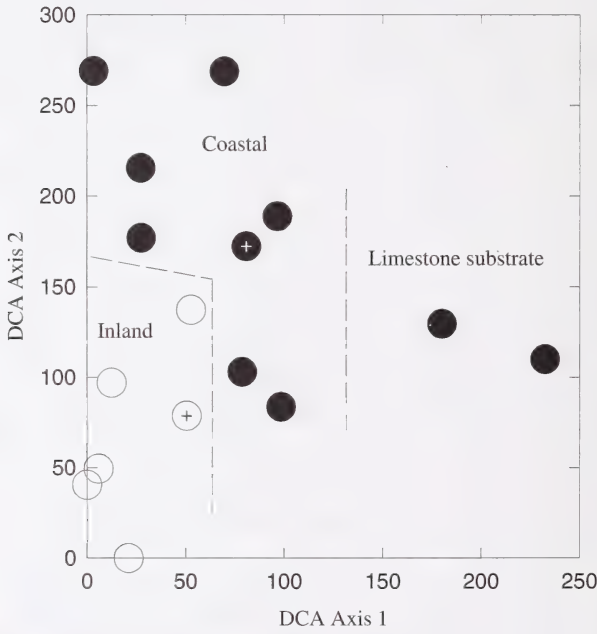


FIGURE 4. Detrended Correspondence Analysis (DCA) of associate species abundance from 16 sites in which *Festuca arundinacea* occurs. Symbols indicate endophyte infection frequency (from Spyreas *et al.* 2001a), filled symbols >85%, open symbols <20% except Polegate at 58%, '+' inside one of the indicates the Polegate site, and '+' inside one of the filled symbols indicates a site in which it was not possible to determine endophyte infection frequency.

populations were associated, fell into three general types; inland, coastal and limestone-based (Fig. 4) representing 10 NVC plant communities. It is noteworthy that we observed *F. arundinacea* to be particularly frequent in roadside MG1 communities, a vegetation type in which it has not been reported to occur previously (Rodwell 1992; Gibson & Newman 2001), despite its presence in this community in the N.V.C. database (A. J. C. Malloch, pers. comm.).

Within the habitats sampled here, *F. arundinacea* was often restricted in occurrence to a very narrow area. For example, at Berrow saltmarsh, it occurred only along the narrow (< 2 m wide) margin between the upper salt marsh and the old shoreline (Willis 1990). At the two beach habitats (Fairlight Glen and Mill Bay), the population occurred exclusively at the rear of the beach. At Bibury verges, *F. arundinacea* was restricted to within 1 m of the roadside. In other habitats, *F. arundinacea* was an important and widespread component of the grassland vegetation, e.g., cliff-top grasslands at Little Dartmouth, Paiges hay meadow, roadside verges at Wineham Lane and Little Dartmouth 1, calcareous grassland at Salisbury Plain and carboniferous limestone grassland at Cressbrook Dale.

The presence of fungal endophytes in *F. arundinacea* may be playing an important role in the population dynamics of this species (Clay 1998). Endophyte infection frequency of *F. arundinacea* was low or zero in the inland sites and high (> 85%) in the coastal and limestone-based sites (Fig. 3). It is possible that endophyte infected *F. arundinacea* populations at the inland sites have been out-competed by colonization from nearby pastures or roadsides sown with the endophyte-free S170 cultivar (Latch *et al.* 1987). Alternatively, the coastal and limestone habitats may be too stressful to allow endophyte-free populations of *F. arundinacea* to persist in competition with vigorous endophyte-infected individuals (Shelby & Dalrymple 1993). Fungal endophytes improve drought resistance in *F. arundinacea* (West 1994; Elbersen & West 1996; Hill *et al.* 1996) and may allow infected individuals to survive the moisture limited and saline conditions of coastal environments. The presence of endophyte infection has been shown to be affected by environmental factors and can lead to an increase in the proportion of infected individuals under moisture stress (Spyreas *et al.* 2001b). Furthermore, the presence of fungal endophytes in grasses, especially *F. arundinacea*, can have a significant negative affect upon associated species diversity (Clay 1997a, b; Clay & Holah 1999), although this relationship was not observed in this study.

The principal and overriding gradient in morphological variability corresponded to overall plant size. This observation is in contrast to Sugiyama *et al.*'s (1980) findings from a common-garden study of 19 ecotypes of *F. arundinacea* from European countries where two principal gradients of variability, also obtained using Principal Components Analysis, contrasted seed size/phenology with seasonal growth pattern. In their study, culm length and the number of florets per head were negatively correlated, whereas in our study these two variables, and all other morphological variables, were positively correlated. The place of origin of the plants in Sugiyama *et al.*'s (1980) study was more widespread than described here, and they included a Japanese and North American cultivar.

In this study, large plants, in all measured parameters, occurred in the most productive habitats. However, these habitats were compositionally quite varied; for example, the hedgerow at Little Dartmouth 1, the hiking trail at Polegate, the railway trackway at Harrington, and the Berrow salt marsh. The smallest plants were observed in unproductive and stressful habitats, such as beach strandlines (Mill Bay, Fairlight Glen), disturbed field margins (Wytham Woods) and Bolton-le-Sands saltmarsh. There are few other studies on *F. arundinacea* with which to compare these data. Nevertheless, the culm heights and panicle lengths observed in the present study were similar or somewhat larger than reported for Polish ecotypes (Grynja 1980), but smaller than reported for Moroccan plants (Ueyama & Sato 1994). Overall, the range of sizes found in this study is within those reported for the species (Hubbard 1984; Stace 1997). An exception was the length of vegetative leaves which Hubbard (1984) reports as ranging from 10 – 60 cm. Vegetative leaves > 60 cm were observed in this study at nine sites, with the population mean > 60 cm at the roadside hedge at Little Dartmouth, the salt marsh (Berrow), the trail (Polegate), railway trackside (Harrington) and the Carboniferous grassland (Cressbrook Dale). The maximum leaf length was 1050 cm measured on a plant growing in the roadside verge at Bibury.

Festuca arundinacea exhibits ecotypic variation across its natural range (Chatterjee 1961; Grynja 1980; Ueyama & Sato 1994). Hubbard (1984) suggests that different strains occupy

distinct habitats with the largest individuals in the most productive habitats. Our study supports this observation. The largest plants were found at the four sites noted above where the mean vegetative leaf length exceed 60 cm. These were highly productive habitats, despite being very different vegetation types (S26c, MG9b, and MG1b NVC types, respectively: see Rodwell 1992; 1995). Similarly, the smallest plants were from the shorelines at Mill Bay and Fairlight Glen. These two sites were highly disturbed and the *F. arundinacea* populations occupied a narrow zone subject to high levels of salt spray. However, there was considerable overlap in plant size among the different populations (Fig. 1) that does not support the occurrence of discrete strains or ecotypes as suggested by Hubbard (1984). There was also a lack of any geographic structuring in the size of individuals among populations (Fig. 1) in contrast to observations of Polish plants (Grynja 1980) and of Sugiyama *et al.*'s (1980) study of ecotypes collected from sites in several European countries. For example, the Mill Bay and Fairlight Glen sites were the most geographically distant (>310 km apart), yet the plants from these sites were small and showed complete overlap in size (Fig. 1). Similarly, the plants from Polegate Trail and Berrow salt marsh were large, overlapped in size, but were separated by over 225 km. After accounting for plant size in the data analysis, there was considerable overlap in the extent of population variation (Fig. 2).

If ecotypes do exist across the range of populations studied in southern England, then there is considerable overlap with respect to the morphological variables measured in this study. This variability was reflected in the greater among- than within-population variability. A common-garden experiment or molecular analysis would be required to establish the occurrence of ecotypes among these populations (e.g., Dixon 2001) and determine the extent of the genotype by environment interaction. Much of the variation among populations is likely a phenotypic response to the local environment, which, itself is a product of genotypic variation (Cheplick 1991). Grime *et al.* (1986) have suggested that plants from highly productive habitats exhibit higher morphological plasticity than plants from unproductive habitats. Our data for *Festuca arundinacea* populations do not support this view with only a poor relationship between morphological variance and habitat productivity. We observed the largest, but not necessarily the most variable plants in the most productive habitats. Experiments with the S170 cultivar of *Festuca arundinacea* have shown that inflorescence characters, including seed number per panicle, are subject to both genetic and genetic by environmental control (Bean 1969).

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A reconsideration of the native status of *Linnaea borealis* L. (Caprifoliaceae) in lowland Scotland

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ABSTRACT

Doubt is cast on the native status of *Linnaea borealis* L. in pine plantations in the coastal areas of north-east Scotland. These woods were mostly planted between 1750 and 1850 on ground that was previously grassland, and *Linnaea* is believed to have been accidentally carried to the sites in the root masses of the young pines being planted. *Linnaea* suffers from the dense shading of the mid-rotation stage of plantations and from the dense herbaceous growth that occurs after clear-felling, and without re-introduction is unlikely to perpetuate itself into the next rotation. In native pinewoods the conditions fluctuate less and survival is better, thus extinctions at introduced sites have exaggerated the present overall threat to the species.

KEYWORDS: Twinflower, transplantation, introduction.

INTRODUCTION

Linnaea borealis L. (Twinflower) (Caprifoliaceae) has been assumed native throughout its range in Scotland despite growing sometimes in plantations (Lusby 1994; Preston *et al.* 2002). This attractive plant is thought characteristic of pinewoods, and many present-day colonies occur in semi-natural woodland in which grow *Pinus sylvestris* (Scots Pine) trees of native provenance. However, *Linnaea* has lost numerous sites in recent years, possible causes being the clearance of semi-natural woodland (Lusby 1994) or its restocking with conifers that cast dense shade, e.g. *Picea sitchensis* (Sitka Spruce). Concern about the loss of sites has resulted in the species being given a Biodiversity Action Plan (UK Biodiversity Working Group 1998).

Dickie (1860) gave a long list of localities for *Linnaea*, its apparent widespread occurrence at this time in north-east Scotland being a major piece of evidence for its subsequent decline. His records span a period from approximately 1820 to 1860 (in his Addendum), and cover Aberdeenshire, Banffshire and Kincardineshire, equating to vice-counties 91–94. Dickie listed 39 localities in total for *Linnaea borealis*, counting as single localities all records given single names even when two or several stations were said to be present. Several of Dickie's localities were stated to be in or near avenues, and others were in the policies of mansion houses. Some of the latter, and also several of the plantations and woods named, are in lowland areas that were intensively farmed in the eighteenth and early nineteenth centuries; and are very unlikely to have been former sites of native pinewood. Hence I believe that many of the observed occurrences were the result of introduction in new woodlands by one or more means now uncertain.

PAST AND PRESENT DISTRIBUTION OF LINNAEA

The first British record of *Linnaea borealis* was made in 1795 at Inglismaldie in lowland Kincardineshire, and many further sites were discovered in north-east Scotland in the next few decades (Dickie 1860). For Table 1, I have assessed Dickie's localities and additional sites found after 1860 as native, possibly native, or introduced, this last for situations where woodlands had not previously existed, and I give vice-county totals for these categories. The possibly native category has been used where the locality covers too large a spread in a lowland district to be identified with a remnant native woodland, e.g. occurrences in whole parishes as given in Craib

(1912). I have also included in Table 1 pre-1970 and post-1970 occurrence in hectads as given in the maps of *Scarce Plants in Britain* (Lusby 1994), and I give the class counts separately for coastal and inland zones. I placed in the coastal zone the three hectads along each grid line nearest the east coast and the two hectads nearest the north coast, thus picking out hectads with no, or negligible, ground higher than 300 m.

The 39 Dickie localities and 12 subsequent discoveries give rise to 28 pre-1970 and 12 post-1970 hectad occurrences in the four vice-counties (Table 1). This is explained by some single hectads having two or more localities, and there are no examples of Dickie localities being omitted in the *Scarce Plants* map. But for three parishes with *Linnaea* recorded in Craib (1912), all in the coastal zone, there appear to be no equivalent hectad records, perhaps because the records were judged unreliable or because the parishes straddled hectad boundaries awkwardly. The 28 lost (pre-1970) hectad occurrences in Aberdeenshire, Banffshire and Kincardineshire are almost half the total lost hectads of *Linnaea* recorded for all Britain in 1994 (Lusby 1994).

The majority of lost hectads occur in the coastal zone (18, cf. 10 inland), and only one of these coastal hectads, NJ70, was classed as having had a native occurrence (Table 1). This record, from Dickie (1860), was from "the north face of the Hill of Fare above Midmar Castle", and the *Linnaea* probably grew at an altitude of 300–350 m; many Scots pines still exist and regenerate on and around the Hill of Fare. Seven of the coastal lost hectads were considered to be from definite introductions, other examples besides those from avenues being at Banchory House (NO90) and Balmakewan fir plantation (NO66) in Kincardineshire. The coastal zone has a single extant post-1970 record from Whiteash Forest (NJ35); I have put this in the possibly native class since Dickie has a record for "near an avenue on the Hill of Whiteash" and the policies of Gordon Castle verged on these plantations, yet the hill rises to 260 m.

TABLE 1. PAST AND PRESENT OCCURRENCES OF *LINNAEA BOREALIS* L. IN FOUR VICE-COUNTIES IN NE SCOTLAND CATEGORISED BY THEIR PROBABLE STATUS

Vice-county	No. of localities								No. of hectads (as given in Lusby (1994))							
	C. 1820–1860 (as given in Dickie)				1860–1994 (additional to Dickie)				Only pre-1970				1970–1994			
	nt	?	int	T	nt	?	int	T	nt	?	int	T	nt	?	int	T
<i>Coastal Zone</i>																
Banff		4	1	5		4*		4		2		2		1		1
N. Aberdeen			1	1			1	1			2	2				0
S. Aberdeen	1	5	4	10				0	1	2	3	7				0
Kincards.		5	4	9	1			1		5	2	7				0
Total	1	14	10	25	1	4*	1	6	1	9	7	18		1		1
<i>Inland</i>																
Banff		1		2	2			2	3			3	1			1
N. Aberdeen				0	1			1		1		1	1			1
S. Aberdeen	8	3	1	12	2			2	5	1		6	8			8
Kincards				0	1			1				0	1			1
Total	9	4	1	14	6	0	0	6	8	20	0	10	11		0	11
Grand Total	10	18	11	39	7	4	1	12	9	10	7	28	11	1	0	12

Status categories: nt = native, ? = uncertain, int = introduced

For hectads with multiple occurrences of different status, native is the category employed.

* based on occurrence in parishes in Craib (1912).

PAST DISTRIBUTION OF WOODLAND

The lack of woodland and even trees in the coastal zone of NE Scotland in the eighteenth century is illustrated by the comments of Pennant (1774): "The land prospect is extremely unpleasant; for no trees will grow here Crossed the country towards Bamff, over oatlands, a coarse sort of downs and several black heathy moors, without a single tree for numbers of miles. See Craigston castle ..., where the plantations thrive greatly." One of Dickie's records comes from Craigston woods, which are very probably the plantations Pennant saw.

In the hundred years from 1750 to 1850 many thousands of hectares were planted in Aberdeenshire (Alexander 1870), and pine was the main species used. Young trees for planting were raised in nurseries, many being run by estates and situated in or near the policies. Local newspapers such as the *Aberdeen Journal* regularly carried advertisements of young trees for sale normally in prices of shillings per thousand trees, e.g. in 1750 Crathes Castle was selling ash seedlings 18 inches in height, in 1751 Marischal College had 100,000 2-year-old firs and in 1760 Abergeldie (near Crathie) was offering firs. At the spacing of c. 1 m then used, and the acreage involved, this would have led to many billions of trees being raised, transported across or into the north-east lowlands, and then being planted out. For example Alexander (1870) reported 3 million trees being planted in a single enclosure at Fyvie Castle.

The location of the first British colony of *Linnaea borealis* was named in Dickie (1860) as "the woods of Inglismaldie". From the *Statistical Accounts* of Marykirk parish for 1791–99 and 1845, it is evident that the woods of Inglismaldie were pine plantations: "Inglismaldie has long been famed for its plantations of fir timber, some of which are upwards of one hundred years old and for size and quality are inferior to none in the county" (Low 1845, p. 300); this writer also described *Linnaea* as being "found in great abundance" in these plantations (p. 300). The two accounts for Marykirk, and those for neighbouring parishes, indicate that the planting at Inglismaldie started earlier than in the surrounding lowlands; thus in Fordoun parish to the immediate north "there are no forests or indeed plantations exceeding the age of seventy years" (Leslie 1845, p. 77). The planted ground at Inglismaldie is flat, and old maps including the large-scale 1868 O.S. map (surveyed 1863) give no indication that any woodland was there previously, so almost certainly the ground was farmland or heath.

MEANS OF INTRODUCTION

Possible mechanisms for the introduction of *Linnaea* are 1) deliberate planting as an ornamental species, and 2) accidental transport with the young trees being planted. The former is unlikely since the sites were discovered by botanists and assumed native (Dickie 1860), although at present *Linnaea* is successfully cultivated in some gardens in NE Scotland. Accidental transport would entail living plants or seeds being moved in the soil attached to the roots of the young trees, and requires that at least one of the nurseries in NE Scotland producing pines, ash, beech or oaks, had colonies of *Linnaea* established at least for a time in the eighteenth and early nineteenth centuries. There would also need to have been transport to this nursery from native colonies of *Linnaea*; perhaps seedlings were sometimes collected from regenerating pinewoods and grown on in the nurseries. Nurseries of upland estates such as Abergeldie, Invercauld and Glenmuick which lie close to extant sites of *Linnaea* presumed native, are the most likely to have supported such colonies.

The creation of avenues perhaps gave a variant on this second means of introduction. In order to establish trees more rapidly and obtain the landscape that appealed to gentry in the eighteenth century, it appears that quite old tall saplings were used in this situation. These would most likely be taken straight from regenerating pinewoods to the place required rather than being grown on in nurseries. My evidence for this is a letter of 1762 quoted in Phillips (1996): the factor of Gordon Castle wrote to the Duke of Gordon about the avenue the Duchess desired "we will be at a loss for trees of proper size to make it up" although in the same letter he reported that 400,000 firs had been planted above Fochabers in 203 acres of newly enclosed farmland in the past year.

DISCUSSION

The theory of accidental transport in rooting soil attached to pines being transplanted seems first to have been put forward by Hardy (1885), and is accepted by present-day botanists in the Borders and NE England (Braithwaite 1984; Braithwaite & Long 1990; Swan 1993) as the probable source of their local *Linnaea* colonies. Indeed the map in *Scarce Plants* marks as introduced all six English hectad records (Lusby 1994). It has also been suggested that the planting (c. 1770) of Scots pines raised in Norway was the means of introduction of the Catcherside colony in Northumberland (v.c. 67), but this opinion is not widely shared (Swan & Swan 1965). At Longformacus, Berwickshire (v.c. 68), *Linnaea* occurred in "strips of Scotch pine" and Hardy (1885) reported "The pine trees planted here were brought on ponies' backs from Braemar, and it is possible the *Linnaea* plants may have come here as seedlings in the soil, or as packing". McAiken (1907) confirmed Braemar (Aberdeenshire) as the source of the Longformacus pines, and believed that other local colonies were of British rather than foreign (Canadian or Norwegian) provenance "seeing that in other local plantations where it (*Linnaea*) has been found the original seeds or roots are believed to have been transported along with the trees, which in every instance were brought from the North".

The lateness of the discovery of the plant despite active botanising in lowland Scotland in the eighteenth century gives further support to the theory of accidental introduction here. In the 1760s a knowledgeable botanist, Dr David Skene, made many records of plants in lowland Aberdeenshire (Welch 1993), and from his correspondence with Professor John Hope, Regius Keeper of the Botanic Garden in Edinburgh (Welch 1995), it was clear that they were trying to add species to the British list. Skene was a medical practitioner and travelled widely to mansions in NE Scotland, botanising on his rounds (Welch 1993). Since he found plants such as *Clinopodium vulgare* (Wild Basil) which have always had very few sites in the area, it is strange that he did not see a plant that in the next century had at least 20 recorded sites in the district he regularly searched, including one at Craigston where he had patients. So it is reasonable to conclude that *Linnaea* was not established there in the 1760–1770 period.

The decline of *Linnaea* in lowland commercial woodland has resulted from several causes but especially its poor or non-existent sexual reproduction (Lusby 1994; UK Biodiversity Working Group 1998; Wilcock & Jennings 1999; Wilcock 2002). With no viable seeds to allow survival during the unfavourable stages of forest rotation, the colonies would inevitably be lost or much reduced once the first crops were felled. *Linnaea*, because of its low stature, is intolerant of the dense herbaceous growth that occurs after felling before the next crop of trees interlock and the canopy closes, and additionally it cannot tolerate dense shading such as occurs in spruce plantations and even in some unthinned pine plantations. So survival depends on the existence of niche habitats which have moderate levels of shading without tall herbaceous growth, e.g. tracks and road edges in forests, and stands in which larch is intimately mixed with pine, since larch casts much less shade than most conifers.

Extinction of *Linnaea* is reported only for one site in Dickie (1860), that at Inglismaldie. It appears that the early date of planting led both to this site being the first discovered and to an earlier end to the first rotation than in neighbouring woodlands. Dickie (1860) included a comment from a local botanist, Dr Simpson (Marykirk), that "it is now extinct there, owing to change in the conditions of growth, consequent on the thinning of the woods". Dr Simpson also reported occurrence in a neighbouring fir plantation at Balmekean (Dickie 1860), so evidently he could compare conditions at the two sites. Collecting is very unlikely to have caused extinction considering the great abundance of *Linnaea* at Inglismaldie (Low 1845), its widespread distribution there (both sides of the Fettercairn road (Gardiner 1848), and the lack of specimens in herbaria (only one specimen is known to me, in **BM**, whereas some choice plants of v.c. 91 such as *Mertensia maritima* (L.) Gray yielded specimens in many herbaria later in the nineteenth century).

A further possible explanation for the occurrence of *Linnaea borealis* in the NE Scottish lowlands is that it was a constituent of heathland, some extant sites of *Linnaea* being in open situations. However, Lusby (1994) considers that these occurrences outside woodland are "in more upland habitats, growing in the shade of mountain rocks"; an example is given by Webster (1978): Glenmore Burn to Snow corrie, Cairngorm, Inverness-shire, 1877. In Dickie's (1860) list of 39

localities there are two non-wooded sites: "on the banks of Loch Muick, Dr. A. Murray" and "among long heather on face of hill, south of Pannanich Wells about level with the top of Pannanich cliffs, Mr A. Cruikshank", but native pinewoods were perhaps formerly present at these sites since they are at moderate altitude c. 450 m. In 1860 heaths were still quite extensive in the NE lowlands, judging from the large-scale O.S. maps of the 1860s and Pennant's mention (1774) of several black heathy moors, and despite much agricultural reclamation some lowland moors still survive. But *Linnaea* has never been found in this habitat, none of Dickie's localities being from such moorland, and *Linnaea* is not recorded in lowland heaths (NVC H9, H10, H11) (Rodwell 1991).

The loss of sites of *Linnaea borealis* in lowland Scotland makes the present threats to this attractive specialised plant seem stronger than they actually are. A few sites have been lost in the inland zone (Table 1), but some were refound here between 1994 and the end of recording in 1999 for the Millennium Atlas (Preston *et al.* 2002). Since the remaining native pinewoods in the uplands of NE Scotland are now relatively well protected, the future of *Linnaea* is more secure than is suggested by its Biodiversity Action Plan (UK Biodiversity Working Group 1998). But some of the extant colonies of *Linnaea* are in pine plantations in inland Aberdeenshire, as at Birkhall near Ballater, and to maintain these colonies sympathetic management is required particularly when the trees become ready for felling, so that habitat conditions similar to those of native woodland can be established. Also some colonies reproduce entirely vegetatively due to their genetic make-up, but knowledge on how to restore sexual reproduction by transplanting certain genotypes or pollen transfer is now available (Wilcock 2002).

CONCLUSIONS

The distribution of *Linnaea borealis* was much increased in the eighteenth and early nineteenth centuries by accidental carriage with young pine trees being planted in order to establish new woodlands on farmland.

The resultant colonies of *Linnaea* were unable to perpetuate themselves due to poor sexual reproduction and strict demands for particular shading regimes, and became extinct after one or two forest rotations.

Decline of *Linnaea* in commercial woodlands with clear felling at the end of rotations has exaggerated the threat to the species in upland native pinewoods.

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Hybridisation between *Schoenoplectus tabernaemontani* and *S. triqueter* (Cyperaceae) in the British Isles

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ABSTRACT

Schoenoplectus samples from the Rivers Arun, Medway, Tamar and Thames were studied using AFLP genetic fingerprinting to test hypotheses concerning the origin of hybrids of *S. triqueter* with *S. lacustris* and *S. tabernaemontani*. *Schoenoplectus lacustris* and *S. tabernaemontani* were shown to be only distantly related, and therefore it is appropriate that they be treated as two distinct species rather than as two subspecies of *S. lacustris*, as recommended by some authorities. *S. lacustris* was excluded as a possible parent in all potential hybrids studied from all rivers, and evidence of additivity was found between the fingerprints of *S. tabernaemontani* and *S. triqueter* in all cases. Material collected as pure species turned out to be of hybrid origin in two cases, and identification of the hybrids and *S. tabernaemontani* appears to be difficult as a result of phenotypic plasticity. Conservation implications of the results and areas of possible future work are discussed.

KEYWORDS: AFLP, club-rushes, hybrids.

INTRODUCTION

The genus *Schoenoplectus* comprises c. 130 species and has a worldwide distribution, with the highest species diversity occurring in eastern Asia and temperate North America. The genus has often been treated as part of *Scirpus* L. s.l. (e.g. DeFilipps 1980; Walters 1984) but a combination of characters, such as the reduction of most leaves to bladeless sheaths and the pseudolateral inflorescence, distinguish it from *Scirpus* s.s. Four species of *Schoenoplectus* are present in the British Isles, namely *S. lacustris* (L.) Palla, common club-rush, *S. pungens* (Vahl) Palla, sharp club-rush, *S. tabernaemontani* (C.C. Gmel.) Palla, grey club-rush and *S. triqueter* (L.) Palla, triangular club-rush. Some workers (e.g. DeFilipps 1980; Walters 1984; Sell & Murrell 1996) have treated *S. tabernaemontani* as a subspecies of *S. lacustris*.

In the British Isles, *S. triqueter* occurs in south-western England and western Ireland. Although it was previously more widespread in southern England, it is now thought to be restricted to one site on the River Tamar (v.c. 2); the population at this site has now been reinforced with plants grown in cultivation from seeds from the Tamar. Hybrids of *S. triqueter* occur where the distributions have overlapped with *S. lacustris* and *S. tabernaemontani*. The hybrid names *S. × carinatus* (Sm.) Palla and *S. × kuekenthalianus* (Junge) D. H. Kent are used for the hybrids with *S. lacustris* and *S. tabernaemontani* respectively (Stace 1997). Due to their morphological variability, Lousley (1931) stated that 'the determination of hybrids in the *Schoenoplectus* group is by no means simple'. Both hybrids are believed to have occurred on the Tamar and possibly the Thames (Lousley 1975), although *S. × carinatus* is now thought to be extinct. Hybrids, thought to be *S. × kuekenthalianus* (Lousley 1931, 1975; Stace 1997), also occur on the Rivers Arun (v.c. 13) and Medway (v.c. 15/16).

Following an earlier study of material from the Tamar (Fay 1998), we have expanded the sampling to include material from the Arun and Medway and other material as available. The aims of the work were: (1) to establish the parentage of the hybrids from the Arun, Medway and Tamar; (2) to make a preliminary investigation into levels of genetic diversity in *S. triqueter* and (3) to provide advice to the Environment Agency relating to the management of *S. triqueter* on the Tamar and the possible reintroduction of appropriate genotypes into sites in south-eastern England.

Because amplified fragment length polymorphism (AFLP™; Vos *et al.* 1995) genetic fingerprinting had proved appropriate in the earlier study (Fay 1998), we decided to use the same technique.

TABLE 1. PLANT MATERIALS USED IN THIS STUDY

a) Samples from 1997

Field identification	Field notes	DNA No.
<i>S. triquetra</i>	Site 3a, River Tamar, v.c. 2	5655
<i>S. lacustris</i>	River Exe catchment, Clyst at tidal weir, v.c. 3	5656
<i>S. tabernaemontani</i>	River Exe catchment, Clyst at tidal weir, v.c. 3	5657
hybrid	Site 1, Calstock, River Tamar, v.c. 2	5658
hybrid	Site 2, Calstock Bridge, River Tamar, v.c. 2	5659
hybrid	Site 3, cottage sites, River Tamar, v.c. 2	5660
hybrid	Site 4, right bank, houseboat, River Tamar, v.c. 2	5661
hybrid	Site 5, River Tamar, v.c. 2	5662
hybrid	Site 6, island, Morwellham, River Tamar, v.c. 3	5663

b.) Samples from 2000

Field identification	Field notes/source
<i>S. triquetra</i>	ex hort. Nat. Mus. Wales (Limerick Bridge, River Shannon)
<i>S. lacustris</i>	ex hort. Kew
? <i>S. lacustris</i>	Peter Nicholson, Site 33, River Arun, v.c. 13
<i>S. tabernaemontani</i>	Peter Nicholson, 715 616, River Medway, v.c. 15
<i>S. tabernaemontani</i>	Peter Nicholson, Site 20 7129 6024, River Medway, v.c. 16
? <i>S. tabernaemontani</i>	M. C. Sheahan 128, Duke's Hollow, River Thames, v.c. 21
<i>S. tabernaemontani</i>	ex hort. Kew
hybrid	Peter Nicholson, Site 1, 0284 0844, River Arun, v.c. 13
hybrid	Peter Nicholson, Site 2 0284 0845, River Arun, v.c. 13
hybrid	Peter Nicholson, Site 4, River Arun, v.c. 13
hybrid	Peter Nicholson, Site 5 0305 0928, River Arun, v.c. 13
hybrid	Peter Nicholson, Site 8 0286 1006, River Arun, v.c. 13
hybrid	Peter Nicholson, Site 61 0322 1628, River Arun, v.c. 13
hybrid	Paul Smith, 0255 1175, River Arun, v.c. 13
hybrid	Paul Smith, 025 1118, River Arun, v.c. 13
hybrid	Paul Smith, 028 098, River Arun, v.c. 13
hybrid	Peter Nicholson, Site 10, 7132 6143, River Medway, v.c. 15

MATERIALS AND METHODS

PLANT MATERIALS

The plant material used in this study is listed in Table 1. All DNAs were extracted from stem material dried in silica gel using a modified 2xCTAB (cetyltrimethyl-ammonium bromide) procedure (Doyle & Doyle, 1987), then purified and quantified using a spectrophotometer.

GENETIC FINGERPRINTING

AFLPs were conducted according to the AFLP Plant Mapping Protocol of PE Applied Biosystems Inc. (AB). Two primer combinations (EcoRI-ACA/MseI-CAG and EcoRI-AAG/MseI-CTC) were used for all individuals. The fragments were separated and visualised as bands on acrylamide gels using an AB377 Automated Sequencer. Only bands with sizes ranging from 50–500 base pairs (bp) were included in the analysis as bands outside this size range cannot be accurately sized. Data extraction from the gels was carried out using Genescan 2.1 and Genotyper 2.0. Nested analyses were then carried out. In the first, all samples of the three species were analysed with representative hybrids, and in the second all samples of *S. triquetra* and *S. tabernaemontani* and the hybrids were included (see Results). The bands were scored as either present (1) or absent (0).

for each individual, resulting in a binary matrix which was analysed using the neighbor joining (NJ) algorithm in the software package PAUP (version 4.0d64 for Macintosh, Swofford 1998) and by principal coordinates analysis (PCO) in the R Package for Multivariate Analysis (version 4.0, Casgrain & Legendre 1999) using Jaccard's coefficient (Jaccard 1908).

RESULTS & DISCUSSION

Preliminary investigation of the AFLP traces showed that those for *S. lacustris* were quite distinct from those of *S. triqueter* and *S. tabernaemontani*; representative traces showing this are presented in Fig. 1. This high level of distinctness can cause problems in the assessment of homology of individual fragments, and for this reason we chose to carry out nested analyses. The first analysis was used to investigate whether *S. lacustris* was implicated as a parent of any of the hybrids and the second (excluding *S. lacustris*) was used for a detailed study of the hybrids and their relationships to each other and to *S. triqueter* and *S. tabernaemontani*.

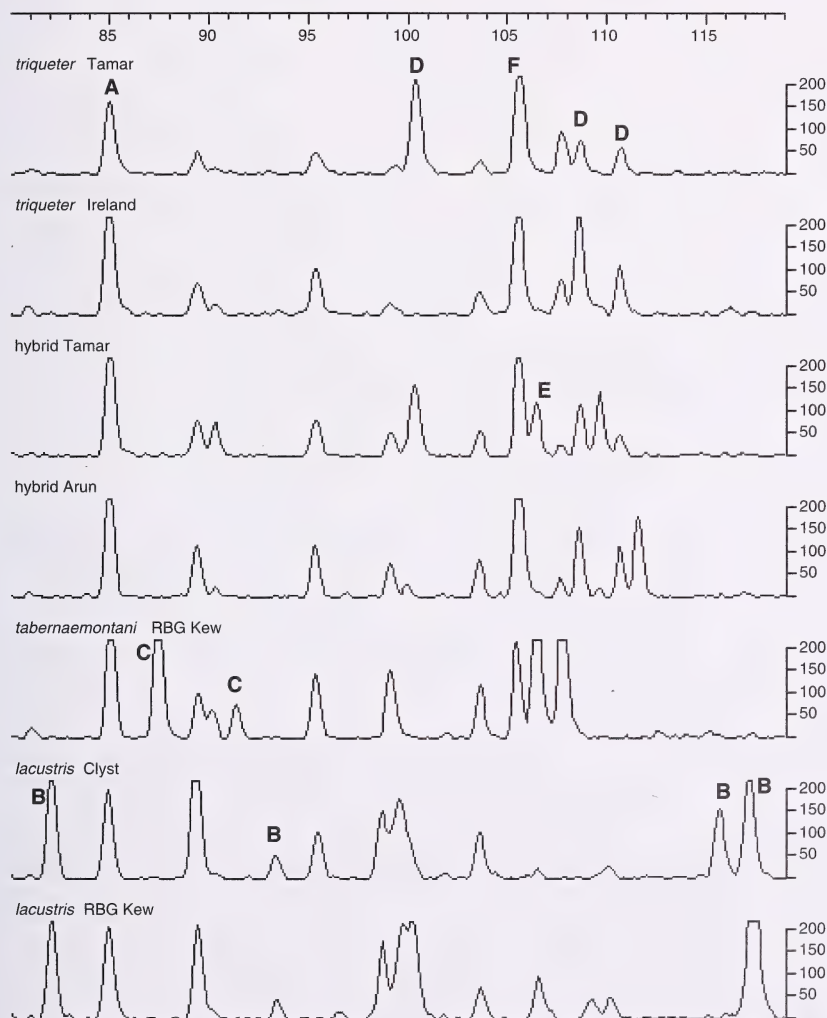


FIGURE 1. Representative AFLP traces for three *Schoenoplectus* spp. and putative hybrids. Different classes of bands are indicated by letters: A – found in all taxa, B – only found in *S. lacustris*, C – only found in *S. tabernaemontani*, D – only found *S. triqueter* + hybrids, E – found in *S. tabernaemontani* + hybrids, F – found in *S. triqueter* + *S. tabernaemontani* + hybrids. Numbers on the horizontal axis indicate the size of the fragments in base pairs. Numbers on the vertical axis indicate the strength of fluorescence in arbitrary units.

TABLE 2. THE TYPES OF BANDS AND THEIR RELATIVE FREQUENCIES

a) Analysis 1

Type of band ¹	Number	Percentage
L	46	23
L + TA + TR + H	41	21
TA	27	14
TA + TR + H	23	12
TA + H	17	9
TR + H	12	6
L + TA + H	11	6
L + TA	6	3
H	6	3
TR	4	2
L + TR + H	3	1
Total	196	100

b) Analysis 2

Type of band ¹	Number	Percentage
TA + TR + H	64	45.1
TA + H	27	19
TA	26	18.3
TR + H	12	8.5
H	10	7.0
TR	2	1.4
TA + TR	1	0.7
Total	142	100

¹ L = *S. lacustris*, TA = *S. tabernaemontani*, TR = *S. triqueter*, H = hybrids

In the first analysis, 196 bands were scored, of which 25 were found in all individuals of the three species and in the hybrids. The bands were of eleven types, and these types and their relative frequencies are shown in Table 2a. The dendrogram is shown in Fig. 2 and the plot of the first two coordinates from PCO (accounting for 49 and 19% of the variation, respectively) is shown in Fig. 3. *Schoenoplectus lacustris* was clearly the most distinct taxon in this analysis; this is indicated by the high number of bands unique to this species (Fig. 1, Table 2a) and by its isolated position in Figs. 2 and 3. These data confirm the treatment of *S. lacustris* and *S. tabernaemontani* as distinct species, as recommended by Stace (1997), among others.

There was no evidence of *S. lacustris* being involved in the parentage of any of the hybrids examined in this study as no bands were shared exclusively by *S. lacustris* and the hybrids. (This does not prove that *S. × carinatus* does not occur in England, only that we did not sample it if it does). Samples collected as ?*S. lacustris* on the Arun (Site 33) and as ?*S. tabernaemontani* (MCS128) on the Thames (v.c. 21) were clearly of hybrid origin. Examination of herbarium material for the latter sample confirmed the absence of any of the main morphological features generally considered to be diagnostic of the hybrids. However, the sample appeared to be mostly sterile (as reported by Lousley 1931, 1975) and it is possible the hybrids show more variability in their vegetative parts than is indicated in the keys, making the characters used to distinguish them unreliable. Based on the sterility of the specimen from the Thames and the genetic results we would conclude that the specimen is a hybrid. This is in line with the observations made by Peter Nicholson of widespread morphological plasticity (even within individual clumps) and difficulty in deciding whether material was of pure species or hybrid origin when he was collecting material

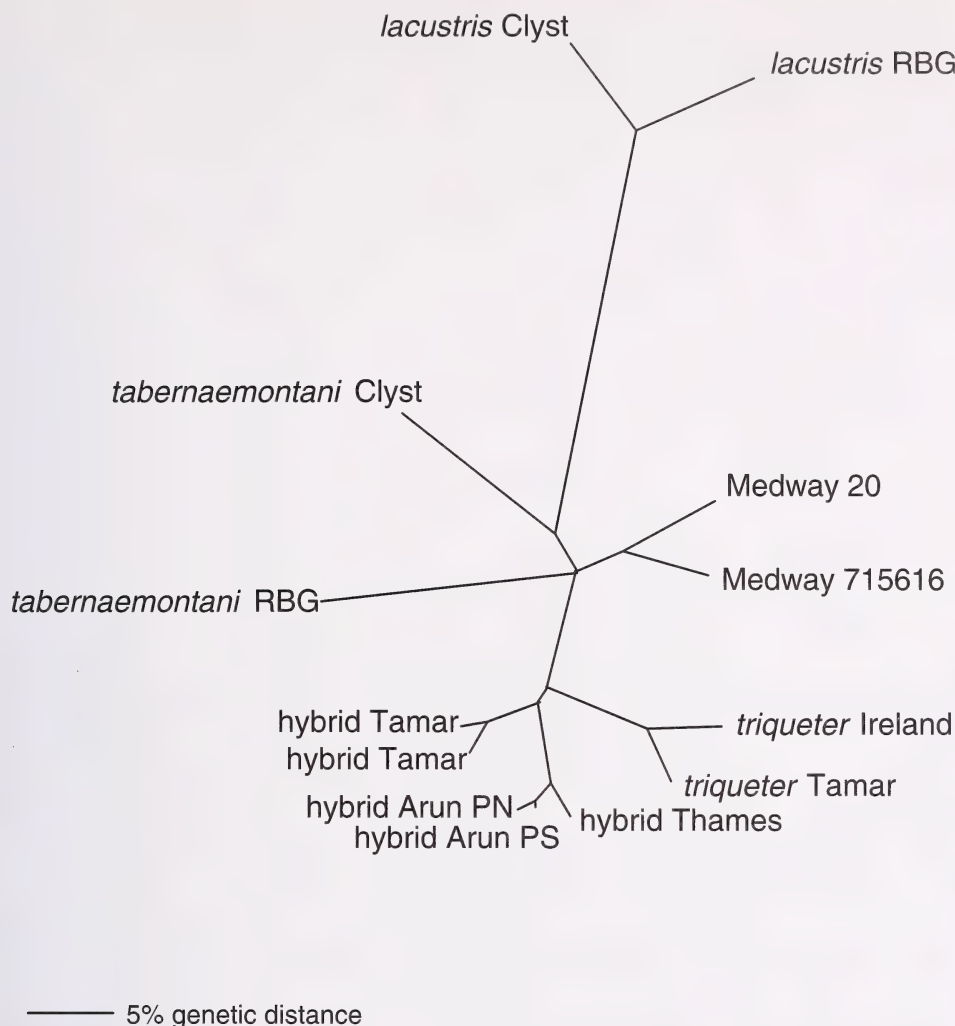


FIGURE 2. Neighbour joining analysis of *Schoenoplectus* spp. and putative hybrids. Note that Medway 20 and 715616 appear to be *S. tabernaemontani*, not hybrids.

for this project (P. Nicholson, pers. comm.). Lousley (1975) stated that the record of *S. × kuekenthalianus* from the Thames by Perring & Sell (1968, p. 145) required confirmation. The data presented in this paper provide that confirmation.

In the second analysis, 142 bands were scored, of which 42 were present in all individuals of *S. tabernaemontani*, *S. triqueter* and hybrids. The bands were of seven types, and these types and their relative frequencies are shown in Table 2b. There was strong evidence of additivity in the hybrids between the bands found in the two putative parents, *S. tabernaemontani* and *S. triqueter*. The samples of *S. triqueter* were genetically very close to each other, despite the obvious size difference even in cultivated material, whereas *S. tabernaemontani* was more variable. In addition, *S. triqueter* had far fewer unique bands than *S. tabernaemontani* (two vs. 26), and both bands unique to *S. triqueter* were found only in the sample from the Shannon. The sample collected as a putative hybrid on the Medway (Site 10) does not appear to be of hybrid origin as it clustered with the samples of *S. tabernaemontani*. The NJ dendrogram is shown in Fig. 4 and the plot of the first two coordinates from PCO (accounting for 38 and 17% of the variation, respectively) is shown in Fig. 5.

TABLE 3. COMPARISON OF FIELD IDENTIFICATION AND RESULTS OF GENETIC STUDIES. THE THREE CASES WHERE THE FINGERPRINTING RESULT DID NOT AGREE WITH THE FIELD IDENTIFICATION ARE SHOWN IN BOLDFACE

Sample information	Field identification	Fingerprinting result
ex hort. Kew	<i>lacustris</i>	<i>lacustris</i>
ex hort. Kew	<i>tabernaemontani</i>	<i>tabernaemontani</i>
ex hort. Nat. Mus. Wales	<i>triqueter</i>	<i>triqueter</i>
Tamar	<i>triqueter</i>	<i>triqueter</i>
Site 1, Calstock, Tamar	hybrid	hybrid ¹
Site 2, Calstock Bridge, Tamar	hybrid	hybrid
Site 3, cottage sites, Tamar	hybrid	hybrid
Site 4, right bank, Tamar	hybrid	hybrid
Site 5, Tamar	hybrid	hybrid
Site 6, Morwellham, Tamar	hybrid	hybrid
Exe catchment, Clyst	<i>lacustris</i>	<i>lacustris</i>
Exe catchment, Clyst	<i>tabernaemontani</i>	<i>tabernaemontani</i>
Arun site 1 0284 0844	hybrid	hybrid
Arun site 2 0284 0845	hybrid	hybrid
Arun site 4	hybrid	hybrid
Arun site 5 0305 0928	hybrid	hybrid
Arun site 8 0286 1006	hybrid	hybrid
Arun site 33	?<i>lacustris</i>	hybrid
Arun site 61 0322 1628	hybrid	hybrid
Arun 0255 1175	? hybrid	hybrid
Arun 025 1118	? hybrid	hybrid
Arun 028 098	? hybrid	hybrid
Medway 715 616	<i>tabernaemontani</i>	<i>tabernaemontani</i>
Medway site 10 7132 6143	hybrid	<i>tabernaemontani</i>
Medway site 20 7129 6024	<i>tabernaemontani</i>	<i>tabernaemontani</i>
Thames (Chiswick) MCS128	?<i>tabernaemontani</i>	hybrid

¹ 'hybrid' in this column refers to *S. × kuekenthalianus* (*S. tabernaemontani* × *S. triqueter*)

One interesting aspect of the data presented in Table 2b is the seeming imbalance between the proportions of bands shared between the hybrids and each of the putative parents. Out of the 79 bands found in *S. triqueter*, only three (<4%) were not shared with any hybrids. All three of these bands were only found in the Irish material and not in English *S. triqueter*, and thus 100% of bands found in English *S. triqueter* are present in at least some of the hybrids. In contrast, out of the 118 bands found in *S. tabernaemontani*, 27 (23%) were not shared with any of the hybrids. This same imbalance was already apparent in the sampling studied in the earlier report on material from the Tamar (Fay 1998), in which the hybrids shared 97% of bands with *S. triqueter* and 83% with *S. tabernaemontani*. In other situations where hybrids have been examined using AFLPs, the proportion of bands shared with each parent is variable (Table 4). In a recent study of hybrids in the *Sorbus latifolia* (Lam.) Pers. complex, thought to result from crosses between *S. aria* (L.) Crantz and *S. torminalis* (L.) Crantz, 53 out of 57 bands (93%) found in *S. aria* and 60 out of 66 (91%) found in *S. torminalis* were found in the hybrids examined (Fay *et al.* 2002). In *Dactylorhiza* allotetraploids, thought to result from hybridisation between *D. incarnata* (L.) Soó *s. l.* and *D. fuchsii* (Druce) Soó, a similar pattern to that found in *Schoenoplectus* was found, with 75 out of 79 bands (95%) found in *D. incarnata s.l.* and 73 out of 93 (78%) found in *D. fuchsii* being found in the hybrids (Hedré *et al.* 2001). In the *Sorbus* example, both parental species appear to be quite genetically uniform with relatively few variable bands. The same applies to *S. triqueter*, where the Irish and English samples are very similar, and to *D. incarnata s.l.*, where there are

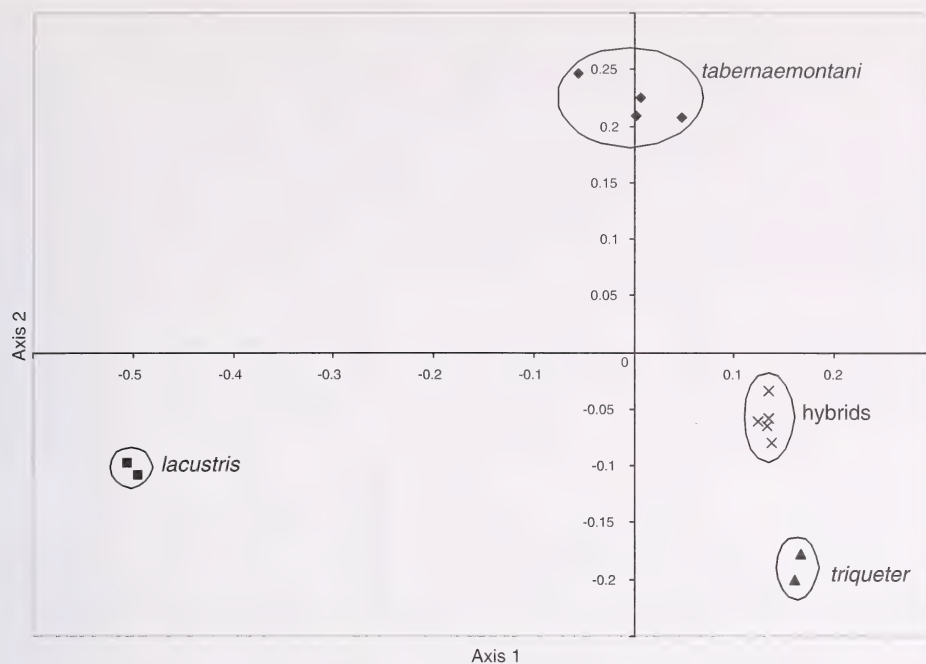


FIGURE 3. Plot of the first (x axis) and second (y axis) co-ordinates from the PCO of *Schoenoplectus* spp. and putative hybrids. The first and second co-ordinates account for 44.3 and 21.2% of the variation, respectively.

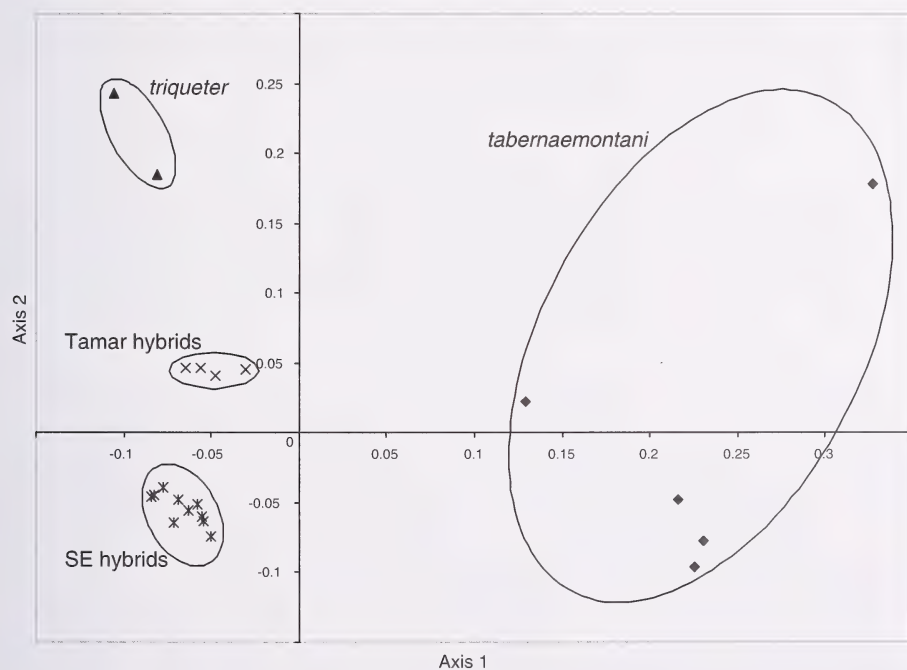


FIGURE 5. Plot of the first (x axis) and second (y axis) coordinates from the PCO of *Schoenoplectus* samples with full sampling of putative hybrids. The first and second coordinates account for 34.7 and 18.4% of the variation, respectively. SE = South-east England.

TABLE 4. COMPARISON OF PERCENTAGES OF AFLP BANDS INHERITED FROM PARENTAL SPECIES IN HYBRIDS OF *DACTYLORHIZA*, *SCHOENOPLECTUS* AND *SORBUS*

Hybrid/s	Bands from parent 1	Bands from parent 2	Reference
<i>Dactylorhiza</i> allotetraploids	95% (<i>D. incarnata</i>)	78% (<i>D. fuchsii</i>)	Hedrén <i>et al.</i> 2001
<i>Schoenoplectus</i> × <i>kuekenthalianus</i>	96% (<i>S. triqueter</i>)	77% (<i>S. tabernaemontani</i>)	this paper
<i>Sorbus latifolia</i> agg.	93% (<i>S. aria</i>)	91% (<i>S. torminalis</i>)	Fay <i>et al.</i> , 2002

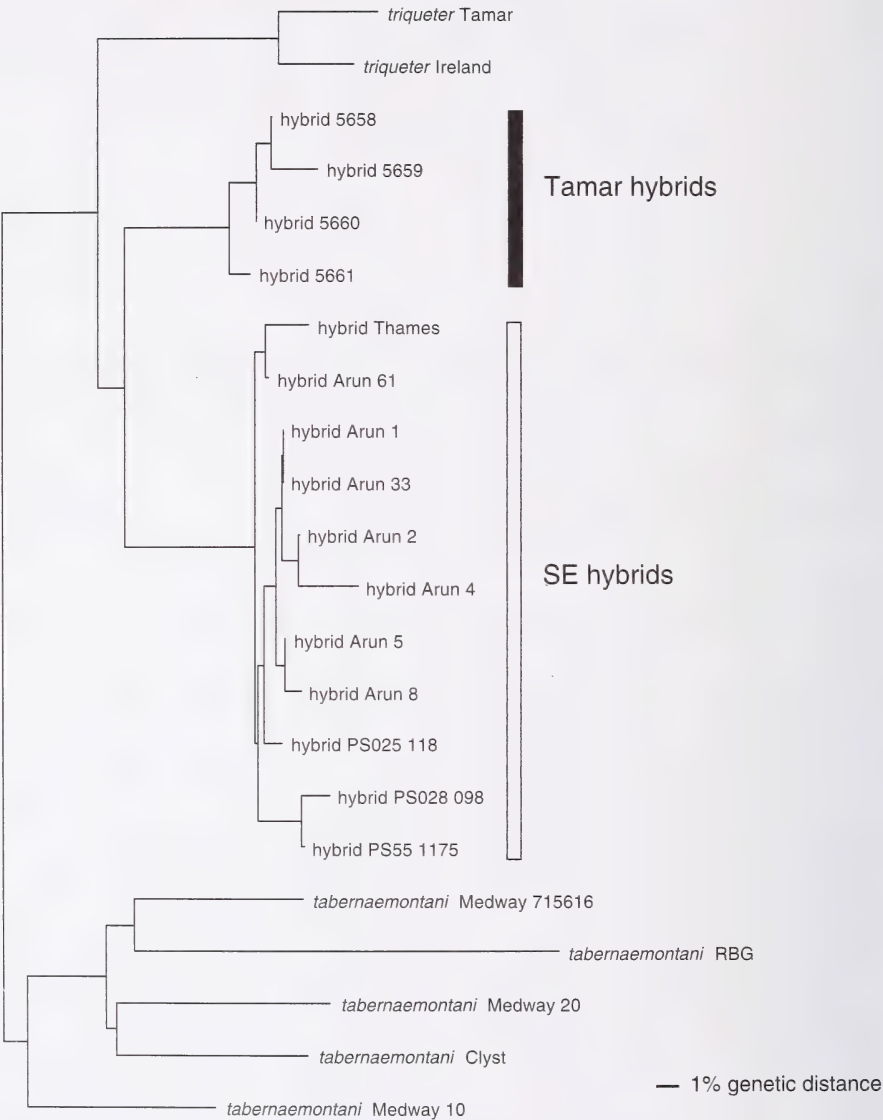


FIGURE 4. Neighbour joining tree with full sampling of hybrids showing relationships to *S. triqueter* and *S. tabernaemontani*. SE = South-east England.

relatively few variable bands even between morphologically distinguishable entities including *D. incarnata* subsp. *cruenta* (O. F. Muell.) P. D. Sell and *ochroleuca* (Boll) P. F. Hunt & Summerh. In contrast, the parent sharing a lower percentage of bands with the hybrids in both *Dactylorhiza* and *Schoenoplectus* (*D. fuchsii* and *S. tabernaemontani*) shows considerably more variation. This type of imbalance would be expected if one species was heterozygous at many loci and the other was highly homozygous, and this is the likely cause of the apparent tendency towards *S. triqueter* in this case, but the low number of samples of *S. tabernaemontani* studied so far means that our measurement of the levels of genetic variation in *S. tabernaemontani* is still provisional. In particular, further samples from the Medway should be included, given the high level of morphological and genetic diversity found in the samples of *S. tabernaemontani* tested so far and the absence of Medway hybrids in the current sampling. Samples from other areas would also be useful.

The close relationship between English and Irish material of *S. triqueter* indicates that this is probably a genuine case of a species with narrow genetic diversity, at least in the British Isles. In terms of reintroduction studies, material from the Tamar source is closer to the genotype that gave rise to the hybrids on the Arun and the Tamar, and it is thus probably appropriate to use Tamar material for such studies.

FUTURE WORK

Samples of hybrids from the Medway and further samples of *S. tabernaemontani* from a range of sites should be fingerprinted for inclusion in the analysis in order to investigate the level of variation within *S. tabernaemontani*. If possible, this should be supplemented with a study using microsatellites so that levels of heterozygosity can be assessed.

Further individuals of *S. triqueter* should be added to the analysis from plants derived from Tamar seed, the Shannon and from continental populations. This would allow investigation of the apparently low level of variation and high level of homozygosity in this species.

Sequencing studies of loci from the plastid genome should be carried out to determine the direction of the hybridisation. Finally, cytogenetic studies should be undertaken to confirm the hybrid nature of the samples shown to be hybrids with AFLPs but which have the morphology of *S. tabernaemontani*.

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(Accepted September 2002)

A Devon and Somerset Bramble (Rosaceae: *Rubus* L. subgen. *Rubus*) revived

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ABSTRACT

The identity of a bramble frequent in parts of Devon and Somerset is discussed, its history reviewed and a new description provided as *Rubus avaloniensis* Newton & R. D. Randall **sp. nov.** (ser. *Anisacanthi* H. E. Weber).

KEYWORDS: Endemic, apomictic species, brambles, distribution, England.

The application of the name *Rubus drejeri* to British brambles has followed a most tortuous course, not least when used in connection with plants found in S.W. England.

R. P. Murray collected a plant at Dunster in 1893 which O. Gelert, the Danish batologist, named as *Rubus drejeri* (“no doubt correct”, comm. W. M. Rogers). It was abundant for 200 yards and occurred “locally over a large area in West Somerset exhibiting considerable variation”, though the Dunster plant (“an extreme form with strong armature” fide W. M. Rogers) was thought a good match for the plant issued by Friderichsen and Gelert as *Rubi exsiccati Daniae et Slesvigiae*, Fasc. 2: 43.

Murray (1896, p.111) describes *R. drejeri* as “very rare, growing at Dunster, Porlock & near Luxborough”; however in the Addenda (p.416), this name gives way to *R. leyanus* Rogers. This was published in 1894 when Rogers realised that gatherings of the Hereford and S.W. England plant differed significantly from the Schleswig-Holstein plant sent him by Friderichsen and Gelert. Murray rather surprisingly accepted this transition in the face of Gelert’s 1893 opinion.

Also present in the Flora of Somerset *Rubus* list (Murray 1896, p.112) is “*R. scaber* W. & N.”, stated to be rare & only known from the west of the county. Localities are given as Dunster to Wootton Courtenay (“remarkably distinct & handsome here”), hedges on Quantock & Peat moor near Shapwick (herb. Babington), the last noted as “not typical” by W.O. Focke, the German batologist.

In 1897 Messrs. Rogers, Murray & Gelert met briefly in Somerset. One result was the determination by Gelert of all the ‘*R. scaber*’ specimens except the peat moor plant (now named *R. ochrodermis* Ley) as “good drejeri”. Murray says that this was the first English record of *R. drejeri* sensu stricto, apparently again forgetful of the accepted view of Gelert on the Dunster plant four years previously. Earlier in 1897 *R. drejeri* s.s. had been reinstated for Scotland from the Stirling district (Rogers 1897).

Marshall (1914) lists “*R. drejeri*” from Brushford to E. Anstey, Dunster, Kingston, West Monkton & Bathealton, also on Burtle peat moor (H. S. Thompson).

The name *Rubus drejeri* is also listed by White (1912) but is here applied to a Durdham Down, Bristol (V.c. 34) plant. Rogers says of the specimens he saw “good *R. drejeri*. I say good rather than typical because in so variable a species it is not easy to fix a type. These agree admirably with Scottish specimens as well as those of Friderichsen & Gelert from Slesvig”. This plant, widespread in the Archenfield region was found to be very distinct & was named *Rubus troiensis* (Series *Radulae*) by A. Newton (1974).

Evidently Rogers gradually expanded his concept of *R. drejeri* as more material was submitted to him. Occasionally new taxa were published: after *R. leyanus* (1894) came *R. hibernicus* (1897) and *R. dunensis* (1901) under pressure from Ulster enthusiasts. Rogers also gave the name to examples of taxa now recognised as *R. wirralensis* Newton and *R. anisacanthos* G. Braun. His vacillation over some determinations is a salutary example of the difficulty of operating a taxonomic system based on "Hauptformen" where described taxa are expanded to include plants which while similar in some respects are not identical. Eventually the names can cease to represent the intention of the original authors and become useless for the taxonomy of critical species. Today we have learned the need to adopt tighter criteria for the elucidation of Rubi.

In Flora of Devon (Martin & Fraser 1937, p.273) H. J. Riddelsdell refers to a "striking variety found by G. B. Savery in the Silverton area" which he cannot name. It had previously been put by Rogers to *Rubus ochrodermis*, with some doubt and then finally in 1910 to "*R. horridicaulis* off-type to *ochrodermis*" (MSS in BM). A Savory specimen (Barton & Riddelsdell herb. no. 10538, BM) was however earlier determined by Rogers in 1903 as '*R. drejeri*'. This plant grows in the same area today and clearly belongs with the Dunster and peat moor examples above.

One of us (AN) has been researching the application of the name *Rubus drejeri* to British plants for many years. First fruits confirmed the presence of the true plant in Scotland (Newton 1979) and unearthed the oscillating opinions of W. C. R. Watson at different times on the various candidates for the name. His last (1952) view referred a plant found at Tilburstow Hill Common (V.c. 17) to *R. drejeri* while equating another from the same locality with '*Somerset drejeri*' which he then stated was identical with *R. rotundifolius* (Bab.) Blox. (*R. rotundifolius* sensu Watson = *R. tamarensis* Newton).

B. A. Miles visited Tilburstow Hill Common in 1962 and collected both forms (CGE). R. D. Randall searched the area in August 2001 and was unable to find specimens of either at Miles' locality, but did manage to locate a small colony of '*Somerset drejeri*' by a woodland path on Godstone Green adjacent to Tilburstow Hill Common. We would agree that this latter plant is identical with the Dunster plant. It does however differ from *R. rotundifolius* (inter alia) by the very short glandular development, terminal leaflet shape and panicle architecture, and from *R. drejeri* G. Jens. ex Lange by abundant short glands, short unequal prickles, also by relatively short filaments, glabrous anthers, and more or less patent sepals. *R. drejeri* sensu Watson (1952) from Tilburstow Hill, of which I have specimens named by Watson (coll. N. Y. Sandwith, 3/7/1932) can be separated from *R. drejeri* G. Jens. ex Lange by much larger flowers, very long filaments and densely pilose carpels. This plant appears to be undescribed but belongs to Series *Mucronati*.

Extensive examination of material cited by Murray and Rogers in BM, BRIST, and CGE, together with our own gatherings and field researches, reveals a plant adapted to a wide range of habitats from peat moor and woods to hedges and stony hillsides but none the less consistent in features, distinct from *R. drejeri* G. Jens. ex Lange, and therefore nameless. Following comprehensive field work separately and in tandem we have established a provisional range for the plant in v.c.s. 3–6 and 17 as shown by the map, and provide a description as *R. avaloniensis* (Series *Anisacanthi*).

DESCRIPTION

***Rubus avaloniensis* Newton & R. D. Randall, sp. nov.** (Series *Anisacanthi*)

Rubus drejeri similis, sed foliolo terminali minus rotundato, glandulis stipitatis brevibus numerosis, aculeis brevibus inaequalibus, filamentis paulo brevioribus, sepalis ± patentibus, antheris glabris praecipue differt. Crescit in Britannia meridionali.

Similar to *Rubus drejeri*, but it differs chiefly in its less rounded terminal leaflet, numerous short stalked glands, unequal short prickles, slightly shorter filaments, more or less patent sepals, and glabrous anthers. It grows in southern Britain. Stems high-arching, suberect in the shade, bluntly angled, sometimes furrowed, green, turning brownish-purple, with frequent, sometimes dense, simple and tufted hairs, glabrescent. Prickles numerous, unequal, the longest on the angles, usually shorter than the stem diameter, declining, some slightly curved from a long base (1.5–5 mm), often

grading into the numerous pricklets, occasional acicles, and abundant unequal short-stalked glands (0.25–0.5 mm). Leaves mostly 3-nate, usually lobate, but often a few 4-nate or 5-nate and pedate; shallowly, finely and almost simply serrate, sparsely strigose above, greyish green and pubescent on the veins beneath. Terminal leaflet (4.5–)5–8(–9) × (3–)3.5–6.5(–8) cm, mostly obovate or subrotund, but sometimes elliptic or misshapen, cuspidate or acuminate at the apex, entire or subcordate at the base, c. 2.5–4.5 as long as its petiolule; petiole 3–5(–9) mm, shorter or longer than lateral leaflets, with numerous short stout falcate prickles to 2.5(–4) mm. Flowering branch with 3-nate leaves below and 3-nate to simple bracts above, not usually leafy to the apex; inflorescence cylindrical above, pyramidal and leafy below, lower peduncles ascending; rachis straight above, flexuose below, clothed like the stem, but prickles more uniform in length; peduncles and pedicels with numerous short, declining or slightly curved prickles, abundant short-stalked glands and a dense layer of short hair. Flowers c. 1.5 cm in diameter, cupped; sepals green or grey-green felted, not aculeate but with numerous short-stalked glands, patent, often with long or short tips ascending; petals 5–10 × 4–6(–8) mm, very pale pink, often appearing white on opening, obovate or oblong, entire or notched, anthers glabrous, filaments white, slightly longer than the greenish or yellowish styles; young carpels glabrous or very slightly hairy; ripe fruit subglobose to ovoid. Flowering in July and August.

HOLOTYPE: Dunster, Somerset, coll. R. P. Murray, July 1893 as *R. drejeri* G. Jens. det. O. Gelert (**BRIST**, herb. J. W. White) (Isotypi distributed through B.E.C., including **E**)

The name commemorates the Isle of Avalon, renowned in myth and legend and associated with Glastonbury, which lies in the centre of its known distribution.

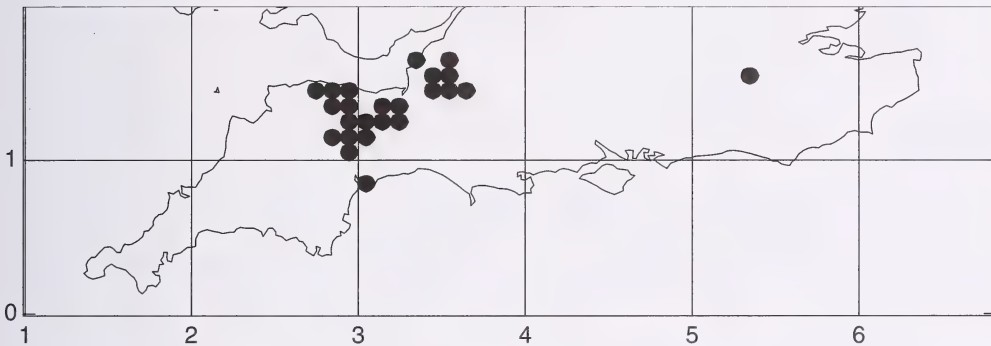


FIGURE 1. The distribution of *Rubus avaloniensis* in the British Isles.

REPRESENTATIVE EXSICCATAE

V.C. 3
Near Criss Cross, Silverton [SS90], on bank by roadside, 7/8/1903, G. B. Savery, *Rubus drejeri* G. Jensen det. W.M. Rogers, herb. Barton & Riddelsdell no. 10538 (**BM**).
Roadside hedge, No Man's Land, Leonard Moor, ST056130, 25/7/2001, A. Newton & R. D. Randall, **herb. R. D. Randall** no. 01.51.
Roadside, Lythecourt, near Tiverton, SS946160, 25/7/2001, A. Newton & R. D. Randall, **herb. R. D. Randall** no. 01.52.

V.C. 4
Wood border, Southern Wood, SS792474, 24/7/1989, A. Newton, **herb. A. Newton**.

V.C. 5
Quarry near Dunster [SS94], 8/9/1892, R. P. Murray as '*R. scaber* W. & N.', *R. drejeri* G. Jensen, teste O. Gelert, comm. W. M. Rogers, B. E. C. specimen no. 450, herb. Barton & Riddelsdell no. 10534 (**BM**).
Roadside near Wiveliscombe [ST02], 7/8/1891, R. P. Murray, det. *Rubus drejeri* G. Jensen (**BM**).

Brushford [SS92], 27/8/1907, leg. E. S. Marshall no. 3184, *R. drejeri* G. Jensen (teste Rogers), (**BM**).

Quarries above West Monkton [ST22], 20/8/1907, leg. E. S. Marshall no. 3181, *R. drejeri* G. Jensen (teste Rogers), (**BM**, **E**).

"Both specimens [no. 3181, 3184 on same sheet, **BM**] are *R. rotundifolius* Blox., not *Drejeri*", W. C. R. Watson, 2/1951. "*Rubus* 'pseudodrejeri' Miles MS. det. B. A. Miles, 1963 – on duplicates in **CGE** of both gatherings, D. E. Allen, 10/1992. Not *R. rotundifolius* sensu Wats. (= *R. tamarensis* Newton)", D. E. Allen.

Timberscombe [SS94], W. H. Mills, 9/1931. "I first saw it below Dowsborough camp and then in other places. Small leaf from Dowsborough Camp" W. H. Mills. "untypical *acutifrons*" det. H. J. Riddelsdell, herb. Barton & Riddelsdell no. 3957 (**BM**). "*Rubus* 'pseudodrejeri' Miles MS. det. B. A. Miles, 1963 – on a dup. in **CGE**", D. E. Allen.

Roadside by view-point, Haddon Hill, SS980286, 25/7/2001, A. Newton & R. D. Randall, **herb. R. D. Randall** no. 01.54.

Garden weed, Ranscombe Lodge, Wootton Courtenay, SS946433, 25/7/2001, A. Newton & R. D. Randall, **herb. R. D. Randall** no. 01.56.

V.C. 6

Near Shapwick [ST44], 21/8/1889, herb. D. Fry as '*R. scaber* W. & N.', later redetermined *R. ochrodermis* Ley, 'Somerset *drejeri*' det. A. Newton, 1982 (**BRIST**).

On the peat-moor, north-west of Ashcott Station [ST44], 3/8/1921, herb. C. Bucknall, as *R. foliosus* Weihe, 'Somerset *drejeri*' det. A. Newton (**BRIST**).

Peat moors, Shapwick, 8/89, H. S. Thompson, as *R. drejeri* G. Jens. fide W. M. Rogers (1901) (**E**) Limestone heath, Burrington Common, ST487585, 21/7/1990, coll. & det. R. D. Randall, **herb. R. D. Randall** no. 90.37. [forma aprica]

Edge of Worlebury Wood, Weston-super-mare, ST331631, 28/7/1990, R. D. Randall, **herb. R. D. Randall** no. 90.44. [forma umbrosa]

v.c. 17

Tilburstow Hill at 550 ft., TQ347501, 16/7/1962, B. A. Miles, as '*R. pseudodrejeri*', **herb. A. Newton**.

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Notes

CREEPING INFLATION IN THE LENGTH OF ENGLISH COUNTY FLORAS, 1730–1960

County Floras are so varied that any general trends which have taken place in their long history can easily be masked by individual variation. This note addresses two questions which it is difficult to answer simply by visual inspection:

Did the average length of Floras increase from 1730 to 1960?

Did the proportion of introductory material to species accounts increase during that period?

Webb (1978) used the phrase “creeping inflation” to describe the tendency of species accounts in multi-volume descriptive Floras such as *Flora Europaea* to increase in length as the project progresses. We have adopted it to cover the tendency of successive books or articles in a formal or informal series to increase in length. An example is provided by the *Biological Flora of the British Isles* series in the *Journal of Ecology*. The accounts of the first 20 species (1941–46) averaged 9.8 pages per species, whereas those of the last 21 species published before a major change in the format of the journal (1985–91) averaged 16.6 pages.

ASSESSING THE LENGTH OF FLORAS

We examined 66 of the 68 Floras listed by Preston (2003, Table 1). Ray (1660) is excluded for statistical reasons as an outlying data point and Jacob (1836) is excluded as an incomplete Flora. Floras published after 1960 were not included as there were major changes in the presentation of data after that date, with the increasing tendency to include distribution maps. The total length of a Flora is taken as the numbers of pages devoted to vascular plants. Pages devoted to non-vascular plants have been disregarded, as have any gazetteers and indexes. This total has been apportioned into two subtotals, for introductory matter and for species accounts (including their addenda and errata). The former includes background material on geology, climate and vegetation, historical and biographical notes, tables of occurrence of species within the county and in neighbouring counties, etc. Although we have used the term introductory matter, substantial sections appear in some Floras after the species accounts.

ANALYSING THE DATA

The data on page length for the 66 Floras are plotted in Figure 1 against the year of publication. These plots suggest an increase in the length of both the introductory material and the species accounts in Floras, particularly in the period 1850–1960. Regression analysis demonstrates that the increases in the total length of Floras is statistically significant ($R^2 = 14.7\%$; slope = 1.7 pages per year, $p < 0.001$), as are the component increases in the introductory material ($R^2 = 18.5\%$; slope = 0.6 pages per year, $p < 0.001$) and the species accounts ($R^2 = 8.5\%$; slope = 1.1 pages per year, $p < 0.5$). The proportion of introductory matter in Floras has increased, but at a very slow rate ($R^2 = 7.6\%$; slope = 0.0009 pages per year, $p < 0.5$).

The plots highlight the outlying points as well as the general trends. The longest Flora (assessed by our methods) is Horwood & Noel's (1933) *The flora of Leicestershire and Rutland*, 144 pages longer than its nearest rival, Druce's (1897) *The flora of Berkshire*. Horwood & Noel (1933) also have the most introductory matter, their 300 pages well ahead of Lees' (1867) *The botany of Worcestershire*, Druce's *Berkshire* and Baker's (1863) *North Yorkshire*. Keble Martin & Fraser's (1939) *Flora of Devon* contains the longest section of species accounts, ahead of Horwood & Noel (1933) and Bromfield's (1856) *Flora Vectensis*. Four Floras have over 50% of their pages devoted to introductory matter, and (not surprisingly) all depart from the standard pattern of county florals. They are Lees' (1867) *The botany of Worcestershire* (82%), discussed by Preston (2003), Baker's (1863) *North Yorkshire* (64%), which as its subtitle indicates, includes ‘studies of its botany, geology, climate and physical geography’, Good's (1948) *A geographical handbook of the Dorset flora* (54%) and De Crespigny's (1877) *A new London flora* (54%).

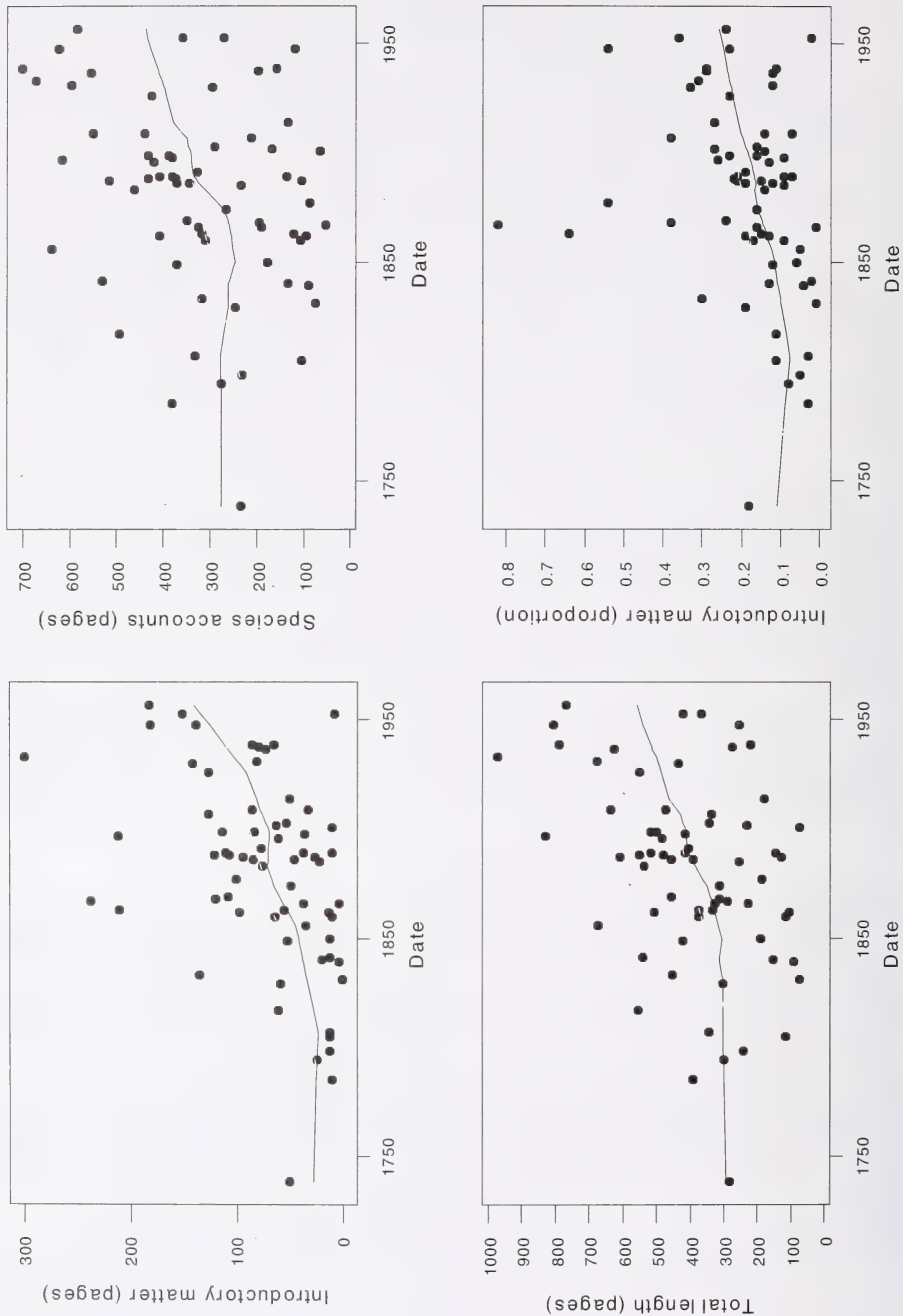


FIGURE 1. The length of the introductory matter and of the species accounts in county Floras published between 1730 and 1960, their total length and the proportion of introductory matter, plotted against date. The linear regression line (dashed) and the LOWESS (locally-weighted scatter plot smoother) line indicate trends over the study period.

The shortest Floras were Bagnall's (1901) *The flora of Staffordshire*, published as a supplement to the *Journal of Botany*, and Winch's (1831) *Flora of Northumberland and Durham*, the latter (ironically) covering an area now divided into three vice-counties. Winch (1831) included fewer than 10 pages of introductory matter, as did Howitt (1839) in *The Nottinghamshire flora*, Keys (1866–72) in his *Flora of Devon and Cornwall* and Kent & Lousley (1951–57) in *A hand list of the plants of the London area*. The shortest section devoted to species accounts is in Lees (1867), followed by Bagnall (1901) and Winch (1831). There are, of course, many shorter county check-lists which we have not included in the works analysed.

CONCLUSION

The number of pages is only an approximate measure of the length of a Flora, as pages vary in size and the amount of written material on the page differs according to design and font size. However, the variation in page size between 1730 and 1960 is less than it subsequently became, as Floras did not appear with the large page sizes subsequently adopted by modern atlas Floras. There therefore seems little reason to doubt that 'creeping inflation' did affect the length of county floras between 1730 and 1960, although there was very great variation in the length of individual Floras throughout that period. The length of the introductory material increased in response to the growing tendency of authors to provide a detailed treatment of the history of botany in the county and (in the 20th Century) the ecological aspects of the flora. Species accounts lengthened as the cumulative number of records increased over the years, and as counties were covered with increasing thoroughness, often by an increased number of recorders. The increase in length in the middle of the 19th Century may also in part reflect cheaper printing costs (Allen 2003). The phrase 'creeping inflation', although in some ways apt, perhaps suggests that the increasing length of Floras is an undesirable trend. In fact, later botanists have reason to be grateful for the wealth of records contained in the late 19th and early 20th Century Floras, even if the introductory accounts in some Floras seem unnecessarily prolix. After 1960, the adoption of grid maps allowed many more records to be summarised in a succinct manner, although sometimes this was at the expense of the historical context provided by the earlier works.

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PLOIDY OF *PRIMULA FARINOSA* L. REVISITED

Since 1932 the existence of polyploidy in *Primula farinosa* L. of European provenance has been accepted without re-examination of the sources of information. Chromosome numbers were given as $2n = 18$, $2n = 36$ and $2n = 72$ in *The Chromosome Atlas of Flowering Plants* (Darlington & Wylie 1955). The sources of these records have been traced, and the validity of characteristic numbers other than $2n = 18$, at least for European material, is questioned. Chromosome counts for *P. farinosa* distant from Europe are based on material from the mountainous Sayan region of Russia: Krogulevich (1978) records $2n = 18$ and $2n = 36$ "according to our data" and 18, 36, and 72 "from other sources"; discussion of these records is beyond the scope of this note.

Darlington (1956) suggested that some *Primula* species including *P. farinosa* have produced tetraploids – "(probably auto-tetraploids) which have appeared within their own limits of distribution and variation (e.g. in Gothland [*sic*])". Darlington was evidently referring to intraspecific variation and quoted no source for his reference to *P. farinosa*, but this might be presumed to relate to a letter to *Nature* (Davies 1953) in which evidence for such tetraploidy was illustrated by a photograph of a meiotic configuration in a squash preparation from a plant taken from the Swedish island of Götland. No clear indication of the numbers of cells or plants examined was provided although the comment that *the plant* appeared morphologically distinct from the British *Primula* may be a clue. Davies' (1953) count of $n = 9$ for *P. farinosa* is evidently based upon material from a number of English localities.

Bruun (1932) had previously established $2n = 18$ as characteristic of *P. farinosa* material, but also illustrated a count of $2n = 72$ in a root tip cell, "with chromosomes clearly shorter than the main species", for one plant of unspecified provenance designated *P. farinosa* L. f. *Warei* Stein.; and, in a single plant with poor roots from Scotland, he found two anaphases of "probably, 36 to 50 chromosomes". Chromosome numbers other than $2n = 18$ are thus based on very few cells from very few plants. Bruun expressed the need for re-examination of British material, and Davies (1953) mentioned the desirability of a more comprehensive cytological survey.

Bruun's illustrations, clearly establishing a chromosome number of $2n = 18$ for *P. farinosa* from the island of Öland, Sweden, include an indubitable mitotic metaphase in polar view, and an illustration (see Fig. 1) of "*P. farinosa* ... Metaphase I $n = 9$ ". The latter comprises two cells, each with nine stained bodies, but the bodies are not obviously bivalent and the configurations seem more likely therefore to be meiotic telophase II cells in incipient pollen grains derived from a broken-down pollen mother cell tetrad: with either interpretation the number of chromosomes is not in doubt.

Discussion here must now centre on the suggestion by Davies (1953), and taken up by Darlington (1956) that a "form" of *P. farinosa* with $2n = 36$ existed or exists. Three photographs, each measuring approximately 25×20 mm, and captioned "Meiotic metaphases ... of forms of *Primula farinosa*" provided the cytological evidence presented by Davies. It is necessary to consider only one of these – captioned "Tetraploid from Gotland". The photograph is evidently of a pollen-mother cell, although this is not stated. It is not reproduced here; instead, interpretative drawings are presented in Fig. 1. The stained units have shapes suggesting that they are each duplex, this being particularly evident in the body on the extreme left. However, the meiotic figure is not a meiotic metaphase, either first or second. It is, in fact, a telophase following anaphase I of meiosis. This contention is supported by the addition of explanatory lines to the illustration: the dashed line E – E in the enlarged drawing in Fig. 1 shows the notional position of the equator of metaphase I, and highlights the existence of two sets of chromosomes – the end product of a division. Furthermore, had the cell been at metaphase I the usual technique of aceto-carmine staining and squashing would have presented an equatorial view with stained bodies clearly bivalent, and more-or-less in a row prior to the separation of their components: spindles are usually tipped onto their sides during squashing. The dotted lines in the figure enclose notional groups of chromosomes (each comprising two chromatids) reflected on each side of the dashed line showing how the final resting places of the anaphase I chromosomes corresponded in the living cell.

There are nine chromosomes in each telophase I configuration; each chromosome would be due to 'appear' on the spindle of metaphase II, and to reveal more clearly its component chromatids as

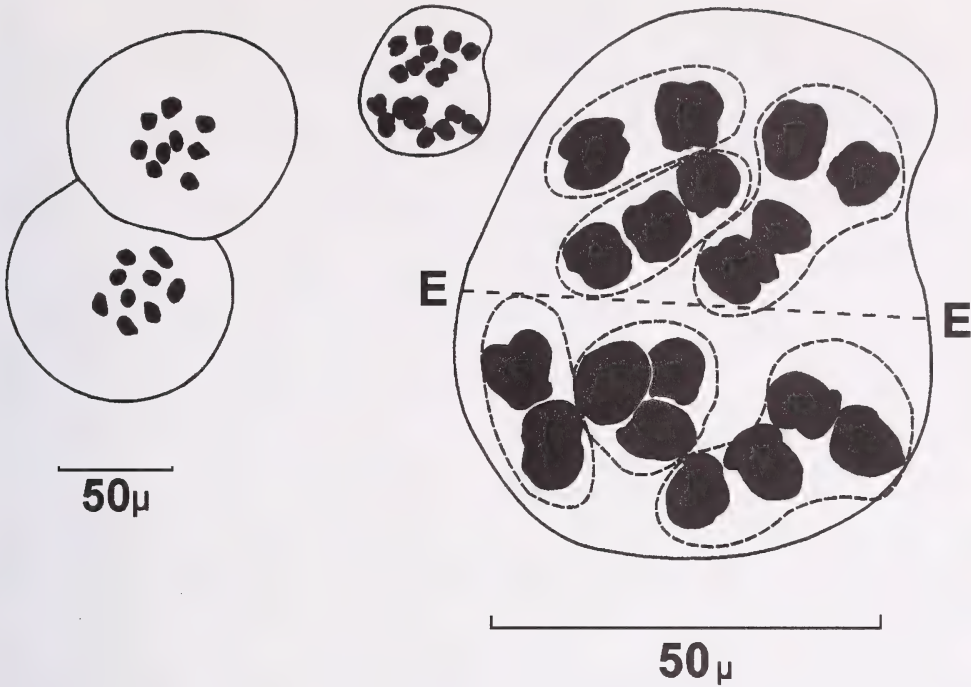


FIGURE 1. Chromosome complements of *P. farinosa* illustrated. Left: Bruun's (1932) "meiotic metaphase I $n=9$ [x3500]" from Öland, and inset an interpretative drawing based on a photograph described as a meiotic metaphase in acetocarmine of a form of *Primula farinosa* $\times 1200$ "Tetraploid from Götland" by Davies (1953) - both at original size. Right enlargement of the inset with further interpretation: E --- E hypothetical position of spindle equator; dotted lines enclose notionally corresponding groups of chromosomes on each side of the equator. Scales for the larger drawings are approximations calculated from the figures given by these authors.

these separated at anaphase II. The photograph thus provided good evidence that the pollen mother cell would have given rise to a tetrad with each potential pollen grain carrying nine chromosomes. Thus $n = 9$, and $2n = 18$, in this Götland material.

As Davies (1953) wrote - "it is now clear that a more detailed cytological survey of this group [*Farinosae*], from all over its geographical range, is desirable." To this might be added the provision that counts based on very few cells or single plants should be viewed with caution as being representative of a population. The presence of an endemic autotetraploid population anywhere (especially on a small island alongside diploids) is *a priori* unlikely. Autopolyploid individuals, with reduced sexual fertility, may occur sporadically in a plant species, as may single polyploid cells through failure of cytokinesis; whether chromosome counts greater than $2n = 18$ in Bruun's paper were representative of individual plants or of atypical cells cannot be known. This re-examination of *Primula farinosa* cytology illustrates how disputable information can originate, and generate theory persisting in the botanical literature for decades.

ACKNOWLEDGMENTS

Sources of illustrations reviewed here are given in the text and in the references.

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NEW RECORDS FOR *FALLOPIA* × *CONOLLYANA*: IS IT TRULY SUCH A RARITY?

Hybrid seed between *F. japonica* and *F. baldschuanica* was first discovered as long ago as 1983 from a range of locations, many of them in Wales (Bailey 2001), during the examination of seed produced by open-pollinated *Fallopia japonica* var. *japonica* plants. It took another four years for it to be found established in the wild at Railway Fields, Haringey by David Bevan (Bailey 1988). Since then no more established plants have been recorded from the British Isles. The discovery of isolated occurrences of this taxon throughout Europe prompted the publication of the new hybrid combination *F. × conollyana* (Bailey 2001). It is a most remarkable feature of this story that although most seed produced by *F. japonica* var. *japonica* in Europe is of this combination, only a vanishingly small proportion of it ever seems to become established in nature. Such seed when collected in the wild is frequently viable, and high germination rates are achieved when sown under greenhouse conditions.

There the situation remained until September 2002 when one of the authors (M.S.), discovered four putative *F. × conollyana* plants in the London Borough of Haringey whilst undertaking survey work for the Greater London Authority. The plants were found growing in a south-facing gutter on the asphalted roof of an old brick building at the North Middlesex Sports Club ground on Park Road GR TQ2988 (v.c. 21). The substrate was mostly humic run-off from the roof and approximately 5 cm deep. The *F. × conollyana* plants were growing in association with *Senecio squalidus*, *Poa annua* and *Solanum dulcamara*, and were suffering from water-stress in the unusually dry autumn. The largest of the plants was approximately 30 cm tall, much branched with a woody base; the second plant although smaller also had a woody base and the two remaining plants were single unbranched stems less than 10 cm tall. From this, it is evident that we are not dealing with a single cohort and that these plants represent successful germination and establishment over a period of two or more years. The largest plant appears to be two or three years old. The other woody plant could be younger or the same age, but certainly more than a year old as evidenced by the woody base. The two smallest are 2002 seedlings. What at first might appear to be a somewhat eccentric place for seed germination and establishment, is on reflection not so odd when considering the natural habitat of Japanese Knotweed in Japan. Bailey (in press) discusses the question of seed germination in Japan, where there is a marked distinction between the habitat of tall lowland *F. japonica* and the dwarf montane varieties. At high altitudes *F. japonica* is often the only higher plant present, and when other taxa do occur, there are still considerable areas of bare rock or volcanic ash to be found. In such habitats *F. japonica* is regularly recruited from seed and there is much genetic variation, with plants of all ages including seedlings. In contrast, at lower altitudes the taller lowland plants eke out their existence at the margins of dense forest and often appear to be clonal. Considering the very slow growth and lack of competitive ability of *F. japonica* seedlings, it is probable that seed germination in lowland habitats can only occur in the aftermath of major earth movements or volcanic activity. In this context, a hot bare roof does not seem such an odd place for a seedling with initial slow growth and little competitive ability. This does however beg the question of what happens to all the seed produced in Britain, which falls on bare soil. A reasonable theory is that seed does not survive our winters. Not, we hasten to add, due to the cold, as *F. japonica* grows at 3,500m on Mt Fuji! Although the hybrid seed is perfectly viable, it is still hybrid seed and, as such, the endosperm is

not fully developed compared to seed produced by intraspecific fertilization or between taxa with comparable ploidy levels and base numbers (see Bailey 2001). The seed which gives rise to *F. × conollyana*, often contains enough endosperm for germination, but there is frequently a gap between the pericarp and the endosperm. In the damp conditions of a typical British winter it is quite possible that such malformed seed could be vulnerable to attack and destruction by zoosporic soil fungi such as *Pythium* and *Phytophthora*. The occurrence of plants of *F. × conollyana* where fungi dependant largely upon ground water for dispersal are unlikely to occur is of interest and may partially explain the apparent great rarity of this hybrid as mature plants in north-west Europe.

Finally, one must consider the implications of the first two confirmed British records for *F. × conollyana* occurring in the same region of London – is there something special about Haringey and if so, what? Or are urban botanists uniquely positioned to become adept at alien and novel plant identification? Whilst this note was in preparation another established plant of *F. × conollyana* was discovered growing in a garden in Eydon Northamptonshire (v.c. 32 SP5450), raising the possibility of *F. conollyana* occurring in further sites across the British Isles; additionally, the potential for a new allopolyploid speciation event should now be considered more seriously.

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Book Reviews

The Plant Life of Snowdonia. Edited by P. Rhind & D. Evans. Pp. xv +173. Gomer Press, Llandysul, Ceredigion. 2001. £19.95. ISBN 1 84323 044 5

The best books are often written by people who not only know their subject intimately but are passionate about it too. It's clear that the ten contributors to *The plant life of Snowdonia* fulfil both these criteria, and the result is an intelligent and wonderfully evocative account of a very special area.

After the preface (Dick Roberts) and Introduction (Peter Rhind), eight chapters follow, each dealing with different groups of plants in Snowdonia – Seed Plants, Ferns, Clubmosses and Quillworts, Horsetails, Mosses and Liverworts, Fungi, Lichens and finally Freshwater Algae. This ensures a refreshingly complete treatment of all the groups, an approach that is reinforced by the use of similar headings within each chapter. These cover an introduction to each group, a history of recording, descriptions of habitats, a discussion of conservation issues and a bibliography. Although this could lend the book a slightly pedestrian feel, it does not, bringing instead a structure that is especially welcome when reading chapters dealing with unfamiliar groups. I was surprised, however, that ferns, clubmosses and quillworts, and horsetails were each given chapters of their own, whilst mosses and liverworts were lumped together.

Dealing with such a wide range of subjects in a book of 150 pages obviously means that some readers will be left wanting more. The bibliographies help, but these too can be a bit short (Chris Page's *The ferns of Britain and Ireland* (1997) should perhaps have been included in several chapters and Dewi Jones's *The botanists and guides of Snowdonia* (1996) in that on flowering plants). The target audience, however, I suspect is a wider general readership and, as a thoroughly readable introduction to the subject, it is excellent.

Finally, it has to be said that the photography is stunning. Peter Rhind has an ability to capture the "mood" as well as the form of each subject, and his portraits of fungi are particularly good.

T. DINES

Les Orchidées de France, Belgique et Luxembourg; (a collective work under the aegis of the Société Française d'Orchidophilie.) Parthenope, Paris. 1998. £32.00 from Lopinga Books Tel: 01799-599643. ISBN: 2-9510379-1-0.

This is an extremely comprehensive work on the orchids of metropolitan France (i.e. including Corsica, but excluding overseas territories such as Réunion), Belgium and Luxembourg – a region that cuts a swathe through the west of Europe, and therefore includes a wonderful variety of species, amounting to almost 150 taxa in all.

Before the species description, there is an extensive general section, covering the biology, biogeography, ecology, conservation and history of orchids, followed by about 250 pages of species descriptions, totalling 416 pages in all. There is a simple key to the genera, then more detailed keys within every genus other than monospecific ones. I haven't had the chance to try these in the field, but they look easy enough to follow.

The species descriptions are the core of the book, with 1–2 pages per species, comprising one or more photographs, a distribution map, description, and details of habitats, protection, known hybrids, and flowering time. The photographs are almost all of very high quality, well-chosen to show what is required. The maps are very useful, but are based only on presence or absence by Département, so they can be slightly misleading, and I suspect that there is a fair bit more to be discovered about the distribution of orchids in France, especially in the light of new subdivisions of species. The text is detailed and useful. The definition of species is not very different to Delforge's Collins photoguide to orchids of Britain and Europe, though there will be a few surprises to anyone used to older books; for example, the old vanilla orchid *Nigritella nigra* no longer exists, replaced by four component species, none of which has the original name.

I can recommend this book wholeheartedly if you visit this area and can read French, and the photos and maps would make it useful even if you don't. It's one of a small series that also includes an excellent guide to butterflies of France.

B. GIBBONS

The Evolution of Plants. K. J. Willis and J. C. McElwain. Pp. x + 378. Oxford University Press, Oxford, 2002. Pbk £22.95. ISBN 0-19-850065-3.

Aimed at undergraduates, this new textbook on plant evolution begins with a valuable discussion of how we know what we know, i.e. of fossil data and of the various methods of dating the finds. The book then proceeds to describe the main events in plant evolution: origin of prokaryotes, followed by eukaryotes, the colonisation of land, diversification and evolution of the land flora, the origin of the seed habit and finally of flowering plants and their subsequent diversification. There are also interesting discussions on the roles of dinosaurs and insects in stimulating plant radiations. Given the title of this book, I expected somewhere to find a clear definition of 'plant', or at least an indication of the groups that collectively make up this taxon. The authors appear to regard the various algal groups as plants (p. 1), but this issue is not further addressed and the account simply drifts into how green algae invaded the land and generated a whole new flora. Given that it is green plant evolution that is intended, the authors have provided a well illustrated and up-to-date treatment of the relationships between the various extant land-plant lineages and their fossil relatives, citing much recent evidence from palaeontological and molecular (including fossil DNA) studies. A key innovation is the emphasis given to the development of various vegetation types and their biogeographical distribution at each stage in history, all of which makes for fascinating reading.

All in all I recommend this book, but do not be misled by the absurd hyperbole offered by the publishers on the cover, which puffs this volume as "the most accessible, modern, and comprehensive book on plant evolution ever published". The claim to being the most comprehensive is of course complete nonsense. This is not a criticism of the authors, however, who are to be congratulated on summarising successfully a great deal of recent evidence on plant evolution from a global perspective.

R. J. GORNALL

Poisonous Plants and Fungi in Britain and Ireland (Interactive identification system on CD-ROM). Primary editors E. A. Dauncey, T. G. J. Rayner and D. A. Shah-Smith. The Royal Botanic Garden, Kew and the Medical Toxicology Unit, Guy's and St Thomas's Hospital NHS Trust. £39.95. ISBN 1-900347-92-X

The Royal Botanic Garden Kew and the Medical Toxicology Unit, Guy's and St Thomas's have collaborated to produce this database of poisonous plants and fungi. By combining their talents they have created a unique reference tool. The CD covers approximately 350 plant and fungal groups. Some genera such as *Asparagus*, *Crocus* and *Agaricus* are dealt with as single groups, while others, such as *Hyoscyamus niger* and *Amanita virosa*, are dealt with as single species. In total 2000 plants and 125 fungi are covered.

The information provided on each species is extraordinarily detailed. Information on the toxicity, clinical effects and treatment are given along with a detailed botanical description of the species. To condense this information for rapid appraisal there is a summary page noting the key points. Glossaries of botanical and medical terms are provided and prove essential to understanding the language used.

The publication features three interactive, illustrated keys. One key is to identify the fungi, another for the plants and another to diagnose poisoning syndromes. The intention is that these keys can be used with only basic botanical knowledge. Unlike standard dichotomous keys, these keys can be used in a number of ways. Questions can be skipped, answers can be amended and questions can be answered out of sequence. If the species can not be uniquely identified from the given answers then a short-list of possible identifications is provided. Each species can then be reviewed independently for a final identification. The identification keys are a primary feature of the CD. They operate well but, like all keys, they are not infallible. I was unable to identify a *Cyclamen* from its rootstock because I had answered that the rootstock was a corm rather than a tuber. To be generous, perhaps only a botanist would have answered the question this way.

I found two "bugs" in the program, though these are largely cosmetic and may be unique to the operating system (Windows 2000) and screen resolution (1024 × 768 pixels) I used. The first of these problems is that the *continue* button is not visible on the start up screen. I only know it should be there from the instruction manual. I've now discovered that you can go into the program by pressing the keyboard's *enter* key. The second problem is that some of the labels on the

illustrated key are only partially visible. In general this has been more of an irritation than a problem.

The database of information on this CD is a significant reference tool. The software supporting this database is reliable and functional, but not elegant or progressive. Nevertheless, if you have either professional need or a morbid interest in poisonous plants and fungi then this CD is likely to satisfy your requirements.

Q. J. GROOM

The Flora of County Cavan. P. A. Reilly. Pp. 177, with 16 colour photographs, 2 maps. National Botanic Gardens, Glasnevin, Dublin, Occasional Papers No. 13. ISSN 0792-0422. Pbk Euros 15.20 (incl. postage)

It came as a complete surprise one day when a copy of Paddy Reilly's Cavan flora landed on my desk in the Ulster Museum. I had known that Paddy had been assiduously working towards a flora of this attractive county for some years, but had no idea that its appearance in print was imminent. One gets used to flora projects which extend well beyond the projected time (including my own third edition of the *Flora of the North-east of Ireland* which was originally intended to mark the centenary of the first edition but missed that event by some four years!), so Paddy's realisation of his work must be a point of congratulation.

Cavan is not a region with which I can personally claim any great familiarity, for I am ashamed to say that it has served merely as a county which I have driven through in order to reach somewhere else. It has also been somewhat ill-served by Irish botany in that it is one of the Irish counties which has never had a published flora or even checklist produced, perhaps because it lacks dramatic scenery and a sea coast. This defect is now remedied by this attractive paperback.

The book contains a comprehensive historical summary of the contributions of earlier workers in the county. Not surprisingly, botanical field investigations can be divided effectively into the pre-Praeger era, the Praeger era and the 1950 – 2000 era. Praeger's contribution completely outweighs that of his predecessor, but the real meat of this work has largely come from recorders of the past thirty years or so, and particularly from Paddy and his associates in the BSBI over the last twenty years.

There is an introduction to the topography, geology and land use of Co. Cavan, quite comprehensive, but a decent map of the county is something of an omission. An important geological feature is the carboniferous limestone of the north of the county, including some which is exposed as limestone pavement. The 'feel' of the landscapes are transmitted through some nice colour photographs, although the quality of their reproduction is not of the best.

The systematic catalogue of the flora provides the expected bulk of the book. It is interesting as a stranger to peruse the lists and note the balance and make-up of the flora of a county one does not know well. One of the important features is the large proportion of freshwater lakes in the county – part of the great Erne system extends into the county, while Lough Macnean is also shared with adjacent Co Fermanagh. Not too surprisingly, then, one notes the presence of *Hydrocharis morsus-ranae*, *Stratiotes aloides*, *Butomus umbellatus*, *Sagittaria sagittifolia*, *Bidens* spp. and *Sisyrinchium bermudiana* to name a few aquatic and waterside plants, and the *Potamogeton* list is quite healthy, partly owing to the attentions of Chris Preston on BSBI field excursions. There have been some notable recent records of species which had not been seen for some time including *Saxifraga hypnoides*, last previously recorded in 1802 and *Ophrys apifera*, last previously recorded in 1920, while species reported in the county for the first time ever include *Senecio erucifolius*, *Zannichellia palustris* and *Trollius europaeus* – all reports from the 1900s. Several alien species are reported here for the first time also, including *Impatiens glandulifera* which, surprisingly, is still reported as rare in the county. Surprising absentees on the established alien front are the *Acaena* species. Being more familiar with the flora of Northern Ireland, I was also surprised to note the rarity of *Sinapis arvensis*, the absence of *Fallopia sachalinensis* and the recorded presence of only two *Hieracium* species.

The book concludes with a useful topographic index, a bibliography and indexes to scientific and English names (but not to Irish names, which are given with each species account where available). There is a useful list of Areas of Scientific Interest within the county.

All in all, a valuable addition to the regional floristic literature for these islands, and no visitor to the county should fail to take a copy with him (or her) – preferably one that they have purchased!

P. HACKNEY

Wild Flowers of Fife and Kinross. G. H. Ballantyne. Pp. 137. Fife Nature, Glenrothes 2002. Pbk £5.00. (no ISBN)

This handy annotated checklist is the culmination of years of toil. It begins with a brief history of botany in the county and continues with short paragraphs on the geology and landscape, habitat and notable plants, recording methods and the nomenclature used, and a short bibliography is given before the start of main text of the book. The sequence of species follows Kent/Stace order and gives the scientific and common name followed usually with habitat, locality and frequency. A map shows the more important localities mentioned in the text and another shows roads, towns and villages. I am glad to see that a group of plants (stoneworts) rarely covered by floras and checklists has been included as well as a list of casuals with the date last recorded. It is a pity that localities were not given for the plants believed to be extinct so that plant hunters may search for them in the years ahead. Sometimes the author does not adhere to the common names used in Stace e.g. Red Catchfly instead of Sticky catchfly, also *Asplenium* $\times$ *alternifolium* is not the forked spleenwort but a hybrid of it. One or two other common names also deviate from the standard list, e.g. *Sequoiadendron gigantea* is given as Giant Redwood rather than Wellingtonia and *Nothofagus* is given as Silver Beech rather than Southern Beech. Stricter editing could have improved some of the colloquial English "overlooked to a degree; in wet spots; persisting for a spell"; *Persicaria maculosa* was entered twice and sometimes habitats were given and sometimes not. Groups of families are dealt with together so that often genera of different families run into one another and you cannot tell where one family ends and the next begins.

Apart from these minor quibbles there are few errors but some that need mentioning are: *Poa humilis* can be confused with *P. pratense* and not *P. compressa* and both subspecies of *Odontites* should have been mentioned and the *Euphrasia* hybrids have no mention. I was surprised to learn that *Rorippa* $\times$ *sterilis* is more common than either of the parents as the hybrid is rare in the Lothians and I was impressed with the amount of willowherb hybrids, some of which I have not been aware of at all are listed as occasional! The type face is very clear and easy to read and the paper is glossy and of good quality and the cover is attractively illustrated with colour pictures. Over 30 colour photographs illustrate some attractive habitats and notable plants. The book is good value and should grace the shelf of all local botanists and naturalists.

D. R. MCKEAN

Flora of Assynt: Flowering Plants. P. A. Evans & I. M. Evans; *Bryophytes*. G. P. Rothero. Pp 284. Privately published by P. A. and I. M. Evans. Pbk. £15.00 ISBN 0-9541813-0-1.

Assynt is a single parish but this excellent work approaches close to being a county flora in its scope and standards. The parish constitutes roughly 15% of the area of West Sutherland (v.c. 108), and is representative of the whole vice-county having coast, high mountains and very numerous lochs and lochans. The limestone habitats of Inchnadamph make the district especially attractive to botanists, while the shapely peaks of Canisp, Quinag and Suilven draw many climbers.

The flora puts on record a prodigious amount of recording (and walking) carried out since 1988 by the wife-and-husband team of Pat and Ian Evans, besides bringing together the scattered reports of many previous botanists. There is also a very useful account of the bryophytes produced by Gordon Rothero and based almost entirely on his own surveys since 1992.

Both higher plants and bryophytes were recorded on a tetrad basis, so the flora represents a new advance in Scottish botany. Altogether 164 tetrads lie in the parish, contributing substantially to 9 hectads, and the resulting dot maps give a much more complete description of species' abundance and distribution than hectad occurrence and subjective frequency descriptors could achieve. A useful feature is the text accompanying the dot maps that states succinctly the species' habitat preferences as observed during the Evans' recording. There are some surprises even to this North Scottish reviewer, albeit one who operates on the other side of the country; thus *Campanula rotundifolia* was found in only 8 tetrads, mainly new road verges, and *Ajuga reptans* and *Sonchus arvensis* are very rare.

The introductory part of the flora comprises about a fifth of its length. It provides 25 colour photographs of landscapes and habitats as well as coloured contour and geological maps that will be helpful to many readers. The text is well written but somewhat patchy: there are good accounts

of vegetation types, climate, and the current survey (its timing and technique), then a considered analysis of the apparent recent gains and losses in the flora, while geology is given superlative treatment (some might say excessive). But grazing, the other main factor shaping the flora, gets just scattered mentions (p. 25 - sheep numbers dropping in crofting areas, none of the other estates have livestock (but we are not told about the main estate(s)), p. 28 - many islands grazed till quite recently, p. 29 - browsing severely restricts woodland regeneration, p. 31 - sheep now virtually confined to areas under crofting tenure but still a large population of red deer, p. 102 - increased grazing may be responsible for *Parnassia palustris* being lost from former sites and now occurring in only 1 tetrad). A consolidated section on the present agriculture and sporting management would have been desirable, with an indication of the densities of sheep and red deer and perhaps a map of land holdings.

Other irritations are the lack of precise grid references in the main flora (although six-figure references were obtained) and the general non-naming of places of occurrence. The flora plan says that record details are given only for species with 6 or fewer tetrads, but wisely the authors do not rigidly adhere to this, e.g. for *Phyllitis scolopendrium* (7 tetrads). But other rare and scarce species could have benefited, for example *Carex rupestris*, *Galium steneri* and *Potamogeton berchtoldii* (each with 9 tetrads), which will be hard to find without more precise details. Space for this information could have been created by the omission of some dot maps since around a hundred show only 1 tetrad, and by the dropping of some text on first records. It is a quirk of the interests of past botanists, and the authors' rigid definition of reliable records, that so many widespread species, e.g. *Digitalis purpurea*, *Holcus lanatus*, *Juncus effusus* and *Trifolium repens* (each with c. 130 tetrads), should be "first recorded in the 1950s survey"; this may confuse some readers and obscures real colonisation, e.g. by *Epilobium brunnescens*. By and large these are minor reservations and I congratulate the authors on so speedily completing their enterprise and providing a flora that deserves to sell well.

Finally, I reflect on whether the production of this type of flora should be generally encouraged for upland Britain. In my opinion the first priority for the few botanists in remote regions should be to produce accounts for all vice-counties, and only special areas will justify the present intensive treatment, Breadalbane and Ben Lawers being another possible example. Hopefully workers as well organised and dedicated as the present team will not all flock to the Meccas, but rather will help level up the existing uneven botanical coverage.

D. WELCH

Obituaries

ELIZABETH WINSOME WOODWARD (NÉE DAVIES) (1924–2002)

Elizabeth Woodward died at the age of 77 after a long battle with cancer. She was born at Woodville, Bristol. After attending Badminton House School in Bristol and Downe House in Berkshire, she studied Horticulture at Studley Agricultural College, Warwickshire, followed by a degree in Botanical Genetics at Newnham College, Cambridge. She then undertook postgraduate work on *Polypodium* and Madeiran ferns at the University of Leeds under Professor Irene Manton and contributed numerous chromosome counts for Manton's *Problems of Cytology and Evolution in the Pteridophytes* (1950). However, she left Leeds after two years, not agreeing to take on additional teaching on Saturdays as required by Professor Manton. Her first paper, the only one on ferns, was on hybrid vigour in *Asplenium adiantum-nigrum*. Another early paper (1953) in *Nature* concerns an unexpected tetraploid form of *Primula farinosa* found in 1950 on the Baltic island of Gotland.

After leaving Leeds 'Liza' Davies, following advice from her Cambridge mentor, Humphrey Gilbert-Carter, began research at University College, Leicester, to study *Carex flava* agg. under Professor T. G. Tutin; she was awarded her Ph.D. from the University of London (1953) on this research. Her publications on this aggregate, mainly in *Watsonia* from 1953 to 1956, are substantial contributions to the taxonomy of the group. She described *Carex scandinavica* E. W. Davies as new to the British Isles (1953), this typically coastal plant occurring mainly in N. W. Scotland. This sedge is now known as var. *pulchella* (Lönnr.) B. Schmid of *C. viridula* Michx. ssp. *viridula*. At a research post in the University of Lund, Elizabeth Davies worked further on sedges, her papers covering the cytogenetics of the *C. flava* group (1955), new chromosome numbers in the Cyperaceae (1956) and features of the aneuploid series in *Carex* (1956). She also spent a year at University College London working with Peter Bell.

While at Leicester she was able to follow her other major interest, riding; she fitted her botanical research round days with the Fernie and the Quorn. By this time she was an accomplished horsewoman; indeed, she reported on the equestrian Olympics for the *Daily Telegraph* in Helsinki in 1952. Subsequently she was much involved with point-to-pointing and the then new sport of Eventing.

On returning to the Cotswolds in the mid-50s, she joined the University of Bristol, funded by a scholarship from the Bristol Zoological Garden. As well as teaching pharmacy to dental students she turned her attention to interesting cytological and taxonomic problems in the Lusitanian element of the British flora, amongst which was a study of *Asparagus officinalis* ssp. *prostratus*, resulting in contributions concerning polyploidy (1959), its ecology and distribution (1961) and, after many years, taxonomy (2001); it was hoped that this study would ultimately lead to an account in the *Biological Flora of the British Isles*. In 1957 *Juncus subulatus*, now called the Somerset rush, was found new to Britain in the salt marsh at Berrow and she collaborated in a publication on this plant (1960).

On marrying the University of Bristol chemist Peter Woodward in 1958 (whom she got to know after persuading him to drive her to the Lizard to collect plants), and settling near Chewton Mendip, there they brought up their two sons, with Elizabeth continuing to follow her equestrian interests. Most unfortunately, while competing in a cross-country event in 1968, her horse, tripping on parallel bars, fell on her, causing spinal injuries which confined her to a wheelchair for the rest of her life. She bore this adversity with enormous fortitude, never complaining. Despite her accident she continued to teach biology at Millfield School, Street and Sunnyhill Girls' School, Bruton; she also served as Chairman of the Community Health Council in Bristol, was on the Somerset County Council and the committee of the Axbridge Cheshire Home. She became chief instructor for the Mendip Pony Club and in 1996 qualified as a List I Dressage judge, being due this year to receive an award from British Dressage for her 'outstanding contribution' to the sport.

Elizabeth had a very discerning eye for plants and made many field records in the 1950s. She had a formidable intellect and, had she stayed in research, would have made a major contribution

to British botany. No doubt she would also have made valuable records for *The Flora of the Bristol Region* (2000) had she been able to leave her wheelchair.

I am grateful to Elizabeth's younger son Anthony for much information and to Dr Tim Rich for a literature search and many helpful suggestions.

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ARTHUR J. WILLIS

KNUT FÆGRI

(1909–2001)

Knut Fægri, an honorary member of the B.S.B.I. since 1968, died early on 10 December 2001 after a few days in hospital. He will long be remembered internationally as one of the great pioneers of Quaternary pollen analysis and palaeoecology, as author of the main textbooks on pollen analysis and on pollination ecology and of two volumes of *Maps of the Distribution of Norwegian Vascular Plants*, as an active member of many committees concerned with the International Code of Botanical Nomenclature, as secretary and then president of the International Union of Biological Sciences, and as Norway's leading botanist for over half a century.

He was born in Bergen on 17 July 1909 and he always said that his study of botany started at the age of 3 in the garden and never stopped. He was educated in Bergen and obtained his first degree in 1933 and unbelievably his doctorate a year later in 1934. He was a free-lance researcher until 1945 when he was appointed Professor of Systematic Botany and Plant Geography at Bergen's Museum, which became the University of Bergen in 1948. He subsequently transferred to a new chair, Professor of Systematic Botany and became director of the Norwegian Arboretum at Milde near Bergen in 1975. He was also Dean of the Faculty of Science (1959–1965) and Pro-Rector (1961–1965) of the University of Bergen. He formally retired in 1979 but he remained extremely active and was usually working in the Botanical Institute in Bergen, even on Saturday mornings, until about two months before his death.

Knut Fægri's botanical interests were very wide: floristics, ecology, vegetation dynamics, algae, fungi, lichens, aquatic plants, orchids, trees, plant geography, plant systematics and nomenclature, then also pollen analysis, vegetation history, pollen morphology, pollination ecology, culinary plants, garden history, and plant dispersal. He also published on glaciology, local history, and Norwegian cultural history. His breadth and scientific energy are reflected in his 600+ publications, the first of which appeared in 1929. A list of all his known publications, *Bibliographia Fægriana*, has been prepared by Dagfinn Moe and will soon appear in the Norwegian botanical journal *Blyttia*. Fægri travelled widely and had a remarkable knowledge of the flora, not only of Scandinavia, but also of Mediterranean Europe, western North America, southern Africa, and Australia. He regularly attended the evening meetings of the Norwegian Botanical Society in Bergen and he invariably had some difficult and penetrating questions to ask after the talk.

Knut Fægri's first major botanical studies were on the re-vegetation and succession on four glacial forelands in the Jostedal area of western Norway following the glacial retreat over the last two centuries. In this work, which formed the basis of his 1934 doctoral thesis, he presented

many novel ideas in primary successional studies, such as using lichen size as an index of moraine age, the near-random accidental immigration of species in the initial pioneer stages, and the role of the initial colonisers in determining the subsequent successional stage. This work, published as 255 pages in German and in the obscure *Bergens Museum Årbok*, never received the scientific attention it deserved. His interests in short-term plant succession and vegetation dynamics quickly changed to long-term vegetation dynamics and Quaternary vegetation history after he learned about the newly developing subject of pollen analysis. In the autumn of 1933 he attended a so-called Baltic Course on pollen analysis led by the Swedish geologist and father of pollen analysis, Lennart von Post. Fægri rapidly started pollen-analytical studies in Norway and published major monographs on the late-glacial and post-glacial vegetational history of western Norway in 1935, 1940, 1943, 1944, and 1950. As a result of the 1933 Baltic Course, Fægri developed a life-long friendship with the Danish ecologist and pollen analyst Johannes Iversen, and between them they published their *Textbook of Modern Pollen Analysis* in 1950. This has been revised and updated in three subsequent editions as *Textbook of Pollen Analysis* (1964, 1975, 1989). This textbook remains the “bible” for Quaternary pollen analysts worldwide. Another of Fægri’s long-standing interests was pollination ecology and, in conjunction with L. van der Pijl, he published three editions of *Principles of Pollination Ecology* (1966, 1971, 1979).

Throughout his life, Knut Fægri had a great love for plants in the field, the herbarium, and the garden. He compiled two of the three volumes of *Maps of the Distribution of Norwegian Vascular Plants* – the Coast Plants (1960) and the South-east Element (1996 with Anders Danielsen). These volumes present not only detailed “dot” maps of the known distribution of the species based largely on herbarium material but also critical notes about their distribution, ecology, and history. Fægri served as one of the regional advisers for Norway for *Atlas Flora Europaeae*, and he always enjoyed searching the Bergen Herbarium for obscure plant records that other people had missed. He also published in Norwegian a very successful and popular 2-volume account of Norwegian plants (1958) and several books on spice plants and on garden history.

Knut Fægri served as general secretary (1968–1969) and president (1970–1973) of the International Union of Biological Sciences. He attended all the International Botanical Congresses from 1935 (Amsterdam) to 2000 (St. Louis) where he was honoured as one of the “Millennium Botanists”, an honour that he greatly appreciated. He received many other honours including Commander of the Royal Order of St. Olav (1980), an honorary doctorate from the University of Uppsala (1977), honorary membership of many botanical and biological societies including the B.S.B.I., and many prizes, awards, and medals from different organisations in several countries including Norway, India, Finland, Japan, Sweden, Russia, USA, and Germany.

An important national side to Knut Fægri was his devotion to the popularisation of science for the Norwegian public. He edited the Norwegian popular science magazine *Naturen* for 30 years and published over 300 articles in there on a wide range of scientific topics. He frequently appeared on radio and television and in the newspapers discussing many topics including Norwegian plants and their ecology and history, cultural history of gardens and ornamental plants, and culinary plants. He received several prizes within Norway for his contributions to the popularisation of science. He was a well-known public figure in the media, prominent in nature conservation and education matters, and an active and lively participant in many general debates. Fægri seemed to enjoy being in a minority of one and he often expressed rather radical and controversial views about sex, drugs, and naturism. One of his main hobbies was cooking and he published over a dozen books and papers on culinary topics and he won two prizes in national cooking competitions.

Although he did little plant systematics research himself, Knut Fægri loved all things systematic, not only plants and nomenclatural codes, but also books, journals, offprints, colour slides, identification keys, pollen morphology, all forms of terminology and nomenclature, cooking recipes, wines, diaries, and notebooks. He often seemed his happiest in later years re-classifying and re-arranging the books and journals in the Bergen Botanical Institute library. His ideas on how books should be classified and arranged never agreed with anybody else’s ideas, and he thrived on devising new classification schemes.

Knut Fægri was a great botanist, a famous public figure both nationally and internationally, a very generous person, an inspiring colleague, and a wonderful friend. He loved helping people and when we moved to Bergen he was among the very first to help us, to provide support, to make us feel welcome, and to encourage and stimulate new botanical studies. When it was obvious that he

did not have long to live, the Norwegian Broadcast Corporation recorded what Fægri himself knew were his last interviews. The resulting television programme was broadcast in January 2002 and it included the final part of his funeral in which, at Fægri's request, the first movement of Paganini's Violin Concerto No. 1 was played as "a tribute to the joys of life."

H. J. B. BIRKS and HILARY H. BIRKS

ANNE BEATRICE MARY BREWIS
(1911–2002)

Lady Anne Brewis, who died on 31 March 2002, had a lifelong attachment to Hampshire and its natural history, and more especially to the area round Selborne which she came to know well in youth and to which she returned to live for the second half of her long life. The many years she then devoted to the recording and conservation of the county's vascular plants culminated in the publication in 1996 of the widely-admired *Flora of Hampshire*, of which she was one of the three editors.

Born on 26 March 1911, the Hon. Anne Palmer, as she was until her father's succession to the Earldom of Selborne in 1942, was the eldest of five children of Viscount Wolmer and the Hon. Grace Ridley. On both sides of the family there was a strong tradition of public and political service, and among her more immediate forbears were a Prime Minister, a Lord Chancellor, a Lord Lieutenant of Ireland and a bishop sufficiently esteemed as a mathematician to be elected Secretary of the Royal Society. Her paternal great-grandfather, the Lord Chancellor, had been a keen botanist and entomologist in youth, an interest he could trace back to an early 18th Century ancestor, the famous Yorkshire naturalist Dr. Richard Richardson, whose published correspondence with Sherard and other leading figures has long been a mine for historians of the subject. Richardson was a cousin by marriage of Gilbert White's boyhood tutor, so it was highly appropriate, and probably no coincidence, that it was in the vicinity of Selborne that the Lord Chancellor acquired a small estate and from that village took his title on his subsequent elevation to the peerage. It was on that estate, at Blackmoor, by then the home of her grandfather, that Anne was able to roam at will on childhood holidays from a London home and upbringing, and imbibe in turn that family fondness for natural history. A plantsman uncle, the Hon W. J. L. Palmer, did much to turn that in a more particularly botanical direction.

A compensation for two London 'seasons' as a debutante, otherwise a distasteful endurance test for her, must have been meeting many another in that circle caught up in the then fashionable enthusiasm for 'painting one's Bentham' – that is, trying to find as many as possible of the species in Bentham and Hooker's *Handbook of the British Flora* and marking the discovery of each new one by colouring its figure in Fitch's companion volume of illustrations, with the date and place added: the botanical equivalent of the birdwatchers' 'life list'. Later, at Oxford University, where she was at Somerville College and read zoology, dances continued to come a poor second to natural history: sent some money by her parents with orders to put it towards the cost of a dress for one, she spent the sum instead, to their intense annoyance, on a copy of Gerard's *Herball* that she came across on offer at a price too tempting to resist. It was to be the source of the several quotations from that work that appear in the pages of the *Flora of Hampshire*.

A year after taking her degree in 1934 marriage to the Rev. John Salusbury Brewis, then Vice-Principal of St. Edmund Hall, took her successively to the City of Durham (where she did some teaching at the University during the war) and the neighbourhood of Doncaster before a return to London in 1954, following her husband's appointment as Rector of St. James's, Piccadilly. Renewed incarceration in the capital, with a demanding parish to assist with as well as four children, far from the countryside, might have led to the abandonment of botany by someone less keen; luckily, however, her husband had one day off each week in which to drive her out in summer in search of plants, while the weed flora of the nearby parks could also provide occasional excitements. By Park Lane, opposite the Dorchester Hotel she found an unknown grass which turned out to be an alien new to the British Isles list, and her discovery of a patch of hemp growing in Green Park was sufficiently embarrassing to the police to earn her a write-up in the newspapers.

It was close to the ancestral home in Hampshire, however, that she made a discovery that brought her to wider botanical notice. In 1959 she chanced upon an astonishing array of unfamiliar weeds in some fields on the Blackmoor fruit farm which turned out to have been manured with the

wool waste known as 'shoddy', that transient farming fashion of the early post-war years (though Gilbert White had recorded woollen rags in use for that same purpose on the light soils of this hop-growing district two centuries earlier). The find drew down to Blackmoor a stream of eminent botanical collectors including in particular J. E. Lousley, in whose eventual list of Britain's alien wool flora of 1946–60 that corner of Hampshire was to be credited as the sole source of no fewer than 29 of the taxa recorded. A recent recruit already to the Wild Flower Society, in which she was to become a long-serving Branch Secretary, Anne now joined the B.S.B.I. as well, in 1961, on the strength of this.

On her husband's retirement in 1967, Anne and he were at last able to make their home in Hampshire permanently, settling in a cottage on the family estate. Sadly, they were not to be allowed to enjoy that together for very long, for a lengthy illness led to his death in 1972. Providentially, just at that point the Hampshire and Isle of Wight Naturalists' Trust was looking for someone with the requisite standing as a field botanist, organising energy and freedom from competing commitments to take further forward the project to produce a new Flora, on a tetrad basis, of – as then still envisaged – those two counties together. Work had been in progress to that end for some twenty years by then, but following the early death of its original mainstay, A. W. Westrup, momentum had been lost. Had Westrup not bequeathed his data to the Trust, which consequently felt a responsibility to ensure the project's continuance, it might well have petered out entirely. An active participant in it since soon after settling in Hampshire and a member of the Flora Committee instituted by the Trust in the mid-1970s, Anne had the range of abilities that the task required and accepted the invitation to take over in 1974. Concurrently, she also agreed to act as B.S.B.I. Recorder for vice-county 12, the duties of which were broadly coterminous with co-ordinating the work on the Flora.

The thirty years that followed brought her, in her own words, "solace and stimulation" in what was to prove a widowhood as active as it was lengthy. She lost no time in fostering more intensive study of the critical groups, forming extensive collections of her own of both *Rubus* and her particular favourite, *Taraxacum*. Though her knowledge of the former never advanced to the point where she could put a name to the individual species, she had a sharp eye for any that looked distinctive. In that way she added *R. arrheniiformis* to the Hampshire list and restored *R. boraeanus* to it after an interval of a century. Her discoveries in *Taraxacum* were no less impressive, particularly in the ancient grassland bordering the Blackwater. Fieldwork was indeed her forte, the arduous processing of records and searching of the literature and herbaria inseparable from county Flora compiling less so – though she grappled with those with her customary conscientiousness.

Those who did not know Anne well were liable to be taken in by a superficial appearance of disorder and frailty, an impression accentuated by a lifelong habit of punctuating her speaking with long and seemingly anguished pauses, as if she had suffered a mild stroke and was making a fighting recovery. Her performance behind a wheel, which was not for passengers of a nervous disposition, was all of a piece with this. Yet behind that deceptive front was a steely determination and great acuteness. These came to the fore at the meetings of the Flora Committee, at which a certain ambiguity in her role vis-à-vis the Trust was a continuing source of tension.

On the Trust's orthodox territory of conservation, relations between the two were altogether more harmonious. Here all of Anne's strengths came fully into play, and her years of service in this cause, including acting as warden of the Trust's nearby Noar Hill reserve with its outstandingly rich orchid diversity, received due recognition in the shape of the MBE in 1998 and the Trust's Dutton Prize two years after.

All but two sections of her herbarium was donated shortly before her death to Hampshire County Museum Service (HCMS), which has made it available for study at its central store at Winchester, and has produced a catalogue that can be accessed on the Museum Service's website. Excluded were the nationally important collection of *Taraxacum*, which was given to **BM**, and the *Rubi*, which have been divided between **BM** and **NMW**.

A splendid colour photograph of Lady Anne in the field accompanied the obituary that appeared in *The Times* of 12 April, to which this account is indebted in part. Additional information has kindly been provided by Mrs Elizabeth Norman, who has also contributed an obituary to the *Wild Flower Magazine*.

D. E. ALLEN

Report

ANNUAL GENERAL MEETING, 11 MAY 2002

The Annual General Meeting of the Society was held at the Royal Botanic Gardens, Edinburgh at noon. The retiring President, Dr G. Halliday initially took the chair in the presence of 70 members.

Apologies for absence were read out and the minutes of the 2001 Annual General Meeting, published in *Watsonia* 24: 131–132, were approved as a correct record and signed by the President.

REPORT OF COUNCIL

This had been circulated to members and the President went through it, commenting on the achievements of the Society during the past year, noting with especial pleasure that Atlas 2000 had been handed over to Oxford University Press in May 2001 and that publication, together with extra research work commissioned by DEFRA, was scheduled for July 2002. He expressed his and the Society's great gratitude to all who had contributed.

Dr Halliday said also that he had enjoyed his term of office as President and warmly thanked the Society for its support during the past two years.

The Honorary Treasurer presented the financial part of the Report; summary accounts had been circulated to all members, full sets of accounts had been available by post and were now available at the meeting.

He reported that the Society's finances were in good order; this was, in part, the result of the excellent response of the membership to the Gift Aid campaign, for which he expressed his thanks to the Membership Secretary; however, less happily, the foot and mouth disease epidemic had meant that field work projects, which were to have been financially supported by the Society, had not taken place.

The Membership Secretary had again reported a slight decrease in membership. The Annual Report of the Society was adopted unanimously.

ELECTION OF PRESIDENT

Mr R. D. Pryce was unanimously elected President.

Mr Pryce began by expressing his own and the Society's thanks to Dr Halliday, the retiring President, for his service to the Society during the previous two years. He then thanked the meeting for electing him, stating that he intended to serve the Society as President for three years.

ELECTION OF VICE-PRESIDENT

Mr A. O. Chater had been nominated by Council; his election was unanimous.

RE-ELECTION OF HONORARY GENERAL SECRETARY

Miss A. Burns was nominated by Council, her re-election was unanimous. The President thanked her for her work for the Society during the preceding year.

RE-ELECTION OF HONORARY TREASURER

Mr M. E. Braithwaite, nominated by Council, was re-elected unanimously. He was warmly thanked by the President for all his good work on behalf of the Society.

RE-APPOINTMENT OF EDITORS, INDEXERS AND REPRESENTATIVES OF COMMITTEES

The President warmly thanked the Editors, Indexers and Representatives of Committees for all their hard work.

ELECTION OF COUNCIL MEMBERS

In accordance with Rule 11, nominations had been received for Professor R. M. Bateman, Dr C. M. Cheffings, Mrs C. L. Coleman and Mr J. P. Woodman. Profiles had been circulated and would be published. The election of these new members of Council was accepted unanimously.

ELECTION OF HONORARY MEMBERS

The President stated that this year's nominations for Honorary Membership were for Mr C. R. Boon and Mr P. Hackney; the sponsors were, respectively, Mr R. G. Ellis and Dr G. Halliday. Mr Ellis' appreciation of Mr Boon was, in his unavoidable absence, read out by Miss A. Burns and Dr Halliday's of Mr Hackney was given at the meeting. Both appreciations will be published in 'News'. The proposals for Honorary Membership were accepted unanimously.

RE-ELECTION OF HONORARY INDEPENDENT EXAMINER

The President expressed the Society's gratitude to Mr J. H. Coats, CA, for his exemplary examination of the Society's Accounts. His re-election was accepted unanimously.

There was no other business and the meeting closed at 12.45 pm.

AILSA BURNS
Honorary General Secretary

INSTRUCTIONS TO CONTRIBUTORS

Scope: Authors are invited to submit Papers and Notes concerning British and Irish vascular plants, their taxonomy, biosystematics, ecology, distribution and conservation, as well as topics of a more general or historical nature. Authors should consult the Hon. Receiving Editor for advice on suitability or any other matter relating to submission of manuscripts.

Papers and Notes must be submitted *in duplicate*, typewritten on one side of the paper, with wide margins and double-spaced throughout. Pages should be numbered. Submission of final edited copy on computer disc will be requested, but two hard copies of the text are acceptable if computer facilities are not available.

Format should follow that used in recent issues of *Watsonia*. Underline where italics are required. Names of periodicals should be given in full, and herbaria abbreviated as in *British and Irish herbaria* (Kent & Allen 1984). The Latin names and English names of plants should follow the *New Flora of the British Isles* (Stace 1997). Further details on format can be obtained from the Hon. Receiving Editor or by viewing the website at:
http://www.bsbi.org.uk/new_style_manual.htm

Tables, figure legends & appendices should be typed on separate sheets and attached at the end of the typescript.

Figures should be drawn in black ink or be laser-printed and identified in pencil on the back with their number and the author's name. They should be no more than three times final size, bearing in mind they will normally be reduced to occupy the full width of a page. Scale-bars are essential on plant illustrations and maps. Lettering should be of high quality and may be done in pencil and left to the printer. Black and white photographs can be accepted if they assist in the understanding of the article. If you are able to submit figures on disc please contact the Receiving Editor to check they are in a suitable format.

Contributors must sign a copyright declaration prior to publication which assigns the copyright of their material to the Botanical Society of the British Isles. Twenty-five offprints are given free to authors of Papers and Notes; further copies may be purchased in multiples of 25 at the current price. The Society takes no responsibility for the views expressed by authors of Papers, Notes, Book Reviews or Obituaries.

Submission of manuscripts

Papers and Notes: Mr M. N. Sanford, c/o The Museum, High Street, Ipswich, Suffolk, IP1 3QH.

Books for Review: Dr C. D. Preston, Biological Records Centre, Monks Wood, Abbots Ripton, Huntingdon, PE17 2LS.

Plant Records: the appropriate vice-county recorder, who should then send them to Dr C. D. Preston, Biological Records Centre, Monks Wood, Abbots Ripton, Huntingdon, PE17 2LS.

Obituaries: Mrs M. Briggs, 9 Arun Prospect, Pulborough, West Sussex, RH20 1AL.

Back issues of *Watsonia* are available from the official agents for BSBI Publications, Summerfield Books (John & Sue Atkins), Summerfield House, High Street, Brough, Kirkby Stephen, Cumbria CA17 4AX. Tel: 017683 41577. Fax: 017683 41687. E-mail: bsbipubs@beeb.net



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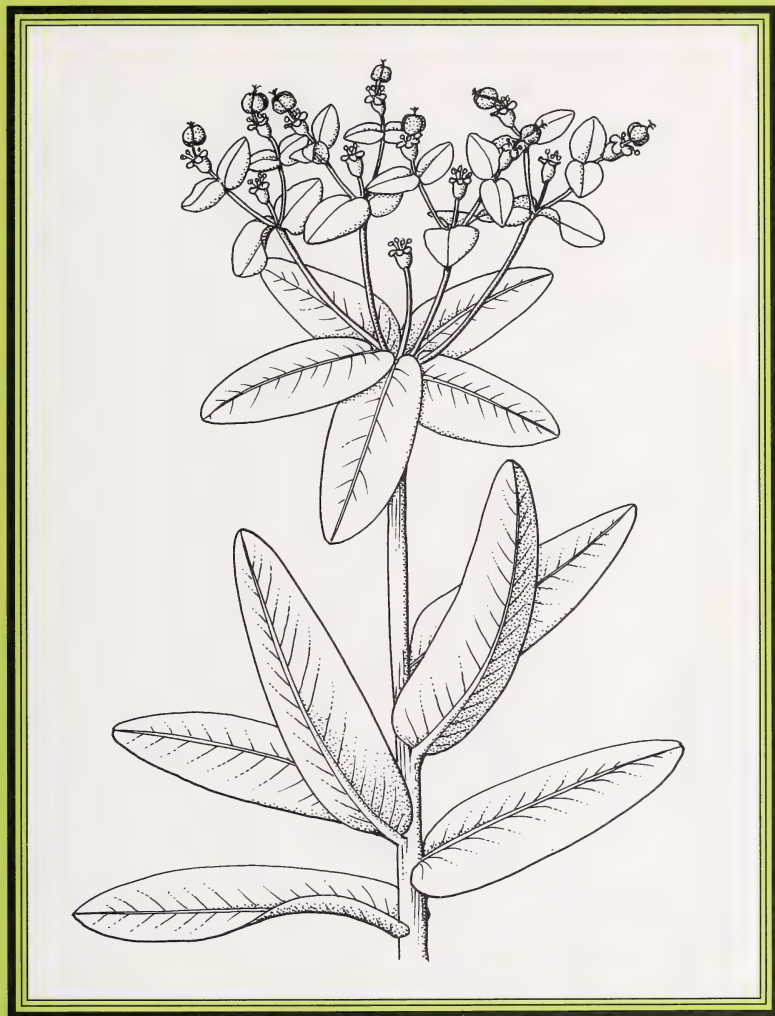
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C. D. Preston, M. N. Sanford, D. A. Simpson

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The cover illustration of *Euphorbia hyberna* L. (Irish Spurge) was drawn by Rosemary Wise.

An assessment of the status of *Gaudinia fragilis* (L.) P. Beauv. (Poaceae) in the British Isles

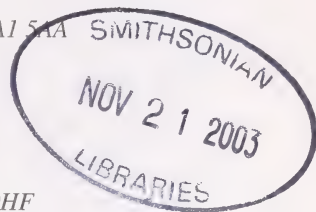
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ABSTRACT

Gaudinia fragilis (L.) P. Beauv. (French oat-grass) has usually been considered an introduction in the British Isles. Until the early 1970s it had been recorded in our area mainly as a casual of waste and cultivated ground and dock quaysides, apart from on the Isle of Wight where it was recorded from 1917 onwards in apparently unimproved grassland. In the last 30 years it has been found to be locally well established in neutral grasslands, particularly those on heavy clay soils, across a wide area of central southern and S.W. England. Its occurrence in "old", often herb-rich pastures and hay meadows, including many sites of high conservation value, led to *G. fragilis* being given a status of "native or alien" in the *New Atlas of the Flora of Britain and Ireland*. In this paper we summarise the history and recent upsurge in records of *G. fragilis* in the British Isles, and describe its habitat preferences and the plant-communities in which it occurs. We then weigh up the evidence for and against it being viewed as a native species – at least within the core of its range in southern Britain – and explain why, on balance, a rather unsatisfactory "native or alien" is probably the best that can be offered.

KEYWORDS: distribution, conservation, native or alien status, French Oat-grass.

INTRODUCTION

The genus *Gaudinia* P. Beauv. (Poaceae) comprises four species centred on the Mediterranean region and the Azores. *G. fragilis* (L.) P. Beauv. (French oat-grass) is the most widely distributed member of the genus, occurring in S. Europe, and in N.W. Africa, the Aegean, Turkey, Syria, Lebanon and the Crimea (Davis 1985). We have seen no map of the world distribution, though Zohary (1986) describes the range as Mediterranean, extending into the Euro-Siberian. It is also found as a casual or naturalised introduction in other non-tropical regions, well beyond its presumed native range (e.g. Tsvelev 1983).

The northern limit of *G. fragilis* as a native species in Europe is unclear, but most of our Floras, describing it as an established alien in Britain and Ireland, go on to summarise its distribution in mainland Europe as being essentially "southern" (e.g. Stace 1997) or "Mediterranean" (e.g. Clapham *et al.* 1987; Sell & Murrell 1996). In the species account in the *New Atlas of the British & Irish Flora* (Leach 2002), *G. fragilis* is assigned to the Submediterranean-Subatlantic floristic element, one of three Mediterranean elements recognised by Preston & Hill (1997).

Within its presumed native range we have found very little information on its habitat preferences and ecology. Davis (1985) described the habitat in Turkey as "lightly grazed damp grassy slopes on volcanic rocks, and sandy soil near the sea", while one of us (D.A.P.), with A. J. Byfield in Turkey, found it not infrequently in a community we described as "damp *Gaudinia fragilis* – *Trifolium campestre* dune-slack grassland", a habitat echoed by the Floras of other Mediterranean countries, and by Tutin *et al.* (1980) who cite it as a species of "grassy, usually damp habitats".

The species is generally regarded as an alien in mainland N.W. Europe, possibly coming in with imported seed (e.g. Hegi 1935; Fournier 1946). It is patchily distributed in France, away from the

south, but frequent to common up the western seaboard to Brittany (Bonnier 1934, des Abbayes 1971). We have no more recent information from northern France, but understand that, as in Belgium (Mullenders 1967), it is usually viewed there as an introduction. Interestingly, Bonnier (1934) describes three varieties (vars *breviopica*, *linearis* and *nardoides* (i.e. like *Nardurus maritimus* = *Vulpia unilateralis*)), and gives the habitat of var. *linearis*, the variety that seems to fit our specimens, as "pastures by the sea".

In the British Isles, *G. fragilis* was first recorded in the wild in 1903, as a casual in Surrey and Mid-Lothian (McClintock 1972). Many of the earliest records were of casual plants from dock quaysides, waste ground and other artificial habitats, and this certainly helped to give the impression that it was an introduction. Until the 1970s the species received scant attention from botanists which was hardly surprising, given its omission from the 1st edition of *Grasses* (Hubbard 1954), and just the briefest of mentions in the 2nd edition (Hubbard 1968). Despite a minor "rush" of Irish records in the 1960s, it was only when McClintock (1972) reviewed the historical records, and in particular noted its occurrence in long-established grassland on the Isle of Wight, that British field botanists sat up and took notice. There followed a spate of new records, most of them from old, apparently unimproved and often species-rich pastures and hay meadows in southern England. Unlike so many of the early records, in these grasslands *G. fragilis* had every appearance of being native: Green *et al.* (1997), for example, expressed the view that in Somerset "as the majority of... sites are in old herb-rich pastures it is difficult to imagine it is not a native species". Thus, while most 20th century Floras dismissed *G. fragilis* as an introduction, the species account in the *New Atlas* broke with tradition, describing it more equivocally as "native or alien" (Leach 2002).

The purpose of this article is to review the history of the discovery of *G. fragilis* in the British Isles, to summarise what we now know of its distribution and ecology, and to re-assess its status in the light of this new information. We trust that the evidence presented here will, at the very least, help to explain why the *New Atlas* dared to suggest that *G. fragilis* "...might be native, at least in its core areas".

A COUNTY-BY-COUNTY REVIEW OF *G. FRAGILIS* IN THE BRITISH ISLES

The early records of *G. fragilis* in the British Isles were well summarised by McClintock (1972), who, in addition to some comment on its occurrences on the Isle of Wight, and in the Channel Islands and Ireland, listed all records, including all the casual records, then known.

In the present paper we give a résumé of the discovery of *G. fragilis* in those vice-counties that together form the core of its distribution in Britain, or in which it has been reported as occurring in old, agriculturally unimproved grassland. These are the vice-counties for which records were tentatively mapped "as if native" in the *New Atlas* (v.cc. 3, 5; 6, 7, 8, 9, 10, 11, 13, 14 & 44). We also consider the history of *G. fragilis* in the Channel Islands, where some consider it to be possibly native, and in the south of Ireland, where it is generally regarded as a recent introduction.

We do not give details of casual records here, unless they happen to be from within areas now forming part of the core range. For casual records in other vice-counties (v.cc. 1, 4, 17, 34, 41, & 74), readers should refer to McClintock (1972), but we are also aware of casual records from the following vice-counties that are additional to those given in that paper: v.c. 2 (SW94, Tregony, 1981–1988); v.c. 18 (TQ88, Daws Heath, 1948); v.c. 24 (SP91, Steps Hill, 1970+); v.c. 33 (SO81, Gloucester Docks, 1974); v.c. 59 (SJ89, 1997); v.c. 83 (NT27, Leith Docks, 1903, 1920).

A distribution map, amended and updated from the one given in the *New Atlas*, is presented in Figure 1.

V.C. 3. SOUTH DEVON

G. fragilis was first recorded in 1998, a small colony growing on a damp grass verge adjoining a minor road between Chudleigh Knighton and Bovey Tracey (SX837776). The discovery was made by Ms E. J. McDonnell, a botanist already well acquainted with the species in Somerset. In 1999 R. E. N. Smith located a second site, near Bickington, "...where it occurs in two fields on either side of the A38, and on adjacent verges (SX793727 & SX796727). It is locally abundant, even dominant in closed grassland" (Ms E. J. McDonnell, in litt. to S.J.L.).

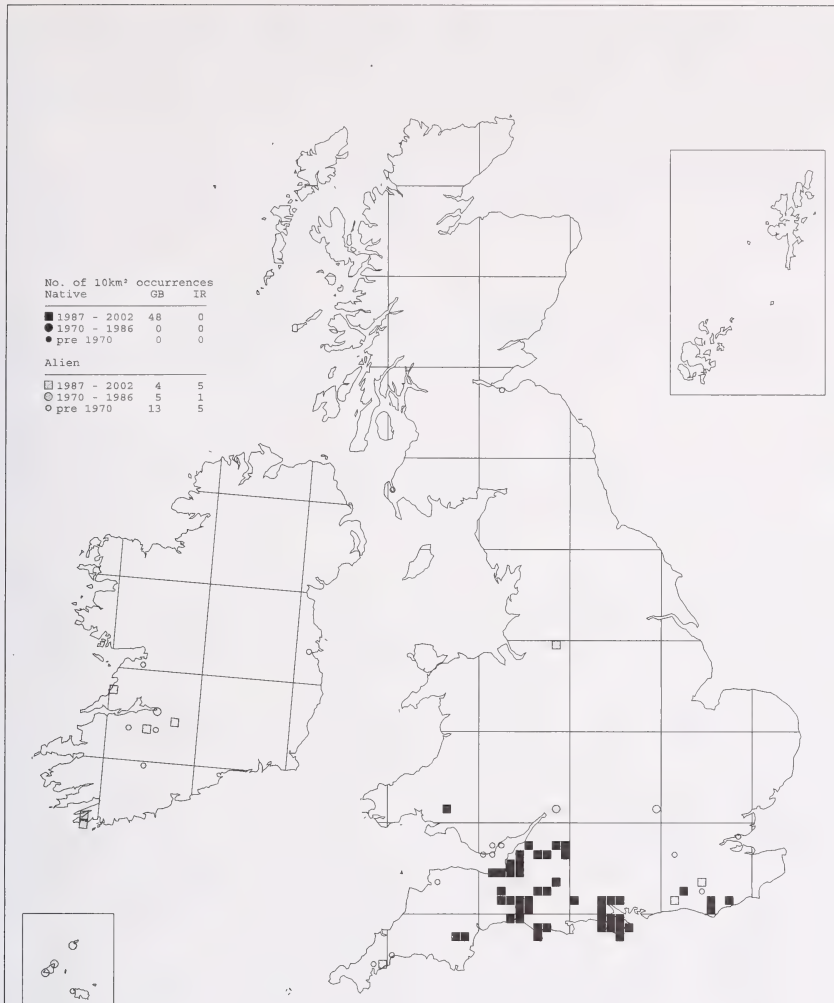


FIGURE 1. 10 km square distribution of *Gaudinia fragilis* in Britain and Ireland, amended and updated from that given in the New Atlas (Leach 2002).

V.C. 5. SOUTH SOMERSET

To anyone familiar with *G. fragilis* in v.c. 5 it seems remarkable that the earliest record of it was not until 1970, when J. G. Keylock found it growing along a ride in a forestry plantation near Haselbury Plucknett (ST491108). In 1972 the same botanist located it at a second site, about a mile away from the first, in a stand of what appeared to be recently sown grassland. Then, in 1974, he found it to be well established near Halstock (ST501087) in old species-rich grassland (now a Site of Special Scientific Interest (S.S.S.I.) within two miles of the first site and thought to be "... probably the source of the earlier sightings" (Roe 1981). Interestingly, according to the farmer, this field "had not been ploughed in living memory" (J. G. Keylock, unpubl. note to D.A.P.), and R. G. Corns (pers. comm.) was told in the late 1970s that *G. fragilis* already occurred in the field when the present family started farming there, in the 1920s – almost half a century before it was discovered there by a botanist! John Keylock subsequently found it in more fields in the same general area, and formed the opinion that *G. fragilis* was a "...natural component of these 'ancient' neutral grasslands" (J. G. Keylock, in litt.).

From 1989 onwards field botanists in Somerset began intensive survey work for a new county Flora and they found *G. fragilis* to be a locally frequent constituent of old grasslands over a wide area of v.c. 5. By 2002 it had been recorded from at least 21 tetrads in v.c. 5, with most populations occurring in fairly species-rich hay meadows and pastures, including several S.S.S.I.s and two National Nature Reserves (Barrington Hill N.N.R. and Hardington Moor N.N.R.), and also on track-ways, green lanes and roadside banks and verges.

It is not infrequent, and locally abundant, in coastal pastures and on roadsides in the area around Hinkley Point (ST14, ST24), where it was first noted in 1985, and it appears to be spreading there. It also occurs along the northern edge of the Blackdown Hills in the Thurlbear-Barrington area (ST21, ST22 & ST31), where it is now known from numerous localities following its discovery at Barrington Hill N.N.R. in about 1990 (though we suspect it had long been present, but overlooked, at this site), and in grassland adjoining Thurlbear Wood S.S.S.I. in 1992. In both these clusters of sites, *G. fragilis* is a feature of unimproved or "semi-improved" grassland underlain by calcareous clays derived from rocks of the Lower Lias. A third cluster – including the meadows found by John Keylock in the 1970s – lies between Crewkerne and Yeovil, close to the border with Dorset (ST40, ST41, ST50 & ST51). These meadows too are on clay soils, this time overlying Fullets' Earth. All three groups of sites, along with two outliers near the eastern edge of the vice-county, are on heavy Jurassic clays prone to waterlogging in winter, but often baked dry in summer. The only record "off the clays", as far as we are aware, is from the verge of the A38 at Thurloxton, near Taunton (ST280299), where it was found in 1999 by P. R. Green.

V.C. 6. NORTH SOMERSET

The earliest records of *G. fragilis* in v.c. 6 were in 1986 and 1988, when it was found in several fields of damp neutral grassland and rushy pasture at Max Bog S.S.S.I. (ST409574), by S. M. Hedley, J. P. Woodman, T. N. Twiggs and others. One of the main colonies was described at the time as being in "pasture... on calcareous peat, scattered over several hundred square yards" (S. M. Hedley, field notes).

G. fragilis is now known from at least a dozen localities in v.c. 6 (Green *et al.* 1997; Green *et al.* 2000). These sites include two on an outlier of the Lower Lias, near Wedmore: at Barrow Hill, Panborough (ST474444), where it was recorded by P. R. Green in 1992, and at Yarley Fields (ST496447), a nature reserve of the Somerset Wildlife Trust, where it was discovered in 1998 by Mrs A. W. Bodley. Interestingly, she noted (in litt. to S.J.L.) that, "...I see from my records that I first found *Gaudinia* [at Yarley] on May 15th, just after we'd been to Max Bog – otherwise I probably wouldn't have recognised it". A survey of Yarley Fields in 1999 by S.J.L. and Somerset Rare Plants Group showed *G. fragilis* to be locally abundant across 4 ha of species-rich grassland, and present too along the verges of an adjoining green lane. It was also found nearby, around the (unimproved) fringes of several fields that had been recently re-seeded.

There are three recent records of *G. fragilis* from grasslands on the Carboniferous limestone: at Uphill S.S.S.I. (ST316581) from 1993 onwards (Dr N. J. Chaffey, P. R. Green, S. J. Parker, S.J.L. and others), The Perch S.S.S.I. (ST4555) in 1997 (M. J. Edgington), and Hellenge Hill (ST346574) in 1999 (Ms E. J. McDonnell/Somerset Rare Plants Group). It was also seen in 1999 in a hay field near Publow (ST619657), where it was reported to occur in "species-rich, semi-improved calcareous grassland" with *Anacamptis pyramidalis* and *Oenanthe pimpinelloides* (P. Quinn, unpubl. site report); and, again in 1999, in short grassland beside an old railway line at Easton-in-Gordano (ST505759) (Green *et al.* 2000; I. P. Green in litt. to D.A.P.).

As in v.c. 5, it continues to be found at new sites, the most recent being in 2002 when it turned up in a new 10 km square "...near junction 22 of the M5, on the side of a track beside Burnham Moor Lane (ST337485)" (Ms E. J. McDonnell, in litt. to S.J.L.).

Regarding its status in v.c. 6 and beyond, Green *et al.* (2000) think that *G. fragilis* is more likely to be a recent introduction than an overlooked native, suggesting that "it comes in with grass seed or bird feed and becomes naturalised if it reaches suitable habitats".

V.C. 7. NORTH WILTSHIRE

The first record in Wiltshire was made by J. D. Grose in 1951, from waste ground at Sandridge Hill, near Melksham (ST96), and it was recorded nearby in a "carrot field" and "allotments", by Miss M. McC. Webster, in 1957. Mrs J. Swanborough was the first to find it in grassland, when she came across it in 1978 in "a damp, grazed meadow", again near Melksham, while Mrs O. M.

Stewart noted it in pasture "near Melksham" (possibly the same site?) in 1980. Between 1984 and 1989 it was recorded by D. E. Green from a "cluster" of unimproved meadows in the Bowden Hill-Frogditch area (ST96), along with further sites across ST96 and two neighbouring 10 km squares (ST87 & ST97), comprising 21 fields in all (Green 1990; Gilham 1993). "Of the 21 fields known, nine are improved leys or recent permanent pasture; eleven are species-rich, semi-improved or unimproved neutral pasture; the final site is a hill pasture containing eighteen grass species... The majority of the localities – thirteen in fact – lie on the heavy Jurassic clays [Oxford Clay]. A further six are on the junction of the clay and the greensand. One site is on the oolitic limestone" (Green 1990).

V.C. 8. SOUTH WILTSHIRE

The only record is from the Kimmeridge Clay, at West Swainsford, near Mere (ST807313), where it was found in 1995 by Mrs P. Palmer and P. Wilson during an English Nature-funded survey of Wiltshire grasslands. P. Wilson (in litt. to D.A.P.) reported that "...it was growing in superb quality MG5a, *with every appearance of being native*" [our italics].

V.C. 9. DORSET

The first record of *G. fragilis* in v.c. 9 was in 1980, at Chickerell (SY646800), when Dr H. J. M. Bowen found it in an area of damp neutral grassland (now built over) about 2 km from the sea (Bowen 1981). In 1989 Miss A. Horsfall discovered it beside a green lane in the Marshwood Vale, at Mutton Street (SY391989), while in 1994 D. E. Green and D.A.P. found it in north Dorset in "semi-improved" grassland at Westbrook Farm (ST783252), not far from to the v.c. 8 site at West Swainsford.

Then, in the late 1990s, D.A.P. and others found it to be far more widespread than previously thought. It occurred not only in several old meadows overlying the Liassic clays in the Marshwood Vale but also on the Oxford Clay, in numerous grassy herb-poor (and possibly semi-improved and/or re-seeded) fields along the coast, from a single site to the west of Weymouth (SY658770), and then in many fields over a 4 km stretch from Bowlease (SY705819) to Ringstead (SY749814). In 1998 J. H. S. Cox located it on Tertiary clays near Edmonsham (SU074105). The following year, Ms L. Warman discovered *G. fragilis* at Marshwood (SY385982), where it was said to be "frequent in hay meadows and quite common but less obvious in cattle-grazed pastures" (Ms L. Warman, field card), while Mrs F. Greenshields saw it in quantity nearby in a meadow at Crabbs Bluntshay (SY415970); recent searches by D.A.P. have turned it up in at least six other fields in this area. Almost all the Dorset sites are on heavy clay soils.

The spate of new records since 1998 could indicate that *G. fragilis* is becoming more frequent in v.c. 9, though it is just as likely that the apparent increase is due to botanists "getting their eye in"; indeed, many of these sites have large and well-established populations that must surely have been present for some considerable time prior to their discovery. Regarding its status, Bowen (2000) describes the grass as "rare and inconspicuous, *but apparently native*, in fairly damp neutral grassland on clay" [our italics].

V.C. 10. ISLE OF WIGHT

The early history of *G. fragilis* in v.c. 10 was summarised by McClintock (1972). Briefly, the first record for the island was in 1917, when J. W. Long discovered it in a meadow near Ryde (SZ59), where it "quickly became firmly established" (Bevis *et al.* 1978). In 1937 it was collected by Miss G. Bullock from another meadow in the same 10 km square, at Havenstreet, in which there was "quite as much *Gaudinia* as any other grass" (McClintock 1972). From 1950 onwards the grass was recorded from numerous other localities overlying the (often lime-enriched) Tertiary clays to the north of the chalk ridge.

One of the best sites in the early 1970s was a 16-acre field "that had not been ploughed since the current farming family took over the farm in 1919. Here the *Gaudinia* is not merely present each year, but dominant in some parts" (McClintock 1972). Several populations lie within S.S.S.I.s or N.N.R.s, including Locks Farm Meadow S.S.S.I. (SZ449908), "a small [2.3 ha] meadow situated on poorly draining neutral clay soils", which has "...been managed without the application of herbicide or artificial fertiliser. [This site] represents one of only six areas of this type of meadow on the Isle of Wight" (English Nature, unpubl. S.S.S.I. citation). Other species of note on this S.S.S.I. include *Spiranthes spiralis*, *Genista tinctoria*, *Oenanthe pimpinelloides*, *Ophioglossum*

vulgatum and *Silaum silaus*, along with one of the largest populations on the island of *Orchis morio*.

G. fragilis certainly seems to have become more frequent on the Isle of Wight in recent decades, and is now a prominent component of neutral grasslands (and green lanes and road verges) on the clay belt: by 2000 it had been recorded from at least 39 1-km squares, with the main concentration of sites being to the west of Newport, in the area around Shalfleet, Newtown, Porchfield and Calbourne (SZ48, SZ49).

There has been some uncertainty, and not a little conjecture, as to its origins and status on the island. The then vice-county recorder, B. Shepard, wrote to D. McClintock, "it is not conceivable that it existed in anything like the present abundance... and was overlooked by earlier recorders" (McClintock 1972). Thus, the general consensus – despite its occurrence in old grassland – is that the grass must have been originally introduced. As B. Shepard (in litt. to D. McClintock) commented, "it may be significant that [the] first record was during the First World War, when there was considerable movement of men and material between here and the Middle East".

V.C. 11. SOUTH HAMPSHIRE

The first record was in 1993, when J. Rowe discovered "a small patch" of *G. fragilis* in grassland on Tertiary deposits at Curdridge (SU5213) (Rowe 1995; Brewis *et al.* 1996). The field had been horse-grazed since before the First World War, and "no sprays or fertilizers have been applied; [it] has merely been spring grazed and topped... The field is probably directly descended from Curdridge Common... [and] is most notable for [the] large numbers, certainly hundreds, of *Orchis morio*" (J. Rowe, unpubl. report), along with abundant *Danthonia decumbens*, *Rhinanthus minor* and *Oenanthe pimpinelloides*. A second population found in 1997 at Hounsdown (SU353117), again by John Rowe, was in "horse pasture in...fairly rich area of grassland, on clay" (Rowe 2001). It has since been located at two further sites in v.c. 11, by P. Stanley in 1998 (SU475148), and by Miss M. E. Young in 1999 (SU344093).

Regarding its status in Hampshire, Brewis *et al.* (1996) listed *G. fragilis* as a "colonist", which they defined as "an invader [that] arrived in the county unintentionally as a result of human activity... and now normally present in open and artificial habitats". However, John Rowe (in litt. to D.A.P.) observed that the sites at Curdridge and Hounsdown were both "high quality neutral grassland, and the *Gaudinia* was growing in 'rough', but by no means degraded or disturbed, closed perennial vegetation".

V.C. 13. WEST SUSSEX

There are three records. B. Bishop discovered *G. fragilis* in a "new car park area" at Wiston (TQ165128) in 1998, while A. W. Jones, again in 1998, found it in "nice" grassland at Cowfold (TQ229205) that looked as if it had been sown in the not too distant past. A. W. Jones located it at a third site, at Twineham (TQ240213), in 1999, in an area of "semi-improved" grassland. The first of these records was mapped as "alien" in the *New Atlas*, but its occurrence in TQ22 was mapped, perhaps a little optimistically, "as if native".

V.C. 14. EAST SUSSEX

There was a relatively early record of *G. fragilis* by D. W. Parry, from a roadside at Camp Hill, Ashdown Forest (TQ4628) in 1960 (McClintock 1972). In 1993 T. C. G. Rich found it in a car park, again in Ashdown Forest (TQ469307) and, while presumed to be "casual" at this site, it was still present in 2000. More interestingly, Ms K. Ryland discovered it in 1998 in neutral grassland on the Wealdan clays at Lower Dicker (TQ550108) and Upper Dicker (TQ553102). Kate Ryland (in litt. to S.J.L.) commented that, at Lower Dicker, it "certainly looks native" but, although the fields have not been cultivated or re-seeded in living memory, it is possible that *G. fragilis* could have been introduced "in the early part of the century under the previous owner". Associated species at Lower Dicker include *Genista tinctoria*, *Ophioglossum vulgatum* and *Silaum silaus*. Since the *New Atlas* it has been found in improved grassland at Polegate (TQ577060), and on a newish road verge, adjoining old grassland, near Crowhurst (TQ778118).

Regarding its status in v.cc. 13 and 14, Briggs (2001) noted that "...at some locations, especially Upper and Lower Dicker, [*G. fragilis*] occurs in meadows that have been unimproved for more than 130 years, giving rise to the possibility that *it could be native*" [our italics].

V.C. 44. CARMARTHEN

The first record of *G. fragilis* for v.c. 44 was in 1942, when it was discovered by F. E. Williams to be “fairly abundant in a wettish hay meadow” (McClintock 1972). Unfortunately no locality details exist for this record. However, in 1988 Ms S. M. Gooch found it in a “flowery meadow” at Cefn Goleu, Garnant (SN696139). The site also supported populations of several other interesting species, including *Carum verticillatum*, *Cirsium dissectum* and *Sanguisorba officinalis*. There are no other recent records, and these are the only Welsh records from apparently unimproved grassland; the Garnant record, despite being some considerable distance from the core range in England, was mapped “as if native” in the *New Atlas*.

V.C. 113. CHANNEL ISLANDS

The first record of *G. fragilis* in the Channel Islands was in 1928, when A. J. Wilmott and I. A. Williams found it “in great quantity in part of the Grande Mare, Guernsey” (WV27). It was re-found there in 1971 (McClintock 1972). *G. fragilis* turned up at a second site in Guernsey in 1970, when Mrs P. Garratt found it in short, sandy turf near Doyle Rock on L’Ancrese Common (WV38). “It would be surprising if this grass had not been here for some considerable time, in an area moreover where no grass mixture would have been sown and no other possible introductions are to be seen” (McClintock 1972). There have been no more recent records.

It was discovered on Alderney in 1933, by A. B. Jackson, “in a grassy cutting in a field near Whitegates” where it was “associated with *Lolium* [and] apparently well established” (WA50). It was also recorded from two further sites on Alderney (McClintock 1972): from 1963 onwards (but now extinct) on rough, disturbed ground “near the States Dairy” (WA50); and in 1967 on a roadside at Bray (WA50). We do not have any more recent records than these for Alderney.

On Jersey there have been just two records: in sandy turf at Pont Marquet, in 1954 (Mrs F. le Sueur, Miss K. Rob and D. McClintock), and on a rubbish dump at St Ouen, in 1958 (D. McClintock) (McClintock 1972; Le Sueur 1984). Neither population persisted.

These records suggest that *G. fragilis* has probably only occurred as a “casual” in the Channel Islands, though its status in a few of the more “native-looking” sites, especially those on Guernsey, is hard to assess.

IRELAND

The first record of *G. fragilis* in Ireland was as a casual at Ringsend, near Dublin (O13) in 1906 (Scannell 1973). There were no further sightings until 1963, when Miss M. Scannell and J. E. Donovan discovered it growing on a road verge in West Cork (v.c. H3), at Toomore, west of Schull (V83). Scannell (1964) speculated that its presence there could have been “due to the activities of Spanish and French fishing trawlers in the area”. In 1965 three further sites were found in Co. Limerick (v.c. H8), in an “intensively farmed pasture” at Patrickswell (R55), near Croom (R53), and at Newcastle West (R23) (O’Sullivan & White 1967). McClintock (1972) noted that, while “one of the three stations in Co. Limerick, so Dr A. M. O’Sullivan tells me, has been recently re-seeded... two were very old pastures”, although the age of the latter was subsequently disputed. At about this time it was also found in Mid Cork (v.c. H4), at Lombardstown, west of Mallow, on the edge of a “relatively new ley” (W49) (Farragher 1968; McClintock 1972). Finally, in 1966 Miss E. M. Booth found *G. fragilis* in Co. Clare (v.c. H9), on a “roadside at 300 ft... four miles S.W. of Kinvarra” (M30) (Booth 1967).

G. fragilis has evidently persisted at several of these sites, including that at Toomore (V83) where it was seen again in 1992 (Ó Críodáin 1992). Meanwhile, there have been recent records of it from three further localities in v.cc. H8 and H9: on a B.S.B.I. Field Meeting at Cleedagh Bridge, v.c. H9 (R039797), in 1988 (Reynolds & Skeffington 1989); “by main road” near Pallas Grean, v.c. H8 (R780450), in 1997 (Reynolds 1998); and at a second site near Croom (R43), in 2000, “numerous plants on compacted gravelly soil beside unoccupied house, growing with common native grasses – not obvious how it got there” (Ms S. Reynolds).

Despite its occurrence in (arguably) old grassland, *G. fragilis* is considered by most Irish botanists to be alien in the south of Ireland (Ms M. J. P. Scannell, in litt. to D.A.P.). It is widely believed to have arrived there as a contaminant of grass-seed. As McClintock (1972) noted, “Miss Scannell sent me a copy of a letter... from Mr J. Mullin, of the Irish seed-testing station, who had reports of it from other counties, e.g. Wexford, and expected it to be much more widespread. He

recorded that in the early 1960s some inferior rye grass seed had been 'dumped' from Portugal with such weeds as *Gaudinia* and *Chrysanthemum myconis* [= *Coleostephus myconis*]. The trade was stopped, but started again for a short while in Dutch bags via Holland".

HABITATS AND PLANT-COMMUNITIES

GENERAL OBSERVATIONS

G. fragilis occurs predominantly in species-rich agriculturally unimproved or "semi-improved" neutral grasslands. It was this, more than anything else, that led us to toy with the notion that *G. fragilis* might be native in the British Isles, at least in parts of southern England, and persuaded us to take a fresh look at the evidence (Leach & Pearman 1997). These grasslands are generally managed as hay meadows or pastures, with hay meadows having their aftermath grazed by cattle in the traditional fashion. Pastures are usually grazed year-round by cattle or horses (rarely sheep), with additional grazing pressure at some sites from rabbits. A substantial number of sites are on roadsides and "green lanes", and these are frequently left largely unmanaged, apart from periodic mowing and hedge trimming. Most sites are in fairly open and sunny situations; *G. fragilis* avoids tall, rank grassland, and shows a distinct preference for shorter, rather "thin" or "patchy" swards. It tends to occur on neutral to calcareous clay soils that are frequently wet in winter, but quickly dry out in summer.

All the Floras we have consulted suggest that *G. fragilis* is an annual, though *Flora Europaea* (Tutin *et al.* 1980) describes the genus as a whole as "annual or biennial" and Sell & Murrell (1996) refer to it as comprising "annual herbs *sometimes lasting a few years*" [our italics]. In the British Isles, at least, several observers – ourselves included – have come to the conclusion that *G. fragilis* frequently behaves as a perennial, though possibly only a short-lived one (McClintock 1967; Bevis *et al.* 1978; B. Edwards, E. J. Clement & C. Pope pers. comm.).

When we began this investigation there was little information available on the species composition of grasslands supporting *G. fragilis*, and the species fails to get a single mention in the grassland accounts of the National Vegetation Classification (N.V.C.) (Rodwell 1992). However, our impression was that most stands containing *G. fragilis* belonged to the "mesotrophic grassland" (MG) section of the N.V.C., and we had records of it from vegetation that was clearly referable to MG5, *Cynosurus cristatus*-*Centaurea nigra* grassland.

QUADRAT SURVEY

To provide a fuller description of our "Gaudinia grasslands", between 1997 and 2001 we recorded a total of 102 quadrats from 25 sites in S. Devon (v.c. 3), Somerset (v.cc. 5 and 6), N. Wiltshire (v. c. 7), Dorset (v.c. 9) and the Isle of Wight (v.c. 10). Quadrats of 2 × 2m (occasionally 4 × 1m along road verges) were located non-randomly within patches of homogenous vegetation containing *G. fragilis*, care being taken to ensure that they were representative of the wider vegetation in which they occurred.

An initial examination of the quadrat data confirmed that *G. fragilis* generally occurred in fairly species-rich grassland. The average number of species per quadrat was 26 (range 10–53), slightly higher than the figure for MG5 in Rodwell (1992). A total of 192 species (including bryophytes) were recorded in the quadrats; 21 were frequent – that is, they occurred in more than 40% of the quadrat sample – and, apart from *G. fragilis*, there were nine "constants" (in >60% of quadrats), namely *Anthoxanthum odoratum*, *Cynosurus cristatus*, *Festuca rubra*, *Holcus lanatus*, *Lolium perenne*, *Lotus corniculatus*, *Ranunculus acris*, *Trifolium pratense* and *T. repens*. Of these, only *L. perenne* and *R. acris* are not MG5 constants, although they do appear as constants in the MG5a *Lathyrus pratensis* sub-community, the commonest and most widely distributed of the three sub-communities (Rodwell 1992).

One further point: grasslands containing *G. fragilis* are composed almost entirely of native species. Indeed, of the 192 species recorded just three are aliens – two archaeophytes, *Geranium dissectum* (18 quadrats) and *Picris echioides* (four quadrats), and one neophyte, *Crepis vesicaria* (one quadrat).

VEGETATION CLASSIFICATION

The quadrat data were examined more closely by means of a two-way indicator species analysis (TWINSPAN) (Hill 1979; Gauch & Whittaker 1981), and we have used this to distinguish several floristically distinct grassland types.

The indicator species at divisions 1 and 2 of TWINSPAN are shown in Fig. 2. The first division distinguishes a large group of samples containing *Holcus lanatus*, often at high cover, and lacking *Leontodon saxatilis*, *Medicago lupulina*, *Daucus carota* and *Agrimonia eupatoria*. This group (Group A) is generally "grassier" – with several graminoids, including *G. fragilis*, frequently occurring at high cover – than the second group (Group B). The species composition of each of the four final groups of division 2 of the TWINSPAN analysis is summarised in Table 1.

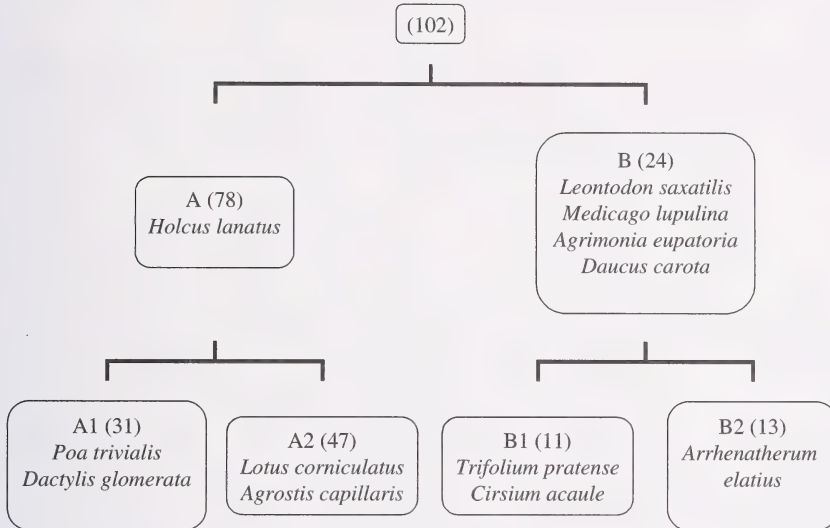


FIGURE 2. Indicator species of the TWINSPAN hierarchy for the first two divisions. The number of quadrat samples in each group is shown in parentheses.

Group A1 (31 samples) is the least species-rich (average of 21 species/quadrat), being distinguished from Group A2 by the high frequency, and occasionally high cover, of *Poa trivialis*, *Ranunculus repens*, *Alopecurus pratensis* and *Dactylis glomerata*. There are also occasional records of *Heracleum sphondylium*, *Arrhenatherum elatius* and *Vicia cracca*, all of which are strongly preferential to Group A1 and rare or absent in Group A2. Seventeen quadrats in Group A1 were from roadside sites, while several others were from "semi-improved" fields or the unimproved borders of fields that had been otherwise agriculturally improved (re-seeded).

Group A2 (47 samples) is best distinguished from Group A1 by the high constancy of *Agrostis capillaris*, *Centaurea nigra*, *Festuca rubra*, *Lotus corniculatus* and *Prunella vulgaris*. In comparison with the other TWINSPAN groups, *Hordeum secalinum*, *Luzula campestris*, *Oenanthe pimpinelloides* and *Rumex acetosa* are all preferential to Group A2. Other less frequent species that are nonetheless helpful in distinguishing this group from Group A1 include *Briza media*, *Carex flacca*, *Leucanthemum vulgare* and *Phleum bertolonii*. Group A2 tends to be more species-rich than Group A1 (average of 25 species/quadrat), although samples here still tend to be less rich, and more "grassy", than those in Group B. Group A2 quadrats typically came from unimproved hay meadows and pastures – only one quadrat was from a roadside – including several important nature conservation sites, e.g. Barrington Hill N.N.R. and Grove Farm S.S.S.I. (S. Somerset), and Newtown N.N.R. and Locks Farm Meadow S.S.S.I. (Isle of Wight).

Group B1 (11 samples) is best distinguished from the other TWINSpan groups, and in particular from Groups A1 and A2, by the high frequency of species indicative of more calcareous soils. For example, *Carex flacca* and *Briza media* – both of which helped to distinguish more species-rich Group A2 samples from Group A1 – occur as constants here. *Cirsium acaule* and *Plantago media* are restricted to Group B1, while *Galium verum*, *Ononis repens*, *Pilosella officinarum*, *Pimpinella saxifraga* and *Thymus praecox* are occasional but preferential to this group. Of the grasses, *Trisetum flavescens* occurs here at high frequency and is strongly preferential, while *Bromopsis erecta* and *Helictotrichon pratense* are rare but restricted to this group. *G. fragilis* does not attain here anything like the cover it does in Groups A1 and A2. This is the most species-rich of the TWINSpan groups (average of 37 species/quadrat). Group B1 samples were recorded from a handful of well grazed or cut-and-grazed unimproved grasslands in Somerset – including Uphill S.S.S.I., Thurlbear Wood S.S.S.I. and the Somerset Wildlife Trust nature reserve at Yarley Fields – and from one site on the Isle of Wight.

TABLE 1. SPECIES COMPOSITION OF GRASSLAND CONTAINING *GAUDINIA FRAGILIS*. ONLY SPECIES WHICH ARE CONSTANT OR FREQUENT (>40% FREQUENCY) IN AT LEAST ONE TWINSpan GROUP ARE INCLUDED. DOMIN COVER-ABUNDANCE RANGES ARE SHOWN IN BRACKETS

	TWINSpan group (see Fig. 2)				
	A1	A2	B1	B2	Total
<i>Gaudinia fragilis</i>	V (2–7)	V (2–7)	V (2–4)	V (1–4)	V (1–7)
<i>Trifolium pratense</i>	IV (1–6)	V (1–5)	V (2–4)	IV (1–4)	V (1–6)
<i>Lolium perenne</i>	IV (2–7)	IV (1–5)	IV (2–4)	III (1–3)	IV (1–7)
<i>Cynosurus cristatus</i>	IV (1–7)	V (1–6)	V (1–6)	II (1–4)	IV (1–7)
<i>Holcus lanatus</i>	V (2–8)	V (1–8)	III (1–3)	II (2–3)	IV (1–8)
<i>Anthoxanthum odoratum</i>	IV (1–5)	V (1–5)	II (1–3)	II (1–5)	IV (1–5)
<i>Ranunculus acris</i>	IV (1–4)	V (1–5)	II (1–3)	III (1–3)	IV (1–5)
<i>Trifolium repens</i>	III (1–5)	V (1–6)	IV (1–3)	II (2–4)	IV (1–6)
<i>Festuca rubra</i>	III (2–6)	V (1–6)	V (2–4)	V (3–6)	IV (1–6)
<i>Lotus corniculatus</i>	II (1–3)	IV (1–6)	V (2–4)	V (1–4)	IV (1–6)
<i>Poa trivialis</i>	V (1–7)	II (1–4)	I (1)	I (1)	II (1–7)
<i>Ranunculus repens</i>	III (1–7)	I (1–4)	I (1)	II (1–2)	II (1–7)
<i>Alopecurus pratensis</i>	III (1–4)	II (1–4)			II (1–4)
<i>Hordeum secalinum</i>	II (3–6)	III (1–6)	I (1–2)	I (1)	II (1–6)
<i>Luzula campestris</i>	I (1)	III (1–3)			II (1–3)
<i>Oenanthe pimpinelloides</i>	II (1–4)	III (1–4)	I (2)	I (1)	II (1–4)
<i>Rumex acetosa</i>	II (1–3)	III (1–4)		I (1)	II (1–4)
<i>Ranunculus bulbosus</i>	II (1–4)	III (1–4)	V (3–4)	III (1–4)	III (1–4)
<i>Leucanthemum vulgare</i>	I (1–5)	III (1–4)	IV (2–4)	III (1–3)	III (1–5)
<i>Bellis perennis</i>	II (1–3)	II (2–3)	V (1–3)	III (1–3)	II (1–3)
<i>Brachythecium rutabulum</i>	I (3–4)	I (2–4)	IV (1–3)	I (2)	II (1–4)
<i>Trisetum flavescens</i>	I (1–3)	II (1–4)	IV (1–4)	II (1–2)	II (1–4)
<i>Achillea millefolium</i>	II (1–2)	II (1–5)	IV (1–3)	II (1–3)	II (1–5)
<i>Phleum bertolonii</i>	I (1–2)	II (1–4)	IV (2–3)	II (1–3)	II (1–4)
<i>Poa pratensis</i>	I (1–4)	II (1–6)	III (1–2)	I (1)	II (1–6)
<i>Briza media</i>		II (2–4)	IV (1–4)	I (2)	II (1–4)
<i>Leontodon saxatilis</i>		I (2–4)	V (1–5)	III (1–3)	II (1–5)
<i>Leontodon autumnalis</i>	I (1–3)	I (1–3)	III (2–3)	II (1–2)	I (1–3)
<i>Convolvulus arvensis</i>	I (2–4)	I (3)	IV (1–2)	II (2–3)	I (1–4)
<i>Cirsium acaule</i>			IV (1–4)		I (1–4)
<i>Plantago media</i>			IV (1–3)		I (1–3)
<i>Sanguisorba minor</i>			III (1–5)	I (1–4)	I (1–5)

TABLE 1 CONTINUED

	A1	A2	B1	B2	Total
<i>Taraxacum</i> agg.	II (1-5)	III (1-4)	III (1-3)	V (1-3)	III (1-5)
<i>Arrhenatherum elatius</i>	II (1-4)	I (1)		IV (1-5)	II (1-5)
<i>Agrostis stolonifera</i>	II (2-5)	I (1-4)	II (1-3)	IV (2-5)	II (1-5)
<i>Leontodon hispidus</i>		I (2-4)	I (1-5)	III (1-3)	I (1-5)
<i>Rubus fruticosus</i> agg.	I (1-2)			IV (1-3)	I (1-3)
<i>Pseudoscleropodium purum</i>			I (2-3)	III (2-5)	I (2-5)
<i>Dactylis glomerata</i>	V (1-4)	II (1-4)	IV (1-3)	V (1-5)	III (1-5)
<i>Cerastium fontanum</i>	III (1-4)	III (1-3)	II (1-2)	I (2-3)	III (1-4)
<i>Agrostis capillaris</i>	I (2-5)	IV (1-8)	IV (2-3)	I (2-3)	III (1-8)
<i>Centaurea nigra</i>	II (1-7)	IV (1-4)	V (2-5)	II (1-4)	III (1-7)
<i>Prunella vulgaris</i>	II (1-4)	IV (1-4)	V (1-4)	III (1-3)	III (1-4)
<i>Potentilla reptans</i>	III (1-4)	III (1-4)	IV (2-3)	IV (2-3)	III (1-4)
<i>Carex flacca</i>	I (1-4)	III (1-5)	V (1-6)	IV (1-6)	III (1-6)
<i>Plantago lanceolata</i>	III (1-6)	III (1-5)	V (1-6)	V (1-7)	III (1-7)
<i>Trifolium dubium</i>	II (1-5)	III (1-4)	III (1-3)	I (1-3)	II (1-5)
<i>Agrimonia eupatoria</i>	I (1-2)	I (1-3)	IV (1-3)	IV (1-4)	II (1-4)
<i>Medicago lupulina</i>	I (1-4)		IV (2-4)	IV (1-4)	II (1-4)
<i>Daucus carota</i>	I (2)	I (1)	IV (1-4)	IV (1-2)	I (1-4)
Number of samples	31	47	11	13	102
Number of species/sample	21 (12-33)	25 (10-39)	37 (25-50)	32 (20-53)	26 (10-53)

Constancy classes. I: 'sparse', recorded in $\leq 20\%$ of quadrats; II: 'occasional', 21-40%; III: 'frequent', 41-60%; IV: 'constant', 61-80%; V: 'constant', 81-100%.

Domin cover-abundance values. 1: rare, $< 4\%$ cover; 2: occasional, $< 4\%$ cover; 3: frequent, $< 4\%$ cover; 4: 4-10%; 5: 11-25%; 6: 26-33%; 7: 34-50%; 8: 51-75%; 9: 76-90%; 10: $> 90\%$.

Species are divided into blocks as follows: first block, overall constants (though no necessarily constant in all four TWINSPAN groups); second block, Group A1 preferentials; third block, Group A2 preferentials; fourth block, Group B1 preferentials; fifth block, Group B2 preferentials; sixth block, species which are not preferential to any one TWINSPAN group, are frequent and/or constant in two or more TWINSPAN groups, but which are not constant overall.

Group B2 (13 samples) is distinguished from Group B1 by the frequent presence (generally at low cover) of *Arrhenatherum elatius*, and with *Taraxacum* agg., *Agrostis stolonifera*, *Leontodon hispidus*, *Rubus fruticosus* and *Pseudoscleropodium purum* as additional preferentials. There are occasional records of *Festuca arundinacea*, *Elytrigia repens*, *Lathyrus nissolia*, *Knautia arvensis* and *Linum bienne*, all of which help to distinguish this group from Group B1. Group B2 was mainly recorded from roadsides and under-managed, but still herb-rich, grasslands in Somerset, especially in the areas around Hinkley Point and Thurlbear-Barrington. Group B2 thus occurs in similar situations to Group A1 - which also has occasional records of *A. elatius* and constant *Dactylis glomerata* - but Group B2 is more species-rich (average of 32 species/quadrat) and has a stronger representation of calcicoles.

From the above, we suspect that *management* is an important determinant of the species composition in grasslands containing *G. fragilis*. A lack of grazing on roadsides and, in meadows and pastures, a degree of agricultural improvement, appear to be two of the main factors leading to the development of Group A1 grasslands as opposed to Group A2; equally, Group B2 is, in essence, a "less managed" (ungrazed or lightly grazed) version of Group B1.

N.V.C. COMMUNITIES

Quadrat samples were assigned to N.V.C. communities/sub-communities with the aid of the published keys (Rodwell 1991, 1992) and the computer programs MATCH, version 2 (Malloch 1997) and TABLEFIT, version 1 (M. O. Hill, unpubl.). It often proved impossible to assign quadrats neatly to a particular community or sub-community, and many stands were considered to be intermediate between two N.V.C. categories.

The relationships between the TWINSPAN-derived grassland types and the various N.V.C. communities, sub-communities and "intermediates" are summarised in Table 2. Nine of the 14 N.V.C. categories, and 81.2% of the quadrat samples, were either MG5 or intermediate between MG5 and another community, while exactly half these quadrats were assigned to MG5a, the *Lathyrus pratensis* sub-community of the *Cynosurus cristatus*-*Centaurea nigra* grassland community. This sub-community appears to be largely analogous to our Group A2, although the latter also included a few quadrats referred to other N.V.C. categories, including several from wet grassland that were judged to be intermediate between MG5 and either MG9, *Holcus lanatus*-*Deschampsia cespitosa* grassland, or MG8, *Cynosurus cristatus*-*Caltha palustris* grassland. One quadrat, from Max Bog S.S.S.I. (N. Somerset), was quite unlike the rest and – despite lacking *Juncus subnodulosus* – appeared to be floristically closest to M22b, the *Briza media*-*Trifolium* spp. sub-community of the *J. subnodulosus*-*Cirsium palustre* fen-meadow community.

In contrast, none of the samples in Group B1 were assigned to MG5a. Not surprisingly, given the large contingent of calcicoles, Group B1 mainly comprised quadrats referable to MG5b, the *Galium verum* sub-community of the *Cynosurus cristatus*-*Centaurea nigra* grassland, or to an intermediate category between MG5b and the calcicolous community CG3, *Bromus erectus* [= *Bromopsis erecta*] grassland. There was also one sample, from the Carboniferous limestone at Uphill S.S.S.I., which was intermediate between CG1, *Festuca ovina*-*Carlina vulgaris* grassland and CG2, *F. ovina*-*Avenula pratensis* [= *Helictotrichon pratense*] grassland.

Group A1 seems to encompass a wide array of N.V.C. types, including less species-rich examples of MG5a, but there does appear to be a slight bias towards MG1, *Arrhenatherum elatius* grassland (especially on roadsides), and MG6, *Lolium perenne*-*Cynosurus cristatus* grassland (in "semi-improved" meadows and pastures). Two road verge samples were tentatively assigned to MG7, *Lolium perenne* grassland.

Group B2 also shows a slight bias towards MG1, but three samples here were assigned to MG5b, while the two intermediate samples between MG1 and MG5 were floristically much closer to MG5b than MG5a.

INFLUENCE OF GEOLOGY

Grassland management is clearly important, but an obvious floristic difference between quadrat samples at the first division of the TWINSPAN (i.e. between Groups A and B) was the much higher frequency of calcicoles in Group B. This suggests that soils, and therefore underlying geology, could be having an influence on species composition.

This is indicated in Table 3, which summarises the occurrence of quadrat samples within each TWINSPAN group across the various geological formations encountered during the quadrat survey. As already noted, most grassland supporting *G. fragilis* overlies heavy clay soils. However, whilst Group A samples occurred on almost all geological formations, they were clearly predominantly on the Tertiary clays and Oxford Clay. In contrast, Group B samples were centred on the calcareous clays of the Lower Lias, with outliers on the Fullers' Earth and Carboniferous limestone, and a single sample from a Tertiary deposit – the Bembridge Limestone and Marls – on the Isle of Wight.

DISCUSSION

When confronted by *G. fragilis* growing in what appears to be an ancient, herb-rich and agriculturally unimproved meadow, it is hard not to imagine that it must be native there. As we have discovered, there is a wide scatter of such sites across southern England, and a wide scatter too of puzzled botanists, each of them wrestling with the apparent contradiction between their own experience of the grass and the general consensus of the Floras that it is a recent, albeit well established, introduction. Here we examine the evidence for and against it being considered a native species.

TABLE 2. NUMBER (AND PERCENTAGE) OF QUADRAT SAMPLES FROM EACH TWINSpan GROUP ASSIGNED TO DIFFERENT N.V.C. COMMUNITIES AND SUB-COMMUNITIES

N.V.C. code	N.V.C. community/sub-community (Rodwell 1991, 1992)	TWINSpan group (see Fig. 2)				
		A1	A2	B1	B2	Totals
MG1a + MG1e	<i>Arrhenatherum elatius</i> grassland, <i>Festuca rubra</i> and <i>Centaurea nigra</i> sub-communities	3 (9.7%)	-	-	4 (30.8%)	7 (6.9%)
MG1/MG5	Stands intermediate between <i>Arrhenatherum elatius</i> grassland and <i>Cynosurus cristatus-Centaurea nigra</i> grassland	8 (25.8%)	-	-	2 (15.4%)	10 (9.8%)
MG5a	<i>Cynosurus cristatus-Centaurea nigra</i> grassland, <i>Lathyrus pratensis</i> sub-community	7 (22.6%)	32 (68.1%)	-	2 (15.4%)	41 (40.2%)
MG5b	<i>Cynosurus cristatus-Centaurea nigra</i> grassland, <i>Galium verum</i> sub-community	1 (3.2%)	-	6 (54.5%)	3 (23.1%)	10 (9.8%)
MG5a/MG5b	<i>Cynosurus cristatus-Centaurea nigra</i> grassland, stands intermediate between <i>Lathyrus pratensis</i> and <i>Galium verum</i> sub-communities	-	3 (6.4%)	1 (9.1%)	-	4 (3.9%)
MG5b/CG3	Stands intermediate between <i>Cynosurus cristatus-Centaurea nigra</i> grassland, <i>Galium verum</i> sub-community and <i>Bromus erectus</i> grassland	-	-	3 (27.3%)	-	3 (2.9%)
CG1/CG2	Stands intermediate between <i>Festuca ovina-Carlina vulgaris</i> grassland and <i>Festuca ovina-Avenula pratensis</i> grassland	-	-	1 (9.1%)	-	1 (1.0%)
MG5a/MG5c	<i>Cynosurus cristatus-Centaurea nigra</i> grassland, stands intermediate between <i>Lathyrus pratensis</i> and <i>Danthonia decumbens</i> sub-communities	-	2 (4.3%)	-	1 (7.7%)	3 (2.9%)
MG5c/MG9	Stands intermediate between <i>Cynosurus cristatus-Centaurea nigra</i> meadow, <i>Danthonia decumbens</i> sub-community and <i>Holcus lanatus-Deschampsia cespitosa</i> grassland	-	5 (10.6%)	-	-	5 (4.9%)
M22b	<i>Juncus subnodulosus-Cirsium palustre</i> fen-meadow, <i>Briza media-Trifolium</i> spp sub-community	-	1 (2.1%)	-	-	1 (1.0%)
MG5/MG8	Stands intermediate between <i>Cynosurus cristatus-Centaurea nigra</i> grassland and <i>Cynosurus cristatus-Caltha palustris</i> grassland	-	1 (2.1%)	-	-	1 (1.0%)
MG5/6	Stands intermediate between <i>Cynosurus cristatus-Centaurea nigra</i> grassland and <i>Lolium perenne-Cynosurus cristatus</i> grassland	6 (19.4%)	-	-	-	6 (5.9%)
MG6a + MG6b	<i>Lolium perenne-Cynosurus cristatus</i> grassland, Typical and <i>Anthoxanthum odoratum</i> sub-communities	4 (12.9%)	3 (6.4%)	-	-	7 (6.9%)
MG7	<i>Lolium perenne</i> leys and related grasslands, including <i>Lolium-Plantago lanceolata</i> verges and lawns	2 (6.5%)	-	-	-	2 (2.0%)
-	"Unclassifiable"	-	-	-	1 (7.7%)	1 (1.0%)
	Totals	31	47	11	13	102

TABLE 3. NUMBER (AND PERCENTAGE) OF QUADRAT SAMPLES FROM EACH TWINSPAN GROUP ON DIFFERENT GEOLOGICAL FORMATIONS

TWINSPAN group (see Fig. 2)					
Underlying geology	A1	A2	B1	B2	Totals
Carboniferous limestone	-	-	2 (18.2%)	-	2 (2.0%)
Lias clays	10 (32.2%)	6 (12.8%)	7 (63.6%)	11 (84.6%)	34 (33.3%)
Fullers' Earth	-	7 (14.9%)	1 (9.1%)	1 (7.7%)	9 (8.8%)
Oxford Clay	5 (16.1%)	6 (12.8%)	-	-	11 (10.8%)
Lower/Upper Greensand	1 (3.2%)	-	-	-	1 (1.0%)
Tertiary clays	13 (41.9%)	26 (55.3%)	1 (9.1%)	-	40 (39.2%)
Others/unknown	2 (6.5%)	2 (4.3%)	-	1 (7.7%)	5 (4.9%)
Totals	31	47	11	13	102

THE CASE FOR *G. FRAGILIS* BEING INTRODUCED

The view that *G. fragilis* is an alien in the British Isles seems to revolve around the following lines of argument.

1. *Date of first record in the wild.* *G. fragilis* was first recorded in the wild – and then only as a “casual” – in 1903, and was not discovered in “semi-natural” habitat until 1917, on the Isle of Wight. Surely, if it were native, there would have been at least a smattering of 18th or 19th century records? However, we have found that *G. fragilis* can be easily overlooked if one is not intentionally searching for it, being missed altogether or else passed off as another species. At first glance it can bear more than a nodding resemblance to *Trisetum flavescens*, while (if one overlooks its hairiness) its flowering stems can frequently be “lost” amongst *Lolium perenne*. Vegetatively, it can be confused with *Bromus commutatus* or *T. flavescens*, and might even be dismissed by some as an odd-looking *Holcus* – although it is easily distinguished once one is familiar with it. Also, its flowering season is usually rather short, and the mature inflorescence soon starts to disintegrate, making it then difficult to spot, especially in “closed” grassland swards. Thus, we are tempted to speculate that earlier botanists may have failed to see it, not because it was not there, but rather because they were unfamiliar with it and were not *expecting* to find it. There are parallels here with *Poa infirma*, an undisputed native species which was not discovered in our area until 1876, and not seen again until 1950 (Hubbard 1954), but which – once botanists had been encouraged to search for it, had a good description (and illustration) of it and had “got their eye in” – was found to be widespread near the sea in S.W. England and the Channel Islands (Takagi-Arigho 1994), with recent records extending its known range eastwards to Hampshire, Sussex and the Isle of Wight. *P. infirma* belongs to a group of “easily overlooked” native species, and we think that *G. fragilis* could fall into the same category.
2. *Earliest records as a “casual” of artificial habitats.* The first records of *G. fragilis* in the British Isles were as a “casual”, and the earliest records in several counties, even within its core range, were from artificial or otherwise untypical habitats – e.g. road verges in S. Devon and E. Sussex, a forest ride in S. Somerset, waste ground and cultivated land in N. Wiltshire, a car park in W. Sussex – and it was only later found in these counties in neutral grassland. Yet there are other species, native or possibly so, which show this same pattern of “artificial” first, “semi-natural” later. Take, for example, *Gastridium ventricosum*, thought to be almost exclusively an arable colonist until detailed recording in the 1980s and 1990s revealed it to be widespread in drought-prone grassland on calcareous soils in S.W. England and S. Wales. *G. ventricosum*, like *G. fragilis*, is given as “native or alien” in the *New Atlas*, although recent accounts lean towards the view that *G. ventricosum* is almost certainly native in its grassland habitat, and that its true status had previously been obscured by its widespread occurrence as a cornfield weed (Trist 1983, 1986; Green & Pearman 1999).

3. *Evidence of recent spread.* *G. fragilis* may have been overlooked in the past, but we still suspect that the flood of new records indicates that it is increasing, at least within its core areas. This spread cannot be related to an increase in the area of suitable habitat (on the contrary, there is now much less agriculturally unimproved neutral grassland than there was in, say, the 1930s), and it suggests a recent introduction rather than a native species. However, Preston *et al.* (2002) have shown that "Mediterranean" species have, as a group, considerably expanded their range in our area over the last 40 years, possibly as a result of climate change. Thus, one could argue that the spread of *G. fragilis* is entirely consistent with the recent increases shown by native "Mediterranean" species like *Medicago arabica* and *Crassula tillaea*.
4. *Known (or suspected) sources of introduction.* There is evidence from Ireland to suggest that *G. fragilis* may have been introduced there as a contaminant of imported grass seed, and it seems reasonable to suppose that this could have been a source of introduction in Britain too. Was there, perhaps, a period after the First or Second World Wars, and before the mass ploughing and destruction of old grassland, when "top-up" seeding was carried out (with a seed mix inadvertently containing *G. fragilis*) in an effort to "refresh" worn-out meadows? Yet, if this was the case, why do our records of *G. fragilis* display such a coherent "geography"? Why are there not records of *G. fragilis* turning up in re-seeded grassland in, say, Oxfordshire, Norfolk, Lincolnshire or Warwickshire? And, lastly, if *G. fragilis* did come in with imported grass seed, why is there no evidence of other grassland aliens arriving in this way? It is easier to ask questions than give answers, but we think a study of the history of imported grass-seed mixtures (and their origins and species composition) would help enormously to improve our understanding of the distribution of many grassland species, not least *G. fragilis*.
5. *Status in N.W. Europe.* Whatever its status in the British Isles, we need to remain mindful of the fact that *G. fragilis* is regarded as an introduction in mainland N.W. Europe. This view is indisputable, but it is very difficult to find reliable, recent information from that area in support of it. Recent work on other "Mediterranean" species, for example *Valerianella eriocarpa* (Pearman & Edwards 2002), raises this same point.

THE CASE FOR *G. FRAGILIS* BEING NATIVE

There are several lines of argument that could be used in support of *G. fragilis* being considered a native species in our area. Some have already been introduced as "counter-arguments" in the section above, but there are others that should also be mentioned.

1. *A coherent distribution.* Until the 1960s and 1970s most British and Irish botanists were unfamiliar with *G. fragilis*, but now, after fifteen years of intensive recording, we find that this grass has a remarkably coherent "geography". Compare, for example, its national distribution (Figure 1) with that of *Oenanthe pimpinelloides* (Figure 3), an undoubted native species with which it is often associated; or with that of *Gastridium ventricosum* (Figure 4), a "native or alien" which, while it does not grow directly alongside *G. fragilis* is found occasionally on sites near by. Both these species have distributions that are strikingly similar to that of *G. fragilis*; and both, incidentally, are "Mediterranean" species (Preston & Hill 1997). We accept that there is no reason why an alien should not acquire a coherent distribution, perhaps after an initial flurry of widely scattered records and then a "settling down" period as it becomes well established (persistent) in those areas particularly suited to it. Even so, we would argue that the distribution of *G. fragilis* appears to "make sense" in ways that suggest a native species rather than a recent introduction.
2. *A readily definable semi-natural habitat.* We have found *G. fragilis* in a range of grassland plant-communities, but it seems to show a distinct preference for MG5 *Cynosurus cristatus*-*Centaurea nigra* meadows and pastures, especially those on sticky, often somewhat calcareous, clay soils. This preference for a semi-natural habitat suggests a native rather than an introduced species; and species-rich neutral grassland is not renowned as a habitat for aliens, although a question mark hangs over *Fritillaria meleagris* (e.g. Oswald 1992; Harvey

1996) which, like *G. fragilis*, is given as "native or alien" in the *New Atlas*. Our own quadrat survey of grassland containing *G. fragilis* produced records for 188 native species and just three aliens.

3. *Occurrence in "ancient" grassland with no history of agricultural improvement.* There is anecdotal evidence pointing to the likelihood that many grassland sites supporting *G. fragilis* are agriculturally unimproved, and we have reports of several that have certainly not been ploughed or otherwise disturbed since at least the 1920s. But looks can be deceptive, and one can be easily misled into thinking that if a sward is species-rich it is therefore "old" and in pristine condition. We know of sites which were converted to arable, or ploughed and re-seeded, at some point in the 19th or 20th centuries, for example during (or after) the First or Second World Wars; as Marren (1999) noted, "...although much of the native flora seems to have survived the temporary ploughing, so much so that today you would never have suspected an arable episode, it does seem possible that *Gaudinia* could be a wartime introduction". Hard

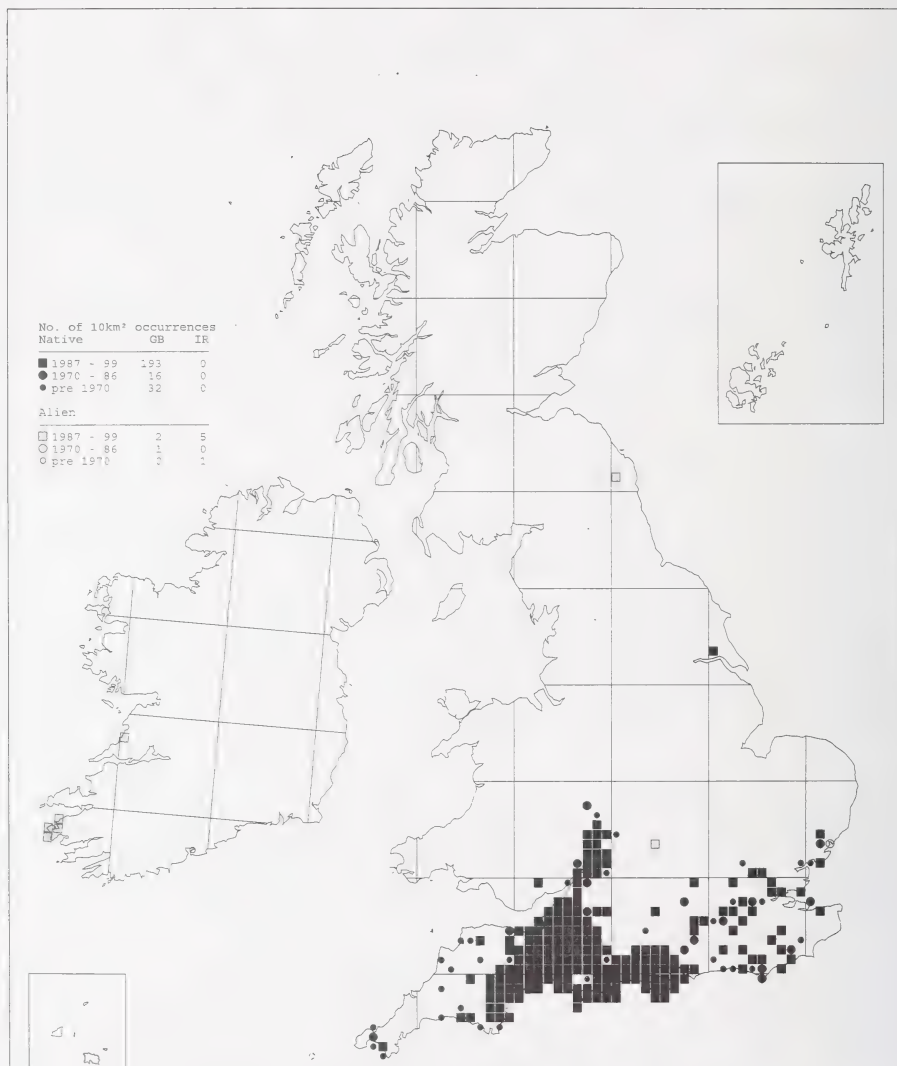


FIGURE 3. 10-km square distribution of *Oenanthe pimpinelloides* in Britain and Ireland.

information is difficult to come by, but Gibson (1998), in a study of selected S.S.S.I. grasslands in S. Somerset, found that *G. fragilis* was especially frequent in fields known to have been "under the plough" at some point in their history. It was particularly associated with younger (or "early successional") swards. He discovered that several of these fields – thought of as prime examples of "ancient" species-rich grassland – were shown as arable on 19th century estate or tithe maps, while one field (with abundant *G. fragilis*) was ploughed after the Second World War, and had 2–3 years of arable cropping in the 1970s before being re-seeded as ryegrass pasture. This might mean that *G. fragilis* was introduced at these sites, yet it was also found (though more sparsely) in fields that were "pasture" in 1808 and with no record of having been subsequently ploughed or re-seeded. Thus its abundance in "early successional" grassland could merely reflect the fact that *G. fragilis* has a preference for open swards; even those kept open by periodic gross disturbance like ploughing.

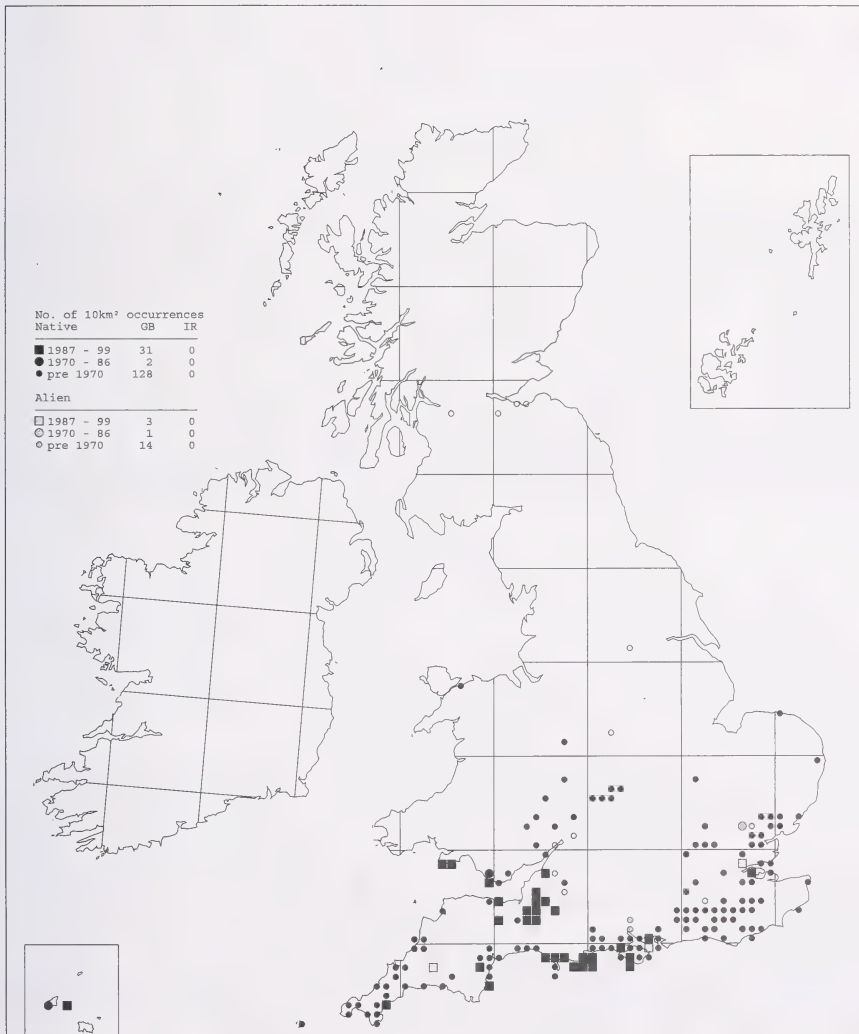


FIGURE 4. 10 km square distribution of *Gastridium ventricosum* in Britain and Ireland.

CONCLUSIONS

With all the evidence before us, we remain uncertain as to the true status of *G. fragilis* in the British Isles. Indeed, when one of us decides it is probably native the other, almost perversely, starts to think it must be introduced, and then when we next meet we discover that each of us has switched to the view of the other! That said, we both agree that, from a conservation standpoint, this grass should be treated "as if native", at least in neutral grasslands in southern Britain, and, as such, should be added to the British list of Nationally Scarce species. High-quality neutral grassland containing *G. fragilis* is already well represented within the protected sites network (including several N.N.R.s and S.S.S.I.s), especially in Somerset and on the Isle of Wight, but there may be a need to consider further site protection in some areas.

It is unlikely that we will ever know for certain whether *G. fragilis* is introduced or native (and even if some populations prove to be alien this does not mean that others cannot be native). But there is considerable scope for further study, particularly relating to management history and the possible use of imported grass-seed mixes, and we are sure there is a wealth of relevant information still to be gathered. For the moment, however, we think an equivocal "native or alien" is probably the best that can be offered. We leave it to others to unearth the evidence that convinces us that "sitting on the fence" can no longer be justified.

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Wisbech and Fenland Museum herbarium (WBCH): a history with a list of collectors

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ABSTRACT

An account is provided of the contents of Wisbech and Fenland Museum herbarium (**WBCH**), with a list of collectors represented in the collections. The herbarium contains around 3300 specimens almost all dating from the nineteenth century and collected in the vice-counties of West Norfolk (v.c. 28) and Cambridgeshire (v.c. 29).

KEYWORDS: Cambridgeshire; West Norfolk; Peckover; Townley; Weatherhead; history of botany.

INTRODUCTION

The Wisbech Museum (now the Wisbech and Fenland Museum; henceforth **WBCH**) was founded in 1835 and today occupies the same purpose-built building that was erected in the town centre in 1846 (for a history see Archer (1985)). In a previous paper (Crompton & Nelson 2000), about the Wisbech-born surgeon-botanist William Skrimshire (1766–1829), some of the specimens now in **WBCH** were discussed.

During the past six years (1996–2002), with the able assistance of Mrs M. Johnson and Mr W. R. Knowles, I undertook a complete overhaul of the **WBCH** collection, mounting loose specimens, remounting others, and transferring the majority of specimens into insect-proof metal cabinets within acid-free folders. All the specimens have been recorded on a database (using MODES for Windows) which includes all the information on the original labels, as well as updated Latin botanical names, botanical family names and, when this can be determined, vice-county numbers. There are around 3300 records in the database. The majority of the specimens represent angiosperms; only a small proportion comprises gymnosperms and cryptogams. Almost all the specimens come from Britain (see below).

While the specimens have been rehoused little critical taxonomic work has been done. A very few specimens were redetermined during the cataloguing process, generally only when the name attached was obviously incorrect. Mrs Gigi Crompton did arrange to have some critical genera examined for her research on the historical flora of Cambridgeshire; Dr C. D. Preston examined *Potamogeton* and *Ruppia*, Dr S. M. Walters examined *Silene* and Dr T. C. G. Rich examined *Cochlearia*. In addition, at Mrs Crompton's request, in 1993 Robin Stephenson redetermined some of the bryophyte specimens (see below).

Kent & Allen (1984) included some of the **WBCH** collectors in their work; however, when they were compiling their data the collections in **WBCH** had not been properly or completely catalogued, and so some of the individuals noted here are not credited to **WBCH** by those authors.

HERBARIUM COLLECTIONS

As McReynolds (1985) has pointed out, the Wisbech and Fenland Museum is a “superb example of a Victorian museum”, and the small herbarium largely reflects the same era. The bulk of the specimens were collected before the close of the nineteenth century and a small number date from

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the late eighteenth century, the earliest being *Origanum vulgare* gathered in 1791 by William Skrimshire (see Crompton & Nelson 2000: 26). Only one collection represents the twentieth century – the most recent specimens in **WBCH** were collected during June 1914 in Surrey by W. G. Kent (see below). Although the last substantial donation to the herbarium was in 1993, those specimens all dated from the 1800s.

Like every herbarium, **WBCH** contains specimens that range from the fully documented (with dates of collection, locality and name of the collector) to the entirely undocumented (with only a botanical name). Three-quarters of the specimens bear the name of a collector or can definitely be assigned to an individual, while 70% have at least a locality of collection noted although it is often not possible to assign vice-county numbers because of the duplication of some place-names in different counties. Only half the specimens are dated.

More than half (> 54%) of the localised specimens come from the vice-counties of West Norfolk (v.c. 28) and Cambridge (v.c. 29), and undoubtedly a very high proportion of the unlocalised specimens also originated in those vice-counties. Because of W. G. Kent's collection, 14.5% of the localised specimens originated in Surrey (v.c. 17), while the fact that several of the contributors studied in the University of Edinburgh during the early 1800s accounts the next largest (3.6%) representation from Midlothian (v.c. 83). The remaining vice-counties of England, Wales and Scotland are each represented by fewer than 30 specimens (<1%), and many are not represented at all. There are 3 specimens from Guernsey (v.c. S), and 18 from Ireland (v.cc. H4, 12, 16, 21, 29, 38, 39).

Considering the collectors, around 150 are represented. The largest individual collection is that of John Rose Weatherhead (who was incorrectly listed in Kent & Allen (1984) as I. R. Weatherhead); 421 specimens are included in **WBCH**. The other individuals represented by more than 50 specimens are Mrs W. G. Townley (317 specimens), James Balding (c. 300 specimens), W. G. Kent (268 specimens); Richard Dykes Alexander (243 specimens), and William Skrimshire (174 specimens; see Crompton & Nelson 2000), while various member of the Peckover family made substantial contributions – Miss Susannah Peckover, 217 specimens; Mrs Priscilla Peckover, c. 200 specimens; Miss Priscilla Hannah Peckover, 55 specimens.

HISTORY OF THE COLLECTIONS

Following the Museum's formation in 1835, explicitly "for the purpose of receiving natural curiosities, antiquities etc." (Arthur 1985, p. [3]), the earliest donations were largely of natural history material. The first botanical specimens recorded in the Museum's extant registers were "Musci from the collection of the late William Skrimshire 162 specimens" with "A quarto Vol: bound & lettered for the above collection of Mosses". This handsome leather-bound volume, a veritable *hortus siccus*, remains intact with all its specimens in place. It was donated by a Wisbech solicitor, Charles Metcalfe jun.; this is stated in Latin inscription on the cover of the volume: "*Muscos quos collegit Gul. Skrimshire Arm[iger]. hujus villae olim civis. D. D. Carolus Metcalfe Junr. 1835.*" The specimens are of mosses (74) and liverworts (11); they were critically examined and many were re-determined in 1993 by Robin Stephenson. The collectors represented in it included both William Skrimshire and his brother Dr Fenwick Skrimshire (Charles Metcalfe was their brother-in-law), Revd Richard Relhan, John Pitchford, Revd John Hemsted, Arthur Bruce, John Nainby (of King's Lynn) and a Mr Hayden also of King's Lynn (for some of these see Crompton & Nelson 2000: 34).

Around the same time, Richard Dykes Alexander Esq. of Ipswich presented "Four folio volumes containing a series of British Plants", while Miss Alexander of Ipswich (see below), Mr J. R. Weatherhead, Mrs Algernon Peckover and Mr Charles Metcalfe jun. each gave, according to the Museum's register, "A variety of British plants". The register entry records that the specimens in R. D. Alexander's four volumes were subsequently "arranged with the general British collection". It has been possible to recognise these various separate donations among the extant specimens. (Kent & Allen (1984) listed G. Metcalfe for **WBCH** but this is evidently an error.)

Other collections followed. On 4 December 1835 Miss Weatherhead donated "47 species of British lichens"; as very few lichen specimens are in **WBCH**, these particular specimens have evidently been lost or were destroyed, for whatever reason. An unnamed donor added "Some

specimens of moss found on the sandhills at Hunstanton" in 1838, but as the number of specimens is not stipulated and there is no substantial collection of mosses, other than William Skrimshire's *hortus siccus* donated by Charles Metcalfe in 1835, these must also be presumed lost, as are Mr Girdlestone seaweeds, also donated in September 1838. Apart from miscellaneous donations of curiosities – "A piece of bark of the Wellington Tree from Waterloo" donated by Dr England on 20 June 1842; some "Burnt corn from Thorney" given by Master J. Watson on 26 June 1848; "Stalk of asparagress in seed" from Mr R. Leayears of Upwell on 24 November 1850, for example – the next herbarium accession was in August 1851 when Wisbech Museum received a collection of 420 specimens from the Botanical Society of London (see Allen 1986). Mr Algernon Peckover was instrumental in arranging this acquisition (Price 1983). Given that these all had labels indicating they were from the Society, they can be easily identified; 388 of these specimens are recorded on the database. In January 1862 Mrs W. G. Townley presented 330 specimens – 266 of these are extant. An annotated copy of *The London catalogue* was evidently provided with the specimens, and this is extant in **WBCH**; the marks in the catalogue have not yet been compared with the extant specimens.

The largest donation was a seven-volume *hortus siccus* presented to the Wisbech Museum in July 1862 by Mrs Weatherhead, widow of John Rose Weatherhead (c. 1787–1849) who had been William Skrimshire's apprentice before entering the University of Edinburgh where he studied medicine. These volumes remained intact until recently when it was decided to incorporate all specimens into a single sequence with the others. Around 650 specimens were in these volumes, including many collected by William Skrimshire (for further information see Crompton & Nelson 2000).

A further addition was made on 5 November 1877 when Miss Susannah Peckover presented a collection of plants of "Wisbech and the Neighbourhood", including around 130 unlocalized and undated specimens given to her a year previously by James Balding (see below). Accompanying this was a manuscript (comprising 8 folios) headed "List of Plants collected in the neighbourhood of Wisbech", written and signed by William Marshall (1815–1890) and dated "Ely, May 17 1874", and a copy of C. C. Babington's *Manual of British botany* of which there is now no trace in the library of **WBCH**. Lacking localities and dates, Marshall's manuscript list, which is extant, is uninformative.

Almost half a century elapsed without any significant botanical material being added to the Wisbech Museum's collections, and certainly none that was suitable for inclusion in a collection of pressed and dried plants. On 7 December 1925, W. G. Kent (see below) of Clarkson Avenue, Wisbech, donated his "Herbarium of British Plants, mostly collected in Surrey. Nearly 300 sheets, in poor condition." That last comment recorded in the Museum's accession register is certainly not correct for while the individual specimens may not always be the best, they are undoubtedly the best documented.

The last substantial addition to **WBCH** was the remnants of James Balding's herbarium presented in July 1993 by Mr Basil A. E. Lambert, through the good offices of Mrs G. Crompton. Specimens from James' brothers Alfred and George are also in this collection. This material was then unmounted but it has now been mounted and re-labelled. Only nine plant families were represented with the largest number of specimens being *Juncus* spp. from West Norfolk (mainly Sandringham). Almost all date from the 1880s. The preponderance of *Juncus* may be an artefact due to the large number of families that were missing. However there were many duplicates and specimens of the same *Juncus* taxa collected at different stages and dates. The reason for Balding's sudden interest in these is not known.

One further accession should be noted. In 1868, under the will of the Revd Chauncy Hare Townshend, the Wisbech Museum was bequeathed Townshend's "collection of dried plants and all other of [his] effects coming under the denomination of 'Curiosities', objects of antiquity or vertu ... on condition that the same several article be never sold or exchanged but deposited and kept in the same museum for ever under proper regulations and exhibited to the public for the advantage of the town and neighbourhood" (Archer 1985). The "collection of dried plants" apparently comprised a number of what may be described as "souvenir" collections of pressed plants, often prettily arranged, from England and the Alps. For example there is a book (*hortus siccus*) labelled "Mosses and lichens 1831" which is inscribed "Chauncy Hare Townshend from E. F. T. Keswick Jan. 21st 1832"; the initials are those of his wife, Eliza Frances Townshend (née

Norcott). A second similar volume has “Keswick 1831” on the spine and likewise contains bryophyte and lichen specimens. And there is a third volume without any indication of provenance. None of the specimens is named nor are there any collection data, so these are merely “curiosities”. A fourth volume contains pressed flowers, and probably was made in Switzerland in 1846–1847; again no data accompany the specimens. A box with unidentified “seaweeds” and a box containing alpine “flowers” also originated from Townshend’s bequest (Anonymous 1996). Townshend was a “dilettante ... poet, composer, artist, dabbler in mesmerism” (Archer 1985); while he took holy orders, illness prevented him from serving in a parish, and because he had independent means – he owned houses in London and Lausanne – he spent his life on “literary pursuits” and travelling.

While on the topic of albums of pressed plants, there is also an *hortus siccus*, presented to **WBCH** in 1959 by Mrs M. L. Newell, with an elaborate hand-worked beaded cover, the work of Elizabeth G. Webster and dated 1862. According to a note this was “hidden in an underground oven in Paris during the Franco-German War of 1870–1871 (Anonymous 1996). The specimens are not documented.

NOTES ON COLLECTORS

WILLIAM AND FENWICK SKRIMSHIRE AND JOHN ROSE WEATHERHEAD

These collectors are accounted for in detail in Crompton & Nelson (2000), and no additional comments are required here. Some of William Skrimshire’s specimens are included in the catalogue of Cambridgeshire plant records available on www.MNLG.comm/gc (for additional details see Crompton 2001).

THE ALEXANDERS AND PECKOVERS

Apart from John Rose Weatherhead (c. 1787–1849; see Crompton & Nelson 2000: 35–36), the principal contributors to **WBCH** were Richard Dykes Alexander (1788–1865) and his sister Priscilla who married Algernon Peckover (1803–1893) in 1828. Richard Dykes Alexander’s herbarium amounts to 243 specimens; only 13 bear localities and none is dated rendering them of little value. A small number of specimens bearing the initials MA must also have come from a member of the Alexander family; the few localities of collection coincide largely with those on R. D. Alexander’s specimens including such Suffolk localities as the River Gipping and Leiston. The register of donations to **WBCH** recorded the donation of plant specimens by Miss Alexander – bearing in mind the initials MA the only possible person is Miss Martha Alexander (1799–1871) whose twin sister, Mary, died in 1800. No other members of the family have suitable initials.

Priscilla Alexander (Mrs Algernon Peckover) collected more than 110 specimens (assuming that the initials PP represent her name, which assumption tends to be confirmed by the date range). Her oldest daughter, Susannah (1832–1903), can be credited with almost 220 specimens. Her sister, Priscilla Hannah (1833–1931; for her photograph, see McReynolds 1994, p. 10), contributed around 150 specimens. Whereas Susannah’s gatherings are mainly from vice-counties of Cambridgeshire and West Norfolk, there are specimens from Cornwall (v.c. 1), Isle of Wight (v.c. 10), Carnarvonshire (v.c. 49) and Derbyshire (v.c. 57), among Priscilla Hannah’s collection. Not surprisingly for a person whose family came from Ipswich, Mrs Priscilla Peckover’s specimens include a proportion from the Suffolk vice-counties (v.cc. 25 and 26).

Strangely there are no specimens collected by Algernon Peckover FLS (1803–1893) in **WBCH**, although he was interested in botany as shown by the acquisition of the specimens from the Botanical Society of London in 1850 (Price 1983) as well as by several annotated plant-lists among Babington’s papers in the Department of Plant Sciences, University of Cambridge, one of which was “annotated by Mr Peckover’s family” (G. Compton, unpublished notes).

In 1904 Miss Algerina Peckover (1841–1927) donated an *hortus siccus* of “Ferns from Madagascar”; only three of the specimens have been named and none is dated. This collection appears to be connected with Mrs Sarah Street (see Dorr 1997: 459–460), from whose garden in Antananarivo the only localized specimen was collected, and it may have been assembled by her.

THE BALDING BROTHERS

When Mr Basil Lambert presented the Balding collection in 1993, he provided the following additional information:

"... I think the herbarium was collected by my Grandfather's brother (Mr. James Balding) although I notice that some of the specimens were collected by my Grandfather (Mr. George Balding) ... My Grandfather ... was a keen collector of butterflies & moths (as indeed was his brother ... James ... too) & I know he kept an extensive diary recording where specimens were collected & various notes about them but unfortunately I no longer have these ..." [B. A. E. Lambert to D. C. Devenish 1 July 1993. **WBCH**]

There are no specimens explicitly labelled as having been collected by George Balding in **WBCH**, unless a single *Juncus* with "Geo Hunstanton" is counted. There is at least one bearing the monogram AB – Alfred Balding – in handwriting that matches other examples of Alfred Balding's manuscript in the Museum's library. Undoubtedly the specimens from West Norfolk and Cambridgeshire in the Fielding-Druce Herbarium, Oxford (**OXF**) from one A. Balding (see Kent & Allen 1984; Clokie 1964) are also from Alfred.

There were three brothers – James, Alfred and George – and they all were involved at some stage of their lives in the printing business, like their father (Burall 1970). Like his brothers, Alfred (1838–1915; for his portrait see Burall 1970: 11) was also described as an "enthusiastic entomologist and botanist" (Burall, 1970) – "he collected many fine specimens and a number of pressed plants still survive." He described himself as a "Portrait, Animal & Landscape Painter" and, again according to Burall (1970), by the 1890s had "a reputation for his 'floral studies' and the accuracy of detail in form and colour were features that recommended his paintings for reproduction in florists' catalogues" (Burall 1970: 12). A charming, competent and accurate oil-painting showing two narcissi and a bluebell by Alfred Balding is on display in Wisbech and Fenland Museum, and is the only example of his flower studies that the present author has so far traced.

James Balding was explicit about his botanical interests in a letter written to Miss Susannah Peckover dated 10 November 1876.

"Dear Miss Peckover

I am pleased to find the plants I sent were worth your acceptance. All the specimens have been mounted upwards of twenty years. During the interval I have done but little with our local flora, but have devoted my leisure time to insects. Should I be well enough and circumstances permit during the ensuing year, I will try and revise my former knowledge and add to our list of specimens. I am vain enough to believe I can get some of Professor Babington's lost plants. This year I have seen *Sedum album* and *Myosurus minimus*. They only want looking for by those who know where and how to look."

James Balding's reference to "Babington's lost plants" (cf Babington 1860: 314–315) evidently alludes to contact he had had with Professor Charles Cardale Babington in 1859 when they exchanged plant lists.

According to a comment by Algernon Peckover in a letter to Professor Babington, dated around 1859, Balding was at that time employed as a bookbinder by Eleazar Johnson, a bookseller in Wisbech. He must subsequently have joined a solicitors' firm because Burall (1970) stated that James was "from 1855 for fifty-five years with the predecessors of the Wisbech solicitors Ollard, Ollard and Bell."

MRS W. G. TOWNLEY

Harriet Townley (b. c. 1800) was the wife of the Rector of Outwell, Revd William Gale Townley of Beaupre Hall, Outwell, a small village five miles from Wisbech.

Her collection is distinguished by its annotations. She copied on to the individual sheets information about the uses of plants. This does not appear to be original, local lore, but to have been derived from published sources although no attempt has yet been made to determine what those sources were.

W. G. KENT AND HIS FELLOW WISLEY STUDENTS

W. G. Kent (c. 1890–1974) enrolled as a student gardener at the Royal Horticultural Society's Garden, Wisley, in 1907; his career and that of his fellow student can be sketchily traced through the *Journal of the RHS Gardens Club* (cited below as *JRHSC*). His collection includes 268 specimens that were gathered mainly within the R.H.S. Garden and in surrounding villages during 1908 and 1909; his annotated, interleaved copy of *The London catalogue*, including details of the specimens, is in **WBCH**. Subsequently he moved to the University Botanic Garden, Cambridge (Kent 1910). There are a few specimens from Cambridgeshire and West Norfolk dating from 1912 to 1914. He served in the First World War with the Royal Sussex Regiment, and married around 1919. About this time he was appointed Horticultural Superintendent to the Isle of Ely County Council. By 1922 he had moved to live at The Cabin, Clarkson Avenue, Wisbech, and it was from that address that he donated his herbarium to the Wisbech Museum. Ten years later, having gained his N.D.H., Kent moved again and became County Advisory Officer in Commercial Fruit Growing under Kent County Council, and was evidently based at the East Malling Research Station at Maidstone. Mr Kent was one of the panel of judges at the 1935 Imperial Fruit Show in Cardiff. In the Queen's Birthday Honours list in 1963 he was awarded the O.B.E.; he was then described as Provincial Horticultural Advisory Officer, Grade I, Ministry of Agriculture. W. G. Kent died in 1974 (*JRHSC* 2: 60 (1909); – 13: 25 (1920); – 15: 40 (1922); – 23: 22, 40 (1930); – 28: 12 (1935); – 49: 23 (1956)).

G. Sidney Damsell (c. 1890– c. 1953), from Lydbrook, Gloucestershire, joined the RHS Garden, Wisley, in 1906, and emigrated to South Africa, in 1910 “in search of health and work” (Damsell 1911). He described his journey there by way of the Canary Islands, Ascension Island, St Helena and Cape Town. He disembarked and went to Johannesburg by train. For a month he had a temporary job in Durban Botanic Garden but then obtained a more permanent job in a 150-acre nursery at Pietermaritzburg (Damsell 1911). Damsell returned to England, perhaps in the early 1930s for his address is then given as Painswick, Stroud, Gloucestershire. The last entry for him among the list of former Wisley students was in 1953. As well as his account of his journey to Pietermaritzburg, Damsell (1912) described “An autumn ramble” near his home in Lydbrook (*JRHSC* 3: 60 (1910); – 26: 36 (1933); – 46: 27 (1953)).

B. P. Perry (c. 1890– c. 1964) was at Wisley from 1906 to 1909. Thence he moved to the Horticulture Department of Holmes Farm, Kilmarnock, Scotland. In 1922 he had an address in Broomhill, Glasgow. In 1929 he was in the Horticulture Department of the West of Scotland Agricultural College at Auchincruive, Ayr. By 1948 Perry had moved to Parkstone in Dorset and he disappeared from the list of former students published in the *JRHSC* in 1964 (*JRHSC* 2: 61; – 15: 41 (1922); – 22: 37 (1929)).

Norman A. Phillips, who like Kent entered the RHS Gardens, Wisley, in 1907, joined a fellow ex-student, Hugh Lancelot Robson in 1909 to establish The Guildford Fruit Farm near Burpham, Surrey. During the First World War Phillips joined the Royal Flying Corp and was serving on the Western front when he was killed at the end of March 1917 (*JRHSC* 2: 61, 62 (1909); – 10: 7 (1917); – 46: 17 (1953)).

J. Ridley, a student at Wisley in 1907, gave addresses in Bury St Edmunds during 1909 – he was then described as being “temporarily at home” – and 1910, and in Bushwood Road, Kew Gardens during 1912. By 1914 he was in Sumatra. Ridley does not appear in the address list of former students after 1933 (*JRHSC* 2: 61, 63 (1909); – 3: 62 (1910); – 5: 54 (1912); – 7: 51 (1914)).

R. McK. Robson was living in Aberdeen in 1914–48. His address up to 1953 was Hazelhead Nurseries, Aberdeen (*JRHSC* 15: 41 (1922); – 41: 31 (1948)).

CONCLUSION

The Wisbech and Fenland Museum herbarium is of considerable local, historical interest. The hinterland of the town of Wisbech is now intensively farmed. The few patches of “wild” vegetation that occur in the area are restricted to such sites as the banks of ditches and rivers, roadsides and “waste ground”, but even the river banks are managed, often on a huge scale, to control potential flooding. Widespread use of artificial fertilizers and other agricultural chemicals also must have a considerable influence on any “natural” vegetation in this region. It is notable that some of the specimens in **WBCH** are of “weeds” that are no longer the constant companions of cultivated crops.

In the wider context, **WBCH** contains few specimens of importance to nomenclature. The only probable type specimens (isotypes) are two sheets of *Stachys xambigua* J. E. Sm. – the ambiguous woundwort – gathered by J. R. Weatherhead (see Crompton & Nelson 2000: 36) near Edinburgh in 1809.

The **WBCH** herbarium represents a sample of the flora of this region during the nineteenth century, and while the landscape was already much altered, especially by drainage ditches, there were probably many more species growing in the region than could be recorded today. That the **WBCH** herbarium is largely intact, without any apparent substantial loss of specimens during the past almost 170 years since the formation of The Wisbech Museum, is as much due to the fact that the collection is little known to botanists as to the care of the Museum's curators.

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COLLECTORS IN WBCH

The symbol ‡ indicates that there is an entry for the collector in Desmond (1994), and * indicates that there is an entry in Kent & Allen (1984). The number of specimens logged on the **WBCH** database for each individual precedes the person's name.

no.	Names	Years of collection	Vice-counties
‡	1 Abbiss, Henry Walter (1891–1965)	1908	17
‡ *	243 Alexander, Richard Dykes (1788–1865)	—	4, 8, 9, 10, 25, 70
	1 Anderson	1810	?
‡ *	1 Balding, Alfred (1838–1915).	1884	26
	‡1 Balding, George	—	‡28
*	315 Balding, James	1872, 1884–1886, 1888, 1890–1891, 1896–1897	5, 14, 17, 27, 28, 29, ‡34, 62, 71, 83, 85, 110, 112
‡ *	1 Balfour, Hugh M.	1847	83/84
	1 Balfour, Dr (? John Hutton; 1808–1884)	—	82
‡ *	4 Ball, John (1818–1889)	1848, 1850	52, [‡96, ‡106]; H21
‡ *	3 Barham, Frederic (1809–1878)	1845, 1848–1849	15, 21
‡ *	5 Barnard, Alicia Mildred (1825–1911)	1847, 1849–1850	16, 20, 27, 36
‡ *	2 Bentall, Thomas (c. 1820–1875)	1845, 1849	19
	1 Bidcock, R.	1842	40
‡ *	1 Biden, William Downing	1845	17
‡ *	2 Bigge, John Frederic (1814–1885)	1849	?
	1 Binks, W.	1844	66
‡ *	3 Bladon, James	1847–1848, 1850	35
‡ *	2 Bloxam, Andrew (1801–1878)	—	38, 55
‡ *	14 Borrer, William (1781–1862)	1809	6, 10, 13, 14, 15/16, 25/26, 27, 34
‡ *	1 Brand, William (1807–1869)	1833	—
‡ *	7 Brent, Francis (1816–1903)	1848–1850	15, 41, 49
‡ *	22 Brewer, James Alexander (1818–1903)	1843–1844, 1846–1850	13, 14, 17
	1 Brown (? Robert; 1773–1858)	1796	—
‡ *	5 Bruce, Arthur (c. 1725–1805)	1796–1797	83
‡ *	2 Bull, Henry	1846	17
	1 Burrel, Revd J.	1806	27
‡ *	2 Carroll, Isaac (1828–1880)	1849–1850	H4/5, H12
‡ *	1 Clark, Thomas (1793–1864)	1849	5
	3 Coates, F.	1821	28
	1 Coates, J. (? James: d. 1919)	1844	—
*	1 Cox, T.	1849	10
‡ *	8 Crotch, William Robert (1799–1877)	1847, 1849, 1850	5, 6, 13, 40, 80
	3 Damsell, G. Sidney (c. 1890–c. 1953)	1908	17, 34
‡ *	2 Dennes, George Edgar (1817–c. 1860)	1847, 1850	17, 21
	1 Dickie (? George 1812–1882)	—	92/93
‡ *	1 Don, Mr (i.e. Donn, James 1758–1813)	1795	[29]
	7 Done, Miss (? Alice B. Done fl. 1870)	1832	36
‡ *	8 Douglas, Robert Cooper (1823–1887)	1846, 1849–1850	29, 39
*	1 Dutton, Thomas (fl 1850)	1850	7
*	2 Fenton, J. A.	1849–1850	5/6, 69
‡ *	2 Fitt, George (c. 1809–1893)	1846–1847	25/27
‡ *	4 Fordham, Henry (1803–1894)	1846–1847	20, 29
‡ *	20 French, Joseph Barnabas (1825–1911)	1847–1849	5, 6, 7, 15, 16, 34
‡ *	6 Fryer, Alfred (1826–1912)	1877, 1879–1880, 1883, 1884	28, 29
‡ *	1 Gardiner, William (1808–1852)	1840	?
‡ *	1 Gibson, George Stacey (1818–1883)	1847	19
‡ *	3 Godley, William (c. 1805–1862)	—	22, 23
‡ *	2 Gourlie, William (1815–1856)	—	76, 86

no.	Names	Years of collection	Vice-counties
† *	1 Graham, Robert (1786–1845)	—	90
† *	2 Gray, Peter (1818–1899)	1849	72
	6 Greig, R.	1809	799
† *	1 Grindon, Leopold Hartley (1818–1904)	—	?
	2 Hayden, Mr (of King's Lynn)	—	28
† *	1 Hailstone, Samuel (1767–1851)	1845	29
† *	1 Harpur-Crewe, Henry (1828–1883)	1850	51
† *	6 Haworth, Adrian Hardy (1768–1833)	1800	—
† *	20 Hemsted, John (c. 1747–1824)	1795–1797	29
† *	3 Henfrey, Arthur (1819–1859)	—	15, 16 17
	2 Herford	—	? 64
† *	3 Hind, William Marsden (1815–1894)	1850	57, 69; H39
† *	4 Holland, Robert (1829–1893)	1849	34, 58
† *	2 Holman, Henry Martin (1821–1881)	1840, 1842	13
† *	43 Hooker, William Jackson (1785–1865)	1807	13/14, 15/16, 25, 27, 60, 61/65, 66, 70, 88, 797, 799
† *	3 Hort, Fenton John Anthony (1828–1892)	1848–1849	48, 66, 70
† *	1 Hudson, Robert (1802–1883)	1849	14
	1 Hull (? John 1761–1843)	1797	—
*	268 Kent, W. G. (c. 1890–1974)	1908–1909, 1912–1914	17, 26, 28, 29
	1 Kerr, A. (? Andrew; 1807–1881)	1840	—
† *	1 Kirk, Thomas (1828–1898)	1848	38
† *	1 Lees, Edwin (1800–1887)	1840	35
	1 Liddell, W.	—	—
	1 Maher, D.	—	19
† *	1 Mann, Robert James (1817–1886)	1847	27
† *	6 Marsham, Henry Philip (1817–1892)	1847, 1850	19, 27, 29
† *	7 Mateer, William (fl. 1830–1850)	1846–1847, 1849–1850	H38, H39
	18 Maughan (? Edward James 1790–1868)	1809	82, 83, 103, 104
† *	18 Maw, George (1832–1912)	1847, 1849–1850	1, 3, 4, 762
† *	2 Meehan, Thomas (1826–1901)	1846	17
*	5 Metcalfe, Elizabeth (Miss)	1819, 1822	28, 57
	1 Metcalfe (Mrs)	1809	62
† *	2 Mitchel[I], James (1822–1862)	1850	56
† *	9 Moore, Thomas (1821–1887)	1846–1850	13, 17, 21
† *	1 Murley, Charles Hemsted (1822–1873)	—	34
	1 Nainby, John (of King's Lynn)	1796	28
	1 Notcutt, L.	—	26/27
*	3 Notcutt, Revd William	1846, 1848	25
† *	4 Notcutt, William Lowndes (1819–1868)	1846–1848	25, 28
† *	1 Oliver, Daniel (1830–1916)	1850	H16
† *	1 Pascoe, Francis Polkinghorne (1813–1893)	1847	1
*	8 Peckover, Mrs Algernon (née Priscilla Alexander)	1829	4, 21, 23, 25
	105 PP [= Peckover, Priscilla (Mrs Algernon Peckover)]	1827, 1833–1835	10, 22, 25, 28, 29, 56, 57, 64
	55 Peckover, Priscilla Hannah	1851	1, 10, 25, 28, 46/47, 49, 57
	98 Peckover, Priscilla [Hannah]	1870–1875	28, 29
*	217 Peckover, Susannah (Miss)	1853, 1860–1861, 1869– 1876	28, 29, 53
	1 Perry, B. P. (c. 1890– c. 1964)	1909	17
	1 Phillips, Norman A. (c. 1890–1917)	1909	11
† *	44 Pitchford, John (c. 1737–1803)	1796–1800	27, 29
† *	8 Purchas, William Henry (1823–1903)	1845, 1849–1850	36
† *	6 Ray, John (1797–c. 1853)	1845	19
† *	28 Relhan, Richard (1754–1823)	1799, 1808, 1818	29
	3 Ridley, J.	1908	17, 26

COLLECTORS IN **WBCH** Cont.

no.	Names	Years of collection	Vice-counties
	1 Ritchie	—	—
	1 Robson, R.	1909	17
*	4 Roby, M.	1847, 1849	37, 70
‡ *	9 Russell, Mrs Anna (1807–1876)	1845, 1849	1, 3, 4, 6, 11, 48
*	5 Russell, Frederick	—	S, 4
‡ *	16 Salmon, John Drew (c. 1802–1859)	1846–1847, 1849–1850	17, 19
	1 Sandys, George L.	1846	16
‡ *	2 Sandys, George William (c. 1812–1848)	1847	16
	1 Sansom, J.	1850	58
‡ *	3 Sansom, Thomas (1818–1872)	1846, 1850	59
	1 Sewel, Elizabeth	—	25/27
	29 Skrimshire, Fenwick	1796–1797, 1808	83, 88, 90, ?98
	6 Skrimshire, George	1821	32
‡ *	174 Skrimshire, William (1766–1830)	1794–1797, 1800, 1813, 1818–1822, 1824, 1828	27, 28, 29, 31, 32, 53, 83, ?89
‡ *	1 Stables, William Alexander (1810–1890)	—	105/106
‡ *	7 Stephens, Henry Oxley (1816–1881)	1845, 1848	6, 66
	1 Stevens, G. A.	1840	15
‡ *	5 Stock, Daniel (c. 1797–1873)	1841–1843, 1850	25, 27
‡ *	2 Storey, John (1801–1859)	1849–1850	57
‡ *	25 Syme, John Thomas Irvine (1822–1888) [olim Boswell-Syme]	1847–1850	82, 83, 85, 91, ?92/93, 111
‡ *	16 Tate, Ralph (1840–1901)	1870	28, 29
‡ *	11 Tatham, John (1793–1875)	1843–1844, 1848–1850	61/65, 90
*	4 Taylor, Henry	1846–1848	14, 17
	1 Thompson	1846	—
*	1 Thompson, John (c. 1778–1866)	1846	—
‡ *	1 Thwaites, George Henry Kendrick (1812– 1882)	—	6
	317 Townley, Mrs W. G.	1824, 1831–1837	8, 10, 11, 12, 13, 14, 17, 22, 25, 26, 27, 28, 29, 36, 49, 57, 62, 70, 90, 92; H21
	1 vol. Townshend, Mrs C. H.	1831/1832	69/70
‡ *	1 Turner, Dawson (1775–1858)	—	30
‡ *	4 Unwin, William Charles (1811–1887)	1850	14
‡ *	6 Varenne, Ezekiel George (1811–1887)	1848–1850	18, 26
‡ *	3 Ward, James (1802–1883)	1848, 1850	?62
‡ *	1 Ward, Nathaniel Bagshaw (1791–1868)	1846	H16
‡ *	8 Wardale, Benjamin Dornale (c. 1770–1854)	1841, 1844, 1847, 1849– 1850	15, 26, 28, 57
‡ *	2 Waring, M. (Miss) (<i>fl.</i> 1810–1840)	—	34
‡ *	1 Watkins, Burton Mounsher (1816–1892)	1850	36
‡ *	14 Watson, Hewett Cottrell (1804–1881)	1843–1845, 1848–1850	12, 16, 17, 21
*	423 Weatherhead, John Rose	1807–1813, 1816–1818, 1829	11, 27, 28, 29, 32, 53, 75, 83/84
‡ *	7 Whittaker, Joseph (1813–1894)	1846–1847, 1849–1850	27, 29, 57
‡ *	2 Wigg, Lilly (1749–1829)	1795–1796	25/27
‡ *	1 Wing, William Edward (1827–1855)	1849–1850	17
‡ *	16 Withers, Robert (c. 1814–1855)	—	4, 7, 8, 41
	1 Wright, Thomas junior	1848	H4
‡	1 Wynne, John Arthur (1801–1865)	—	H29
Initials only			
	9 CM [? Metcalfe, Charles]	—	—
	1 JB [? Balding, James]	1870	28/29
	36 MA [i.e. Alexander, Martha (1799–1871)]	—	25, 26
	1 SP [? Peckover, Susannah]	—	—

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

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ABSTRACT

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

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

INTRODUCTION

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

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

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

METHODS

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

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

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

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

RESULTS

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

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

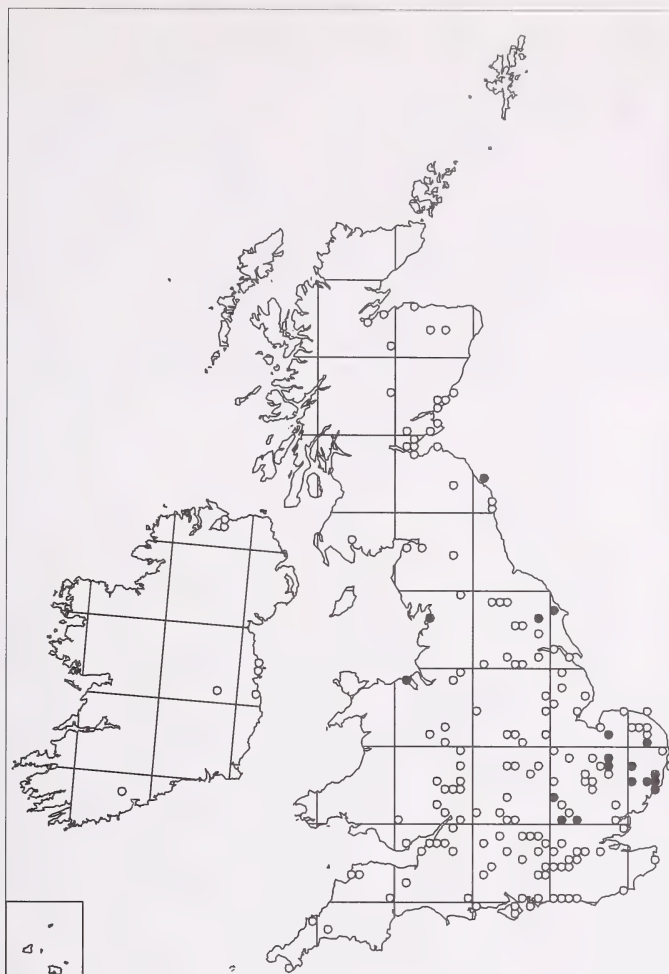


FIGURE 1. Distribution map of *Alyssum alyssoides*. ○, pre-1950. ●, 1950 onwards. Undated records are not included.

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

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

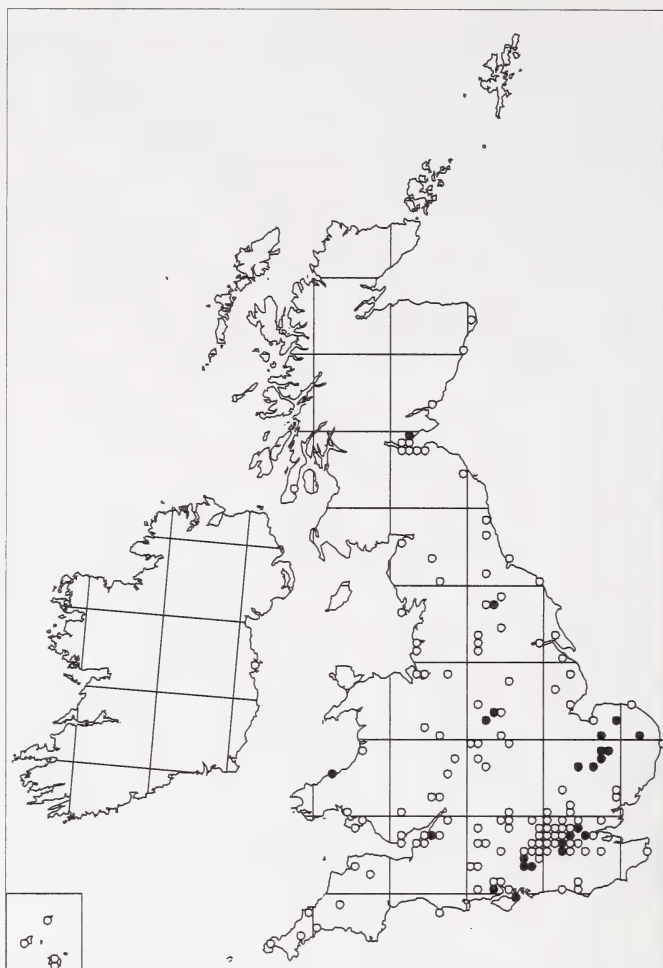


FIGURE 2. Distribution map of *Berteroa incana*. ○, pre-1950. ●, 1950 onwards. Undated records are not included.

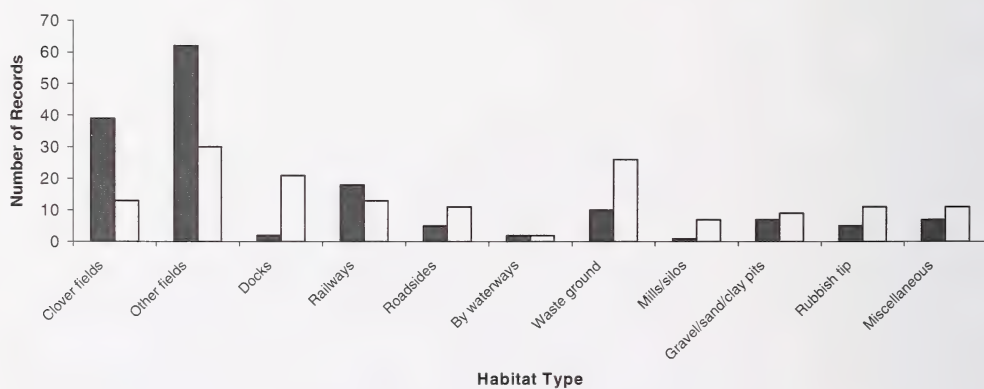


FIGURE 3. Number of records for each habitat for *Alyssum alyssoides* (■; n=158) and *Berteroa incana* (□; n=154). Repeat records for the same sites are not included.

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

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

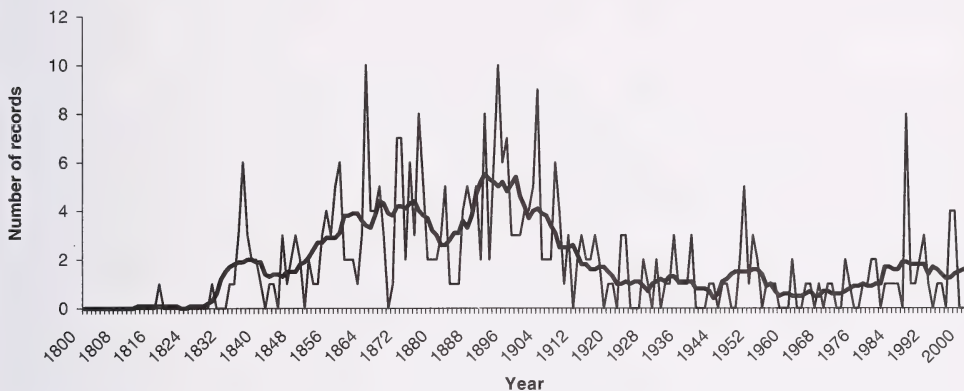


FIGURE 4. The number of records/year of *Alyssum alyssoides* 1800–2000 showing both the actual number of records (thin line) and the 10 year running average (thick line).

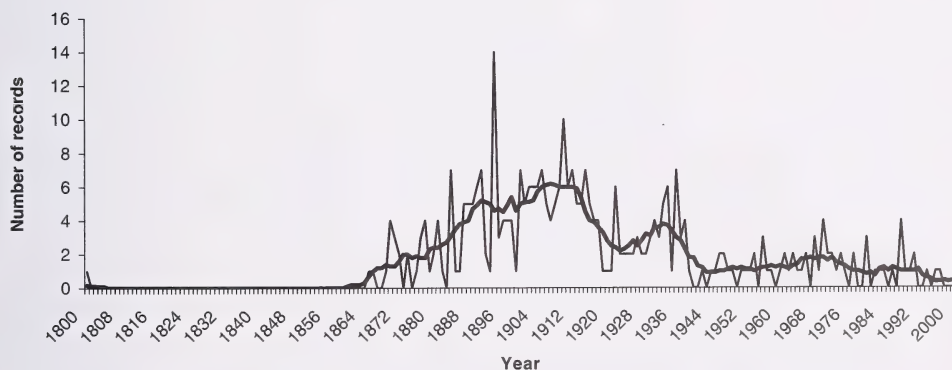


FIGURE 5. The number of records/year of *Berteroa incana* 1800–2000, showing both the actual number of records (thin line) and the 10 year running average (thick line).

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

DISCUSSION

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

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

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

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

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

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

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

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

ACKNOWLEDGMENTS

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A preliminary investigation of genetic variation in Western European *Carex depauperata* Curtis ex With. (Cyperaceae), Starved Wood-sedge

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ABSTRACT

AFLP genetic fingerprinting studies of seven samples of *Carex depauperata* from England, Ireland, France and Spain were undertaken to investigate the level of genetic variation. There was a high degree of similarity between five of the samples (two English, two French and one Spanish). The other two samples (from Chateau Bellefontaine, France and Cork, Ireland) were relative outliers, and the Irish sample was the most distinct. Numbers of bands scored per individual were more or less uniform, and these differences thus appear to reflect real genetic differences rather than artifacts due to DNA quality.

KEYWORDS: AFLP, Conservation.

INTRODUCTION

Carex depauperata Curtis ex With. is a very rare plant in Britain. It is listed as Critically Endangered in Britain and is on Schedule 8 of the Wildlife and Countryside Act 1981. It is also regarded as endangered in north-western Europe. It has been the subject of conservation work at Cambridge Botanic Garden, in Plantlife's 'Back from the brink' project, and in English Nature's Species Recovery programme. Rich & Birkinshaw (2001) have summarised its current status and conservation in Britain.

In Britain there are two extant populations, each of which are likely to have been derived from a single genotype. In the 1960s the site near Cheddar consisted of a single plant, but through transplants and habitat management the population has now increased to more than 50 plants. The last of the three Godalming sites became 'extinct' in c. 1972 due to a landslide, but one plant was rediscovered in 1992 after increased light levels resulting from the Great Storm of 1987 stimulated buried seed to germinate. This population has now increased to four plants, again following conservation work. It was discovered in its sole site in County Cork, Ireland by T. O'Mahony in 1973; only two tussocks were present in 2000 (O'Mahony 2001).

Rich & Birkinshaw (2001) noted that, despite being widespread in Europe and Asia with many scattered, disjunct localities, it showed little morphological variation. In cultivation four different genotypes (two from England, one from France and one from Ireland) showed no significant morphological differences (Rich & Birkinshaw 2001). However, subsequently there has been some indication that the Irish plants have a significantly shorter life-span in cultivation and in the wild, indicating that there may be some genetic variation (T. O'Mahony, pers. comm. 2001). As four collections were available in cultivation (which were supplemented with three additional wild-collected samples), the opportunity was taken to undertake a preliminary investigation into the genetic variation between sites in western Europe.

The studies were carried out using amplified fragment length polymorphism (AFLP™) fingerprinting, a highly reproducible method of obtaining genetic fingerprints from small amounts of DNA consisting of fragments of different sizes (numbers of base pairs) which are then visualised as bands on a gel (Vos *et al.* 1995). This technique has proved effective with other *Carex* species (*C. muricata* L.: Fay *et al.* 2001; *C. otrubae* Podp. and *C. vulpina* L.: Cowan *et al.* 2002) and with other members of Cyperaceae (*Schoenoplectus* spp.: Fay *et al.* 2003; Fay & Cowan 2001).

MATERIALS AND METHODS

Shoots from one individual from each of seven separate localities (Table 1) were collected directly into desiccant silica gel in 2001, using the method of Chase & Hills (1991). The exact locality of the plant from southern central France (Cdep 3) was not recollected (P. Harmes, pers. comm. 2001). Vouchers are held in the National Museums and Galleries of Wales (NMW).

DNA was extracted from approximately 0.2 g of dried material using a modified 2×CTAB (cetyltrimethyl-ammonium bromide) procedure (Doyle & Doyle 1987), purified and quantified using a spectrophotometer.

AFLP fingerprints were performed according to the AFLP Plant Mapping Protocol of Applied Biosystems Inc. For each specimen, 0.5 µg of DNA was digested using the restriction enzymes *MseI* and *EcoRI*. The primer combinations selected for use with *C. muricata* (Fay *et al.* 2001) were used for this study. Amplification reactions were separated on a 5.0% polyacrylamide gel using an ABI 377 automated sequencer. Genescan 2.1 and Genotyper 2.0 were used to analyse bands. Data presented here are for the primer combination *EcoRI*-AC and *MseI*-CAC.

Bands were scored as either present (1) or absent (0) for all individuals and exported from Genotyper as a binary matrix which was analyzed using the UPGMA (Unweighted Pair-Group Method using Arithmetic Averages) algorithm in the software package PAUP version 4.0 for Macintosh (Swofford 1998) and by principle coordinates analysis (PCOA) in the R Package for Multivariate Analysis version 4.0 (Casgrain & Legendre 2001) using Jaccard's coefficient (Jaccard 1908).

TABLE 1. DETAILS OF *CAREX DEPAUPERATA* MATERIAL

Accession	Locality	NMW voucher.	No. of DNA bands on gel
Cdep 1	Chantilly, Oise, France	V.2001.025.1203	92
Cdep 2	Cheddar, U.K.	V.1999.045.33	93
Cdep 3	S. C. France	—	92
Cdep 4	La Hermida, Spain	V.2001.033.006	93
Cdep 5	Godalming, U.K.	V.1999.045.29	91
Cdep 6	Cork, Ireland	V.1999.045.30	90
Cdep 7	Chateau Bellefontaine, France	V.2001.033.1202	87

RESULTS

In total, 102 bands were scored, of which 24 (23.5%) were variable. Band number was more or less uniform, ranging from 87 in sample 7 to 93 in samples 2 and 4 (Table 1).

The UPGMA dendrogram is shown in Figure 1, in which the plants tested fell into one relatively tight cluster of five closely related individuals (two from England, two from France and one from Spain). The sample from Chateau Bellefontaine (Cdep 7) fell outside this cluster, and the sample from Cork (Cdep 6) was the most distinct.

In the PCOA, the first two coordinates accounted for 79.8% and 15.4% respectively of the variation. The plot of the first two coordinates against each other is shown in Figure 2. In this analysis, the same groupings were identified, i.e. a cluster of five individuals and two outliers.

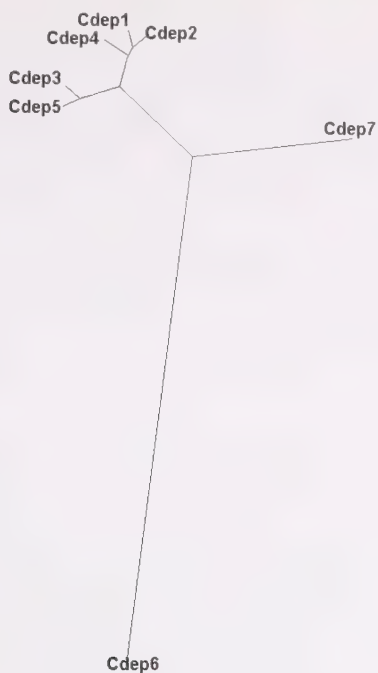


FIGURE 1. UPGMA dendrogram showing relationships of *Carex depauperata* samples (see Table 1 for sources).

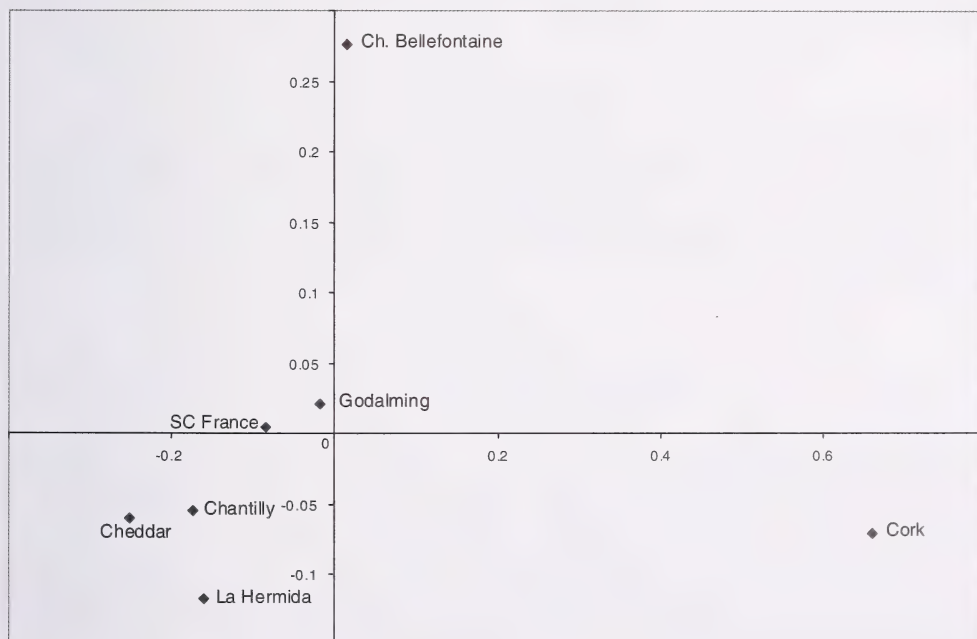


FIGURE 2. Plot of the first and second axes from the principle coordinates analysis of *Carex depauperata* samples.

DISCUSSION

The level of variation reported here appears to be relatively low, compared to other *Carex* species. For example, in a study of British populations of *C. muricata* L. subsp. *muricata* (Fay *et al.* 2001), 84 bands were scored, of which 55 (65%) were variable, although this may be partly a reflection of the larger number of plants included in that study. At this level of sampling there does not appear to be a clear geographical pattern in *C. depauperata*, and larger numbers of continental samples would be necessary to clarify the geographical origin and relationships of the English and Irish plants.

The distinctness of the Irish sample (and to a lesser extent, the Chateau Bellefontaine sample) is unexpected, given the genetic homogeneity shown by the cluster of five samples. This is in sharp contrast to *Schoenoplectus triqueter* (L.) Palla, where Irish material was genetically closely related to English material (Fay *et al.* 2003; Fay & Cowan 2001). When one sample falls in an isolated position, this can be for various reasons, including:

1. Degraded DNA (recognisable by a lower number of bands and by examination of the DNA on an agarose gel),
2. Hybridization (recognisable by a higher number of bands than expected), and
3. Misidentification of material (related species often share some bands).

Degraded DNA and hybridization can be discounted on the basis of the number of bands, which for the two outlying samples is close to that seen in the other five samples. The high level of overall genetic similarity also indicates that misidentifications are unlikely.

These results thus appear to reflect real genetic differences and indicate that the plants sampled are genetically distinct. Five of the samples are closely related, but the samples from Chateau Bellefontaine, France and Cork, Ireland were relative outliers. The Irish plants have a shorter lifespan, also indicating a genetic basis for the differences; the Chateau Bellefontaine material has not been cultivated.

We would welcome further live samples of *Carex depauperata* from different parts of its range to extend the studies.

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Conservation of Britain's biodiversity: *Hieracium snowdoniense* (Asteraceae), Snowdonia Hawkweed

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ABSTRACT

Hieracium snowdoniense. P. D. Sell & C. West (Asteraceae), Snowdonia Hawkweed, is a rare endemic plant only known in Snowdonia, Wales. It has been recorded from about seven sites historically. Only one plant was found during field surveys in 2000 and 2002. It may have declined due to over-grazing and acid rain deposition affecting soils. It is 'Critically Endangered' under the I.U.C.N. threat criteria. Seed has been collected and it is being cultivated at the National Botanic Garden of Wales.

KEYWORDS: Compositae, Endemic, rare species, Snowdonia, Wales.

INTRODUCTION

Hieracium snowdoniense P. D. Sell & C. West (Asteraceae), Snowdonia Hawkweed, or Heboglys Yryri in Welsh, is a rare, endemic plant only known from the mountains of Snowdonia, Wales. It is a Red Data Book species recorded from rocky faces of mountains in two 10-km squares (Wigginton 1999; Sell & West 1968). As part of a joint project between the National Museum & Gallery, Cardiff and the Countryside Council for Wales into the ecology and distribution of critical taxa, the information available about *H. snowdoniense* was drawn together and combined with field surveys in 2000 and 2002 to assess its current status. In this paper the information about this rare species is summarised; full details are given in Hand & Rich (2000) and Rich & Hand (2002).

H. snowdoniense belongs to *Hieracium* Section *Vulgata* (Griseb.) Willk. & Lange. It was first named as *H. murorum* L. var. *pulcherrimum* F. J. Hanb. by Hanbury (1892), who included it with a plant from Catterick Force near Settle, Yorkshire. However, Hanbury's herbarium was subsequently found to contain two different plants; the Settle plant which was used as the basis of the description was subsequently found to be *H. killinense* (Zahn) Roffey, which left the Welsh plant without a name, so Linton (1905) provided a new one, and description, under *H. pellucidum* L. var. *pulcherrimum*, which was, excluding the pilose-tipped ligules (a character of the Settle plant), restricted to the Welsh plant. Zahn (1921) then raised it to a subspecies of *H. murorum*, partly confusing it with *H. cuneifrons* Ley from Brecon in the process, and cited Hanbury's varietal name as the basionym. Unfortunately this meant that his combination and the subsequent combination of *H. pulcherrimum* at species rank by Roffey in the *London Catalogue* were illegitimate. Pugsley (1948) used Roffey's name, and gave a good description and notes. Finally, Sell & West (1955) made the new combination *H. snowdoniense* by which it is now properly called.

H. snowdoniense is a distinctive species, distinguished by its beautiful, close panicle of deep, golden-yellow flowers, livid styles, very black, velvety, glandular involucre, slender almost straight peduncles and glabrous-tipped ligules. The leaves are lanceolate to ovate, weakly toothed and narrowed at the base into a shaggy petiole (Fig. 1).

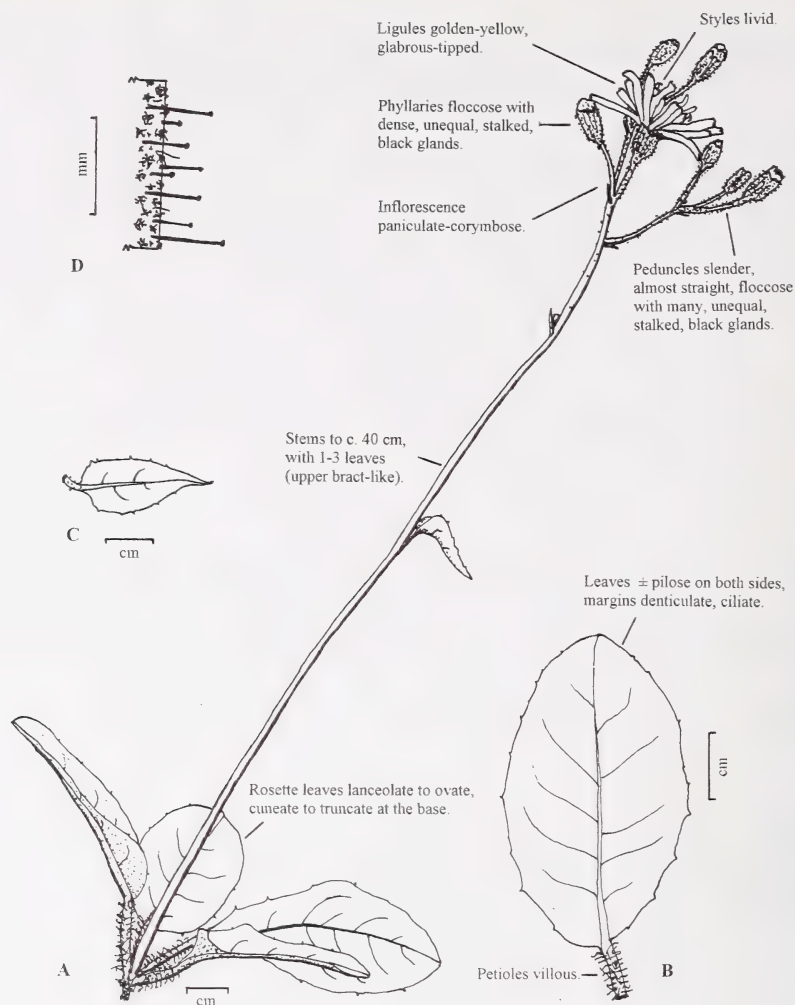


FIGURE 1. *Hieracium snowdoniense* with some distinguishing features (del. TCGR). A. Whole plant. B. Rosette leaf. C. Stem leaf. D. Detail of hairs on peduncles and phyllaries.

DISTRIBUTION AND POPULATION SIZE

Historical information was abstracted from the literature and from herbarium sheets at **BM**, **CGE**, **LIV** (Corrie 2000), **MANCH** and **NMW**. Information from the *Hieracium* database was provided by D. McCosh. The records traced are listed in Table 1, which suggest the plant has been found in about seven different sites (records cited as Ysgolion Duon and Carnedd Daffydd may refer to one or two parts of the same mountain). These records were used to direct the field surveys.

Field surveys were carried out between 25 July and 2 August 2000, and 8–10 August 2002. Sites were surveyed from the bottoms and tops of crags, and using binoculars. No rock climbing or rope access work was undertaken, though rough scrambling was often necessary to gain access to some rocks. No plants were found at Carnedd Daffydd (3 visits), Cwm Glas (1 visit), Cwm Perfedd (1 visit), Glyder Fach (1 visit), Nant Ffrancon (2 visits), Pen-y-Gwryd (1 visit) or Ysgolion Duon (3 visits). After an unsuccessful search in 2000, one plant was finally located in Devil's Kitchen, Cwm Idwal in July 2002, close to where it had last been seen in 1953. The rediscovery attracted significant media coverage (e.g. Kennedy 2002). An updated distribution map is given in Figure 2.

TABLE 1. HERBARIUM AND LITERATURE RECORDS OF *HIERACIUM SNOWDONIENSE*.
THE GRID REFERENCES INDICATE THE APPROXIMATE LOCATION OF THE SITES

CWM GLAS (SH6155)

Cwm Glas Fach, Snowdon, 13 July 1904, A. Ley (**CGE**).

Cwm Glas, undated, J. E. Griffith (**BM**).

NANT FFRANCON (SH6365–SH6461)

Nant Ffrancon, Aug 1894, J. E. Griffith (**CGE, MANCH**).

DEVIL'S KITCHEN, CWM IDWAL (SH6358)

Twll Du, June 1887, J. E. Griffith (**LIV**).

Devil's Kitchen, on rocks on cliffs, seen from the end of a rope (SH6359), 26 June 1953, P. D. Sell (**CGE**; pers. comm. 2002).

Rock ledges and cliffs near top, Twll Du, 24 June 1961, J. N. Mills (**MANCH**)

Rock ledges and cliffs near top, Twll Du, 1 July 1967, J. N. Mills (**MANCH**)

YSGOLION DUON (SH6663–SH6763)

Ysgolion Duon, July 1892, J. E. Griffith (**BM, NMW**; Griffith 1895).

Ysgolion Duon, July 1893, J. E. Griffith (**BM, CGE, LIV**; type specimen in **BIRM**, cf. Sell & West 1955).

Ysgolion Duon, Carnedd Daffydd, 14 July 1904, A. Ley (**CGE, NMW**).

CARNEDD DAFFYDD (SH6563–SH6663)

Carnedd Daffydd, root from cliff cultivated at Clapton 1894, F. J. Hanbury (**BM**).

Carnedd Daffydd, cliff, 'though the specimens were fine, they were by no means abundant' 28 July 1891, F. J. Hanbury & A. Ley (**CGE**; Hanbury 1892).

Carnedd Daffydd, 28 July 1892, Linton (**LIV**; Linton 1905).

GLYDER FACH (SH6558)

Glyder Fach (Linton 1905; no specimen traced).

CWM PERFEDD (SH6262)

Cwm Perfedd, July 1892, J. E. Griffith (**BM, NMW**; Griffith 1895).

PEN-Y-GWRYD (SH6555)

Pen-y-Gwryd (Pugsley 1948; no specimen traced).

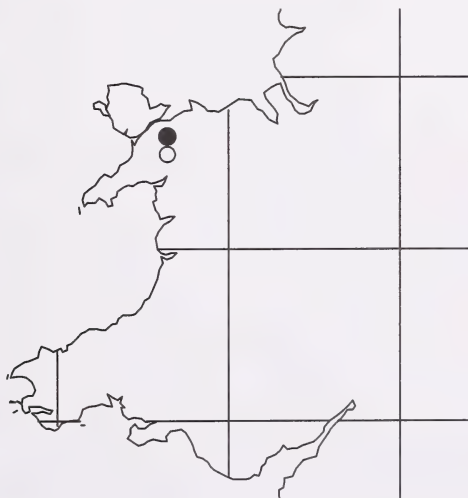


FIGURE 2. Distribution of *Hieracium snowdoniense*. ●, 2002. ○, Pre-1950. Plotted using DMAPW by Alan Morton.

We are aware of at least four other searches for this species since the 1950s, all of which have failed to find the plant, and thus have some confidence that the negative results for six sites may be real, though clearly it may survive on the unsurveyed parts of cliffs. It is difficult to search such large complex mountains thoroughly, especially where the historical records are unspecific (e.g. Nant Ffrancon, an area of approximately 8 km²), and vegetative rosettes, which cannot be reliably identified, are easily overlooked.

The current known population is thus one plant, and it must rank as one of the rarest plants in the world. Indeed, it may always have been a rare plant. Hanbury (1892) noted of *H. snowdoniense* 'with the Rev. Augustin Ley, found it in Carnedd Dafydd cliffs near Bethesda. Though the specimens were fine, they were by no means abundant, and in all probabilities we failed in finding its headquarters in the district'.

TABLE 2. SPECIES ASSOCIATED WITH *HIERACIUM SNOWDONIENSE* IN AN APPROXIMATE 2 × 2 M QUADRAT IN CWM IDWAL, 2002

Species	Domin	Species	Domin
<i>Hieracium snowdoniense</i>	1	<i>Leucanthemum vulgare</i>	3
<i>Agrostis capillaris</i>	3	<i>Luzula sylvatica</i>	4
<i>Alchemilla glabra</i>	1	<i>Mnium hornum</i>	2
<i>Anthoxanthum odoratum</i>	2	<i>Oxyria digyna</i>	1
<i>Calliargon cuspidatum</i>	3	<i>Peltigera membranacea</i>	3
<i>Calluna vulgaris</i>	4	<i>Plagiochila spinulosa</i>	1
<i>Cirsium palustre</i>	1	<i>Pleurozium schreberi</i>	1
<i>Cladonia pyxidata</i>	3	<i>Pseudotaxiphyllum elegans</i>	1
<i>Deschampsia flexuosa</i>	4	<i>Rhytidiadelphus loreus</i>	3
<i>Dicranum scoparium</i>	3	<i>Saxifraga hypnoides</i>	2
<i>Diplophyllum albicans</i>	1	<i>Scleropodium purum</i>	2
<i>Festuca rubra</i>	3	<i>Sedum rosea</i>	1
<i>Filipendula ulmaria</i>	2	<i>Solidago virgaurea</i>	2
<i>Geum rivale</i>	2	<i>Succisa pratensis</i>	3
<i>Hymenophyllum wilsonii</i>	3	<i>Thuidium tamariscinum</i>	4
<i>Hypericum pulchrum</i>	3	<i>Tritomaria quinquedentata</i>	1
<i>Hypnum jutlandicum</i>	3	<i>Veronica officinalis</i>	2

Vegetation cover 95%. Vegetation height 10 cm. Slope c. 85°.

BIOLOGY AND ECOLOGY

Like all hawkweeds, *H. snowdoniense* is probably a polycarpic perennial which is an obligate apomict which reproduces by seed. According to the specimens seen, the main flowering period is July, but like many other mountain hawkweeds it may flower irregularly rather than annually (D. McCosh, pers. comm.). Seeds were ripe about one month after flowering. The seeds have a small pappus and are wind-dispersed.

There is very little information available on its ecology. The plant seen grew on a steep, more or less north-facing, rocky cliff of acid ash-flow tuff/pyroclastic breccia which, like the basalt of the Cwm Idwal massif, clearly had some base-enrichment though the soil was still quite acidic (pH 4.8, measured with a pHep2 Hanna pocket-sized pH meter in a 50:50 mixture with distilled water). It occurred in damp, flushed U17a *Luzula sylvatica* – *Geum rivale* tall-herb community *Alchemilla glabra* – *Bryum pseudotriquetrum* sub-community of the national vegetation classification (Rodwell 1992) (Table 2). This vegetation type is typical of base-enriched, mesotrophic, damp soils on inaccessible ledges and cliffs in the mountains of northern Britain, but is restricted in distribution in Snowdonia, and is a typical vegetation type of many other upland hawkweeds. It has been recorded from altitudes ranging from about 300–900 m, possibly descending lower in the Nant Ffrancon valley.

CONSERVATION

With a total known world population of one plant, *H. snowdoniense* really must be regarded as IUCN category 'Critically Endangered' (IUCN 2001). It is not protected under Schedule 8 of the Wildlife and Countryside Act 1981, but it is also not likely that such protection would contribute to its survival in upland Snowdonia. All current and historic sites lie within Sites of Special Scientific Interest, the Snowdonia National Park and the Yryri Candidate Special Area of Conservation, which give significant degrees of protection to the sites.

The most likely cause of the decline is a long and sustained period of over-grazing, and especially the huge increase in sheep grazing at high altitudes in the mountains over the last 50 years (A. Turner, pers. comm. 2002). Most hawkweeds are highly palatable to sheep, and it may simply have been eaten to extinction in the more accessible sites. Over-grazing is a serious problem throughout Snowdonia, where most *Hieracium* species are now largely restricted to rocks and ledges out of reach of the sheep and goats. An exceptional recent management development at Cwm Idwal National Nature Reserve, funded by the Countryside Council for Wales, the National Trust and the European Union has been the removal of sheep grazing to benefit the wildlife. Already since 2000 the grasslands have become more flowery and colourful, and it is hoped that this removal of grazing will also allow *H. snowdoniense* to spread into other areas.

Another possible explanation is the change in soils following acidification by acid rain which is widely affecting Snowdonia (Gritten 1992). Snowdonia receives one of the highest recorded wet-deposited sulphate and nitrate rates in Britain (Williams *et al.* 1989). Studies by Kuylenstierna & Chadwick (1991) found average soil pH reductions of c. 0.8–0.9 pH units (range 0.1 and 1.7) on weakly-buffered soils in 12 sites in Snowdonia between 1957 and 1990, and also found that the higher the original pH, the greater the decrease. As many of the relatives of *H. snowdoniense* (i.e. Series *Pellucida*) are calcicoles, it is also likely that it prefers more basic soils, and the severe increase in soil acidity in Snowdonia may have significantly affected the habitats of some populations.

There is no evidence for decline due to collecting by botanists, but with only one plant remaining this is now a significant threat. Some losses might have occurred due to natural events such as rock falls.

Two ripe seed heads were collected on 8 August 2002 and seedlings are being cultivated at the National Botanic Garden of Wales. Further surveys should be carried out, especially in Cwm Idwal, to see if more plants can be found, and consideration should be given to a restocking programme at Cwm Idwal and other sites where the grazing is controlled.

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A new *Epilobium* (Onagraceae) hybrid: *Epilobium brunnescens* (Cockayne) Raven & Engelhorn $\times$ *Epilobium parviflorum* Schreber (*E.* $\times$ *argillaceum*)

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ABSTRACT

Epilobium $\times$ *argillaceum* Kitchener **hybr. nov.** is described and illustrated. This is a hybrid between a naturalised New Zealand species, *Epilobium brunnescens* (Cockayne) Raven & Engelhorn, and a Eurasian species native to Britain, *Epilobium parviflorum* Schreber. The description is taken from a single plant found in a china clay quarry in East Cornwall, v.c. 2, in 2002.

KEYWORDS: china clay, New Zealand, willowherb.

INTRODUCTION

Epilobium brunnescens (Cockayne) Raven & Engelhorn (New Zealand Willowherb) is well naturalised in the wetter parts of the British Isles, especially in the west and north. Five hybrids with native or other introduced taxa have been recognised (Kitchener & McKean 1998). These are the crosses with *Epilobium ciliatum* Raf., *Epilobium lanceolatum* Sebast. & Mauri, *Epilobium montanum* L., *Epilobium obscurum* Schreber and *Epilobium palustre* L. New Zealand Willowherb hybrids have been found in Northern Ireland and Wales, but there appears to be a particular affinity for mining waste in Cornwall. From this habitat, all these hybrids, except for the cross with *E. palustre*, have been recorded. *Epilobium parviflorum* Schreber (Hoary Willowherb) is also to be found on Cornish mining waste, and so the discovery of a hybrid between this species and *E. brunnescens* was not unexpected.

This is not a hybrid that is likely to occur outside the British Isles, due to the limited distribution of *E. brunnescens* outside New Zealand, and the limited distribution of *E. parviflorum* within New Zealand. While *E. parviflorum* primarily has a Eurasian distribution and is native to Britain, it has been found in New Zealand as an adventive on the North Island, and may be widespread in the eastern parts through the fertile farming country there (Raven & Raven 1976, repeated by Webb *et al.* 1988). Only four records for New Zealand, however, are cited by Raven & Raven, who suppose it to have been introduced not long before the first record, in 1967. *E. brunnescens* in this part of the North Island exhibits a preference for higher ground, at middle elevations, so the New Zealand distribution of the two species is unlikely to coincide to a material degree.

Within the British Isles, the New Atlas of the British and Irish Flora (Preston *et al.* 2002) shows coincidence of distribution of the two species (all records) in 1109 10-km recording squares, primarily in Wales, the Lake District, Northern Ireland and Cornwall.

DISCOVERY

A single hybrid plant was found by the author on 17 July 2002, in the upper parts of Wheal Remfrey china clay works, towards Fraddon Down, and south east of Indian Queens. It was located in a hollow on top of a ridged bank of china clay waste and granite chippings, 5 m high on one side and 10 m on the other. The hollow had apparently remained undisturbed for some time, and vegetation was beginning to establish. In the immediate vicinity of the plant were *E. brunnescens* (5 cm distant), *E. parviflorum* (15 cm), *E. ciliatum* (10 cm) and *E. obscurum* (15 cm). *E. montanum* was in the general vicinity, but not nearby. A colony of 20 plants of *Epilobium* $\times$ *brunnatum* Kitchener & McKean and *Epilobium* $\times$ *confusilobum* Kitchener & McKean was within 30 m. *E. lanceolatum* was not present, although seen in other china clay quarries.

The china clay area north and north west of St Austell has characteristics that are favourable to *Epilobium* spp., as colonizers of open and disturbed habitats. That includes in particular *E. brunnescens*, which has been noted as typically present there by Margetts & David, 1981, and French *et al.*, 1999. Its establishment on the china clay waste seems to have taken place in the 1940s (Davey 1961).

The area as a whole is dominated by the production, movement and tipping of large quantities of waste sand and gravels deriving from the mining of kaolin, the Hensbarrow deposit at St Austell being the largest in Europe. This is the most intensively tipped location in the UK (Cornwall County Council 1998). Colonization by a permanent flora is slow (Roberts *et al.* 1981), and is inhibited by several factors.

Bradshaw *et al.* (1975) remark that "the sand is almost pure silica: its mineral content is therefore very low indeed", and that "the rainfall of the area is high and evapotranspiration low. This leads to considerable excess rainfall and leaching even during summer months". Storm water run-off carries away the granular sand particles, and "erosion remains active on many of the higher or disturbed tips, with the result that natural colonisation cannot proceed" (Wardell Armstrong 1993). Because the china clay waste retains its open status for so long, pioneer *Epilobium* species have commensurately long opportunities for hybridization. This is in contrast to many disturbed habitats elsewhere, such as felled woodland, which are quickly colonized by *Epilobium* spp. and only remain open for two or three years, with a hybridization window limited to that period.

The plant was distinctive, first as an *E. brunnescens* hybrid, reddish with an upwards curving habit, and secondly because of the hoariness of the stem indumentum. It consisted of four shoots, each curving up to semi-erect position. The tallest was 15 cm high (16 cm long) with damaged tip, the leader and an axillary shoot having apparently been bitten off. The three other shoots were 9 cm high (9.5 cm long), 5.5 cm (8 cm) and 3.5 cm (5 cm). The specimen was taken and grown on until 7 September 2002, in order to provide more flowering and fruiting material, although seed could not be obtained due to sterility, the anthers being indehiscent. In cultivation, the habit became more straggling, and red coloration was limited to stems, but with light bronzing on the underside of the leaves. A cutting was taken which, when rooted, also sent up curving shoots from the lowest nodes. This was over-wintered indoors, when flowering ceased in mid-November, but revived from mid-January into February. The shoots, in lengthening, became prostrate and the reddening of the stems and leaf undersides intensified. Measurements given in the description below are taken from material in both the original and in cultivated state.

DESCRIPTION

Epilobium × *argillaceum* Kitchener, **hybr. nov.**

(*Epilobium brunnescens* (Cockayne) Raven & Engelhorn × *E. parviflorum* Schreber (Fig. 1)

Hybrida inter *Epilobium brunnescens* (Cockayne) Raven & Engelhorn et *Epilobium parviflorum* Schreber, caracteribus inter parentes variantibus; planta semi-prostrata, stigmata lobis confusis ferens, caulibus pilis abundis et patentibus.

Herb, conspicuously reddish in the wild, less so in cultivated conditions, main stem branched above and with secondary stems emerging at lowest nodes, and curving upwards to erect or semi-erect position, at least to 15 cm high (up to 30 cm high, exceeding 65 cm long in cultivation), flexuous to rigid and up to 1.5 mm diameter, with a dense covering of patent hairs, each generally curving towards the end, often glandular in upper parts, the indumentum being visible without lens and the longest hairs projecting 0.2–0.3(0.35) mm from the stem surface. Leaves opposite below, alternate on the inflorescence, young growth green, then turning reddish except under favourable growth conditions; lowest leaves nearly sessile, others with hairy petioles not exceeding 4.5 mm; cauline leaves 1.1–2.8 mm long, 0.7–1.7 mm wide, ratio of length to breadth ranging from 1:0.52 to 1:0.65, ovate to broadly elliptic with a few teeth; some short crisped hairs on underside, especially on midrib and veins; minutely pubescent on margins; upper leaf surface minutely pubescent, glabrescent with age, generally four lateral veins on either side of midrib. Sepals lanceolate, 3–4 mm long, 0.95–1.2 mm wide, with both short crisped and patent hairs, some

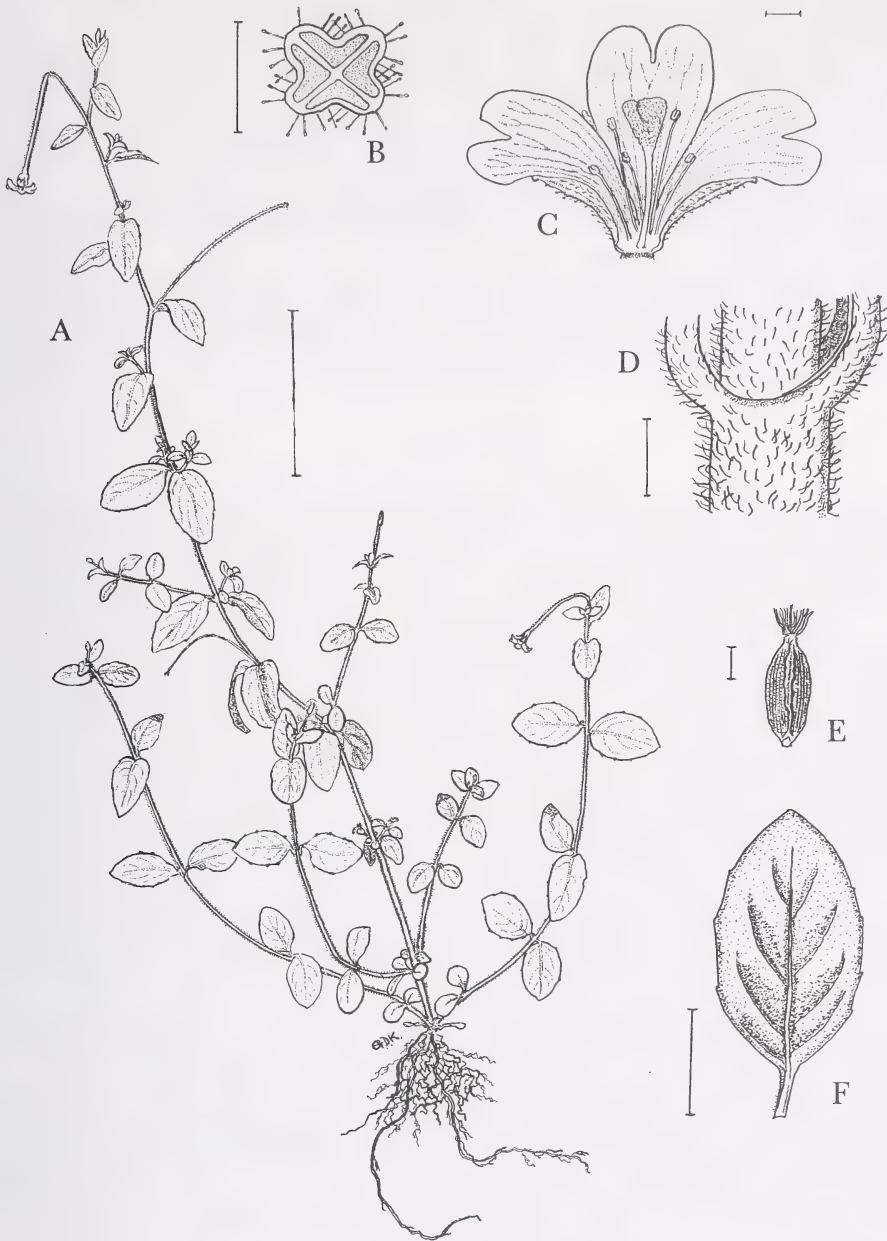


FIGURE 1. *Epilobium* $\times$ *argillaceum*.

Drawing based on material cultivated as a cutting from the original wild plant. A. habit (scale bar 5 cm); B. cross-section of capsule (scale bar 1 mm); C. flower (scale bar 1 mm); D. axil from mid-stem (scale bar 1 mm); E. sterile seed (scale bar 0.1 mm); F. mid-cauline leaf (scale bar 1 cm).

glandular; apical knob prominently red except under favourable growth conditions. Flowers opening to 9(10) mm diameter, with petals (5.5)6.0–7.0(8.0) mm, very pale pink with purple veins. Four long stamens projecting to the level of the stigma; four short stamens below; anthers 0.4–0.6 mm long, 0.25–0.35 mm wide, yellow, indehiscent. Ovary (1.4)1.7–2.1(2.8) cm long, with fairly dense patent glandular hairs, becoming more scattered down the pedicel. Stigma with confused partial lobing; style longer than the stigma. Capsule 1.9–3.1(3.8) cm, generally shriveling up rather than ripening, and containing shrunken abortive seeds 0.30–0.45 mm long.

HOLOTYPE: East Cornwall, v.c. 2, upper part of Wheal Remfrey china clay works, south east of Indian Queens, grid reference SW/925581, on china clay gravels, alt. 160–180 m, 17 July 2002, G. D. Kitchener, s.n. (**E**).

The epithet adopted in naming this hybrid reflects the plant's discovery on the white waste residues of the china clay deposits that dominate the landscape of the St Austell area. The term *argillaceum* – used by Pliny the elder in his *Naturalis Historia* (Mayhoff 1967–70) – is an adjective deriving from *argilla*, meaning white or potter's clay.

DISCUSSION

The hybrid plant shows the influence of New Zealand Willowherb as a parent in its general habit – the prostrate growth of *E. brunnescens*, combined with the erect growth of the second parent, producing a plant whose stems curve upward from an initially semi-prostrate base. The hybrid plant's stigma, with its confused lobing, points to the second parent having a four-lobed stigma (that of *E. brunnescens* being clavate). The only *Epilobium* species in the vicinity possessing a four-lobed stigma were *E. montanum* and *E. parviflorum*.

E. montanum may be discounted as a potential parent on account of its stem hairs. These are generally short and crisped, sometimes with an admixture of glandular hairs in the upper parts. In the cross of this species with *E. brunnescens* (*E. × confusilobum*) the stem hairs are close-set, crisped and near appressed, so that they scarcely stand out from the stem – not more than 0.05 mm.

E. parviflorum bears patent stem hairs, which may be straight or bent in various directions in a tangled manner, and often in considerable quantity so as to give a soft hoary appearance to the stem, and these hairs may project from 0.8 mm to 1.25 mm from the stem surface. In the upper parts, there is an admixture of glandular hairs. One would accordingly expect a hybrid with *E. brunnescens* to reflect these characteristics, tempered by the influence of *E. brunnescens*, whose stems are glabrous, or with some minute pubescence. The Indian Queens plant does so by exhibiting numerous patent stem hairs, both straight and bent in various directions, the longest of which project from 0.2 mm to 0.3 mm (to 0.35 mm in cultivation) from the stem surface, and there are numerous glandular hairs in the upper parts.

While the absence of *E. lanceolatum* from the vicinity suggests that this species may be discounted as a parent, although it bears a four-lobed stigma, it is also possible to discount this on morphological grounds. The stem hairs of *E. lanceolatum* are fairly similar to those of *E. montanum*, short and crisped, occasionally longer and glandular. In the cross of this species with *E. brunnescens* (*E. × cornubiense* Kitchener & McKean), the stem hairs are similar to those of *E. × confusilobum*, close-set, crisped and near appressed, so as to stand out no more than 0.05 mm from the stem. Accordingly, *E. lanceolatum* may be discounted as a potential parent, in much the same way as *E. montanum*.

CONCLUSION

This find provides further evidence of the potential for hybridization between Australasian and European species of *Epilobium*, including between prostrate and erect taxa, demonstrated experimentally by Brockie (1970), and with natural occurrences in the British Isles described by Kitchener & McKean (1998), McKean (1999) and Holyoak & Kitchener (2001).

With the discovery of this hybrid, there have now been found crosses of *E. brunnescens* with all British *Epilobium* species with which it may commonly grow together, except for *E. hirsutum* L.

Other less frequently sympatric species include *E. tetragonum* L., although its distribution is related to the drier lowland parts of the British Isles, and bears limited coincidence with the distribution of *E. brunnescens*, which favours wetter and upland areas. The data in Preston *et al.* (2002) show both species (all records) as having been present in 284 10-km recording squares, although this requires the caveat that proximity within those 10-km squares is not necessarily implied. The potential overlap of distribution with *E. roseum* Schreber is also limited, with 342 recording squares, which probably overstates the position, because of the greater proportion of historic records. Attempts to synthesize the cross between *E. brunnescens* and *E. roseum* have failed due to slow pollen tube growth (Thakur 1965), but as the same sequence of experiments was unsuccessful with *E. brunnescens* × *montanum* which has occurred naturally, then it should not be assumed that an *E. roseum* hybrid is impossible.

Although the habitat preferences of the montane species *E. alsinifolium* Villars and *E. anagallidifolium* Lam. may apparently offer opportunity for co-location with *E. brunnescens*, and there is a high level of coincidence at 10-km recording square level, their relative scarcity limits the possibilities for further New Zealand Willowherb hybrid combinations in the wild in the British Isles.

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A new, purple-leaved form of *Poa annua* L. (Poaceae) is a cryptic weed

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ABSTRACT

A name, *Poa annua* f. *purpurea*, is provided for a purple-leaved form of *Poa annua*. So far it is only known from cultivated ground in gardens where it is a significant weed.

INTRODUCTION

In recent years a distinctive purple-leaved form of *Poa annua* L. (Annual Meadow-grass) has become widespread at The Royal Horticultural Society's (R.H.S.) Garden at Wisley, Surrey (v.c. 17) (Grant 2000). It is particularly common, and a significant problem weed, on the Portsmouth Field (trials area) and Rock Garden, both areas where annual weeds need constant elimination. The leaves of this form are a brownish-purple and serve to camouflage it well against bare soil – its favoured habitat. It only becomes obvious when it flowers because the spikelets, although purple-tinged, reveal green areas as they expand. *P. annua* flowers and sets seed so quickly that herbicides are relatively ineffective and this novel leaf camouflage provides further defence against hand-pulling and hoeing.

The appearance of this new weed is interesting because its evolution has been driven by physical selection pressures (the camouflage deters hand-pulling and hoeing) rather than chemical selection by herbicides.

P. annua is predominantly self-pollinating or inbreeding (Hutchinson & Seymour 1982) and our purple-leaved population remains true to type every year. Wherever it forms substantial colonies, and these can cover several square metres if a whole bed is fallow, only a few plants of the green-leaved form persist against the competition. However, it is also possible to find a few intermediate forms which have leaves of a purplish-green colour and are usually twice the size of either of the other two forms. It is tempting to speculate that these are hybrids that have arisen from occasional outcrossing as is reported in this species (Hutchinson & Seymour 1982).

I have not yet heard of this form occurring in the wild and its likely method of distribution is by seed in soil transferred with plants from nurseries or informal plant exchange. Despite an extensive search of the literature containing infraspecific epithets in this species (e.g. Chase & Niles 1962; Gibeault 1966; Gibeault & Goetze 1972; Naylor *et al.* 1982) I have not been able to find any that cover this variant. It is desirable to provide a name for this plant because of its present weed status and because it may need recording from the wild in the future. Distinguishing such variants is also in line with recent exhortations (Chater 2003) to characterise infraspecific variation in British taxa.

***Poa annua* L. f. *purpurea* M. L. Grant, f. nov.**

Differt a typo foliis purpureis bruneolis suffusis fortiter, glumae et lemmae margine purpurea suffusus.

Differs from the typical form in having the leaves heavily suffused with brownish-purple giving an overall colour approximating to N186A on the R.H.S. Colour Chart (R.H.S. 2001). The margins of both the glumes and lemmas are also flushed purple. It is annual and does not belong to any of the short-lived perennial infraspecific taxa such as var. *aquatica* Asch. or var. *reptans* Hausskn.

HOLOTYPE: R.H.S. Garden, Wisley, Surrey, v.c. 17, TQ066578, on bare cultivated soil, 28 August 2002, *M. L. Grant* s.n. (WSY).

HISTORY AND DISTRIBUTION

The origin of the present form is not known but reports of purple-leaved *P. annua* date back over 50 years. The late David McClintock (pers. comm. 2000) had it in his W. Kent garden (v.c. 16) since he moved there in 1945 and samples I collected there in 2002 (deposited at **WSY**) represent f. *purpurea*. The small, dark form from his garden (McClintock 1980) which he deposited at **BM** and **MNE**, and the similar form found by A. W. Stelfox in Co. Down (v.c. H38) in 1965 and deposited at **K**, which he also referred to, have very narrow leaves and small inflorescences and do not appear to represent typical f. *purpurea*. The latter was determined as “? var. *parviflora* Fiek” by C. E. Hubbard. A later 1993 sheet deposited by McClintock at **BM** consists of two robust plants with distinctly purple leaves which do represent f. *purpurea*.

T. G. Tutin made detailed observations (Tutin 1957) on a number of inbreeding races of *P. annua* in his Leicester garden (v.c. 55), one of which (stock C) was purplish but smaller than the typical green form (stock A, which he regarded as var. *annua*). He referred to it again from the same location in a later paper (Tutin 1973). The purple-leaved form described here is not smaller than typical *P. annua*.

There are anecdotal reports (J. England, pers. comm. 2002) of f. *purpurea* being present at R.H.S. Garden Wisley since the late 1960s. Tony Lord (pers. comm. 2001) remembers seeing it at a large nursery wholesalers in E. Norfolk (v.c. 27) in the 1970s and Alan Leslie (pers. comm. 2002) has known it in his Surrey garden (v.c. 17) and as a nursery weed in Surrey and Cambridgeshire (v.c. 29) for over 20 years. Tom Cope (pers. comm. 2002) recently found it at the Royal Botanic Gardens, Kew, Surrey (v.c. 17). The R.H.S. Members' Advisory Service has received specimens of f. *purpurea* from the gardens of A. W. Page, W. Kent (v.c. 16) in 1999 and A. F. J. Russell, S. Hants (v.c. 11) in 2000. Since my earlier request (Grant 2000), I have also received reports of this form from the gardens of M. Edmunds, W. Lancs (v.c. 60), T. Tarpey, N. Essex (v.c. 19) and P. R. Woods, Cheshire (v.c. 58).

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(Accepted November 2002)

Notes

A SPECIMEN OF “*COCHLEARIA CONFERTA*” IN THE HERBARIUM OF THE UNIVERSITY OF BIRMINGHAM

When examining material of the genus *Cochlearia* in **BIRM**, as part of my work for an MSc dissertation, I came across a specimen named “*Cochlearia conferta*” by E. S. Marshall. This was not a name I was familiar with and which did not occur in *Flora Europaea* (Tutin *et al.*, 1993), Stace (1997), Dalby (in Rich 1992) or any of the editions of CTW. Extensive Internet searches also drew a blank. In the absence of ripe capsules I initially identified the plants as *C. pyrenaica* DC. using the keys in Rich (1992). Subsequent work proved this identification to be incorrect and I felt that a note detailing the background might save others who find this material some nugatory effort as well as putting the name in the public domain for any future Internet searches.

DESCRIPTION

The specimen, consisting of 2 plants on one sheet, was from the Augustin Ley bequest, 1911, and was labelled in manuscript:

“*Cochlearia conferta* mihi, ined.

Originally from Ben Lawers, VC88, Mid Perth.

Fl garden Milford 9.5.1893

ESM legit E. S. Marshall”

In addition it was stamped “The Botanical Exchange Club of the British Isles. See Report for 1893”.

Plant one was some 14 cm tall, plant two around 11 cm tall. The roots of both plants were thick and slightly woody. The basal leaves were orbicular to slightly deltate, having long petioles and their bases truncate or slightly cordate. The basal leaves on plant one were 7.5–9 mm wide while those on plant two were 4–5 mm wide. The lower stem leaves were shortly petiolate, the petiole being about as long as the lamina, deltate to ovate in shape and most having a tooth on each side. The upper stem leaves were a similar shape but had no petioles. They clasped the stem and had minute auricles. The petals were white and 4–4.5 mm long. The plants had unripe, more or less globose fruits, which were 2.5–3 mm in diam and 3–3.2 mm long.

In the “Report” for 1893 (Groves 1894) Marshall says “This is the plant (from Ben Lawers) for which the name *C. arctica*, Fries, has been suggested; but it does not agree with specimens from Th. M. Fries in **BM**. I have cultivated this since 1887, and found it very constant, also coming true from seed. “There is no species name in the report as the editor, J. Groves, said that “... I will not be an accessory to the mischievous practice of publishing names without any valid descriptions.” There is, however, a footnote in the report to suggest that Marshall had later described the plant as *C. micacea* in the *Journal of Botany* in 1894.

The *Journal of Botany* for October 1894 contains a description of *Cochlearia micacea* E. S. Marshall (Marshall, 1894) for which Marshall gives the synonym “*C. conferta* mihi, *in sched*” even though the name had not been validly published merely, as indicated, annotated on the herbarium sheet and thus, technically, a nomen nudum. He rejected the name *conferta* as “... being equally applicable to other species (eg *C. alpina* Watson), and have substituted that of *micacea*, since the plant above described has as yet only been detected on micaceous debris near the summits of some of the higher Breadalbane hills.” The paper is illustrated by a rather poor figure, which shows pointed basal leaves and rather odd elliptical stem leaves, none of which are petiolate. The rather squat habit depicted is also nothing like the plants on the herbarium sheets and the shape of the ripe fruits not typical. Marshall designates no type but gives the location as Ben Lawers, Am Binnein and Ben Dothaidh. I found that in their report to “Plantlife” on *C. micacea*, Dalby and Rich (1994) also identified this problem and suggest that material from Ben

Lawers, grown in Milford (as the Birmingham specimen was), pressed in 1892 and held in **BM**, be regarded as the type. This would make the cultivated material, rather than the original gathering, the type. There is an illustration of a specimen of *C. micacea* on the **PTH** website with the suggestion that this is the type. In fact, what Perth Museum have is a series of duplicates of the cultivated Marshall material plus some sheets of specimens from Am Binnin and The Cairnwell (M. J. Simmonds, **PTH**, pers comm 2003).

C. micacea is a member of the *C. officinalis* L. complex which is notoriously variable. Dalby (in Rich 1992) says that taxa in this group "... form a very complex group where species limits are not easily drawn, and authors do not agree on the number present in Britain and Ireland". Indeed, although *C. micacea* is generally recognised as a "good" species in this country (eg by Stace 1997), it still only merits a footnote under *C. pyrenaica* in both editions of *Flora Europaea* (Chater & Heywood in, Tutin *et al.* 1964, Wyse Jackson & Akeroyd in, Tutin *et al.* 1993). Marshall himself admits that the species might be confused with *C. alpina* (= *C. pyrenaica*) and says, "Dried flowering specimens of the two are not always readily separable..." (Marshall 1894). It is a pity then that the material in the herbarium specimen does not show well formed ripe fruit which, together with the unique $2n=26$ chromosome number (not available in dried material!), are the diagnostic features of the plant (Dalby in Rich 1992); certainly in fully mature herbarium specimens the shape of the fruit is very distinctive. Presumably Marshall was content to name his distributions to the Botanical Exchange Club on the strength of his knowledge of the plant's origin despite the fact that they are poor examples of the species. Given this, it is, I believe, appropriate to treat specimens named *C. conferta* nom. nud. as *C. micacea* E. S. Marshall.

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CAREX MURICATA L. SUBSP. MURICATA (CYPERACEAE) IN SHROPSHIRE

Carex muricata subsp. *muricata* is listed by Wigginton (1999) as Critically Endangered in Britain. Foley & Porter (2000) reported that it had been recorded in no more than eight sites prior to its discovery in Shropshire (v.c. 40) in 1999 (Whild & Lockton 1999), and that at all those sites it was either extinct or the population size was very small. Since then a second site in Shropshire has been discovered (Lockton 1999, 2000). Both have sizeable populations. Details of these sites are given below, together with some observations on its ecology.

JONES'S ROUGH

This is a small (4.3 ha) Shropshire Wildlife Trust reserve situated at SJ247247, on a south-western facing slope near the eastern end of the hill called Moelydd, near the village of Nantmawr in the parish of Oswestry Rural in Shropshire. It comprises several formerly enclosed, steeply-sloping parcels of land between 185–225 m OD. At the top of the reserve is a low cliff, below which there are several patches of natural Carboniferous limestone block scree covering a few hundred square metres of slope.

The reserve is now largely woodland and scrub, but the 1901 Ordnance Survey map shows the area as rough grazing. On the lower slopes there is a stand of Yew, *Taxus baccata*, which makes up a small area of mature woodland that seems to be of the N.V.C. community W13 *T. baccata* woodland, although this is outside the range given for this community in Rodwell (1991). The remainder is W8 *Fraxinus excelsior*–*Acer campestre*–*Mercurialis perennis* woodland, in various stages of succession towards high forest.

Only on the screes and the cliffs is there any grassland remaining, which is closest in character to CG2 *Festuca ovina*–*Avenula pratensis* community (although Meadow Oat-grass, *Helictotrichon pratensis*, does not occur in Shropshire (Lockton & Whild 1997)). This is where *Carex muricata* subsp. *muricata* was discovered by one of us (S.J.W.) on 15 May 1999, whilst undertaking a survey of the reserve on behalf of the Wildlife Trust. The identification was subsequently confirmed by A. O. Chater, D. A. Pearman and A. C. Jermy, and specimens have been deposited at BM, LTR and NMW. The population at this site was estimated in June 2002 to number some 350 individual plants. The total area occupied by the sedge is approximately 10 × 10 m, and it does not appear to occur elsewhere on the reserve, even in apparently similar habitats.

The grassland at Jones's Rough is maintained by rabbit grazing and, occasionally, by a few sheep that escape through the fence from the fields above. This grazing pressure is insufficient to prevent the development of scrub, even in the dry soil on the block scree, and there is evidence of the gradual encroachment of the woodland from below and to the sides of the clearing where the sedge occurs. Species closely associated with *Carex muricata* include *Festuca ovina*, *Helianthemum nummularium*, *Briza media* and, most noticeably, a dwarf form of *Silene dioica* which regularly appears in close proximity to it. Patches of sedge are found immediately below yew trees, in areas of bare soil, and the largest clumps occur where these yews have been pollarded during the last five years.

MOELYDD

Beyond the western edge of the reserve is an open expanse around the summits of Moelydd (SJ2425), an area of grassland and bracken of about 35 ha, rising to an altitude of 285 m. Apart from a few enclosed fields within and around the hill, the area is owned by an estate based in the nearby village of Nantmawr, and managed as a mountain bike centre, with made and unmade tracks dissecting the grassland. There are moderate levels of sheep grazing, which maintains an open sward throughout, but there is little evidence of agricultural improvement.

Carex muricata subsp. *muricata* was tentatively recorded here by C. Walker of English Nature in 1999. On 18 June 2000, we set out to identify and map this species, which indeed turned out to be the rare subspecies (conf. Pearman & Chater, BM). Subsequently on 14 June 2002, a group from the B.S.B.I. and the Shropshire Botanical Society mapped its precise distribution. In total, 15 separate localities have been identified, mostly on the north-eastern side of the hill. A rough estimate of the number of plants is 1000 (Lockton 2002).

The habitat of *C. muricata* subsp. *muricata* at Moelydd is in some ways different to that at Jones's Rough. Few of the populations are on natural screes; most are in grassy pits 3–5 m in diameter and 1–2 m deep. Each pit is surrounded by limestone spoil of irregular lumps with a main axis of 0.1–0.5 m. The origin of the pits is uncertain, but they are considered by the University of Birmingham archaeologist Roger White (pers. comm.) to be of great antiquity, possibly resulting from copper extraction in Roman times. The sedge occurs either on the lip of these pits or in the base. In several locations it also occurs on the edges of tracks, probably in locations where there were formerly pits.

As at Jones's Rough, the *C. muricata* grows in close association with the dwarf *Silene dioica* in CG2 grassland, a community that is not typical of the sward at Moelydd, which is generally more acidic in character.

TABLE 1. VEGETATION SAMPLES FROM JONES'S ROUGH AND MOELYDD. EACH QUADRAT WAS 2 X 2M SQUARE. ABUNDANCE IS GIVEN USING THE DOMIN SCALE. Q1: JONES'S ROUGH, SJ247247, 5 JULY 1999. Q2: JONES'S ROUGH, SJ247247, 21 MAY 2001. Q3: MOELYDD, SJ244252, 18 JUNE 2000.

Species	Quadrat		
	Q1	Q2	Q3
<i>Tortella tortuosa</i>	3	3	-
<i>Climacium dendroides</i>	-	-	1
<i>Homalothecium lutescens</i>	4	-	-
<i>Scleropodium purum</i>	-	1	-
<i>Rhytidiadelphus squarrosus</i>	-	-	5
<i>Pteridium aquilinum</i>	-	-	1
<i>Arenaria serpyllifolia</i>	1	-	-
<i>Cerastium fontanum</i>	3	6	3
<i>Silene dioica</i>	-	4	2
<i>Rumex acetosella</i>	-	-	4
<i>Rumex acetosa</i>	-	2	-
<i>Helianthemum nummularium</i>	7	-	-
<i>Prunus spinosa</i>	5	-	-
<i>Anthyllis vulneraria</i>	4	-	-
<i>Lotus corniculatus</i>	2	-	-
<i>Trifolium repens</i>	-	-	2
<i>Linum catharticum</i>	3	-	-
<i>Pimpinella saxifraga</i>	-	2	-
<i>Teucrium scorodonia</i>	1	4	-
<i>Thymus polytrichus</i>	4	3	3
<i>Plantago lanceolata</i>	4	5	4
<i>Campanula rotundifolia</i>	-	2	-
<i>Galium verum</i>	3	-	3
<i>Centaurea nigra</i>	1	-	-
<i>Pilosella officinarum</i>	3	-	-
<i>Bellis perennis</i>	2	-	-
<i>Achillea millefolium</i>	3	-	-
<i>Carex muricata</i> subsp. <i>muricata</i>	2	7	5
<i>Carex flacca</i>	2	-	-
<i>Carex caryophylllea</i>	2	-	2
<i>Festuca rubra</i>	-	-	1
<i>Festuca ovina</i>	8	6	9
<i>Briza media</i>	5	-	-
<i>Poa pratensis</i>	2	-	-
<i>Arrhenatherum elatius</i>	-	2	-
<i>Trisetum flavescens</i>	3	-	-
<i>Bromopsis erecta</i>	4	-	-

Correlation with CG2d using Match (Malloch 1997): 50.1%

DISCUSSION

At present the conditions at the two Shropshire sites for *C. muricata* subsp. *muricata* appear to be ideal. A large proportion of the known British population is present there, and it appears to be thriving. Both sites are to be incorporated into a new S.S.S.I. However, it does not necessarily follow that maintaining the present conditions will guarantee its long-term survival. At some other sites in Britain inappropriate management has led to a decline in populations sizes leading inexorably towards extinction (David & Kelcey 1985; Foley & Porter 2000), but at Minera in Denbighshire tree clearance has increased the population from two clumps to some 320 since 1999 (J. A. Green, pers. comm.). The problem seems to be in maintaining habitats at an early stage of succession: allowing tree cover to develop leads to too much shade, whereas cutting back the trees leads to excessive ground cover. Devising management plans for very rare species is often difficult because of the lack of examples from which to draw conclusions. Hopefully the populations in Shropshire are large enough to enable a detailed study and some experimental management, which may lead to better protection for this rare species at its other sites.

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A NEW HYBRID BINOMIAL IN *NARCISSUS* L.

Many of the numerous hybrids in the genus *Narcissus* L. have hybrid binomials, and recently, to ensure that binomials were available for all the hybrids naturalised in Great Britain and Ireland, Sell & Murrell (1997) published names for *N. cyclamineus* DC. $\times$ *N. moschatus* L. (*N. \times dichromus* P. D. Sell) and *N. cyclamineus* DC. $\times$ *N. pseudonarcissus* L. (*N. \times monochromus* P. D. Sell). It is now apparent that another hybrid of *N. cyclamineus* lacking a binomial is naturalised in West Kent and in Cardiganshire, and probably in many other areas. This is *N. cyclamineus* DC. $\times$ *N. tazetta* L., of which the naturalised populations mostly belong to the cultivar 'Tête à Tête', currently the most widely grown of all miniature daffodils in Britain. The story of the breeding of this cultivar by the daffodil grower Alec Gray is well known (Gray 1965, 1985; Wells 1989; etc.). In the early 1920s a hybrid between *N. cyclamineus* and the cultivar known as 'Soleil d'Or' occurred in A. W. Tait's garden in Portugal and the resulting plants were given the name 'Cyclataz'. Whether this occurrence was natural or the result of a deliberate cross is uncertain, and Gray's two accounts differ in some details. 'Cyclataz' is a normally sterile diploid ($2n = 17$), but in the late 1940s Gray found a single capsule on one of his plants of it which contained three seeds, and these developed into plants to which in due course he gave the cultivar names 'Tête à Tête', 'Jumble' and 'Quince', all of which are triploids ($2n = 24$) (Brandham 1992). Gray says that "the history of 'Soleil d'Or' is shrouded in mystery. It is generally held that it is of North African origin, but as far as I know it has never been found wild there". Bowles (1934) and Kington (1998) consider that 'Soleil d'Or', which was in existence in the early eighteenth century, was possibly derived from *N. bertolonii* Jordan. Blanchard (1990) agrees, but mentions a belief by Moggridge that it is the same as *N. aureus* Loisel. At all events, there is general agreement that it belongs within *N. tazetta* L. as circumscribed by Webb (1980) whom we follow in this respect, and who gives *N. bertolonii* Jordan as a synonym of *N. tazetta* subsp. *aureus* (Loisel.) Baker (*N. aureus* Loisel). The description that follows is of 'Tête à Tête'; as in many such cases where various cultivars of a hybrid exist, it would be difficult to provide a description covering all the variation, especially as the origins of some of the cultivars are uncertain. The holotype is also this cultivar, and was kindly made available by Lady Skelmersdale from the Broadleigh Gardens, Taunton, which holds the national collection of Alec Gray miniature daffodils. Illustrations of 'Tête à Tête' can be found in many works, including Gray (1965, fig. 165), Wells (1989, p.126) and Phillips & Rix (1989, p.126, fig. g). So far as is known it is always sterile, and its dispersal in the wild must be by disturbance of the bulbs.

Narcissus \times cyclazetta Chater & Stace, **hybr. nov.**

(*Narcissus cyclamineus* DC. $\times$ *N. tazetta* L.)

HOLOTYPE: Broadleigh Gardens, Bishops Hull, Taunton, Somerset, v.c. 5, ST195250, 27 February 2003, A. O. Chater. **BM**.

Isotypes are in **LTR** and **NMW**.

Hybrida inter *Narcissus cyclamineus* DC. et *N. tazetta* L., caracteribus inter parentes intermedia: caules 15–25 cm; folia grandiora 8–15(–25) mm lata, magis minusve plana; flores 1–2 (–3) in umbella; tubus hypanthialis 11–14 mm, conicus; tepala 13–20 mm, patentia vel aliquantum reflexa, lutea; corona 11–19 mm, lateribus rectis vel ad orem leviter dilatata, perlutea.

Bulb c. 3.5 $\times$ 3 cm, ovoid, with orange-brown scales. Stems 15–25 cm, c. 7 mm wide near base, 4.5–5 mm wide near apex, slightly flattened with 2 sharp angles and several ribs. Larger leaves 15–20(–25) cm $\times$ 8–15 mm, more or less flat, mid-green, not twisted, obtuse. Flowers 1–2(–3) per stem, held horizontally, scented. Spathe 5–5.5 cm. Pedicels 2–6 cm, 2–3 mm thick, straight, subterete. Ovary in flower 9–12 $\times$ 5–6 mm, dark green. Hypanthial tube 11–14 mm, c. 4 mm wide at base, c. 10 mm wide at apex, conical, slightly concave-sided, yellowish-green. Tepals 13–20 $\times$ 10–15 mm, ovate-elliptic, overlapping only slightly at base, acute, patent or more often slightly reflexed, yellow (R.H.S. 8A). Corona 11–19 $\times$ 11–17 mm, straight-sided or slightly widened at mouth, somewhat fluted, crenate-dentate at rim, deep, almost orange-yellow (near R.H.S. 14B). Stamens all the same length, the free part 13–14 mm, the anthers 6–6.5 mm and reaching nearly half-way up the corona.

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THE TYPIFICATION AND CORRECT CITATION OF THE NAME *GERANIUM PURPUREUM* VILL. SUBSP. *FORSTERI* (WILMOTT) H. G. BAKER

INTRODUCTION

Geranium purpureum Vill. is an early-flowering annual similar in appearance to *G. robertianum* but with much smaller petals, more strongly ribbed fruits and a somatic chromosome number of 32 (instead of 64). It is abundant in the Mediterranean region and beyond and is a rare and very local plant of the Channel Isles, southern England and southern Ireland, usually on the coast (for map see Baker, 1955).

HISTORY

Specimens from the South Hampshire locality of Stokes Bay (sometimes written Stoke's Bay), collected by William Borrer, were the subject of a coloured engraving published in 1830 in J. E. Smith, *Sowerby's English Botany, Supplement 1*, edited by W. J. Hooker. The plate was numbered 2648, and the subject was named *G. purpureum* Vill. The account of this plant was written by T. F. Forster, who had died in 1825. He stated that *G. purpureum* had been long known as a British plant, and treated as a distinct species until Hudson united it with *G. robertianum* (as an unnamed variety). Forster had observed it over many years in his garden without its undergoing alteration. He concluded that Villars was right to treat it as a species. (The name of his brother, E. Forster, who survived him, appears at the end of the account.) Nevertheless, in Sowerby (*op. cit.*), ed. 3b, vol. 2 (1864) (editor J. T. Boswell or J. T. I. Boswell-Syme), the same plate appeared, now as tab. CCCVI, with a cross-reference to its previous appearance), but the taxon was presented as a

variety of *G. robertianum* (p. 204). (Sowerby's *English Botany* has a very complicated history of publication.)

Syme said that the plate in *English Botany Supplement* was the source of confusion in this group for much of the 19th century whereas Wilmott (1921) blamed the confusion on Syme. Baker (1955) did likewise, adding that British authors misapplied the name *G. purpureum* to the prostrate maritime populations of *G. robertianum*, a mistake that could not really be attributed to the re-appearance of this plate that clearly shows the small flowers of *G. purpureum*.

In the early part of the 20th Century it became apparent that there were two variants of *G. purpureum* in the British Isles, an erect-growing one and a prostrate one. The first hint of this was given by Evans (1920). He had grown *G. purpureum* from various sources, but remarked that doubt attached to specimens collected by J. E. Little on the coast near Bognor, in West Sussex (between Littlehampton and Bognor, 20.ix.1913, Bot. Soc. Exch. Club distribution, specimen in CGE). A. J. Wilmott went especially to the Sussex site in 1919 and collected specimens. In the very detailed paper written afterwards (Wilmott 1921) he distinguished the prostrate variant as *G. purpureum* var. *forsteri*, with a Latin diagnosis. Wilmott recognized William Borrer's material from Stokes Bay as also belonging to the new variety. *G. purpureum* var./subsp. *purpureum* is absent from the Hampshire sites and seems to have been recorded at only two Sussex sites, one of which was lost long ago (Baker 1955). Small groups of *G. purpureum* now surviving in Sussex require subspecific identification (Yeo 2003).

NOMENCLATURE

The name for the prostrate variety was proposed as "*G. purpureum* var. *forsteri* Wilmott, *nomen novum*", based on "*G. purpureum* T. F. Forster". As the latter name does not exist (see paragraph 2) the *nomen novum* does not exist either. We have to regard Wilmott's action as that of proposing a new taxon, a "*varietas nova*". Wilmott provided plenty of descriptive matter to validate the publication of this name. Probably because he thought he was not publishing a new taxon he did not designate a type, but he mentioned specimens that can be regarded as syntypes and from which a lectotype can be chosen.

Baker (1955), in a thorough survey, proposed to raise the rank of the British taxon to that of subspecies. His comments provide some help in choosing a lectotype. The correct citation and my lectotypification are as follows:

Geranium purpureum Vill. in L., *Systema Plantarum Europae* 1, *Flora Delphinalis* 72 (1786).

Geranium robertianum L. var. *purpureum* (Vill.) DC., *Flore Française* 4: 853 (1805)

Geranium purpureum subsp. *forsteri* (Wilmott) H. G. Baker, *Watsonia* 3: 165 (1955)

BASIONYM *G. purpureum* Vill. var. *forsteri* Wilmott, *Journal of Botany* 59: 95 (1921)

TYPE "*Geranium purpureum* Forster", Sussex: shingle beach near Middleton, A. J. Wilmott, 1919, LECTO., designated here, and ISOLECTO. (4 additional sheets, with minor differences of wording) BM.

Geranium purpureum Vill. var. *purpureum* (autonym)

Geranium purpureum Vill. subsp. *purpureum* (autonym)

TYPIIFICATION

Baker (1955) referred to syntypes at Kew (K) and the Natural History Museum, London (BM), and a 'type' at the latter (though he did not actually designate a lectotype). He also said that Clymping (i.e. Climping, W. Sussex, also called Middleton) was the type locality. It seems he considered that one of Wilmott's specimens from Middleton (1919) should be the type (lectotype). There are five such specimens in BM and in 1999 I found that they and other specimens connected with Forster had been labelled as syntypes of *G. purpureum* var. *forsteri* Wilmott. On one

specimen from Hampshire and one of those from Middleton Wilmott himself has written this name followed by 'mihi'. To the latter a copy of Wilmott's diagnosis has been attached, suggesting that this is the one that Baker thought of as a lectotype. However, it is derived from W. C. Barton's herbarium, and consists of three fragments, so is less suitable for selection as a lectotype than the one I have chosen (under the previous heading). The lectotype and isolectotype have been bar-coded as type material by the Museum.

Specimens of this taxon collected by William Borrer at the South Hampshire locality of Stokes Bay have also been potential lectotypes and one has been bar-coded by the Museum. They are important because they were the subject of the coloured engraving published in the 1830 supplement to Sowerby's *English Botany*, cited in paragraph 2.

ACKNOWLEDGMENTS

I am grateful to the authorities in charge of the herbaria at the Natural History Museum, London, (BM) and Royal Botanic Gardens, Kew, (K), for access to the collections. I am also grateful to Professor John Parker, Director of the University Botanic Garden, Cambridge, and his predecessor, Dr Donald Pigott, for facilitating my work during and after my employment there. The late Mr Paul Bowman and Dr Francis Rose kindly took me to some relevant sites in Hampshire and Sussex. I am grateful to Peter Sell for improving the wording of my discussion of types.

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OBSERVATIONS ON *BROMOPSIS BENEKENII* (LANGE) HOLUB IN BRITAIN

Bromopsis benekenii (Lange) Holub is a Eurasian grass that is closely related to *Bromopsis ramosa* (Huds.) Holub, and Britain is on the western edge of its range. Stewart *et al.* (1994) list *B. benekenii* as a Nationally Scarce plant in Britain. In southern Britain the grass is found in or near deciduous woodland (mainly *Fagus*) on shallow calcareous soils and frequently growing near *B. ramosa*. In northern Britain it occurs in rocky gorges and ravines.

Some botanists have often found it difficult to distinguish *B. benekenii* from *B. ramosa*. This is not a new problem. Although W. Hudson described *B. ramosa* in 1762, it was not until 1871 that J. Lange described *B. benekenii*. Acedo & Llamas (1999) have pointed out that the autonomy of *B. benekenii* was not clear because Lange's material and protologue of *B. benekenii* coincided with those that define *B. ramosa*. In Britain, Stace (1997) suggested that the distinction between the two species needed investigation and this study endeavours to do this.

European Floras use similar characters to separate the two taxa and the following couplets in *Flora Europaea*, (Smith, 1980), are typical:

“Panicle large, very lax; branches long, nodding, with pendent spikelets; lowest panicle-node with 2 branches, each with several spikelets; scale at lowest panicle-node ciliate*B. ramosa*”

“Panicle lax; branches and spikelets patent; lowest panicle-node with 3–5 branches, some with one spikelet; scale at lowest panicle-node not ciliate*B. benekenii*”

Sixty-one specimens of *B. benekenii* (54 from herbaria) and 192 specimens of *B. ramosa* (157 from herbaria) were examined. All had been collected in Britain. 39 of the 61 specimens of *B. benekenii* were selected as definitely being *B. benekenii*. These specimens, which had also been determined as *B. benekenii* by H. J. M. Bowen (1), A. Copping (1), C. E. Hubbard (10), A. Melderis (11), E. W. B. H. Milne-Redhead (1), R. C. Palmer (1), or T. C. G. Rich (14), were used in a comparative morphological study with *B. ramosa*.

The number of panicle branches at the lowest panicle-node and the number of spikelets on each branch from the lowest panicle-node were counted, and the resultant data are in Table 1. From these data it was concluded that the number of panicle branches at the lowest panicle-node and also the number of spikelets on each branch from the lowest panicle-node were not reliable to separate the two taxa in Britain and therefore should be considered, at best, as only secondary indicative characters.

TABLE 1. PANICLE STRUCTURE OF *B. BENEKENII* AND *B. RAMOSA*

	<i>B. ramosa</i>	<i>B. benekenii</i>
No. of branches at lowest panicle-node	%	%
1	10.1	12.9
2	86.4	59.1
3	3.5	10.2
4	—	12.8
5	—	2.4
6	—	2.6
<i>Flora Europaea:</i>	"two branches"	"3 to 5 branches"
This study:	86.4%	72% not so
No. of spikelets on each branch at lowest panicle-node	%	%
1	14.3	39.8
2	21.4	35.7
3	25.0	13.3
4	12.5	8.2
5	17.8	1.0
6	—	—
7	5.4	2.0
8	—	—
9	1.8	—
10	1.8	—
<i>Flora Europaea:</i>	"each with several spikelets"	"some with one spikelet"
This study:	35.7% with only one or two	60.2% not so
Shape of 'scale'	%	%
Scale	—	12.5
Collar	26.5	82.4
Culm edge	73.5	5.1
Indumentum of culm edge	%	%
Glabrous	2.0	56.2
A few cilia	24.6	26.4
Several cilia	73.4	17.4
<i>Flora Europaea:</i>	"ciliate"	"not ciliate"
This study	98%	cilia found in 43.8%

According to most Floras, there is a scale at the lowest panicle-node which is ciliate in *B. ramosa* but not ciliate in *B. benekenii*. Maire (1955) described the 'scale' as a rudimentary bract and Tzvelev (1976) as an upper leaf rudiment. Some British botanists have been unable to find this 'scale' and a reason for this became apparent in the present study. In most of the British specimens of *B. benekenii* examined the 'scale' was reduced to a narrow collar (white in dried material). In most specimens of *B. ramosa* even the collar was absent, but there were often several cilia on the upper edge of the culm at the node (Table 1). The cilia were very thick and varied widely in length and were quite different from the hairs on the adjacent culm and rhachis. Some cilia were present on the edge of the culm at the lowest panicle-node in 98% of the specimens of *B. ramosa*. In 82.6% of the specimens of *B. benekenii* the culm-edge was either glabrous or with only a few cilia, but in 17.4% there were several cilia. It was concluded from these data that the absence of cilia was strongly indicative of *B. benekenii*, but if cilia were present, this became a secondary indicative character that depended on the number of cilia present.

Some botanists are confident that they can distinguish the two taxa by their general appearance and this was probably the main character used by the botanists, named earlier, to determine specimens as *B. benekenii*. In this study most mature specimens could be distinguished by:

- A tall robust grass. Upper leaf-sheath usually with long soft hairs. Panicle very lax and wide spreading, with long patent branches, eventually drooping with pendent spikelets. Several thick cilia usually present on the edge of the culm at the lowest panicle-node *B. ramosa*
- A shorter less robust grass. Upper leaf-sheath usually with minute patent hairs (30×). Panicle lax, narrow and erect; with shorter panicle branches often swept to one side, drooping at maturity. Thick cilia usually absent (or only a few) on the edge of the culm at the lowest panicle-node *B. benekenii*

However, the separation of these two taxa before maturity was not possible, as some immature specimens of *B. ramosa* resembled *B. benekenii* and indeterminates were found.

It is interesting that these taxa in Britain differ from the description in European Floras. As Britain is on the western edge of the range of these species, it is possible that panicle branching, the number of spikelets, and the absence of 'scales' at the lowest panicle-node may have been affected by the British wet atlantic climate with its mild winters. It is also possible that this may have occurred in other *Bromus* taxa. In a separate study of 136 specimens of *Bromus hordeaceus* subsp. *feronii* from many herbaria, it was found that all but two of the specimens had been collected on the West and South Coasts of Britain and there was only two from the East Coast. This distribution was also reported by Perring (1978). In Britain, *Bromus commutatus* var. *pubens* is the more frequent variety and much of the *Bromus secalinus* here is var. *hirtus*. These two varieties are very rare, nearly absent, in Germany (H. Scholz, pers. comm. 2001), in France (Portal 1995), in Iberia (Acedo & Llamas 1999), in Sweden (G. Holmstrom, pers. comm. 2002) and in the former Soviet Union (Tzvelev 1976).

Seed or roots of British *Bromopsis benekenii* are sought for isozyme analyses and new chromosome counts.

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Plant Records

Records for publication must be submitted to the appropriate Vice-county Recorder (see *BSBI Year Book* 2003), and not to the Editors. Following publication of the *New Atlas of the British & Irish Flora* and the impending publication of the *Vice-county Census Catalogue*, new criteria have been drawn up for the inclusion of records in *Plant Records*; these will be published in *BSBI News* and will be followed in future issues of these lists. So, for the last time, the old criteria for inclusion of records are followed here (but with the addition of some casual taxa that are included in the two books mentioned above): Records must normally be of species, hybrids or subspecies of native or naturalised plants (listed in Kent (1992) or Stace (1997)), belonging to one or more of the following categories: 1st or 2nd v.c. record; 1st or 2nd post-1930 v.c. record; only extant v.c. locality, or 2nd such locality; a record of an extension of range by more than 100 km. Such records will also be accepted for the major islands in v.cc. 102–104, 110 & 113. Only 1st records can normally be accepted for *Rubus*, *Hieracium*, *Taraxacum* and hybrids. Records for subdivisions of vice-counties will not be treated separately; they must therefore be records for the vice-county as a whole. Records for *Taraxacum* must normally be additional to those in *Dandelions of Great Britain and Ireland* by A. A. Dudman & A. J. Richards (1997).

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. Taxa not in that book follow *New Flora of the British Isles* Ed. 2 by C. A. Stace (1997). 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.

Records from the following vice-counties are included in the text below (superscript figures indicate number of taxa): 1⁸, 2¹¹, 4³, 5¹¹, 6², 10¹, 11³, 12⁶, 13⁶, 14¹, 17¹, 29¹²³, 33¹, 35²³, 41¹⁴, 42¹⁶, 43⁹, 44⁴⁸, 45¹², 46⁵⁶, 47¹³, 48⁴, 49¹⁹, 50²⁵, 51⁸, 52²⁴, 58²², 60⁵, 61⁴, 64⁵⁰, 65³, 66³, 67¹¹, 68¹¹, 77³¹, 78¹, 79⁸, 80¹⁰, 81⁹, 83⁵, 88¹, 91²², 93¹⁷, 95¹⁰, 96⁴, 99³¹, 110¹⁴, H6²⁶, H8¹, 113(A)¹⁴¹, 113(S)³⁵.

The following signs are used:

* before the record: to indicate a new vice-county record.

† before the species number: to indicate that the plant is not a native species of the British Isles.

‡ before the record: to indicate a species which, though native in some parts of the British Isles, is not so in the locality recorded.

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

1/1.1. HUPERZIA SELAGO **35**, Mons.: One plant on barish area of coal waste, W of Keepers pond, Bloreng, SO250106, H. Wray, 2000. 2nd recent record.

†2/1.2. SELAGINELLA KRAUSSIANA ***113(A)**, Channel Is. (Alderney): Patch about 1m square against N wall of Parish Church, St Anne, WA574074, J. Page, 1993, det. D. McClintock.

3/1.2. ISOETES ECHINOSPORA ***44**, Carms.: In c.1m deep and deeper water at SE corner of lake, Talley Upper (southern) Lake, SN633329, BSBI meeting, 2001, **NMW**, det. A.O. Chater.

4/1.1. EUISETUM HYEMALE ***H6**, Co. Waterford: 2 large stands, in damp wooded river bank (right bank), Whelanbridge River, S of Whelan's Bridge, S520098, I.P. Green, 2001.

4/1.1x3. EUISETUM × TRACHYODON (E. HYEMALE × E. VARIEGATUM). ***52**, Anglesey: Several hundred stems on the road verge near Llyn Penrhyn, SH313765, N. Brown, 2000, det. C.N. Page & A. Paul.

4/1.4x5. EUISETUM × LITORALE (E. FLUVIATILE × E. ARVENSE) ***39**, Staffs.: Edge of ditch on W side of road, near the Butcher's Arms pub, SK081616, R. Maskew, 2001. ***91**, Kincards.: Marsh 25m from Loch of Loirston, NJ937009, D. Welch, 2001, **ABD**, conf. A.C. Jermy.

4/1.4x8. EUISETUM × DYCEI (E. PALUSTRE × E. FLUVIATILE) ***1**, W. Cornwall: With both parents in marsh of Mount Field by Penhale Sands, Mount, near Perranporth, SW782567, C.N. Page, 2000, **herb. C.N.P.** ***2**, E. Cornwall: With both parents alongside wet track, Goss Moor (NNR), SW939596, C.N. Page, 1998. On Tregonetha Downs, SW944635, M.& T. Atkinson, I.J. Bennallick & H.M. Meredith, 1999, det. C.N. Page. 1st & 2nd records.

4/1.4x9. EUISETUM × WILMOTII (E. FLUVIATILE × E. TELMATEIA) ***2**, E. Cornwall: By wet track into the moor, Goss Moor (NNR), SW939596, I.J. Bennallick *et al.*, 1999, det. C.N. Page. New to Cornwall.

4/1.5×8. *EQUISETUM* × *ROTHMALERI* (*E. ARVENSE* × *E. PALUSTRE*) *1, W. Cornwall: With both parents in marshy area, southern end of Mount Field by Penhale Sands, Mount, near Perranporth, SW782567, C.N. Page, 2000, **herb. C.N.P.** *2, E. Cornwall: By disused railway between old and new A30, near Goss Moor (NNR), SW933599, C.N. Page, 1998. New to Cornwall.

4/1.5×9. *EQUISETUM* × *ROBERTSII* (*E. ARVENSE* × *E. TELMATEIA*). *52, Anglesey: Extensive colony with both parents at Traeth Lligwy, SH4987, T.D. Dines & I.R. Bonner, 2000. New to science. Close to the colony of *E. × font-queri* discovered by R.H. Roberts in 1989. *60, W. Lancs.: Canal side, Cabus, Lancaster Canal, SD4847, E.F. Greenwood, 2001, **LIV**, det. C.N. Page. 2nd British record.

5/1.2. *OPHIOGLOSSUM AZORICUM* *H6, Co. Waterford: 2 patches on gravelly shore of small pool below lough, Coumshingaun Lough, S330109, P.R. Green, 2001.

9/1.1. *PILULARIA GLOBULIFERA* *60, W. Lancs.: Wet heath, Ribbleton Common near Preston, SD53, Anon, 1825, **MANCH.** 1st & only v.c. record. *65, N.W. Yorks.: Pond, Good Wood plantation, Catterick Garrison, SE165958, C. Newlands, 2001. 1st recent record. *99, Dunbarton: Muddy runnels by loch shore, near Geal Loch, Loch Lomond, NN3215, A.McG. Stirling & J. Mitchell, 1995, **herb. A.McG.S.** 1st localised record.

10/1.1. *HYMENOPHYLLUM TUNBRIGENSE* *44, Carms.: With *H. wilsonii* & *Phegopteris connectilis* on low cliffs on bank of stream in wooded valley, 1km WNW of Gwernogle, SN520345, R.G. Woods, 2000.

10/2.1gam. *TRICHOMANES SPECIOSUM* (gametophyte) 42, Brecks.: Recesses of sandstone outcrop in woodland, Coed y Fedw, Felin Fach, SO088340, R.G. Woods, 1999. 2nd record.

11/1.1×2. *POLYPODIUM* × *MANTONIAE* (*P. INTERJECTUM* × *P. VULGARE*) 64, Mid-W. Yorks.: Roadside S of village, Laverton, SE2272, D.J. Tennent, 2000, det. R.H. Roberts. 2nd record.

11/1.2×3. *POLYPODIUM* × *SHIVASIAE* (*P. INTERJECTUM* × *P. CAMBRICUM*) *46, Cards.: With both parents on N-facing side of old mortared wall, W part of S wall of St Mary's churchyard, Cardigan, SN180460, A.O. Chater, 1998, **NMW**, conf. A.C. Jermy.

11/1.3. *POLYPODIUM CAMBRICUM* 50, Denbs.: Limestone woodland, Llandulas, SH9077, W. McCarthy & M. Stead, 2001, det. R.H. Roberts. 1st recent record.

11/1×2. *POLYPODIUM* × *MANTONIAE* (*P. VULGARE* × *P. INTERJECTUM*) *39, Staffs.: Several patches, Munster Rock, Arley Wood, SO801826, P.G. Garner & R. Maskew, 2001, det. R. Maskew.

14/2.1. *PHEGopteris connectilis* 81, Berwicks.: A series of large colonies on steep N-facing woodland bank, Ellerburn Wood, NT762607, M.E. Braithwaite, 2000. 2nd extant site.

15/1.1×2.5. × *ASPLENPHYLLITIS CONFLUENS* (*PHYLLITIS SCOLOPENDRIUM* × *ASPLENIUM TRICHOMANES*) *39, Staffs.: A single, several fronded plant, with parents, wet wall, 12 Bath Street, Leek, SJ987565, S. & E. O'Donnell, 2000, conf. A.M. Paul. 1st British record since the 19th century; stolen a few months later.

15/2.2. *ASPLENIUM ONOPTERIS* *H6, Co. Waterford: Wet dripping cliffs, Muggort's Bay, X297876, P.R. Green, 2001, **DBN**.

15/2.5×7. *ASPLENIUM* × *CLERMONTIAE* (*A. TRICHOMANES* × *A. RUTA-MURARIA*) *68, N. Northumb.: 1 good tuft with both parents, in E-facing mortared wall, near Howick Scar, NV255188, G.A. Swan, 2000, **BM**, det. F. Rumsey.

15/2.5c. *ASPLENIUM TRICHOMANES* subsp. *PACHYRACHIS* *64, Mid-W. Yorks.: Castle wall, Knaresborough, SE348569, B. Wright, 2000.

17/1.1×2. *POLYSTICHUM* × *BICKNELLII* (*P. SETIFERUM* × *P. ACULEATUM*) 50, Denbs.: Woodland, Plas Power Country Park, SJ292499, BSBI group, 2000. 2nd record.

17/1.1×mun. *POLYSTICHUM* × *LESLIEI* (*P. SETIFERUM* × *P. MUNITUM*) *2, E. Cornwall: With both parents, on hedgebank by narrow lane, Tywardreath, Par, SX081543, P.J. Acock, 2001, det. A.M. Paul & F.J. Rumsey. 2nd British record.

†17/1.mun. *POLYSTICHUM MUNITUM* 2, E. Cornwall: Originally a garden escape but now established, on hedgebank by narrow lane, Tywardreath, Par, SX081543, P. Hunt, 2001, det. P.J. Acock & A.M. Paul. Known here for the past 30 years.

- 17/3.1. *DRYOPTERIS OREADES* ***60**, W. Lancs.: 1-2 plants only, at top of crags, Fell End Crag, Leck, SD652792, E.F. Greenwood, 2000, det. A.C. Jermy.
- 17/3.8×9. *DRYOPTERIS* × *DEWEVERI* (*D. CATHUSIANA* × *D. DILATATA*) ***1**, W. Cornwall: With both parents nearby, in somewhat marshy area by river at edge of wood, Bishop's Wood, Idless, near Truro, SW829482, M.J. Stribley, 2000, conf. R.J. Murphy.
- †19/1.1. *AZOLLA FILICULOIDES* ***99**, Dunbarton: In great quantity over 2.5km, reduced level canal surface, Forth & Clyde Canal, Old Kilpatrick, NS4672, K. & S. Futter, 2000. All gone 2001.
- †20/7.1. *PINUS SYLVESTRIS* ***113(A)**, Channel Is. (Alderney): Plantation, Newtown Road & Mont Touraille, WA582077, B. Bonnard, 1988.
- †20/7.2a. *PINUS NIGRA* subsp. *NIGRA*. ***113(A)**, Channel Is. (Alderney): Plantation, Newtown Road, WA582077, B. Bonnard, 1988.
- †20/7.2b. *PINUS NIGRA* subsp. *LARICIO* ***113(A)**, Channel Is. (Alderney): Plantation, Newtown Road, WA582077, B. Bonnard, 1988. ***113(S)**, Channel Is. (Sark): 3 planted trees in almost level clearing beside hill path overlooking Les Laches path from La Forge to Harbour, WV475756, R.M. Veall, 1997, **herb. Société Sercquaise**, det. R.A. Waterman.
- †20/7.4. *PINUS PINASTER* ***113(A)**, Channel Is. (Alderney): Plantation, Newtown Road, WA582077, B. Bonnard, 1988.
- †20/7.wal. *PINUS WALLICHIANA* ***29**, Cambs.: One self-sown plant at base of S wall, of Great Shelford church, TL459518, A.C. Leslie, 2001. Large parent tree nearby in churchyard.
- †20A/TAX.dis. *TAXODIUM DISTICHUM* ***77**, Lanarks.: Seedling on waste ground, between Shettleston & Carntyne, Glasgow, NS6364, P. Macpherson, 2000, **herb. P.M.** det. A.McG. Stirling. 1st record other than planted.
- †21/PLA.ori. *PLATYCLADUS ORIENTALIS* ***29**, Cambs.: Churchyard, Whaddon, TL350465, P.D. Sell, 1991, **CGE**. 2 plants, both c.45cm tall and fruiting, on top of brick wall, at N end of Mill Road cemetery, Cambridge, TL461583, A.C. Leslie, 2001. 1st & 2nd records.
- 26/1.1. *NYMPHAEA ALBA* *†**113(A)**, Channel Is. (Alderney): Large patch (probably introduced) from a single plant in pond, Corblets Quarry, WA596088, B. Bonnard, 1986, det. D. McClintock.
- 27/1.1. *CERATOPHYLLUM DEMERSUM* **46**, Cards.: Oxbow in pasture by Afon Teifi 450m W of Alltybwla, Cenarth, SN256422, A.O. Chater, 2000, **NMW**. 2nd record.
- 27/1.2. *CERATOPHYLLUM SUBMERSUM* ***113(A)**, Channel Is. (Alderney): Plentiful in pond, Corblets quarry, WA596088, B. Bonnard, 1987, det. D. McClintock.
- 28/13.4. *RANUNCULUS SARDOUS* **39**, Staffs.: 2 plants 60m apart in wheat field, W of M6 Junction 13, NNW of Dunston, SJ925185, I.J. Hopkins, 2001. 1st recent record. ***64**, Mid-W. Yorks.: 3 plants in field gateway, Eccup, Leeds, SE304422, P.P. Abbott, 2001.
- †28/13.17d. *RANUNCULUS FICARIA* subsp. *CHRYSOCEPHALUS* ***29**, Cambs.: Naturalised in the grounds of Chesterton Towers, Cambridge, TL4659, D.E. Coombe, 1983, **CGE**. 1 plant at base of hedge on N side of road, Histon, TL432638, A.C. Leslie, 2001. 1st & 2nd records.
- 28/13.19×20. *RANUNCULUS* × *NOVAE-FORESTAE* (*R. OMIOPHYLLUS* × *R. TRIPARTITUS*) ***46**, Cards.: Muddy runnels in marsh, 200m SSE of Glasfryn, Felin-wynt, SN222502, A.O. Chater, 1999, **NMW**, conf. N.T.H. Holmes. ***52**, Anglesey: Wet open heathland, Tre Wilmot, SH228814, M. Sutton, 2001.
- 28/13.20. *RANUNCULUS TRIPARTITUS* **46**, Cards.: Muddy runnels in marsh, 200m SSE of Glasfryn, Felin-wynt, SN222502, A.O. Chater, 1999, conf. N.T.H. Holmes. 2nd & 1st recent record. ***49**, Caerns.: 1 plant on bare peat in trampled heath, c.5m S of track at edge of small pool, Mynydd Cilan, Porth Ceriad SSSI, SH292245, R.A. Jones, 2000.
- 28/13.21. *RANUNCULUS BAUDOTII* **113(S)**, Channel Is. (Sark): Over most of area of pond, Grand Dixcart dew-pond, WV463752, R.M. Veall, 2000, **herb. Société Sercquaise**, det. N.T.H. Holmes. 1st recent record.
- 28/17.4. *THALICTRUM MINUS* *†**113(A)**, Channel Is. (Alderney): Planted c.30 years ago on cliff-edge path, near the Lighthouse, WA603090, B. Bonnard, 1988, det. D. McClintock.
- †28/17.spe. *THALICTRUM SPECIOSISSIMUM* ***58**, Cheshire: Casual only, on road verge, Stoke, SJ424729, G.M. Kay, 2001.

†28/2.3. *CLEMATIS TANGUTICA* *29, Cambs.: 1 large flowering plant, at southern tip of disused Chesterton railway sidings, Cambridge, TL475604, G.M.S. Easy, 1999, conf. K.A. Beckett. *44, Carms.: Escape from nearby garden, self sown seedlings nearby, Penylan, Llanelli, SS518998, I.K. Morgan, 2000, **NMW**, det. G. Hutchinson.

†28/2.5. *CLEMATIS VITICELLA* *29, Cambs.: One flowering plant, clambering through ivy on outside of wall surrounding W side of churchyard, Gamlingay, TL241523, A.C. Leslie, 2001.

29/1.1. *BERBERIS VULGARIS* 51, Flints.: Small plant on rock face, adjacent to the 'Leete', Pontnewydd, Pantymwyn, SJ188650, M. Brummage, 1998. 2nd recent record. *†113(A), Channel Is. (Alderney): Established & spreading on low cliff, Longis Bay, WA595080, B. Bonnard, 1988, det. D. McClintock.

†29/1.2. *BERBERIS THUNBERGII* *41, Glam.: Apparently bird-sown in hedgebank, Penmaen, SS526885, A.S. Lewis, 2001.

†29/1.4. *BERBERIS WILSONIAE* *50, Denbs.: Pathside, Rhyd y Foel, SH914772, WFS group, 2000.

†29/1.6. *BERBERIS GAGNEPAINII* *29, Cambs.: Gravel pit, Wimblington, TL437908, G.M.S. Easy, 1975-1983, **herb. G.M.S.E.** Bird sown in car park, riverside, Chesterton, TL462593, G.M. S. Easy, 1987, **herb. G.M.S.E.** 1st & 2nd records.

†29/1.9. *BERBERIS DARWINII* *29, Cambs.: Wall, in Peterhouse, TL448579, G.M.S. Easy, 1987, **herb. G.M.S.E.** *113(A), Channel Is. (Alderney): Garden escape in scrub, at Corblets opposite driveway to Fort, WA598088, B. Bonnard, 1989.

†29/1.9×emp. *BERBERIS* × *STENOPHYLLA* (*B. DARWINII* × *B. EMPETRIFOLIA*) *99, Dunbarton: By path in wood, East Helensburgh, NS3083, A. Rutherford, 1999.

†30/1.3b. *PAPAVER SOMNIFERUM* subsp. *SETIGERUM* *44, Carms.: Several plants in sandy grassland of golf course, Pembrey Burrows, SN431003, V. & A. Lewis, 2000.

30/1.5b. *PAPAVER DUBIUM* subsp. *LECOQUII* 39, Staffs.: Around farm buildings, Combridge, SK094379, I.J. Hopkins, 1996. Rough ground, near Densley Lodge, Draycott in the Clay, SK162301, C. Higginbottom, C.N. Smith & M. Smith, 2001. 1st recent records.

†30/6.1. *ESCHSCHOLZIA CALIFORNICA* *113(S), Channel Is. (Sark): Several plants, in rough grass beside path, Near Myrtle Cottage near Aval du Creux, WV471759, R.M. Veall, 2000, **herb. Société Sercquaise**. No other cultivated plants nearby.

†31/3.1. *PSEUDOFUMARIA LUTEA* *113(A), Channel Is. (Alderney): 3 plants (garden escape) in a gutter, in St Martin's, WA572072, B. Bonnard, 1990.

†31/3/2. *PSEUDOFUMARIA ALBA* *29, Cambs.: Wall, Church Lane, Ely, TL58F, R.M. Payne, 2001. Several self-sown plants (with *P. lutea*) on low brick walls, Tenison Road, Cambridge, TL460576, A.C. Leslie, 2001. 1st & 2nd records.

31/5.1a. *FUMARIA CAPREOLATA* subsp. *CAPREOLATA* f. *CAPREOLATA* *29, Cambs.: About 10 plants on the slope of made up ground, W side of High Ditch Road at its junction with Newmarket Road, NE of Cambridge Airport, TL505594, A.C. Leslie, 2001, **CGE**, det. P.D. Sell.

31/5.3. *FUMARIA BASTARDII* *80, Roxburghs.: Turnip field unploughed for 12 years, Easter Hill, Kittyfield, Gattonside, NT565354, L. Gaskell, 2001, **herb. R.W.M. Corner**, conf. M.E. Braithwaite. Field, Charlesfield, St Boswells, NT588297, L. Gaskell, 2001, **herb. R.W.M. Corner**. 1st & 2nd records.

31/5.6. *FUMARIA PURPUREA* *H6, Co. Waterford: Waste ground on edge of dunes, Bunmahon, X436987, P.R. Green, 2001, **NMW**, det. T.C.G. Rich.

†31/5.car. *FUMARIA CAROLIANA* *29, Cambs.: Garden flower bed, Commercial End, Swaffham Bulbeck, TL556633, G. Crompton, 1996, **CGE**, det. P.D. Sell. 1st British record.

33/1.1×3×4. *ULMUS* × *HOLLANDICA* (*U. GLABRA* × *U. MINOR* × *U. PLOTII*) †77, Lanarks.: Planted trees but extensively suckering and some apparently self sown, on trackside near R. Clyde, Uddingston, NS6860, P. Macpherson, 2000, **herb. P. Macpherson**, det. M. Coleman.

†33/2.3. *CORYDALIS CHEILANTHIFOLIA* *29, Cambs.: One plant at base of wall in alleyway, off Ferry Path, Chesterton, TL455593, A.C. Leslie, 2001.

†34/1.1. *CANNABIS SATIVA* *113(S), Channel Is. (Sark): Casual of unknown origin, in dense woodland, including remains of derelict orchard, near La Moinerie, WV462764, R.M. Veall, 2000, **herb. Société Sercquaise**.

†35/1.1. *MORUS NIGRA* ***29**, Cambs.: 1 apparently bird sown plant (c.45cm tall) emerging from a crack in concrete front 'garden', Clarendon Street, Cambridge, TL455583, A.C. Leslie, 2001. 1st record not planted.

†35/2.1. *FICUS CARICA* ***113(A)**, Channel Is. (Alderney): Originally planted on track and gardens, Clonque, WA563075, B. Bonnard, 1988.

36/1.1gal. *URTICA DIOICA* subsp. *GALEOPSISIFOLIA* ***H6**, Co. Waterford: Several large stands, on banks of R. Suir, Gibbethill, S585135, I.P. Green, 2001.

†36/3.1. *SOLEIROLIA SOLEIROLII* ***93**, N. Aberdeen: Old churchyard, New Aberdour, NJ884643, D. Welch, 1999, **herb. D. Welch**.

39/4.3. *QUERCUS ILEX* *†**113(A)**, Channel Is. (Alderney): Frequent, possibly originally planted but self-seeding well, St Anne, WA574075, C. Helyar, 1988.

39/4.5. *QUERCUS PETRAEA* ***113(A)**, Channel Is. (Alderney): In old hedges, as at Longis Bay, WA589075, B. Bonnard, 1988.

39/4.5×6. *QUERCUS ROSACEA* (*Q. PETRAEA* × *Q. ROBUR*) ***79**, Selkirks.: Middle sized tree with small acorns, on road verge, Ettrick Bridge, NT3824, M. Matthews, 2000, det. D.R. McKean. 1st localised record.

40/1.3. *BETULA NANA* ***93**, N. Aberdeen: Flushed mire, White Hill of Bogs, NJ443257, D. Welch, 2001.

†40/2.3. *ALNUS CORDATA* ***50**, Denbs.: Planted in lead mines park, New Brighton, Wrexham, SJ275510, BSBI group, 2001.

†40/2.rub. *ALNUS RUBRA* **44**, Carms.: 1 bush c.2.5m tall, side of forest road, Crychan Forest, SN844389, J. Iliff, 1991, **NMW**, det. A.O. Chater. 2nd record, assumed to be planted.

40/3.1. *CARPINUS BETULUS* *†**113(A)**, Channel Is. (Alderney): Probably planted along road, Longis Road near Catholic cemetery & St Anne's churchyard, WA584074, R. Waterman, 1988. *†**113(S)**, Channel Is. (Sark): Planted beside footpath, S of Le Manoir, beside path to Stocks Hotel, WV466757, R.M. Veall, 1999, **herb. Société Sercquaise**, det. R.A. Waterman.

†41A/MIR.jal. *MIRABILIS JALAPA* ***113(A)**, Channel Is. (Alderney): Rare persisting garden weed or escape, Platte Saline, WA568079, B. Bonnard, 1987, det. D. McClintock.

†42/1.1. *APTENIA CORDIFOLIA* ***113(A)**, Channel Is. (Alderney): Established on several old walls, in St Anne, WA575075, B. Bonnard, 1987, det. D. McClintock.

†42/8.2. *CARPOBROTUS EDULIS* (yellow-flowered form) ***113(A)**, Channel Is. (Alderney): Established on lower part of cliffs, below Essex Hill, WA595073, BSBI meeting, 1995.

†42/8.3. *CARPOBROTUS GLAUDESCENS* ***113(A)**, Channel Is. (Alderney): Naturalised on sandy shores and near old forts, NE corner of Island, WA604085, B. Bonnard, 1987, det. D. McClintock.

†43/1.1. *CHENOPODIUM AMBROSIOIDES* ***29**, Cambs.: Track of old railway, Burwell, TL584655, G.M.S. Easy, 1991, **herb. G.M.S.E.**

43/1.10. *CHENOPODIUM HYBRIDUM* ***64**, Mid-W. Yorks.: A dozen plants, at edge of arable field, Bridge Hewick, SE333703, Mid-W. Yorks. Plant Recording Group, 1999, det. P.P. Abbott.

†43/1.14. *CHENOPODIUM OPULIFOLIUM* **61**, S.E. Yorks.: Casual only in arable margin, near Skidby, TA0133, J. Dews, 1999, det. J.R. Akeroyd. 1st recent record.

†43/1.des. *CHENOPODIUM DESICATUM* ***29**, Cambs.: Roadside verge on E side of A603, Barton, TL415559, J. Benfield, 1997, det. P.D. Sell & S.M. Walters.

43/3.10. *ATRIPLEX PORTULACOIDES* ***48**, Merioneth: Mature hummocks along c.60m at edge of creek in muddy saltmarsh, Artro estuary, SH5626, P.M. Benoit & D.J. Brown, 2001, 1st localised record.

43/3.2×4. *ATRIPLEX* × *GUSTAFSSONIANA* (*A. LONGIPES* × *A. PROSTRATA*) ***5**, S. Somerset: Growing with *Bolboschoenus maritimus* in brackish ditch, Wall Common, Steart, ST258451, I.P. Green, 2000, conf. J.R. Akeroyd.

43/3.3. *ATRIPLEX GLABRIUSCULA* **35**, Mons.: Several scattered plants in saltmarsh, between the transporter bridge & Alpha Steel, Newport, ST3285, T.G. Evans, 2000. 1st recent record.

43/3.4. *ATRIPLEX LONGIPES* **35**, Mons.: Several plants in saltmarsh, just above mud of River Usk, NW of Alpha Steel, Newport, ST326854, T.G. Evans, 2000, **NMW**. 2nd record. ***H6**, Co. Waterford: 3 plants only, on shore of brackish pond, Little Island, Ballynakil, Waterford City, S652112, P.R. Green, I.P. Green & D. Berridge, 2001, **DBN**, conf. J.R. Akeroyd. New to Ireland.

43/3.8. *ATRIPLEX LACINIATA* ***91**, Kincardines.: Gravelly shore, Nigg Bay, NJ965048, D. Welch, 1998, **ABD**.

43/8.1b. *SALSOLA KALI* subsp. *RUTHENICA* **29**, Cambs.: Waste ground by farm buildings, New Farm, Whittlesford, TL452489, G.M.S. Easy, 1994, **herb. G.M.S.E.** 1st recent record.

†44/1.1. *AMARANTHUS RETROFLEXUS* **44**, Carms.: New embankment for cycleway, Morfa Bacas, SS547983, A. & V. Lewis, 1999. 2nd record.

†44/1.hyp. *AMARANTHUS HYPOCHONDRIACUS* ***44**, Carms.: 3 plants only, with other casuals, on ground recently disturbed by bridge construction, below eastern side of Pont d'Agen, Sandy, Llanelli, SN499002, R.D. Pryce & K.A. Cottingham, 2001, **NMW**, det. T.B. Ryves.

†45/1.1. *PORTULACA OLERACEA* ***113(A)**, Channel Is. (Alderney): Casual in gravel, at the Old Barn, Longis, WA594078, M. Long, 2001.

†45/2.2. *CLAYTONIA SIBIRICA* ***113(A)**, Channel Is. (Alderney): Garden escape, at Platte Saline, WA568078, B. & J. Bonnard, 1986, det. D. McClintock.

46/1.1c. *ARENARIA SERPYLLIFOLIA* subsp. *LEPTOCLADOS* †**64**, Mid-W. Yorks.: Roadside bank, Aberford, SE432386, Leeds Naturalists' Club, 2001. Probably introduced with foreign seed during landscaping.

46/4.2. *MINUARTIA VERNA* ***H6**, Co. Waterford: 31 plants, on E-facing rocky cliff, Coummahon, Comeragh Mountains, S328094, P.R. Green, 2001.

46/7.2x3. *CERASTIUM ARVENSE* × *C. TOMENTOSUM* ***39**, Staffs.: Churchyard, Worsley, SO893878, M.E. Smith, 2001, conf. A.C. Leslie.

46/10.1. *SAGINA NODOSA* **29**, Cambs.: Open rabbit-grazed grassland of old sand and gravel pit, Whittlesey brick-pits, TL253976, N.P. Miller, 1997 & 1998. 1st recent record. ***47**, Monts.: Edge of small flush, Machynlleth, SN79, C. Forster-Brown, 1999.

46/14.1. *ILLECEBRUM VERTICILLATUM* *†**52**, Anglesey: Single plant, presumably casual, limestone quarry, Bwrdd Arthur, SH5881, N. Woodhead, 1958, **NMW**, det. T. Rich, 2001.

46/17.4. *SPERGULARIA RUBRA* *†**H6**, Co. Waterford: Possibly introduced with gravel for forest ride, Portlaw, S463139, I.P. Green, 2001.

†46/19.1. *AGROSTEMMA GITHAGO* **35**, Mons.: 1 large plant in crack between base of wall and patio, Lion Inn, Trellech, SO501055, G. Harris, 2000, det. T.G. Evans. 1st recent record.

46/20.4. *SILENE VULGARIS* **91**, Kincards.: Roadside, Fettercairn, NO629723, D. Welch, 2001, **ABD**. Only extant site.

†46/20.7. *SILENE ARMERIA* ***113(A)**, Channel Is. (Alderney): Casual in rough ground, at La Murette, WA572069, C. Johns, 1993, det. D. McClintock. New to Guernsey Bailiwick.

46/20.11. *SILENE GALLICA* **50**, Denbs.: Railway bank, Abergele, SH947788, M. Stead, 2000. 2nd record.

†46/20.mus. *SILENE MUSCIPULA* ***46**, Cards.: One plant, casual on new Environment Agency floodbank, on S side of Afon Rheidol, Glanrafon Industrial Estate, SN614804, A.O. Chater, 2001.

†46/22.1. *SAPONARIA OFFICINALIS* ***110**, Outer Hebrides: Lochmaddy, NF96, L.S. Garrad, 1998.

†46/25.3. *DIANTHUS BARBATUS* ***52**, Anglesey: 1 plant, well away from habitation, sand dune ridge, Tywyn Fferam, SH3371, BSBI meeting, 2001.

46/25.5. *DIANTHUS DELTOIDES* **50**, Denbs.: Grassland on lead mine spoil tips, New Brighton, SJ273509, P. Thomas, 2000, det. J.A. Green. 2nd recent record. *†**113(S)**, Channel Is. (Sark): Garden escape on roadside bank, Westward Ho, Rue du Sermon, WV462760, R.M. Veall, 1999, **herb. Société Sercquaise**.

†47/1.2. *PERSICARIA CAMPANULATA* ***52**, Anglesey: Thoroughly established in wet woodland, near Ty Fry, Pentraeth, SH5176, I.R. Bonner & N. Brown, 2000. ***110**, Outer Hebrides: Lochmaddy, NF917684, L.S. Garrad, 1998.

47/1.15. *PERSICARIA MITIS* ***49**, Caerns.: Numerous scattered plants at edge of oxbow, near Llanrwst, SH792626, R. Lewis, 1997, det. J. Timson. 1st record for N. Wales.

†47/1.cap. *PERSICARIA CAPITATA* *29, Cambs.: Single plant in gutter and at base of house wall (below a hanging basket including this species), Norwich Street, Cambridge, TL454574, P.H. Oswald & C.D. Preston, 1999. Flowering in gutter, at E end of Saxon Street, Cambridge, TL452576, P.H. Oswald, 2000, **CGE**. 1st & 2nd records. *39, Staffs.: Pavement, alleyway leading from Stanley Street, Leek, SJ983565, J.E. Hawksford, 1998. Pavement, by wall, W side of road, near entrance to car park of The Chetwynd Centre, Stafford, SJ922228, J.E. Hawksford, 1999. 1st & 2nd records. *41, Glam.: On brick paving, in Swansea Marina, SS661927, A.S. Lewis, 2000. *42, Brecks.: Pavement, Crickhowell, SO216182, C. Porter, 2001, det. M. Porter.

†47/1.run. *PERSICARIA RUNCINATA* *77, Lanarks.: Established on bank of R. Clyde, Hazelbank, NS8345, P. Macpherson, 2001, **herb. P.M.** det. E.J. Clement.

†47/3/1. *FAGOPYRUM ESCULENTUM* 46, Cards.: 6 plants, casual only, on new Environment Agency floodbank, on S side of Afon Rheidol, Glanrafon Industrial Estate, SN614804, A.O. Chater, 2001, **NMW**. 1st recent record. 99, Dunbarton: Landscaped area, Pier-head, Helensburgh, NS2982, A. Rutherford & A.McG. Stirling, 1998. 2nd record.

47/4.1. *POLYGONUM MARITIMUM*, 13, W. Sussex: 20+ plants scattered on shingle – ranging from seedlings to mature plants, East Head, SZ766994, E. Sturt, 2001. 2nd recent record & only extant site.

47/4.4. *POLYGONUM AVICULARE* subsp. *NEGLECTUM* *44, Carms.: Cobbled courtyard of farm buildings, Glynhir Mansion, Llandybie, SN640151, A.O. Chater, 2001, **NMW**, det. T. Karlsson. 1st record for subsp.

47/4.6. *POLYGONUM RURIVAGUM* *44, Carms.: Old coal tip, N of Glyn-tai, 2km S of Llandybie, SN617133, A.O. Chater & R.D. Pryce, 2001, **NMW**, det. T. Karlsson.

†47/4.cog. *POLYGONUM COGNATUM* 39, Staffs.: Patch 30cm in diameter apparently established on a raised grassy track in a marshy field owned by a brewery, Burton upon Trent, SK2523, M.E. Smith, 2000, conf. B.S. Wurzell. Only extant site.

†47/5.1. *FALLOPIA JAPONICA* *113(A), Channel Is. (Alderney): Established and locally abundant over 100m, in La Bonne Terre, WA565078, B. Bonnard, 1986, det. D. McClintock.

†47/5.1×2. *FALLOPIA* × *BOHEMICA* (*F. JAPONICA* × *F. SACHALINENSIS*) *29, Cambs.: 1 large patch to N of footpath, W of St Wendreda's church, March, TL413952, A.C. Leslie, 2001, **LTR**, conf. A.P. Conolly. *110, Outer Hebrides: Callanish, NB2130, L.S. Garrad, 1998.

†47/5.3. *FALLOPIA BALDSCHUANICA* *99, Dunbarton: Increasing on railway bank, E of Cardross station, NS3477, A. Rutherford, 2000. *113(A), Channel Is. (Alderney): Garden escape in several sites, as at Crabbe, WA572079, B. Bonnard, 1986, det. D. McClintock.

48/8.1b. *RUMEX ACETOSELLA* subsp. *PYRENAICUS* *44, Carms.: Sparsely vegetated old colliery tip on steep slope, c.300m N of Glytai Fawr, Ammanford, SN617133, A.O. Chater, R.D. Pryce & K.A. Cottingham, 2001, det. A.O.C. 1st record for subsp.

47/8.8×19. *RUMEX* × *HYBRIDUS* (*R. LONGIFOLIUS* × *R. OBTUSIFOLIUS*) *80, Roxburghs.: With both parents, on road verge, Charlesfield roadend near A68, St Boswells, NT592302, M.E. Braithwaite, 2001, **herb. R.W.M. Corner**.

47/8.10×19. *RUMEX* × *LINGULATUS* (*R. HYDROLAPATHUM* × *R. OBTUSIFOLIUS*) 5, S. Somerset: Single specimen growing with both parents, on south bank of canal, Bridgwater & Taunton Canal, Bathpool, ST254260, I.P. Green, 2000. *64, Mid-W. Yorks.: Disused tip, Burley-in-Wharfedale, SE156465, M. Wilcox, 1999, det. J.R. Akeroyd.

†47/8.11. *RUMEX CRISTATUS* *29, Cambs.: Waste ground, Chesterton railway sidings, TL475606, A.C. Leslie, 2000, **herb. A.C.L.**

47/8.13×15. *RUMEX* × *SAGORSKII* (*R. CRISPUS* × *R. SANGUINEUS*) *29, Cambs.: With both parents at cornfield margin, by Borley Wood, TL582475, A.C. Leslie, 1978. 1 plant (with both parents and no other docks), field edge by water towers, S of Madingley, TL393593, A.C. Leslie, 2000. 1st & 2nd records.

47/8.14×18. *RUMEX* × *MURETII* (*R. CONGLOMERATUS* × *R. PULCHER*) *29, Cambs.: 1 plant at the edge of a population of *R. pulcher*, NW corner of Midsummer Common, Cambridge, TL454593, A.C. Leslie, 2000, **RNG**, det. J.R. Akeroyd.

47/8.15×19. *RUMEX* × *DUFFTII* (*R. SANGUINEUS* × *R. OBTUSIFOLIUS*) *68, N. Northumb.: Roadside, near level-crossing, Brunton, NV208238, G.D. Kitchener, 2000.

47/8.16. *RUMEX RUPESTRIS* **45**, Pembs.: 4 flowering plants in flushed strand zone of cobbles, sand & rock platform, SE end of Marloes sands, SM789068, S.B. & A.E. Evans, 2000. Over 25 flowering plants on damp ledges of sea cliff, Watery Bay, Marloes, SM760978, S.B. Evans, 2000. 1st & 2nd recent records.

47/8.21. *RUMEX MARITIMUS* *†**46**, Cards.: 1 large plant, casual only, on new verge, by Ysgol Penweddig, Llanabadarn Road, Aberystwyth, SN595811, A.O. Chater & C.D. Preston, 2001, **NMW**.

50/1.1. *ELATINE HEXANDRA* ***5**, S. Somerset: 6 specimens on exposed mud of reservoir, Clatworthy Reservoir, ST031307, I.P. Green, 2000.

51/1.3. *HYPERICUM ANDROSAEMUM*, **113(A)**, Channel Is. (Alderney): Quarry, Clonque, WA562074, D. McClintock, 1982. 2nd record.

†51/1.3×4. *HYPERICUM* × *INODORUM* (*H. ANDROSAEMUM* × *H. HIRCINUM*) ***39**, Staffs.: Disused car park, rear of Cotwall End Nature Centre, S of Sedgley, SO912927, B. Hopton, 2001.

†51/1.4. *HYPERICUM HIRCINUM* ***44**, Carm.: 1 large bush on stony waste near entrance to WWT Centre, Penclacwydd, SS533987, V. & A. Lewis, 2001. Locally abundant in waste ground and verges, Bynea, SS5598, V. & A. Lewis, 2001. 1st & 2nd records.

51/1.6×7des. *HYPERICUM* × *DESETANGSII* nothosubsp. *DESETANGSII* (*H. PERFORATUM* × *H. MACULATUM* subsp. *OBTUSIUSCULUM*) ***44**, Carm.: River meadow of R. Teifi, SW of Pengraig, Pentre-cwrt, SN393395, G. Hutchinson, 1991, **NMW**, det. N.K.B. Robson. 1st record for nothosubsp.

51/1.10×11. *HYPERICUM HUMIFUSUM* × *H. LINARIIFOLIUM* ***45**, Pembs.: Dry, S-facing seacliff, Morfa Common, Nine Wells, Solva, SM784242, M. Sutton, 2001, det N.K.B. Robson.

51/1.16. *HYPERICUM ELODES* **39**, Staffs.: The Spectacles, Aqualate Mere National Nature Reserve, SJ915231, E. Radford, 2001. 1st recent record.

†51/1.for. *HYPERICUM FORRESTII* ***77**, Lanarks.: Established self-sown colony, in wall and at base of wall, Ruchill, Glasgow, NS5768, P. Macpherson, 2001, **herb. P. Macpherson**, det. N.K.B. Robson.

53/1.1. *MALVA MOSCHATA* **91**, Kincards.: Grassland by ruin, St Mary's Kirk, Stonehaven, NO884873, D. Welch, 2001. Only extant site.

†53/1.5. *MALVA PARVIFLORA* **39**, Staffs.: 3 plants as garden weed, Burton-on-Trent, SK2424, M.E. Smith, 2001. Only extant site.

†53/2.3×olb. *LAVATERA* × *CLEMENTII* (*L. THURINGIACA* × *L. OLBIA*) ***29**, Cambs.: 1 plant in hedge on W side of road, between Ashwell station and A505, TL297383, A.C. Leslie, 2001.

53/3.1. *ALTHAEA OFFICINALIS* *†**2**, E. Cornwall: Established, along the banks by the tidal edge of the R. Lerryn, Lerryn, SX140570, P.R. Green, 2001.

†53/4.1. *ALCEA ROSEA* ***99**, Dunbarton: Hedge bottom by footpath, Craigendoran, NS3081, A. Rutherford, 1999 Still there 2002.

†53/6.vit. *ABUTILON VITIFOLIUM* ***113(S)**, Channel Is. (Sark): 2 mature shrubs self-seeded or bird-sown, c.4m tall, in garden, Maison Pommier, WV466769, R.M. Veall, 2000, **herb. Société Serequaise**.

57/1.1. *VIOLA ODORATA* *†**113(A)**, Channel Is. (Alderney): Established under ash trees, in Val Reuters, WA578073, R. Waterman & B. Bonnard, 1986, det. D. McClintock.

†57/1.2. *VIOLA LABRADORICA* hort. non Schrank. ***29**, Cambs.: Flowering among purplish foliage on pavement, Brookside, Cambridge, TL451575, P.H. Oswald, 1999.

57/1.4×6. *VIOLA* × *INTERSITA* (*V. RIVINIANA* × *V. CANINA*) ***43**, Rads.: W-facing fields, Gilfach, SN964715, S.P. Chambers, 1998, conf. D.M. Moore. ***81**, Berwicks.: N-facing slope, Marchcleugh Craggs, NT687399, M.E. Braithwaite & R.W.M. Corner, 2000.

57/1.6. *VIOLA CANINA* **43**, Rads.: W-facing fields, Gilfach, SN964715, S.P. Chambers, 1998, conf. D.M. Moore. 1st recent record. **81**, Berwicks.: 1 plant in cleft in S-facing rocks, Marchcleugh Craggs, NT687399, M.E. Braithwaite & R.W.M. Corner, 2000. 2nd extant site.

57/1.6a. *VIOLA CANINA* subsp. *CANINA* **65**, N.W. Yorks.: Heath, Catterick Garrison, Foxglove Covert LNR, SE161970, I. Lawrence, 2001. 2nd recent record.

†57/1.11×12×alt. *VIOLA* × *WITTROCKIANA* (*V. LUTEA* × *V. TRICOLOR* × *V. ALTAICA*) *99, Dunbarton: Waste ground, West Helensburgh, NS3083, A. Rutherford & A. McG. Stirling, 1996.

57/1.12a. *VIOLA TRICOLOR* subsp. *TRICOLOR* 45, Pembs.: Coastal reversion field, Llanferran Farm, 3km N of St Davids, SM754288, S.B. & A.E. Evans, 2000. Only extant site.

59/9.1. *ARBUTUS UNEDO* †44, Carms.: Mature tree, reputedly over 100 years old in lawned grounds of hotel, Ashburnham Hotel, Pembrey, SN434008, P. Clark, 2001, det. R.D. Pryce. Only extant site.

61/1.3a. *POPULUS NIGRA* subsp. *BETULIFOLIA* 45, Pembs.: Twin stemmed tree c.18m high on river bank, Western Cleddau near old paper mills, Haverfordwest, SM953177, S.B. Evans, 2000. 1st record as possible native.

†61/1.4. *POPULUS TRICHOCARPA* *44, Carms.: 2 young trees, apparently not planted on slope in abandoned limestone quarry, Cilyrychen Quarry, N of Llandybie, SN614165, A.O. Chater, R.D. Pryce & K.A. Cottingham, 2001.

61/2.2×3. *SALIX* × *RUBENS* (*S. FRAGILIS* × *S. ALBA*) *93, N. Aberdeen: Woodland edge, Laithers, NJ675492, D. Welch, 1999, **herb. D.W.**, det. R.D. Meikle.

61/2.3. *SALIX ALBA* *113(A), Channel Is. (Alderney): Frequent, suckering freely on golf course, The Nunnery, WA595080, B. Bonnard, 1988. Possibly native.

61/2.4. *SALIX TRIANDRA* 79, Selkirks.: Riverside, N bank of R. Tweed upstream from Tweed Bridge, The Rink, NT487322, R.W.M. Corner, 2001, **herb. R.W.M.C.** 2nd extant site.

61/2.4×9. *SALIX* × *MOLLISSIMA* (*S. TRIANDRA* × *S. VIMINALIS*) *49, Caerns.: Sand dunes, West shore, Llandudno, SH7781, W. McCarthy, 2000, det. R.D. Meikle.

61/2.5×11b. *SALIX* × *PONTERIANA* (*S. PURPUREA* × *S. CINEREA* subsp. *OLEIFOLIA*) *46, Cards.: 5 bushes on Teifi bank, 200m S of Llanybydder church, SN518437, T.C.G. Rich & A.O. Chater, 1993, **NMW**, conf. R.D. Meikle on material recollected in 2000.

†61/2.6. *SALIX DAPHNOIDES* *95, Moray: A good sized tree growing with other willows, on shingle bank, R. Spey, Aviemore, NH896120, K.K. Harrison, 2000, det. R.D. Meikle.

†61/2.7. *SALIX ACUTIFOLIA* *80, Roxburghs.: Originally planted at side of loch, N side of Bowden Moor Reservoir, Melrose, NT540317, J.J. Day, 1997, **herb. R.W.M. Corner**.

61/2.9×11×16. *SALIX* × *ANGUSENSIS* (*S. VIMINALIS* × *S. CINEREA* × *S. REPENS*) *58, Cheshire: Dunes, Leasowe, SJ2491, E.F. Greenwood, 2001, **LIV**, det. R.D. Meikle.

61/2.10×11. *SALIX* × *REICHARDTII* (*S. CAPREA* × *S. CINEREA*) *93, N. Aberdeen: Coastal grassland, Bullers of Buchan, NK109379, D. Welch, 1994, **herb. D.W.**, det. R.D. Meikle.

61/2.11a. *SALIX CINEREA* subsp. *CINEREA* *64, Mid-W. Yorks.: Edge of reservoir, Fewston, SE189541, M. Wilcox, 1999, det. R.D. Meikle. 1st confirmed record.

61/2.12×15. *SALIX* × *LUDIFICANS* (*S. AURITA* × *S. PHYLICIFOLIA*), 96, Easterness: Burnside, Elrick Burn, 2.4km S of Coignafearn, NH6712, M. McCallum Webster, 1970, **E**, det. D.R. McKean. 2nd & 1st recent record.

†61/2.bab. *SALIX BABYLONICA* *113(A), Channel Is. (Alderney): Probably planted in gardens, Val du Saue, WA573063, C. Helyar, 1988.

†62/2.1. *DECURAINIA SOPHIA* 44, Carms.: Several plants at edge of cinder-surfaced trackway, Pembrey Saltings LNR, SN417002, I.K. Morgan, 2000. 1st recent record. 80, Roxburghs.: Set-aside grassland (sown), Kittyfield farm, Gattonside, NT556355, L. Gaskell, 2001, **herb. R.W.M. Corner**. 2nd recent record.

†62/10.1. *MATTHIOLA INCANA* *44, Carms.: Escaped into sandy ground in village, Pendine, SN234079, R.D. Pryce & K.A. Cottingham, 2001.

†62/11.3. *BARBAREA INTERMEDIA* *52, Anglesey: Disturbed ground in improved pasture, near Cors Erddreiniog, SH4780, I.R. Bonner, 2000.

62/12.3. *RORIPPA ISLANDICA* *5, S. Somerset: Thousands of plants around margins of reservoir, Clatworthy Reservoir, ST038306, I.P. Green, 2001, conf. T.C.G. Rich. 1st English record.

†62/13.1. *ARMORACIA RUSTICANA* 79, Selkirks.: 1 plant, on eroding river bank, S side R. Ettrick, Victoria Park, Selkirk, NT463285, R.W.M. Corner, 2001, **herb. R.W.M.C.** 1st recent record.

62/14.7×8. *CARDAMINE* × *ZAHLBRUCKNERIANA* (*C. FLEXUOSA* × *C. PRATENSIS*). *46, Cards.: 1 plant in gravelly car park, Eglwys Newydd church, Hafod, SN768736, A.O. Chater & J.P. Woodman, 2001, **NMW**, conf. T.C.G. Rich. *95, Moray: Bare ground on old railway line, Knockando, NJ180411, I.P. Green, 1999, **NMW**, conf. T.C.G. Rich.

†62/14.cor. *CARDAMINE CORYMBOSA* *78, Peebles.: Troublesome garden weed, Broughton Place, Broughton, NT115374, D. Binns, 2000, det. D.R. McKean. *99, Dunbarton: Nursery weed, The Linn, Cove, NS2282, J. Taggart, 1998.

†62/14.hep. *CARDAMINE HEPTAPHYLLA* *64, Mid-W. Yorks.: Holden Clough, SD7749, V. Gordon, 1961, **LIV**, det. T.C.G. Rich.

62/23.1×3. *COCHLEARIA* × *HOLLANDICA* (*C. ANGLICA* × *C. OFFICINALIS*) *95, Moray: Saltmarsh, Findhorn Bay, Findhorn, NJ018633, M. Wilcox, 2001, conf. P.S. Wyse Jackson.

†62/23.3b. *COCHLEARIA OFFICINALIS* subsp. *OFFICINALIS* *29, Cams.: 1 small patch at base of building, South Brink, Wisbech, TF457094, G.M.S. Easy, 2001.

62/28.1. *THLASPI ARVENSE* 110, Outer Hebrides: Garden weed, Stornoway, NB431334, R.J. Pankhurst & W. Cunningham, 2001. 1st recent record. *†113(A), Channel Is. (Alderney): Several hundred plants in a fallow field (probably casual only), Val du Saue, WA573063, B. Bonnard, 1986, det. D. McClintock.

62/30.2. *LEPIDIUM CAMPESTRE* 67, S. Northumb.: 3 plants, by side of dismantled railway line, S of Shiremoor, NZ3269, A. & G. Young, 2000, **herb. G.A. Swan**. Only extant site.

†62/31.2. *CORONOPUS DIDYMUS* 81, Berwicks.: New industrial area, Gunsgreen, Eyemouth, NT948644, M.E. Braithwaite, 2000. 2nd record.

†62/35.2a. *SINAPIS ALBA* subsp. *ALBA* *44, Carms.: 1 casual plant only on W bank of access road to coast, Machynys, Llanelli, SS506982, R.D. Pryce & K.A. Cottingham, 2001. 1st definite record of subsp.

†62/38.1. *HIRSCHFELDIA INCANA* *52, Anglesey: Single plant, dunes, Traeth Lligwy, SH4987, I.R. Bonner & T.D. Dines, 2000.

62/41.1. *CRAMBE MARITIMA* *46, Cards.: 1 plant on shingle, Ynys-las, SN609922, R. Birch, 2001.

†62/ERU.ves.a. *ERUCA VESICARIA* subsp. *SATIVA* *113(A), Channel Is. (Alderney): Casual on dunes, at Platte Saline, WA565079, R. Waterman, 1980, det. D. McClintock. New to Channel Is.

65/12.8. *ERICA VAGANS* *†77, Lanarks.: Dumped or self-sown and surviving, in rough grassland at the edge of an industrial estate, Laigh Mains, East Kilbride, NS6356, B. Simpson, 2001, **herb. P. Macpherson**.

†65/8.1. *GAULTHERIA SHALLON* *H6, Co. Waterford: Small patch, roadside, Ballyrafter, X051997, P.R. Green, 2001.

66/1.1. *PYROLA MINOR* 39, Staffs.: Under *Salix* scrub, Huntley Wood, S of Brookhouses, SJ996414; In large quantity under birch, oak and willow, old spoil mound, Brookhouses, SJ990425; both I.J. Hopkins, 1999. 1st recent records.

66/1.3a. *PYROLA ROTUNDIFOLIA* subsp. *ROTUNDIFOLIA* 39, Staffs.: 53 flowering plants, fen, near Chasetown, SK0308, D.G. Evans, 2001. 1st recent record.

†69/1.9. *PRIMULA JAPONICA* *43, Rads.: Wet woodland, Withybeds, Presteigne, SO310649, S.P. Chambers, 1998, conf. E.J. Clement.

†69/3.1. *CYCLAMEN HEDERIFOLIUM* 44, Carms.: Garden outcast, known for at least 3 years, below Penyfai Lane along B4308, Llanelli, SN497013, I.K. Morgan, 2001, **NMW**. 2nd record. *64, Mid-W. Yorks.: Several clumps naturalised under trees on roadside verge, Copt-Hewick, SE343716, Mid-W. Yorks. Plant Recording Group, 1999. *113(A), Channel Is. (Alderney): Established on grass verge, near Sharp's Farm & Cortil Quartier, WA596087, B. Holding, 1988, det. B. Bonnard. Several clumps established amongst bracken, E coast, St Esqu re Bay, WA607088, B. Bonnard, 1993. 1st & 2nd records.

†69/3.2. *CYCLAMEN COUM* *44, Carms.: Naturalised and in flower on steep roadside bank, Llangathen, SN583222, V. & A. Lewis, 2001.

†69/4.4. *LYSIMACHIA CILIATA* *93, N. Aberdeen: Woodland, New Deer, NJ8947, D. Welch, 1998, **ABD**.

69/6.1. *ANAGALLIS TENELLA* **93**, N. Aberdeen: Marsh, Loch of Strathbeg, NK0859, S. Cutts, 1998, conf. D. Welch. 2nd extant site.

†71/HYD.mac. *HYDRANGAEA MACROPHYLLA* ***113(A)**, Channel Is. (Alderney): Single small bush, ?self-seeded, Roc à l'Epine, WA563075, B. Bonnard, 1987, det. D. McClintock. ***113(S)**, Channel Is. (Sark): Row of bushes up to 2m tall, planted 30 years ago and surviving on roadside verge, near lower end of Harbour Hill, WV476758, R.M. Veall, 1998, **herb. Société Sercquaise**.

†72/2.5. *RIBES ODORATUM* ***46**, Cards.: Roadside hedge, 150m S of Penllwyn crossroads, Capel Bangor, SN652801, S.P. Chambers, 2000, conf. B. Wurzell.

†73/1.3. *CRASSULA HELMSII* **47**, Monts.: Mud adjoining boardwalk across marsh area, Llyn Coed-y-dinas MWT Reserve, Welshpool, SJ221051, M. Wainwright & V. Pate, 2001. 2nd record. ***113(A)**, Channel Is. (Alderney): In water-filled stone tank, on Essex Hill, WA594074, M. Long, 1983, det. D. McClintock. Established in pond, Corblets Quarry, WA596088, B. & J. Bonnard, 1986, det. D. McClintock. 1st & 2nd records. New to Bailiwick.

†73/5.3. *SEDUM CONFUSUM* ***2**, E. Cornwall: Established on exposed head on cliff slopes, between Seaton and Murrayton, SX295543, M.G.C. Atkinson, 1999, det. P.R. Green. ***60**, W. Lancs.: Top of sea wall, near Ferry Cottage, Overton, SD438568, E.F. Greenwood, 2000, **LIV**.

†73/5.4. *SEDUM SPECTABILE* ***41**, Glam.: Gorse scrub by roadside, Pennard Burrows, SS551883, A.S. Lewis, 2000. ***113(A)**, Channel Is. (Alderney): Established garden escape, Le Petit Val and other sites, WA567078, M.L. Mendham, 1986, det. D. McClintock.

†73/5.13. *SEDUM SEXANGULARE* ***64**, Mid-W. Yorks.: Sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE254384, B.A. Tregale & M. Wilcox, 2001.

73/5.16. *SEDUM ANGLICUM* ***77**, Lanarks.: Well established at side of forest track, NNE of Forth, NS9657, F. Macfarlane. 2000, **herb. P. Macpherson**.

†73/5.19. *SEDUM HISPANICUM* ***29**, Cambs.: Single flowering clump on steps of Norwich House, Panton Street (E side), Cambridge, TL453574, P.H. Oswald, 1999. Still present and fruiting in 2000; vegetative only in 2002.

†74/3.1. *BERGENIA CRASSIFOLIA* ***44**, Carms.: Planted on grave and increasing vigorously, Capel Carmel chapelyard, Burry Port, SN458022; Large patch beside recently created walkway in disused quarry, Pentregwenlais, SN604166; both V. & A. Lewis, 2001. 1st & 2nd records. ***113(A)**, Channel Is. (Alderney): Garden escape, Platte Saline, WA567079, B. Bonnard, 1987, det. D. McClintock.

†74/4.1. *DARMERA PELTATA* **80**, Roxburghs.: Well established colony at wet margin of reservoir, N side of Bowden Moor Reservoir, Melrose, NT540317, L. Gaskell, 1998, **herb. R.W. M. Corner**. 1st established record.

74/5.16. *SAXIFRAGA HYPNOIDES* **91**, Kincards.: Flush below rock outcrop, Slack of Birnie, NO676802, E. Woodward, 2000, conf. D. Welch. 1st recent record.

†75/3.7. *SPIRAEA CHAMAEDRYFOLIA* ***95**, Moray: Several bushes, in hedgerow on each side of B9007, S of Bridge of Logie, S of Forres, NJ000496, J. Clarke, 2000, det. E.J. Clement.

†75/5.1. *HOLODISCUS DISCOLOR* ***99**, Dunbarton: Many seedlings of various sizes, on old walls by stream bank, Millig Burn, Helensburgh, NS2982, A. Rutherford, 2000.

†75/7.1. *KERRIA JAPONICA* ***77**, Lanarks.: Established in grassy trackside verge, Bothwell, NS7059, P. Macpherson, 2001, **herb. P.M.**, det. A.McG. Stirling.

75/8.3. *RUBUS SAXATILIS* **39**, Staffs.: A few dozen plants, shady river bank, N of roadside, Ecton, SJ096581, D.R. Larner & J.E. Hawksford, 2000. Only extant site.

75/8.7×321. *RUBUS* × *PSEUDODAEUS* (*R. CAESIUS* × *R. IDAEUS*) ***29**, Cambs.: 1 patch on bank W of A10 just N of roundabout, Royston, TL363423, A.C. Leslie, 2001, **herb. A.C.L.**, conf. A. Bull.

†75/8.9. *RUBUS SPECTABILIS* ***80**, Roxburghs.: Colony 3 × 2m, on riverside with *Salix* spp., S side of R. Tweed NE of Melrose, NT550346, G. MacLaine, 2000, **herb. R.W.M. Corner**.

75/8.28. *RUBUS SCISSUS* ***47**, Monts.: Near Llangurig, SN98, A. Ley, 1886, **BM**, comm. D.E. Allen.

75/8.37. *RUBUS CALVATUS* ***64**, Mid-W. Yorks.: Beside R. Dunsop, Dunsop Bridge, SD659503, D.P. Earl, 1994.

- 75/8.38. *RUBUS CAMBRENSIS* *42, Brecks.: Rocky bank, edge of woodland, track, beside Afon Giedd, N of Cwngiedd, SN789124, BSBI field meeting, 2000.
- 75/8.46. *RUBUS CUMBRENSIS* *64, Mid-W. Yorks.: Roadside, Browsholme, SE687446, D.P. Earl, 1996.
- 75/8.69. *RUBUS PLATYCANTHUS* *64, Mid-W. Yorks.: Stainbeck, Leeds, SE291366, K. Pyne, 1999, det. A. Newton.
- 75/8.82. *RUBUS SILURUM* *64, Mid-W. Yorks.: Laneside, Bashall Eaves, SD690443, D.P. Earl, 1997, det. A. Newton.
- 75/8.88. *RUBUS ACCLIVITATUM* *12, N. Hants.: Hedge of green lane, between Four Marks & Lower Farringdon, SU687347, D.E. Allen, 2000, **BM**, conf. A. Newton.
- 75/8.92. *RUBUS BOUDICCAE* *14, E. Sussex: Balcombe Road, Haywards Heath, TQ3225, R.S. Standen, 1904, **BM**, det. D.E. Allen.
- 75/8.95. *RUBUS CISSBURIENSIS* *29, Cambs.: Locally abundant in front of Museum of Technology, SE side of river, NE of Elizabeth Way Bridge, Cambridge, TL465593, A.C. Leslie, 2001, **herb. A.C.L.**, det. A. Newton.
- 75/8.98. *RUBUS CURVISPINOSUS* *12, N. Hants.: Edge of acid clearing, Itchen Wood, SU525355, D.E. Allen, 2000, **BM**.
- 75/8.105. *RUBUS INCURVATIFORMIS* *64, Mid-W. Yorks.: Roadside, Burley Woodhead, SE151453, D.R. Grant & T. Schofield, 1999.
- 75/8.116. *RUBUS PISTORIS* *12, N. Hants.: Bridleway through heathy birchwood, E of Bramshill Police College, SU757609, D.E. Allen & B. Goater, 2000, **BM**.
- 75/8.116. *RUBUS PISTORIS* *64, Mid-W. Yorks.: Waste grounds, Scotland Mill, Adel, Leeds, SE285387, K. Pyne, 1999, det. A. Newton.
- 75/8.140. *RUBUS ROSSENSIS* *46, Cards.: Roadside hedgebank, 100m N of Henllan Station, SN357408, D.E. Allen, A.O. Chater & R.D. Pryce, 1999, **BM**, conf. A. Newton.
- †75/8.147. *RUBUS BORAEANUS* *29, Cambs.: Horseway, near Chatteris, TL48, A. Newton, 1986.
- 75/8.161. *RUBUS SURREJANUS* *33, E. Glos.: Lidcombe Wood, Stanway, SP0732, H.J. Riddelsdell, 1924, **BM**, det. D.E. Allen.
- 75/8.185. *RUBUS GRIFFITHIANUS* *35, Mons.: Troy Wood, Monmouth, SO51, W.C. Barton & H.J. Riddelsdell, 1923, **BM**, det. D.E. Allen, conf. A. Newton. *64, Mid-W. Yorks.: Wooded laneside, Cow Ark, SD672453, D.P. Earl, 1997, det. A. Newton.
- 75/8.193. *RUBUS MELANODERMIS* *17, Surrey: Wimbledon Common, TQ2171, H.W. Pugsley, 1911 & 1929, **BM**, det. D.E. Allen.
- 75/8.208. *RUBUS CINEROSUS* *11, S. Hants.: Clearing, Coopers Wood, near Bucklers Hard, SZ394987, D.E. Allen, 1984, **BM**.
- 75/8.216. *RUBUS HIBERNICUS* *46, Cards.: Roadside cliff, 250m W of Llwyndafydd, SN368555, D.E. Allen & A.O. Chater, 1999, **BM**, conf. A. Newton.
- 75/8.231. *RUBUS ECHINATOIDES* *42, Brecks.: Scrub, on bank of Afon Tawe, Abercraf, SN813126, M. Porter, 2000.
- 75/8.232. *RUBUS ECHINATUS* 29, Cambs.: Small patch on the abandoned Chesterton railway sidings, Milton, TL474606, A.C. Leslie, 2000, conf. A. Newton. 2nd & 1st recent record.
- 75/8.234. *RUBUS FLEXUOSUS* *47, Monts.: Ffridd Gate, near Machynlleth, SH753025, W.C. Barton, 1923, **BM**, comm. D.E. Allen.
- 75/8.247. *RUBUS PORPHYROCAULIS* *12, N. Hants.: Bracken-covered roadside, Furzy Moor, Winchfield, SU762545, D.E. Allen, 1999, **BM** & **HCMS**, conf. A. Newton.
- 75/8.254. *RUBUS RUFESCENS* *46, Cards.: Lampter, SN5748, R.G. Ellis, 1978, **NMW**, det. R.D. Randall.
- 75/8.259. *RUBUS SUBTERCANENS* *64, Mid-W. Yorks.: Riverside woodland, Gisburn, SD8000485, D.P. Earl & J. Buckley-Earl, 1997.
- 75/8.262. *RUBUS ANGUSTICUSPIS* *46, Cards.: Top of wood by road, Allt y Fedw, Cwm Cou, SN310425, D.E. Allen & A.O. Chater, 1999, **BM**, conf. A. Newton.

75/8.266. *RUBUS BERCHERIENSIS* ***36**, Herefs.: Treville Wood, Wormbridge, SO4332, A. Ley, 1897, **BM**, det. D.E. Allen, conf. A. Newton.

75/8.280. *RUBUS PHAEOCARPUS* *†**64**, Mid-W. Yorks.: Possibly introduced during tree planting from S England, in forest/plantation, Gisburn Forest, SD760574, D.P. Earl & J. Buckley-Earl, 1997, det. A. Newton.

75/8.286. *RUBUS SCABRIPES* ***12**, N. Hants.: Roadside wood margin, Harewood Forest, Andover, SU404464, D.E. Allen, 2000, **BM**, conf. A. Newton.

75/8.289. *RUBUS TARDUS* ***11**, S. Hants.: 2 bushes on ride, Sawyer's Wood, Southwick, SU6408, D.E. Allen, 1995, **BM**, conf. A. Newton.

75/8.301. *RUBUS SCABER* ***46**, Cards.: Felled woodland, Coed Newydd, Coedmor, SN196443, D.E. Allen & A.O. Chater, 1999, **BM**, conf. A. Newton.

75/8.302. *RUBUS ADENOLEUCUS* ***11**, S. Hants.: Roadside, Fulflood, Winchester, SU470301, D.E. Allen, 2000, **BM**, conf. A. Newton. ***42**, Brecks.: Woodland edge near car-park, Henrhyd Falls, Coelbren, SN854120, M. Porter, 1983, **herb. M.P.**

75/8.308. *RUBUS EBORACENSIS* ***29**, Cambs.: Roadside, Little Heath Road, Gamlingay, TL2351, A.L. Bull, 2000, conf. A. Newton.

75/8.314. *RUBUS PICTORUM* *†**10**, Wight: Probably introduced with nursery stock (from Balmoral?), among rhododendrons and on nearby wood margin, Osborne House grounds, SZ5194, D.E. Allen, 1999, **BM** & **HCMS**, conf. A. Newton.

75/8.314. *RUBUS PICTORUM* ***46**, Cards.: Roadside hedgebank, Sarnau, SN315504, D.E. Allen & A.O. Chater, 2001, **NMW**, conf. A. Newton.

75/8.320. *RUBUS WARRENI* ***13**, W. Sussex: Abundant in plantation, Birdham Pool, SU822008, D.E. Allen, 2000, **BM**, conf. A. Newton.

75/8.ari. *RUBUS ARICONIENSIS* ***46**, Cards.: Felled woodland, Coed Newydd, Coedmor, SN196443, D.E. Allen & A.O. Chater, 1999, **BM**, conf. M. Porter.

75/8.pan. *RUBUS PANNOSUS* ***12**, N. Hants.: Clay copses, Ellisfield, SU6343, D.E. Allen, 1982, **BM**, conf. A. Newton.

75/8.pur. *RUBUS PURBECKENSIS* ***H8**, Limerick: Rough ground, Thornfield House, near Annacotty, R6657, E. Armitage, 1901, **BM**, det. D.E. Allen.

75/9.1. *POTENTILLA FRUTICOSA* *†**29**, Cambs.: Small plant in pavement, in front of Shelford railway station, TL465524, G.M.S. Easy, 1988, **herb. G.M.S.E.** Single seedling in E gutter, of Bentinck Street, across pavement from lawn of Hanover Court (with corner planting of shrubs, including presumed parent plant), Cambridge, TL454575, P.H. Oswald & C.D. Preston, 1999. 1st & 2nd records. *†**113(A)**, Channel Is. (Alderney): Occasional garden escape ?self-seeded, Platte Saline, WA568079, B. Bonnard, 1987.

†75/9.7. *POTENTILLA RECTA* ***64**, Mid-W. Yorks.: Old sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE2538, Bradford Botany Group, 1999.

75/9.13×14. *POTENTILLA* × *SUBERECTA* (*P. ERECTA* × *P. ANGLICA*) **5**, S. Somerset: Single large patch on N shore of reservoir, Clatworthy Reservoir, ST045318, I.P. Green, 2001, conf. B. Harold. 1st recent record. **49**, Caerns.: Laneside bank, leading to Pant Gwyn, Tudweiliog, Lleyn Peninsula, SH239379, W. McCarthy, 2001. 1st recent record.

75/9.14×15. *POTENTILLA* × *MIXTA* (*P. ERECTA* × *P. REPTANS* & *P. ANGLICA* × *P. REPTANS*) **49**, Caerns.: Bank near stile, Pant Gwyn, Tudweiliog, Lleyn Peninsula, SH240380, W. McCarthy, 2001. 1st recent record.

75/11.1. *FRAGARIA VESCA* *†**113(A)**, Channel Is. (Alderney): 2 plants of unknown origin in flower & fruit on old stone wall in churchyard, St Anne, WA574074, B. Bonnard, 1997.

†75/18.2. *ACAENA ANSERINIFOLIA* ***99**, Dunbarton: Pavement chinks, West King Street, Helensburgh, NS2982, A. Rutherford, 2001, det. A.McG. Stirling.

75/19.8. *ALCHEMILLA MICANS* **67**, S. Northumb.: Roadside verge, near Ned's Whins, NZ226963, G.A. & M. Swan, 1998, **herb. G.A.S.**, det. S.M. Walters. A considerable extension of range.

†75/19.15. *ALCHEMILLA MOLLIS* **42**, Brecks.: Road verge, Caehopkin, SN826122, M. & C. Porter, 1998. 2nd record.

†75/21.1. *ROSA MULTIFLORA* *29, Cambs.: Hedgerow, Haslingfield Hill, TL402514, G.M.S. Easy, 1975, **herb. G.M.S.E.** Possibly planted or outcast, but growing with wild *Rosa* species only, on right side of road going over A14, at Fen Ditton, TL499599, G.M.S. Easy, 1998, **herb. G.M.S.E.** Still present in 2002. 1st & 2nd records.

75/21.4. *ROSA ARVENSIS* *95, Moray: Road bank and field, Malcolm Bridge, Mulben, NJ365522, I.P. Green, 2001, conf. A.L. Primavesi. 1st confirmed record.

†75/21.4×10. *ROSA* × *ALBA* (*R. GALLICA* × *R. ARVENSIS* AND/ OR *R. CANINA*) *113(A), Channel Is. (Alderney): Large specimen established in old field hedge, near top of Trois Vaux, WA561064, B. Bonnard, 1996.

75/21.4×12. *ROSA* × *IRREGULARIS* (*R. ARVENSIS* × *R. CANINA*) 39, Staffs.: Roadside scrub, Ecton, SK0956, A.L. Primavesi & R. Maskew, 1996. 1st recent record. *50, Denbs.: Old quarry, Terfyn, SH913776, W. McCarthy, 2001, det. A.L. Primavesi.

75/21.5×16. *ROSA* × *INVOLUTA* (*R. PIMPINELLIFOLIA* × *R. SHERARDII*) 49, Caerns.: Spreading several feet along hedgebank, Capel Carmel to Anelog road, N of Aberdaron, SH159282, A.P. Conolly, 2001, **LTR**, det. A.L. Primavesi. 1st recent record.

†75/21.6. *ROSA RUGOSA* 'ALBA' 113(S), Channel Is. (Sark): Originally planted, now with new plants from suckers, roadside verge, Rue de la Peigneurie, WV471756, R.M. Veall, 2001, **herb. Société Sercquaise**, det. A.L. Primavesi.

†75/21.7. *ROSA* 'HOLLANDICA' *H6, Co. Waterford: Single bush on E side of road, field hedge, Ballylinch, S355022, P.R. Green, 2001, det. A.L. Primavesi.

75/21.11. *ROSA STYLOSA* 46, Cards.: Scrub on disused railway, Teifi Marshes, Cardigan, SN186453, A.O. Chater, 2001, conf. R. Maskew. 2nd record.

75/21.12×13b. *ROSA* × *DUMALIS* (*R. CANINA* × *R. CAESIA* subsp. *VOSAGIACA*) *44, Carms.: NE side of road opposite deep road cutting, c.1.5km S of Meidrim, SN288193, G. Hutchinson & R.D. Pryce, 1992, **NMW**, det. A.L. Primavesi. *77, Lanarks.: Roadside, W of Earnock, Hamilton, NS6854, P. Macpherson, 2000, **herb. P.M.**, det. R. Maskew.

75/21.12×14. *ROSA* × *DUMETORUM* (*R. CANINA* × *R. OBTUSIFOLIA*) *46, Cards.: Field hedge, 150m S of Felin-ganol, Penparc, SN198486, R. Maskew & A.O. Chater, 2000.

75/21.12×15. *ROSA* × *SCABRIUSCULA* (*R. CANINA* × *R. TOMENTOSA*) *39, Staffs.: Roadside S of Heaton, 50m S of bridge over Rad Brook, SJ940610, J.H. Clarke, 2000, det. R. Maskew. 44, Carms.: E side of bank in hawthorn, near vehicle park, Ginst Point, SN323079, G. Hutchinson & I. K. Morgan, 1992, **NMW**, det. A.L. Primavesi. 1st recent record.

75/21.12×17. *ROSA* × *MOLLETORUM* (*R. CANINA* × *R. MOLLIS*) *39, Staffs.: Under-the-Hill, near Longnor, SK083658, A.L. Primavesi & R. Maskew, 1996.

75/21.12×18. *ROSA* × *NITIDULA* (*R. CANINA* × *R. RUBIGINOSA*) *29, Cambs.: 1 bush growing between R. canina & R. rubiginosa, Milton Country Park, (formerly Milton gravel pits), TL482623, G.M.S. Easy, 1989, **CGE**, det. A.L. Primavesi. *50, Denbs.: Hedge, New Brighton, Wrexham, SJ276509, J.A. Green, 2001, det. A.L. Primavesi. *67, S. Northumb.: Old roadside hedge, Morpeth, NZ184867, G.A. & M. Swan, 2001, **herb. G.A.S.** det. A.L. Primavesi.

75/21.12×19. *ROSA* × *TODDIAE* (*R. CANINA* × *R. MICRANTHA*) *46, Cards.: Roadside hedgebank, 200m NNE of Llwyn-llwyd, Penparc, SN201489, R. Maskew & A.O. Chater, 2000.

75/21.13×16. *ROSA CAESIA* × *R. SHERARDII* *39, Staffs.: Roadside scrub, near Wetton, SK099553, R. Maskew, 2001.

75/21.13×17. *ROSA* × *GLAUROIDES* (*R. CAESIA* × *R. MOLLIS*) *39, Staffs.: Roadside scrub, near Wetton, SK099553, R. Maskew, 2001.

75/21.13a. *ROSA CAESIA* subsp. *CAESIA* 44, Carms.: Hedgerow on E side of lane c.80m N of 30mph signs, S of Llainlwyd, St Clears, SN280184, G. Hutchinson & R.D. Pryce, 1992, **NMW**, det. A.L. Primavesi. 1st recent record.

75/21.13b×14. *ROSA CAESIA* subsp. *VOSAGIACA* × *R. OBTUSIFOLIA* *39, Staffs.: Lordspiece, near Stanton, SK140463, A.L. Primavesi & R. Maskew, 2001.

75/21.13b×15. *ROSA* × *COTTETII* (*R. CAESIA* subsp. *VOSAGIACA* × *R. TOMENTOSA*) *39, Staffs.: Blore Woodhouses, SK139485, A.L. Primavesi & R. Maskew, 2001.

75/21.14. *ROSA OBTUSIFOLIA* 58, Cheshire: Hedge by canal, Church Lawton, SJ816562, Cheshire Recording Group, 2001, conf. R. Maskew. 1st recent record.

75/21.17×18. *ROSA* × *MOLLIFORMIS* (*R. MOLLIS* × *R. RUBIGINOSA*) *77, Lanarks.: Roadside S of Wiston, NS9631, P. Macpherson, 2000, **herb. P.M.**, det. R. Maskew.

75/21.18×19. *ROSA* × *BIGENERIS* (*R. RUBIGINOSA* × *R. MICRANTHA*) *46, Cards.: N bank of A487, 100m S of Figure Four crossroads, SN588775, R. Maskew & A.O. Chater, 2001, conf. A. L. Primavesi.

75/21.19. *ROSA MICRANTHA* 50, Denbs.: Limestone grassland, Graigfechan, SJ148549, G. Kaye, 2000, det. A.L. Primavesi. 1st recent record.

75/21.19×20. *ROSA* × *BISHOPII* (*R. MICRANTHA* × *R. AGRESTIS*) *50, Denbs.: Limestone grassland, Graigfechan, SJ148549, G. Kaye, 2000, det. A.L. Primavesi.

75/21.20. *ROSA AGRESTIS* *44, Carms.: Wooded roadside hedgebank near disused rookery, 0.4km NE of Pentre-cwrt, SN390391, G. Hutchinson. 1991, **NMW**, det. A.L. Primavesi. Not refound in 2002. 50, Denbs.: Limestone grassland, Graigfechan, SJ148549, G. Kaye, 2000, det. A.L. Primavesi. 2nd record.

†75/22.12. *PRUNUS SEROTINA* *29, Cambs.: 1 fruiting bird sown plant (c.1.5m tall), disused railway track on NW side of current line, SW of Royston station, TL348410, A.C. Leslie, 2001, **CGE**. 1st confirmed record. *77, Lanarks.: Rough waste ground, Shettleston, Glasgow, NS6364, P. Macpherson, 2000, **herb. P.M.**, det. E.J. Clement. Status doubtful; originally planted or bird-sown?

†75/22.3. *PRUNUS CERASIFERA* *113(A), Channel Is. (Alderney): 5 old trees (1 in fruit & 1 suckering) at 3 scattered sites, St Anne, WA574074, R. Ball, 1997, det. B. Bonnard. Planted long ago. *113(S), Channel Is. (Sark): Old tree, probably planted for fruit, in woodland including site of derelict orchard, near La Moinerie, WV462764, C. Helyar, 2000, **herb. Société Sercquaise**.

†75/22.5b. *PRUNUS DOMESTICA* subsp. *INSITITIA* 43, Rads.: Suckering bushes by derelict stone building, Crow Wood, SO104433, S.P. Chambers, 2001. 2nd recent record.

75/22.6. *PRUNUS AVIUM* *†113(A), Channel Is. (Alderney): Sucker or branch from planted ornamental cherry stock which has died off above ground, in Old Churchyard, St Anne, WA573073, R. Waterman, 1988.

†75/22.7. *PRUNUS CERASUS* *113(A), Channel Is. (Alderney): Established and suckering in old 40m hedge on waste ground, in Les Venelles, WA573070, B. Bonnard, 1997.

75/26.2. *PYRUS PYRASTER* *113(A), Channel Is. (Alderney): Quarry, Mannez, WA601088, C. Johns, 1981, det. RBG, Kew. Possibly native in Channel Is. *†113(S), Channel Is. (Sark): Mature tree about 15m tall, numerous suckers up to 2m tall, in ditch and on hedgebank. Le Grand Beauregard, WV457754, R.M. Veall, 1998, **herb. Société Sercquaise**.

75/26.3. *PYRUS COMMUNIS* †113(S), Channel Is. (Sark): Suckers from planted tree in nearby garden, on roadside bank, near La Fougérie, WV465768, R.M. Veall, 1998, **herb. Société Sercquaise**. 1st recent record.

75/28.12. *SORBUS EMINENS* *42, Brechs.: Limestone cliff, Craig y Cilau NNR, SO188158, T.C.G. Rich, 2000, **NMW**.

75/28.20. *SORBUS DEVONIENSIS* 5, S. Somerset: Steep wooded bank, Timberscombe Wood, SS958415, I.P. Green, 2000, det. R.D. Meikle. 2nd record & only extant site.

†75/31.1. *PHOTINIA DAVIDIANA* *64, Mid-W. Yorks.: Waste ground, Leeds, SE314324, M. Wilcox, 1999, det. P.S. Green.

†75/32.9. *COTONEASTER FRIGIDUS* *29, Cambs.: ?bird sown on railway edge from adjacent row next to playing fields, Long Road, TL457558, G.M.S. Easy, 1977 & 1987, **herb. G.M.S.E**.

†75/32.9×10. *COTONEASTER* × *WATERERI* (*C. FRIGIDUS* × *C. SALICIFOLIUS*) *29, Cambs.: Newmarket station, TL652645, G.M.S. Easy, 1977.

†75/32.11×18. *COTONEASTER* × *SUECICUS* (*C. DAMMERI* × *C. CONSPICUUS*) *29, Cambs.: 1 old prostrate shrub, waste ground, Chesterton railway sidings, TL4761, A.C. Leslie, 2000, **CGE**, det. J. Fryer. *64, Mid-W. Yorks.: Waste ground, Central Leeds, SE306632, M. Wilcox, 1999, det. J. Fryer.

†75/32.13. *COTONEASTER LACTEUS* *29, Cambs.: Back of railway station, Newmarket, TL645627, G.M.S. Easy, 1978.

- †75/32.16. *COTONEASTER INTEGRIFOLIUS* *93, N. Aberdeen: Rock outcrop, Strichen, NJ942570, D. Welch, 1999.
- †75/32.18. *COTONEASTER CONSPICUUS* *64, Mid-W. Yorks.: Disused sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE2538, M. Wilcox, 1999, det. J. Fryer.
- †75/32.22. *COTONEASTER HJELMQVISTII* *29, Cambs.: Several plants beside old railway track, Histon, just SE of first crossing, TL432634, P.D. Sell, 1998, **CGE**. 1 large plant under birches, Chesterton railway sidings, TL474607, A.C. Leslie, 2001, **CGE**. 1st & 2nd records. *64, Mid-W. Yorks.: Disused sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE2538, M. Wilcox, 1999, det. J. Fryer.
- †75/32.26. *COTONEASTER DIVARICATUS* 29, Cambs.: Large numbers spreading from station garden along old railway line, Histon, TL442626-439628, G.M.S. Easy, 1994, **herb. G.M.S.E.** 2nd record.
- †75/32.35. *COTONEASTER REHDERI* *29, Cambs.: 1 large shrub on SW side of old railway, NW of Milton Road level crossing, Chesterton, TL465613, A.C. Leslie, 2001, **herb. A.C.L.**
- †75/32.37. *COTONEASTER DIELSIANUS* *29, Cambs.: Seedling on top of old wall, at the back of the Botanic Garden, Cambridge, TL4557, G.M.S. Easy, 1988. 3 plants scattered at a major thrush roost, East Pit, (Caius), Cherry Hinton, TL483557, G.M.S. Easy, 2000, **herb. G.M.S.E.** 1st & 2nd records. *50, Denbs.: Top of wall, Llanrwst, SH794622, W. McCarthy, 2001, **NMW**, det. J. Fryer. *H6, Co. Waterford: 1 bush self-sown, in roadside hedge, Kilmacthomas, S400062, P.R. Green, 2001.
- †75/32.40. *COTONEASTER STERNIANUS* *29, Cambs.: Frequent in bramble thickets, waste ground, Wisbech, TF462103, G.M.S. Easy, 1993. 1 plant, old railway track, Cambridge, TL464615, A.C. Leslie, 2000, **CGE**, det. J. Fryer. 1st & 2nd records.
- 75/32.asc. *COTONEASTER ASCENDENS* *77, Lanarks.: Surviving on stonework of bridge over R. Nethan, Lesmahagow, NS83, P. Macpherson, 1998, **herb. P.M.**, det. J. Fryer.
- †75/32.coc. *COTONEASTER COCHLEATUS* *29, Cambs.: 2 spreading plants on clinker along old St Ives railway, Chesterton, TL468612, G.M.S. Easy, 1999, **herb. G.M.S.E.**
- †75/32.glab. *COTONEASTER GLABRATUS* *29, Cambs.: 1 tall shrub on track of old railway, Royston, TL348410, A.C. Leslie, 2001, **herb. A.C.L.**, det. J. Fryer.
- †75/32.glau. *COTONEASTER GLAUCOPHYLLUS* *29, Cambs.: 1 bush, old railway track, Chesterton, TL469612, A.C. Leslie, 2000, **CGE**, det. J. Fryer, conf. B. Hylmö. 1st British record.
- †75/32.ign. *COTONEASTER IGNESENS* *77, Lanarks.: Well established on long abandoned railway viaduct, Dalmarnock, Glasgow, NS6163, P. Macpherson & E.L.S. Lindsay, 2001, **herb. P.M.**, det. J. Fryer. 1st British record.
- †75/32.ind. *COTONEASTER INDURATUS* *29, Cambs.: Old railway track, Chesterton railway sidings, TL4760, A.C. Leslie, 2000, **CGE**, det. J. Fryer, conf. B. Hylmö.
- †75/32.mai. *COTONEASTER MAIREI* *77, Lanarks.: Surviving by fence at side of minor road, Chapelhall, NS7862, P. Macpherson, 2000, **herb. P.M.**, det. J. Fryer. Bird sown & established on long abandoned railway viaduct, Dalmarnock, Glasgow, NS6163, P. Macpherson & E.L.S. Lindsay, 2001, **herb. P.M.**, det. J. Fryer. 1st & 2nd records.
- †75/32.rot. *COTONEASTER ROTUNDIFOLIUS* *68, N. Northumb.: Steep bank above stream, W bank of Usway Burn, NT881091, G.A. & M. Swan, 2000, **herb. G.A.S.**, det. J. Fryer.
- †75/34.1. *MESPILIS GERMANICA* *113(S), Channel Is. (Sark): Young fruiting tree about 1.7m tall, possibly bird sown, among *Prunus spinosa* in scrub, S end of Eperquerie Common, WV462772, R.M. Veall, 1998, **herb. Société Sercquaise**.
- 75/35.7×8. *CRATAEGUS* × *MEDIA* (*C. MONOGYNA* × *C. LAEVIGATA*) *80, Roxburghs.: Old hedgerow, near Hawick, NT533168, C. Dixon, 1999, **E**, det. D.R. McKean. *†95, Moray: One bush, well established on sand dunes, Roseisle Forest, Burghead, NJ109664, M. Wilcox, 2001, conf. J.R. Akeroyd. Near an old ruin so possibly planted.
- †77/3.1×ori. *COLUTEA* × *MEDIA* (*C. ARBORESCENS* × *C. ORIENTALIS*) *29, Cambs.: At least 20 shrubs on edges of old railway track, between Oakington and Histon, TL4264, A.C. Leslie & J.L. Sharman, 2000.
- 77/8.1. *LOTUS GLABER* 58, Cheshire: Grassy waste area, Bromborough, SJ345847, R. Goodchild, 2000. Only certain recent record.

- 77/8.2. *LOTUS CORNICULATUS* **110**, Outer Hebrides: By military road, to Mullach Mor, St Kilda, NF0999, J. Gudge, 1996. 1st record for St Kilda.
- †77/13.1. *SECURIGERA VARIA* **39**, Staffs.: Well established, E side of railway line, Ravenscliffe, SJ838528, I.J. Hopkins, 2001. 2nd recent record. ***50**, Denbs.: Edge of birch wood, New Brighton, Wrexham, SJ275510, M. Williams, 2001.
- †77/14.fab. *VICIA FABA* **99**, Dunbarton: Rough ground, East Helensburgh, NS3083, A. Rutherford & A.McG. Stirling, 2001. 2nd record.
- †77/15.6. *LATHYRUS TUBEROSUS* ***64**, Mid-W. Yorks.: Naturalised, on edge of old mine, Micklefield, SE440327, S. King, 1998.
- †77/15.7. *LATHYRUS GRANDIFLORUS* ***68**, N. Northumb.: By footpath between quarries, Longhoughton Quarry, NV2315, G.D. Kitchener, 2000. ***113(A)**, Channel Is. (Alderney): Planted c.30 years ago, by old German bunker, near Fort Quesnard, WA603089, B. Bonnard, 1988, det. D. McClintock.
- †77/15.9. *LATHYRUS LATIFOLIUS* ***67**, S. Northumb.: Roadside bank SW of Dipton Mill, NY925603, G.A. & M. Swan, 2000, **herb. G.A.S.**
- 77/15.12. *LATHYRUS NISSOLIA* *†**52**, Anglesey: Probably casual, waste grassland, Newborough, SH422656, Ecological consultants to Menter Mon, 2001.
- 77/18.2b. *MEDICAGO SATIVA* subsp. *VARIA* *†**64**, Mid-W. Yorks.: Roadside, Aberford, SE437368, Leeds Naturalists' Club, 2001, det. P.P. Abbott. Probably introduced with foreign seed during landscaping.
- †77/18.2c. *MEDICAGO SATIVA* subsp. *SATIVA* ***93**, N. Aberdeen: Coastal grassland, Sandhaven, NJ9567, D. Welch & M. Innes, ?1998, **ABD**.
- †77/18.lac. *MEDICAGO LACINIATA* ***58**, Cheshire: Casual only, on new road verge, Noman's Heath, SJ5246, A.B. Blacklay & P. Woods, 2001, det. E.J. Clement.
- †77/18.tru. *MEDICAGO TRUNCATUCA* ***58**, Cheshire: Casual only, on new road verge, Noman's Heath, SJ5246, A.B. Blacklay & P. Woods, 2001, det. E.J. Clement.
- 77/19.3. *TRIFOLIUM OCCIDENTALE* ***2**, E. Cornwall: By coastal path along sea cliffs, between Northcott Mouth and Menachurch Point, SS202087, P. Greenwood, 2000, conf. R.J. Murphy & C.D. Preston. ***49**, Caerns.: Short turf, near Ty Pellaf, Bardsey Island, SH122212; Short turf on S-facing bank, Porth Solfach, Bardsey Island, SH115213; both I.R. Bonner & J.M. Brummitt, 2000, **herb. I.R.B.**, conf. C.D. Preston. 1st & 2nd records.
- 77/19.8. *TRIFOLIUM FRAGIFERUM* **39**, Staffs.: Allimore Green Common Nature Reserve, SJ8519, E. Radford, 2001. 2nd record.
- †77/19.19a. *TRIFOLIUM INCARNATUM* SUBSP. *INCARNATUM* ***44**, Carms.: 2 plants on shingle beach, E end of lake, Sandy Water Park, Llanelli, SN497002, Llanelli Naturalists, 2001, det. I.K. Morgan. †**113(S)**, Channel Is. (Sark): Roadside verge beside garden wall, L'Asile, Mill Lane, WV464758, R.M. Veall, 1999, **herb. Société Sercquaise**. 1st recent record. Probably of garden origin but not seen in garden.
- 77/19.23. *TRIFOLIUM ARVENSE* †**99**, Dunbarton: Probably introduced, in grassy waste ground, West Helensburgh, NS3083, A. Rutherford & A.McG. Stirling, 1997. 2nd & 1st localised record.
- †77/21.1×2. *LUPINUS* × *REGALIS* (*L. ARBOREUS* × *L. POLYPHYLLUS*) ***110**, Outer Hebrides: Stornoway, NB4233, L.S. Garrad, 1998.
- †77/22.1. *LABURNUM ANAGYROIDES* ***113(A)**, Channel Is. (Alderney): 2 young plants established in a gutter, in Queen Elizabeth II Street, St Anne, WA574073, B. Bonnard, 1988.
- †77/24.1. *SPARTIUM JUNCEUM* **44**, Carms.: Several plants in sandy grassland on seaward edge of golf course, Pembrey Burrows, SN426004, V. & A. Lewis, 2000. 2nd record. ***113(A)**, Channel Is. (Alderney): Church Glebe land (possibly planted), on Les Rochers, WA583074, B. Bonnard, 1989.
- 78/1.1. *HIPPOPHAE RHAMNOIDES* †**91**, Kincardines.: Grassland near sea, Johnshaven, NO804675, D. Welch, 1998. 1st recent record. *†**113(A)**, Channel Is. (Alderney): Occasional hedging near sea (probably planted) and 2 large plants, in St Martins, WA577083, B. Bonnard, 1986.
- †78/2.com. *ELAEAGNUS COMMUTATA* ***113(A)**, Channel Is. (Alderney): A deciduous species suckering vigorously, at Val du Saue, WA573063, B. Bonnard, 1996, det. RBG, Kew.

†78/2.mac.xpun. ELAEAGNUS × EBBINGEI (E. MACROPHYLLA × E. PUNGENS) *113(A), Channel Is. (Alderney): Frequently established in hedging near coast, as at Fort Quesnard, WA607089, B. Bonnard, 1988, det. D. McClintock. *113(S), Channel Is. (Sark): Seedlings from planted hedge, on roadside bank, Mill Lane, WV463758, R.M. Veall, 1999, **herb. Société Sercquaise**, det. R.A. Waterman. 1st record of self-sown plants.

79/2.1. MYRIOPHYLLUM VERTICILLATUM *113(A), Channel Is. (Alderney): Plentiful in pond, Corblets Quarry, WA596088, B. Bonnard, 1986, det. D. McClintock.

†79/2.2. MYRIOPHYLLUM AQUATICUM 35, Mons.: Covering many square metres of canal, Monmouth - Brecon canal, Malpas, ST301902, S. Williams, 2000. 2nd record. 39, Staffs.: Dominating half of a small pond, Tittensor Chase, SJ876364, I.J. Hopkins, 1998. 2nd record. *50, Denbs.: Man-made pond, Marford, SJ357564, J.A. Green, 2000. *52, Anglesey: A single shoot amongst *Bolboschoenus* stems in a small stream discharging into Red Wharf Bay, Glan Halen, Llanddona Beach, SH564806, I.R. Bonner & T.D. Dines, 2001. *Crassula helmsii* also present and apparently established. *64, Mid-W. Yorks.: Ditch beside former tip, now being landscaped, Burley-in-Wharfedale, SE156466, F.D. Draper, 1994. *113(A), Channel Is. (Alderney): Established in pond, Mannez Quarry, WA604087, B. Bonnard, 1988, det. C. Jermy.

79/2.4. MYRIOPHYLLUM ALTERNIFLORUM 39, Staffs.: A few plants in the small pond to the N of fishing lake, Biddulph Grange Country Park, Biddulph, SJ898590, J.E. Hawksford, 1999. 1st recent record.

†80/1.1. GUNNERA TINCTORIA *46, Cards.: Naturalised by pond in pasture, Felin Geri, Cwm Cou, SN300421, A.O. Chater & L. Gander, 2000. *113(A), Channel Is. (Alderney): Established along streamside, in Val du Saue, WA573063, B. Bonnard, 1986, det. D. McClintock.

81/1.3. LYTHRUM PORTULA 113(S), Channel Is. (Sark): Small pond, partly drying-out at times, Grand Dixcart dew-pond, WV463752, Mr & Mrs R. Long, 2000, **herb. Société Sercquaise**. 1st recent record.

81/13b. LYTHRUM PORTULA subsp. LONGIDENTATUM *44, Carms.: Marginal swampy vegetation, W shore of Talley Upper (southern) Lake, SN632329, R.D. Pryce & BSBI meeting, 2001, NMW, det. A.O. Chater. 1st published record of subsp.

†83/UGN.mol. UGNI MOLINAE *113(A), Channel Is. (Alderney): Single well established bush with roots under rock above shore at St Esquère headland, E coast, WA606088, H. Hayes, 1997, det. R. Waterman & C. Helyar. Seedlings found nearby in 2000.

84/1.1×5. EPILOBIUM × BREVIPILUM (E. HIRSUTUM × E. TETRAGONUM) *29, Cambs.: At least 5 plants scattered through a small field of cultivated peonies (with both parents, some *E. ciliatum* and no *E. parviflorum*), SW of Cottenham, TL439660, A.C. Leslie, 2001, CGE.

84/1.1×8. EPILOBIUM × NOVAE-CIVITATIS (E. HIRSUTUM × E. CILIATUM) *44, Carms.: Few plants, with both parents, near old lime kilns in working limestone quarry, Cilrychen Quarry, N of Llandybie, SN617166, A.O. Chater, R.D. Pryce & K.A. Cottingham, 2001, NMW, det. A.O.C.

84/1.2×8. EPILOBIUM × FLORIDULUM (E. PARVIFLORUM × E. CILIATUM) *39, Staffs.: Concrete path running parallel to M5, Sandwell Park, SP021914, M.W. Poulton, 1998. *44, Carms.: Frequent in working area around quarry entrance, with both parents, Cilrychen Quarry, N of Llandybie, SN617166, A.O. Chater, R.D. Pryce & K.A. Cottingham, 2001, NMW. *46, Cards.: By stream, 300m W of Maesymeillion, Penparc, SN195483, S.P. Chambers, 1999, **herb. S.P.C.**, conf. T.D. Pennington.

84/1.2×9. EPILOBIUM × RIVULARE (E. PARVIFLORUM × E. PALUSTRE) *68, N. Northumb.: Marshy, sandy ground behind golf-course, Alnmouth, NV248104, G.D. Kitchener, 2000.

84/1.3×7. EPILOBIUM × MUTABILE (E. MONTANUM × E. ROSEUM) *46, Cards.: Pavement, Great Darkgate Street, Aberystwyth, SN563817, S.P. Chambers, 1999, **herb. S.P.C.**, conf. T.D. Pennington.

84/1.3×8. EPILOBIUM × INTERJECTUM (E. MONTANUM × E. CILIATUM) *67, S. Northumb.: Roadside hedge, bordering allotments, Castle Leaze, Newcastle upon Tyne, NZ2365, G.D. Kitchener, 1999. *68, N. Northumb.: In grounds of Cragside, near Rothbury, NV0702, G.D. Kitchener, 2000.

84/1.4. *EPILOBIUM LANCEOLATUM* **47**, Monts.: Abundant in one area on bank by quarry track, Craig Breidden, SJ287132, T.C.G. Rich, A. Law & L. Houston. 2001. 2nd record. ***65**, N.W. Yorks.: Waste ground by riverside, near cottage below castle, Richmond, NZ168005, I. Lawrence, 2001.

84/1.6x8. *EPILOBIUM* × *VICINUM* (*E. OBSCURUM* × *E. CILIATUM*) ***68**, N. Northumb.: At foot of old wall, grounds of Doxford Hall, NV189243, G.D. Kitchener, 2000.

84/1.6x9. *EPILOBIUM* × *SCHMIDTIANUM* (*E. OBSCURUM* × *E. PALUSTRE*) **45**, Pembs.: Wetland, Bristgarn near Llanwnda, Strumble Head, SM925395, S. Chambers, 2001. 1st recent record. ***46**, Cards.: Marsh by Forestry road 2.5km NNE of Nant-y-maen, SN775604, A.O. Chater & R.D. Pryce, 2001, **NMW**, conf. G. D. Kitchener.

84/1.7. *EPILOBIUM ROSEUM* **67**, S. Northumb.: Damp, shady ground between wall and roadside, near Littleharle Tower, NZ011835, G.A. Swan, 1999, **herb. G.A.S.**, det. T.D. Pennington. 2nd confirmed record.

†84/1.8. *EPILOBIUM CILIATUM* ***113(A)**, Channel Is. (Alderney): Established along verge, in Le Petit Val, WA567078, B. & J. Bonnard, 1986, det. D. McClintock.

84/1.8x9. *EPILOBIUM* × *FOSSICOLA* (*E. CILIATUM* × *E. PALUSTRE*) ***46**, Cards.: Marsh by Forestry road, 2.5km NNE of Nant-y-maen, Tywi Forest, SN775604, A.O. Chater & R.D. Pryce, 2001, **NMW**, conf. G.D. Kitchener. ***68**, N. Northumb.: Marshy, sandy ground behind golf-course, Alnmouth, NV248104, G.D. Kitchener, 2000.

†84/1.9. *EPILOBIUM PALUSTRE* *†**113(A)**, Channel Is. (Alderney): Probably casual only, in quarry, Mannez, WA603088, B. Bonnard, 1992, det. D. McClintock.

†84/4.1x3. *OENOTHERA* × *FALLAX* (*O. GLAZIOVIANA* × *O. BIENNIS*) ***39**, Staffs.: Disused railway track, Doxey Marshes, Stafford, SJ916235, J.P. Martin, 1987. Demolished factory, by canal towpath, Wordsley, S of Kingswinford, SO892859, B.R. Fowler, 1987. 1st records.

†84/4.1x3. *OENOTHERA GLAZIOVIANA* × *O. BIENNIS* (and/or *O. CAMBRICA*) ***44**, Carms.: Dunes, between Pembrey Forest and the sea, SN3800, F.H. Webb, 1978, **NMW**, det. J.C. Bowra. Previously det. as *O. erythrosepala*.

†84/4.3x4. *OENOTHERA BIENNIS* × *O. CAMBRICA* ***49**, Caerns.: Roadside, Betws-y-Coed, SH791568, J. & H. Lowell, 2001, **MANCH**, det. J. Bowra.

†84/4.5. *OENOTHERA STRICTA*. ***45**, Pembs.: 2 patches in sand dunes, Poppit Sands, SN153485, S.B. Evans, 2000. Disturbed sandy ground, B4327 S of Crabhall Farm, SM808070, S.B. & A.E. Evans, 2000. 1st & 2nd records. ***49**, Caerns.: Base of old sand dune, S of new marina, Pwllheli, SH3834, A. Burns & A.P. Conolly, 2001, **LTR**, det. C.A. Stace.

†85/1.3. *CORNUS ALBA* ***46**, Cards.: Suckering along hedge, 100m N of Rhydowen crossroads, SN443453, A.O. Chater, 2000, **NMW**. 1st seen 1992 & erroneously recorded as *C. sericea*. Only extant site.

†85/2.1. *AUCUBA JAPONICA* ***113(S)**, Channel Is. (Sark): Seeded from (planted) bushes at top of bank, by damp ground near stream at foot of steep bank among trees. Petit Dixcart, WV468753, R.M. Veall, 1999, **herb. Société Sercquaise**. 1st Channel Is. record.

†85/3.1. *GRISELINIA LITTORALIS* ***52**, Anglesey: Single bush on edge of woodland, presumably planted, Menai Bridge, SH5571, I.R. Bonner, 2001.

89/1.1. *ILEX AQUIFOLIUM* *†**113(A)**, Channel Is. (Alderney): A few plants 'in the wild' and at Island Hall, WA573073, B. Bonnard, 1988. Pollen present in the ancient peat, but probably planted in historic times.

†91/2.5. *EUPHORBIA DULCIS* ***91**, Kincards.: Riverbank, Glenbogle, NO655956, D. Welch, 2001, **herb. D.W.**

91/2.7. *EUPHORBIA SERRATULA* †**1**, W. Cornwall: Becoming established on disused rubbish tip, Newham, Truro, SW833432, M.J. Sibley, 2001, det. P.R. Green.

91/2.12. *EUPHORBIA PORTLANDICA* ***6**, N. Somerset: Crack in garden path, Winford, ST542648, M. Webster, 1999, **herb. I.P. Green**, det. A. Radcliffe-Smith. Still there in 2000.

91/2.15. *EUPHORBIA CYPARISSIAS* †**46**, Cards.: Naturalised in Llanilar churchyard, SN623751, A.O. Chater, 2001, **NMW**. 1st recent record. *†**113(A)**, Channel Is. (Alderney): Garden escape at several sites, as at Crabby, WA572080, B. Bonnard, 1986, det. D. McClintock.

- †91/2.16b. EUPHORBIA AMYGDALOIDES subsp. ROBBIAE *42, Brecks.: Escaped along lane bank, Tregraig Road, Bwlch, SO152221, M. & C. Porter, 2001. *99, Dunbarton: Foot of hedge, Helensburgh, NS2882, A. Rutherford, 1998.
- †91/2.17a. EUPHORBIA CHARACIAS subsp. CHARACIAS *29, Cambs.: 10 large plants in full bloom amongst *Conium maculatum* and *Cardaria draba*, on bank (created c.1997) on slip road, near Quy Water, TL504594, G. Crompton, 2000. 5 plants, either at or on the base of tall brick wall, behind Drummer Street bus station, Cambridge, TL452586, A.C. Leslie, 2001. 1st & 2nd records.
- †91/2.17b. EUPHORBIA CHARACIAS subsp. VENETA *49, Caerns.: Wall, Great Orme, Llandudno, SH7782, G.H. Battershall, 2000.
- †91/2.myr. EUPHORBIA MYRSINITES *29, Cambs.: Several plants, bank of rough ground on edge of arable, Wicken, TL572713, G.M.S. Easy, 1998, **herb. G.M.S.E.** Several plants established on old dumped soil at edge of old railway track, Histon, TL431636, A.C. Leslie, 2001. 1st & 2nd records.
- †92/2.obl. EUPHORBIA OBLONGATA *29, Cambs.: Roadside, E side of Church Lane in the area known as 'The Smithy', Kingston, TL345553, P. Reynolds, 1999, conf. P.D. Sell.
- 94/1.1. LINUM BIENNE †39, Staffs.: Patches on two small banks in dry grassland and along edge of a path, Coal Pool, Walsall, SP015998, M.W. Poulton, 2001. Only extant site.
- †94/1.2. LINUM USITATISSIMUM *99, Dunbarton: Landscaped area, Pier-head, Helensburgh, NS2982, A. Rutherford, 1998.
- †94/1.fl.a. LINUM FLAVUM *39, Staffs.: A patch on a former railway line, Gospel Oak, SO9694, M.W. Poulton, 2001, conf. E.J. Clement. 1st British record.
- †94/1.gra. LINUM GRANDIFLORUM *51, Flints.: Disturbed ground, Melyd Avenue, Prestatyn, SJ063817, J. Phillips & P. Ingham, 2001.
- 94/2.1. RADIOLA LINOIDES 44, Carms.: Accreting sandy 'nose' at E end of Burrows, Pembrey Saltings LNR, SS433993, M.V. Prosser & H.L. Wallace, 1998. 1st recent record.
- †98/1.ind. AESCULUS INDICA *29, Cambs.: Many self-sown seedlings on garden wall, Bray's Lane car park, Ely, TL5480, R.M. Payne, 2001, det. K.A. Beckett.
- †99/1.5. ACER SACCHARINUM *29, Cambs.: Single seedling (from large planted tree in garden opposite) in railed area outside King's College hostel, Fitzwilliam Street, near corner with Tennis Court Road, Cambridge, TL450579, P.H. Oswald, 1999.
- †100/1.1. RHUS TYPHINA *42, Brecks.: Road bank, Llangammarch Wells, SN936473, M. & C. Porter, 2001. *58, Cheshire: Probably planted, in hedgerow, Bromborough Port, SJ353835, R. Goodchild, 2000. *113(S), Channel Is. (Sark): Established and suckering, on roadside bank, The Avenue, WV467759, R.M. Veall, 1997, **herb. Société Sercquaise**.
- †101/1.1. AILANTHUS ALTISSIMA *99, Dunbarton: Bank of burn, Central West Helensburgh, NS2982, A. Rutherford, 2000.
- †102/1.10. OXALIS DEBILIS *44, Carms.: Disturbed coastal dunes, Pembrey Harbour, SN436002, V. & A. Lewis, 2000.
- †102/1.13. OXALIS PES-CAPRAE 113(S), Channel Is. (Sark): Established for about 15 years in garden, but not recognised due to frequent mowing, The Avenue near the Post Office, WV466759, M.H. Marsden, 1998, **herb. Société Sercquaise**. Previously recorded only as casual.
- †102/1.3. OXALIS CORNICULATA *113(A), Channel Is. (Alderney): Established at several stations, including damp walls, in St Anne, WA567078, B. Bonnard, 1986, det. D. McClintock.
- †102/1.14. OXALIS INCARNATA *29, Cambs.: Several large patches, apparently naturalised, at base of walls/fences along narrow service alley between houses, in Guest Road & Willis Road, Cambridge, TL459581, A.C. Leslie, 2001.
- †103/1.1. GERANIUM ENDRESSII *113(A), Channel Is. (Alderney): Garden escape along roadside, Valongis, WA581075, B. Bonnard, 1987, det. P. Yeo.
- †103/1.1x2. GERANIUM × OXONIANUM (G. ENDRESSII × G. VERSICOLOR) *29, Cambs.: 1 plant at base of wall, S side of Midsummer Common, Cambridge, TL456581, A.C. Leslie, 1995. *113 (A), Channel Is. (Alderney): Established in quantity round 2 graves in churchyard, St Anne,

WA574074, B. Bonnard, 1994, det. P. Yeo. *†**113(S)**, Channel Is. (Sark): Garden escape, on roadside bank outside garden, near Petite Genetière, WV466768, R.M. Veall, 2000, **herb. Société Sercquaise**.

†103/1.1×2×1. GERANIUM × OXONIANUM × ENDRESSII ***113(A)**, Channel Is. (Alderney): Garden escape on grass verge, Route de Picaterre, WA568078, B. Bonnard, 1988, det. P. Yeo.

103/1.4. GERANIUM ROTUNDFOLIUM ***39**, Staffs.: Gravel on grave, churchyard, Sedgeley, SO915936, W.A. Thompson, 1986. Rough ground, Uttoxeter Racecourse, SK099334, C. Higginbottom, C.N. Smith & M. Smith, 2001. 1st & 2nd records. ***52**, Anglesey: As a garden weed in thin soil over limestone, not knowingly introduced, Tyn-y-gongl, SH509828, I.R. Bonner, 2000.

103/1.5. GERANIUM SYLVATICUM ***39**, Staffs.: Wooded stream bank, N of Pound Green Common, SO751794, J. Bingham, 1994.

103/1.9. GERANIUM SANGUINEUM *†**113(S)**, Channel Is. (Sark): Probably planted and surviving, in mound at roadside covered with rough grass (remains of derelict rockery), near Myrtle Cottage near Aval du Creux, WV471759, R.M. Veall, 2000, **herb. Société Sercquaise**, det. P.F. Yeo.

103/1.14. GERANIUM PYRENAICUM ***91**, Kincardines.: Grassland, Arbuthnott, NO/801746, D. Welch, 1999, **ABD**.

103/1.15. GERANIUM PUSILLUM **79**, Selkirks.: A good sized colony, on waste ground by fence, Selkirk Sewage Works, NT473298, R.W.M. Corner, 2001, **herb. R.W.M.C.** 1st localised record. ***113(A)**, Channel Is. (Alderney): Possibly native, in gravel, at Old Barn, Longis, WA594078, M. Long, 1992.

103/1.18. GERANIUM LUCIDUM *†**113(A)**, Channel Is. (Alderney): Garden escape on roadside bank, in Le Petit Val & Platte Saline, WA568077, P. Selby, 1997.

103/1.20. GERANIUM PURPUREUM ***35**, Mons.: 20m² colony among shrubs in children's play area, Blaenavon, SO253085, R. Hewitt, 2000, **NMW**, det. T.G. Evans.

†103/13×pla. GERANIUM × MAGNIFICUM (G. IBERICUM × G. PLATYPETALUM) ***113(A)**, Channel Is. (Alderney): Garden escape, Platte Saline, WA569079, B. Bonnard, 1986, det. P. Yeo.

103/2.2. ERODIUM MOSCHATUM *†**47**, Monts.: Casual only on roadside by gate into pasture, Berriew, SJ189009, P.M. Benoit & C.A. Small, 2001. Growing with *Ceratochloa carinata*: both probably the result of original garden dumping.

105/1.1. IMPATIENS NOLI-TANGERE **79**, Selkirks.: Dominant over 100×5m, of riverside under *Salix purpurea*, S side of R. Ettrick above road bridge, Victoria Park, Selkirk, NT461284, R.W.M. Corner, 2001, **herb. R.W.M.C.** 2nd extant site.

†105/1.2. IMPATIENS CAPENSIS **50**, Denbs.: Streamside, Iscoed, SJ488442, G. Kay, 2001. 2nd record.

†106/1.1. HEDERA COLCHICA ***58**, Cheshire: Whaley Bridge, SK004810, W.A. Thompson, 2001.

106/1.2b. HEDERA HELIX subsp. HIBERNICA ***35**, Mons.: E wall of churchyard, Penhow Castle, ST424908, T.G. Evans, 2000, **NMW**. Climbing trees on bank of R. Usk, Glebelands recreational ground, Newport, ST315902, T.G. Evans, 2000. 1st & 2nd records for subsp.

†106/1.azo. HEDERA AZORICA Carrière ***29**, Cambs.: Growing over the farmhouse and the neighbouring trees and ground, (leaves up to 15cm across), Abbey Farm, Histon, TL433640, H. Belcher & E. Swale, 2001, det. P.D. Sell.

†106/2.2. ARALIA ELATA ***44**, Carms.: Suckering freely down steep, shaded, roadside bank, Nant-Gwilw, Llanfynydd, SN534268, V. & A. Lewis, 2000. ***113(A)**, Channel Is. (Alderney): Probably planted in a field, in Bluestone Hill, WA586075, B. Bonnard, 1989.

†107/1.ran. HYDROCOTYLE RANUNCULOIDES ***39**, Staffs.: Partly covering small pond to the N of fishing lake, Biddulph Grange Country Park, Biddulph, SJ898590, J.E. Hawksford, 1999. Beginning to colonise another small pond to the S of the lake, Biddulph Grange Country Park, Biddulph, SJ899592, J.E. Hawksford, 2000. 1st & 2nd records. ***47**, Monts.: Off-line reserve pool constructed by British Waterways, Wern Clay-pits, Arddlin, SJ252141, C.D. Preston, 2000. Pool drained and plants removed.

- †107/4.1. *ERYNGIUM GIGANTEUM* *50, Denbs.: 30 plants on waste soil by new cycle track, Llandulas, SH918783, W. McCarthy & M. Stead, 2000, **NMW**.
- 107/6.2. *ANTHRISCUS CAUCALIS* 66, Co. Durham: Probably introduced with sand, on pathside near bowling green, Bishop Auckland, NZ22, P.S. & G.G. Graham, 2000. 1st recent record.
- 107/7.1. *SCANDIX PECTEN-VENERIS* 29, Cambs.: 4-5 plants at edge of cornfield, Parson Drove, TL372098, D.A. Wells, M. Stokes & L. Brown, 1998. 2nd recent record.
- 107/19.1. *OENANTHE FISTULOSA* 50, Denbs.: Ditches near sea, Abergele, SH963783, J.A. Green, 2001. 1st recent record.
- 107/19.3. *OENANTHE PIMPINELLOIDES* *39, Staffs.: Scattered, with several specimens following a damp area down both sides of a hill, Coal Pool, Walsall, SP015998, M.W. Poulton, 2001.
- 107/20.1. *AETHUSA CYNAPIUM* †113(A), Channel Is. (Alderney): Casual in churchyard, by Queen Elizabeth II street gate, St Anne, WA574074, B. Bonnard, 1993. 2nd & 1st recent record.
- †107/21.1. *FOENICULUM VULGARE* 99, Dunbarton: Shore above HWM, East Helensburgh, NS3181, A. Rutherford, 2001. 2nd record.
- †107/26.1. *BUPLEURUM FRUTICOSUM* *29, Cambs.: 1 plant on pavement, several more in garden hedge, (parent in garden), Maids Causeway, Cambridge, TL455588, A.C. Leslie, 2001.
- 107/29.2. *PETROSELINUM SEGETUM* *†113(A), Channel Is. (Alderney): Casual on path, down to Houmet Herbé from road, WA605086, B. Bonnard, 1990.
- †107/30.1. *SISON AMOMUM* 44, Carms.: Several plants (casual only) on top of rough bank, with *Scrophularia scorodonia*, old mineral railway, Ty Mawr, Pembrey, SN417029, V. & A. Lewis, 2001. 2nd record
- †107/37.2. *ANGELICA ARCHANGELICA* *99, Dunbarton: Tide-line with *Atriplex*, etc., Craigendoran Bay, NS3181, A.McG. Stirling, 1998.
- 107/43.1. *TORILIS JAPONICA* 113(A), Channel Is. (Alderney): South cliffs, Bluestone Bay, WA585067, G. Higgs, 1980, det. D. McClintock. 1st recent record.
- †107/44.1b. *DAUCUS CAROTA* subsp. *SATIVUS* *113(A), Channel Is. (Alderney): Patch (casual only) flowering in corner of a rough field, on Grand Blaye, WA580069, B. Bonnard, 1995.
- 108/3.2. *CENTAURIUM ERYTHRAEA* 80, Roxburghs.: Forestry track, Wauchope Forest, Bonchester Bridge, NT559053, J. & E. Allan, 2000, **herb. R.W.M. Corner**. 2nd extant site.
- 108/5.2. *GENTIANELLA CAMPESTRIS* 46, Cards.: 453 plants in pasture, near Bronnant, SN66, S.D.S. Bosanquet & D.K. Reed, 2001. 1st recent record & only extant site.
- 108/5.4c. *GENTIANELLA AMARELLA* subsp. *SEPTENTRIONALIS* 95, Moray: Sand dunes, Roseisle Forest, Burchhead, NJ109664, I.P. Green & A. Stevenson, 2000. 1st recent record.
- †110/1.1. *NICANDRA PHYSALODES* *52, Anglesey: Garden weed, presumed from birdseed, Penlon, Newborough, SH432647, B. Woodward, 2001. *113(S), Channel Is. (Sark): La Seigneurie Garden, WV463765; near Mill Lane (S of Beaulieu), WV464757; both established in gardens (unintentionally introduced), R.M. Veall, 2001, **herb. Société Sercquaise**. 1st & 2nd records.
- †110/6.per. *PHYSALIS PERUVIANA* *99, Dunbarton: 9 plants, on shingle shore in strand line with *Lycopersicon*, East Helensburgh, NS3081, A. Rutherford & A.McG. Stirling, 1998, **E**, conf. E.J. Clement.
- †110/8.3. *SOLANUM PHYSALIFOLIUM* *41, Glam.: 2 plants in *Brassica* field, Rhossili Viel, SS413826, Q.O.N. Kay, 2001. *46, Cards.: Casual, one plant on waste ground in boat-building yard, Ynys-las, SN616932, W. McCarthy & BSBI Field Meeting, 2000. 1 plant, casual only, in unsprayed strip at edge of maize field, 250m N of Waungelod, Gwbert, SN168487, A.O. Chater, 2001, **NMW**. 1st & 2nd records.
- †110/8.ros. *SOLANUM ROSTRATUM* *93, N. Aberdeen: Heap of bulldozed earth at abandoned farm, Piriesmill, Huntley, NJ537401, D. Welch, 1999, **herb. D.W.**, conf. E.J. Clement.
- †110/8.vil. *SOLANUM VILLOSUM* *58, Cheshire: Landfill, Bebington, SJ347788, R. Goodchild, 2001.

†110/9.1. *DATURA STRAMONIUM* var. *TATULA* *113(A), Channel Is. (Alderney): Over 20 plants in recently tipped soil by railway station, Braye, WA577081, B. Bonnard, 2001, det. M. Long. Probably long dormant seed; there again 2002.

†110/9.fer. *DATURA FEROX* *35, Mons.: 1 plant in garden bed, farm-manured previous year, Newton Green, Mathern, ST518918, T.G. Evans & K.C. Jones, 2001. 1 plant in cultivated soil near wild-bird feeding station, Llanwrm, Llanvair Discoed, ST450915, C.W. Thomas, 2001. 1st & 2nd records. *64, Mid-W. Yorks.: Rubbish tip, Esholt, SE178398, B.A. Tregale & M. Wilcox, 1999.

†110/CAP.ann. *CAPSICUM ANNUUM* *29, Cambs.: Tip, Romsey, TL479577-480577, G.M.S. Easy, 1982, **herb. G.M.S.E.**

†110/NIC.ala. *NICOTIANA ALATA* *113(A), Channel Is. (Alderney): 1 plant (garden escape) in hedge, Barrackmaster's Lane, WA592078, B. Bonnard, 1988, det. D. McClintock.

†110/PET.axi×hyb. *PETUNIA* × *HYBRIDA* (*P. AXILLARIS* × *P. INTEGRIFOLIA*) *47, Monts.: Casual pavement weed in town, Welshpool, SJ2207, R. Palmer, 2001. *99, Dunbarton: Lane side, Milton, Dumbarton, NS4074, A. Rutherford, 1998. Over 25 plants, Clyde Street, East Helensburgh, NS3081, A. Rutherford, 2001. 1st & 2nd records.

111/3.2×4. *CALYSTEGIA* × *LUCANA* (*C. SEPIUM* × *C. SILVATICA*) *39, Staffs.: W verge of A513, Stafford, SJ931249, R.H. Woodall, 2001.

†111/3.3. *CALYSTEGIA PULCHRA* *45, Pembs.: Abundant on roadside hedge bank, Park Stone, New Moat, SN054223, S.B. & A.E. Evans, 2001. Ruderal on edge of small tip, SW of Hazel Mill House, Hazelbeach, SM942051, S.B. Evans, 2001. 1st & 2nd records.

†111/3.4. *CALYSTEGIA SILVATICA* 91, Kincards.: Grassland above coastal cliffs, Stonehaven, NO885874, D. Welch, 2001. 1st recent record.

113/2.1. *NYMPHOIDES PELTATA* *†113(A), Channel Is. (Alderney): Several seedlings in Concrete tank on Essex hill, WA594074, B. & J. Bonnard, 1987, det. D. McClintock. Persisted 3 years only.

†115/1.1. *PHACELIA TANACETIFOLIA* *49, Caerns.: Base of tree, High Street car-park, Bangor, SH5771, A. Mundell, 2000. *113(A), Channel Is. (Alderney): Remnant of fodder crop in field, in Le Grand Val, WA564068, B. Bonnard, 1994. In Bracken, on Les Rochers, WA583077, B. Bonnard, 1998. 1st & 2nd records.

116/11.1. *MERTENSIA MARITIMA* 91, Kincardines.: Gravelly shore, Nigg Bay, NJ9604, B. Balingier, 1996. 1st recent record.

†116/12.2. *AMSINCKIA MICRANTHA* *67, S. Northumb.: In grass near museum building, Woodhorn Colliery Museum, NZ290885, J.M. Humphris, 2000, **herb. G.A.S.** *91, Kincardines.: Tipped soil for bank repairs, St Cyrus, NO725622, D. Welch, 1998, **ABD.**

†116/13.1. *PLAGIOBOTHRYIS SCOULERI* *39, Staffs.: Several small plants on bare mud, floor of disused quarry, Cannock Chase, SJ975190; A few specimens, edge of pool, a short distance away, Cannock Chase, SJ974192; both G.M. Kay, P. Newton & J.H. Clarke (BSBI Meeting), 2001. 1st & 2nd records.

116/15.1×4. *MYOSOTIS* × *SUZAE* (*M. SCORPIOIDES* × *M. LAXA*) *43, Rads.: A scrambling plant on stony shore, Llanbwchllyn, SO118463, S.P. Chambers, 1998, conf. A.O. Chater.

116/15.4a. *MYOSOTIS LAXA* subsp. *CAESPITOSA* *113(A), Channel Is. (Alderney): Possibly native, in damp place, in Baxter's Valley, WA556062, B. Bonnard, 1988, det. D. McClintock.

†116/16.1. *OMPHALODES VERNA* *29, Cambs.: Several plants in flower over a long stretch of wall, The Range, Ely, TL5380, R.M. Payne, 2001. Not seen in any of the cottage gardens opposite the wall.

116/2.2. *ECHIU PLANTAGINEUM* †113(A), Channel Is. (Alderney): 5 casual plants in tipped soil, Platte Saline, WA569079, B. Bonnard, 1996. 2nd & 1st recent record.

†116/4.2. *SYMPHYTUM ASPERUM* *77, Lanarks.: Allanton coal bing, Hamilton, NS7453, P. Macpherson & Hamilton Nat. Hist. Soc. 2001, **herb. P.M.**, det. F.H. Perring.

†116/4.4. *SYMPHYTUM GRANDIFLORUM* *39, Staffs.: Grass verge, trackside, Ashley, SJ753368, J.E. Hawksford, 1999. *43, Rads.: Roadside verge, between Brynwrn Bridge and The Bog, Newbridge-on-Wye, SO019569, R.G. Woods, 1996. *79, Selkirks.: Naturalised colony, on roadside bank, Philip Haugh, Selkirk, NT458288, P. Macpherson, 2001, **herb. P.M.**, det. F.H. Perring.

- †116/4.6. *SYMPHYTUM ORIENTALE* *41, Glam.: Many plants on sea-front waste ground, Langland, SS605874, A.S. Lewis, 2001.
- †116/5.1. *BRUNNERA MACROPHYLLA* *29, Cambs.: 1 flowering plant at base of wall along path called Mackerel Hall, Royston, TL350407, A.C. Leslie, 2001.
- †116/8.1. *PENTAGLOTTIS SEMPERVIRENS* *113(A), Channel Is. (Alderney): Established on verge, near Fort Quesnard, WA604090, B. Bonnard, 1986, det. D. McClintock.
- †116/LAP.squ. *LAPPULA SQUARROSA* *29, Cambs.: Newnham, TL45, C.E. Moss, 1911, CGE, det. A.O. Chater. Near farm buildings, New Farm, Whittlesford, TL452489, G.M.S. Easy, 1994, **herb. G.M.S.E.** 1st & 2nd records.
- †116/NON.lut. *NONEA LUTEA* 29, Cambs.: Weed in gardens, Landbeach Road, Milton, TL4763, G.M.S. Easy, 1980s-1990s. 1st recent record.
- †118/1.2. *STACHYS BYZANTINA* 44, Carms.: 1 clump halfway down seawall, Pembrey Harbour, SS436999, V. & A. Lewis, 2001. 2nd record. *46, Cards.: Abundantly naturalised in pasture, S of Wallog garden, SN590856, A.O. Chater, 2000. *58, Cheshire: Casual only, on waste ground, Bromborough Port, SJ392839, R. Goodchild, 2000. *64, Mid-W. Yorks.: Sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE2538, B.A. Tregale & M. Wilcox, 2001.
- 118/1.5x6. *STACHYS* × *AMBIGUA* (*S. SYLVATICA* × *S. PALUSTRIS*) 45, Pembs.: Porthgain, SM816323, J. Partridge, 2001. 1st recent record.
- †118/1.ann. *STACHYS ANNUA* *44, Carms.: Roadside E of Morfa roundabout, Llanelli, SS518917, I.K. Morgan, 2000, **NMW**, det. G. Hutchinson.
- †118/13.rac×nep. *NEPETA* × *FAASSENII* (*N. RACEMOSA* × *N. NEPETELLA*) 50, Denbs.: Pathside, Rhyd y Foel, SH914772, WFS group, 2000. 2nd record. *51, Flints.: In long grass in coastal dunes, E of Prestatyn Golf Course, SJ088841, J.A. Green, 2000.
- †118/16.1. *MELISSA OFFICINALIS* *113(S), Channel Is. (Sark): Probably from introduced soil used to build up a bank forming field boundary, Le Grand Fort, WV467769, R.M. Veall, 2000, **herb. Société Sercquaise**.
- 118/18.2. *CLINOPODIUM ASCENDENS* 39, Staffs.: Abundant on southern slopes of mound, Tutbury Castle, where it was last recorded in 1844, SK209290, M.E. Smith, 2001. 1st recent record.
- 118/18.4. *CLINOPODIUM VULGARE* 91, Kincardines.: Pathside along old railway, Crathes, NO736961, D. Welch, 1997. 2nd extant site.
- 118/20.1. *ORIGANUM VULGARE* *†99, Dunbarton: Probable garden escape, on wall-top, East Helensburgh, NS3081, A. Rutherford, 2001.
- 118/21.2. *THYMUS PULEGIOIDES* 49, Caerns.: Recently widened roadside, Cancoed, Roman Bridge, SH712511, J. & H. Lowell, 2001. 1st recent record.
- 118/23.1x3. *MENTHA* × *GRACILIS* (*M. ARVENSIS* × *M. SPICATA*) 5, S. Somerset: Several plants on S shore of reservoir, Clatworthy Reservoir, ST032307, P.R. Green, 2001. 1st recent record.
- 118/23.3xlon. *MENTHA* × *VILLOSONERVATA* (*M. SPICATA* × *M. LONGIFOLIA*) *113(A), Channel Is. (Alderney): Waste ground along railway line, Longis Common, WA594085, O. Johns, 1980, det. R.M. Harley.
- 118/23.4. *MENTHA SUAVEOLENS* *†29, Cambs.: 1 huge plant, old railway sidings, March, TL413991, G.M.S. Easy, 1994, 1996 & 2000, **herb. G.M.S.E. & CGE**. Survives despite bulldozing operations.
- 118/23.5. *MENTHA PULEGIUM* 52, Anglesey: Rushy pasture, near Traeth Lligwy, SH4987, W. McCarthy & M. Stead, 2000, det. R.M. Harley. 2nd & 1st recent record.
- †118/25.off. *SALVIA OFFICINALIS* *29, Cambs.: Single small casual plant, on low wall, St Eligius Street, Cambridge, TL452574, P.H. Oswald, 1999, Now gone, parent a large plant in adjacent garden. *58, Cheshire: Casual only, on waste ground, Bromborough Pool, SJ351812, R. Goodchild, 2000.
- †118/4.1c. *LAMIASTRUM GALEOBDOLO* subsp. *ARGENTATUM*, 113(A), Channel Is. (Alderney): Established in churchyard and St Vignalis' Garden, St Anne, WA574074, B. Bonnard, 1993, det. D. McClintock. 2nd record.

- 118/5.4. *LAMIUM HYBRIDUM* *†42, Brecs.: Swede field, 1.5km SE of Garth, SN963489, M. & C. Porter, 2000.
- 118/5.6. *LAMIUM AMPLEXICAULE* †42, Brecs.: Base of wall in car-park, Brecon, SO046284, P. Sinnadurai, 2000. 2nd record.
- †118/7.1. *PHLOMIS RUSSELLIANA* *29, Cambs.: Waste ground near industrial estate, Chesterton, TL472609, G.M.S. Easy, 2001. Destroyed in 2002.
- †118/7.2. *PHLOMIS FRUTICOSA* *29, Cambs.: Still survives at rail edge, Shepreth/Meldreth, TL387475, G.M.S. Easy, 2001.
- 120/1.6. *CALLITRICHE BRUTIA* *113(S), Channel Is. (Sark): On mud at end of pond, Grand Dixcart dew-pond, WV463752, R.M. Veall, 2000, **herb. Société Sercquaise**, det. R. Lansdown.
- †122/1.2. *BUDDLEJA DAVIDII* *93, N. Aberdeen: Former sand-pit, Pitmedden, NJ/898271, D. Welch, 1999.
- †122/1.2×3. *BUDDLEJA* × *WEYERIANA* (B. *DAVIDII* × B. *GLOBOSA*) *113(A), Channel Is. (Alderney): Apparently self-sown in scrub, Newtown Road, WA582077, B. Bonnard, 1987, det. D. McClintock.
- †122/1.3. *BUDDLEJA GLOBOSA* *113(A), Channel Is. (Alderney): Garden escape in scrub, on Essex Hill, WA594078, B. & J. Bonnard, 1986, det. D. McClintock.
- 124/1.12. *VERBASCUM LYCHNITIS* 29, Cambs.: Railway sidings, numerous plants in area of sheds and old track, Chesterton, Milton, TL4760, G.M.S. Easy, 2000. Railway sidings, c.1350 plants incl. c.100 flowering and 10 'skeletons' from 1999, March, TL413985, G.M.S. Easy, 2000, **herb. G.M.S.E.** 1st & 2nd recent records.
- 124/1.2×11. *VERBASCUM VIRGATUM* × *V. PULVERULENTUM* *29, Cambs.: Several plants scattered in waste ground, Chesterton railway sidings, TL477611, G.M.S. Easy, 2001.
- 124/1.2×9. *VERBASCUM VIRGATUM* × *V. NIGRUM* *29, Cambs.: 1 plant, old railway sidings, March, TL413993, G.M.S. Easy, 2001.
- †124/1.4. *VERBASCUM BOMBYCIFERUM* *64, Mid-W. Yorks.: Probably introduced with foreign seed during landscaping, of roadside bank, Aberford, SE438368, Leeds Naturalists' Club, 2001, det. P.P. Abbott.
- 124/1.5×11. *VERBASCUM PHLOMIOIDES* × *V. PULVERULENTUM* *29, Cambs.: Several plants scattered, with both parents, at Chesterton railway sidings, TL477612, G.M.S. Easy, 2000, **herb. G.M.S.E.**
- 124/1.7×11. *VERBASCUM* × *GODRONII* (*V. THAPSUS* × *V. PULVERULENTUM*) *29, Cambs.: With *V. thapsus* on disused trackway on waste ground, Milton, TL476620, G.M.S. Easy, 1984. Waste ground, Chesterton railway sidings, TL477610, G.M.S. Easy, 1994. 1st & 2nd records.
- 124/1.7×12. *VERBASCUM* × *THAPSI* (*V. THAPSUS* × *V. LYCHNITIS*) *29, Cambs.: 11 flowering plants & many rosettes, with both parents, railway sidings, March, TL413985, G.M.S. Easy, 2000 & 2001, **herb. G.M.S.E.**
- 124/1.9×10. *VERBASCUM NIGRUM* × *V. SPECIOSUM* *29, Cambs.: Roadside verge, growing near *V. nigrum*, Little Abington, TL535493, G.M.S. Easy, 2001.
- 124/1.9×11. *VERBASCUM* × *MIXTUM* (*V. NIGRUM* × *V. PULVERULENTUM*) *29, Cambs.: With both parents, railway sidings, March, TL413987, G.M.S. Easy, 1999, **herb. G.M.S.E.**
- †124/1.pho. *VERBASCUM PHOENICEUM* *77, Lanarks.: Round a long abandoned castle, High house, Biggar, NT0742, P. Macpherson, 2000, **herb. P.M.**, det. E.J. Clement.
- †124/4.2. *MIMULUS GUTTATUS* *64, Mid-W. Yorks.: Bank of R. Wenning, Clapham Moor, SD739675, P.P. Abbott & G.T.D. Wilmore, 1999. 1st certain record, all earlier records probably *R. × robertsii*.
- †124/4.2×3. *MIMULUS* × *ROBERTSII* (M. *GUTTATUS* × M. *LUTEUS*) *29, Cambs.: Base of wall, St. Mary's Street, Ely, TL5380, R.M. Payne, 2001, conf. K.A. Beckett.
- 124/5.1. *LIMOSELLA AQUATICA* 5, S. Somerset: Shore of reservoir, Wimblehall Reservoir, SS979306, N.T.H. Holmes, R.V. Lansdown & H. Sambrook, 2001. 2nd record.
- †124/8.1. *CHAENORHINUM ORIGANIFOLIUM* *49, Caerns.: Base of wall, Great Orme, Llandudno, SH7782, W. McCarthy, 2000.

124/9.1. *MISOPATES ORONTIUM* **29**, Cambs.: Large colony in gravel behind greenhouse, Girtton College, Cambridge, TL425611, Anon & C.J. Cadbury, 2000. 2nd recent record.

†124/10.1. *ASARINA PROCUMBENS* ***46**, Cards.: Naturalised on wall in grounds of Ynys-hir Hall Hotel, Eglwys Fach, SN681958, A.O. Chater, 2001, **NMW**.

†124/11.1b. *CYMBALARIA MURALIS* subsp. *VISIANII* ***64**, Mid-W. Yorks.: Disused sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE2538, Bradford Botany Group, 1999, det. E.J. Clement.

124/12.1. *KICKXIA ELATINE* **39**, Staffs.: Locally frequent, set-a-side, edge of Nash Elm Wood, SO779813, W.A. Thompson & R. Maskew, 1996. 2nd recent record. †**58**, Cheshire: Growing on damp waste ground (casual only), Caldý, SJ228844, R. Goodchild, 2000. 1st recent record.

†124/13.3. *LINARIA PURPUREA* ***113(A)**, Channel Is. (Alderney): Growing in stone wall (casual only), in Le Val and near Catholic Cemetery, St Anne, WA576073, A. Tucker, 1983, det. D. McClintock.

124/13.3×4. *LINARIA* × *DOMINII* (*L. PURPUREA* × *L. REPENS*) ***29**, Cambs.: 1 plant only in waste ground, Chesterton railway sidings, TL475610, G.M.S. Easy, 2000, **herb. G.M.S.E.** ***64**, Mid-W. Yorks.: Sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE255384, B.A. Tregale & M. Wilcox, 2001.

124/13.4. *LINARIA REPENS* ***†29**, Cambs.: Abundant over c.12 acres, railway sidings, March, TL411998-413996, G.M.S. Easy, 1986 & 1993. Waste ground, Chesterton railway sidings, Milton, TL475608, G.M.S. Easy, 2000, **herb. G.M.S.E.** 1st & 2nd records.

†124/15.1. *ERINUS ALPINUS* ***46**, Cards.: Abundantly naturalised on old walls, Portland Road, Aberystwyth, SN585818, R.G. Woods, 2001. ***91**, Kincards.: Wall of old garden, Glenbervie, NO767805, D. Welch, 1999.

124/16.11×12. *VERONICA* × *LACKSCHEWITZII* (*V. ANAGALLIS-AQUATICA* × *V. CATENATA*) ***52**, Anglesey: Margins of Afon Cefni, Malltraeth Marsh, SH4572, I.R. Bonner, 2000.

124/16.12. *VERONICA CATENATA* ***†46**, Cards.: 2 plants, casual only, on new verge, by Ysgol Penweddig, Llanbadarn Road, Aberystwyth, SN595811, A.O. Chater, 2001.

124/16.1b. *VERONICA SERPYLLIFOLIA* SUBSP. *HUMIFUSA* **49**, Caerns.: Base of rock, E face of Carnedd Llewelyn, SH6864, G.H. Battershall, 2000. 1st recent record.

†124/16.22. *VERONICA CRISTA-GALLI* ***H6**, Co. Waterford: Plentiful, on verge either side of road, Carrickbeg, S397210, P.R. Green, 2001.

†124/16.25. *VERONICA LONGIFOLIA* ***113(A)**, Channel Is. (Alderney): Garden escape, behind Alderney prison, WA573073, B. Bonnard, 1987, det. D. McClintock.

†124/17.2. *HEBE BRACHYSIPHON* ***29**, Cambs.: At least 17 self-sown plants at wall & fence bases, along W side of Chapel Street, March, TL416963, A.C. Leslie, 2001, **CGE**.

124/18.1. *SIBTHORPIA EUROPAEA* ***†39**, Staffs.: In many places on the lawns, and sometimes extending over rocks into flower borders, Biddulph Grange Gardens, Biddulph, SJ893592, C.B. Westall, 2000.

124/18.1. *SIBTHORPIA EUROPAEA*. ***42**, Brecks.: Marshy grassland, moorland, NE of Brynmawr, Mynydd Llangatwg, SO205135, R.J. Williams, R. Jacques & S.P. Chambers, 2000, conf. A.O. Chater.

124/2.3. *SCROPHULARIA UMBROSA* ***†41**, Glam.: In profusion on roadside, near car park of Clydach Bird Reserve, Lower Swansea Valley, SN676033, D. Davies, 1999.

†124/2.5. *SCROPHULARIA VERNALIS* **64**, Mid-W. Yorks.: 13 plants, on waste ground, Walshford, SE413532, S. Schofield, 1994. Only extant site.

124/20.5×19. *EUPHRASIA* × *VENUSTA* (*E. ARCTICA* × *E. SCOTTICA*) ***77**, Lanarks.: Hillside flush, Glenthirston Burn, NT0111, P. Macpherson & E.L.S. Lindsay, 2000, **herb. P.M.**, det. A.J. Silverside.

124/20.5×9. *EUPHRASIA ARCTICA* × *E. SCOTTICA* ***77**, Lanarks.: Flush ESE of burn, Glenthirston Burn, NS0111, P. Macpherson & E.L.S. Lindsay, 2000, **herb. P.M.**, det. A.J. Silverside.

124/20.8. *EUPHRASIA MICRANTHA* **49**, Caerns.: Several patches on leached limestone grassland, Little Orme, Llandudno, G. Battershall, 1998. 1st recent record.

124/23.1. *PARENTUCELLIA VISCOSA* *†51, Flints.: About 40 plants in short, open, wet turf, N corner of Llawndy Farm, Talacre, SJ125846, C.N. Carter, 1996. **64**, Mid-W. Yorks.: Grassland, Kirkstall Valley NR, SE266345, Leeds Urban Wildlife Group, 1993. 2nd extant site. *110, Outer Hebrides: Bank of ditch by gate, Bragar, NB298480, R.J. Pankhurst, 2001.

124/25.2b. *PEDICULARIS SYLVATICA* SUBSP. *HIBERNICA* *35, Mons.: Wet heath, Pontllanfraith, ST167963, M.A.R. Kitchen, 2001.

†125/1.2. *LATHRAEA CLANDESTINA* **5**, S. Somerset: Large patch, at base of willow in damp woodland, Wayford Woods, Wayford, ST400064, I.P. Green, 2000. 2nd record & only extant site.

†127/1.1. *ACANTHUS MOLLIS* *113(A), Channel Is. (Alderney): 1 established plant flowering in scrub, on La Giffoine, WA556065, B. Bonnard, 1998.

†129/1.10. *CAMPANULA POSCHARSKYANA* *113(A), Channel Is. (Alderney): Naturalised garden escape on several old walls, in St Anne, WA575075, B. Bonnard, 1988, det. D. McClintock. Established in top and crevices in several stone walls, in St Anne, WA575075, B. Bonnard, 1994. 1st & 2nd records.

†129/1.9. *CAMPANULA PORTENSCHLAGIANA* *113(A), Channel Is. (Alderney): Established on several old walls, in St Anne and round museum, WA576072, B. Bonnard, 1986, det. D. McClintock.

†130/5.ori. *ASPERULA ORIENTALIS* *29, Cambs.: Old pit now used for rubbish, Kennett Heath, TL694695, G.M.S. Easy, 1996, **herb. G.M.S.E.** *44, Carms.: Neglected garden area, formerly wooded, Cwmffrwd, SN425170, D. Poulter, 2001, NMW, det. G. Hutchinson.

130/6.13. *GALIUM TRICORNUTUM* **29**, Cambs.: 2 plants in fruit on new roadside verge, N side of new road to Little Abington, TL527497, G.M.S. Easy, 1996, **herb. G.M.S.E.** Only extant British site?

130/6.6x7. *GALIUM* × *POMERANICUM* (*G. VERUM* × *G. MOLLUGO*) *39, Staffs.: Many plants, with parents, in dry grassland, Coal Port, Walsall, SP014998, M.W. Poulton, 2001.

130/6.7a. *GALIUM MOLLUGO* subsp. *MOLLUGO* *58, Cheshire: Demolished factory, Portwood, Stockport, SJ904914, G.M. Kay & L. Worthington, 2001. Old railway, Thurstaston, SJ237836, G.M. Kay, 2001. 1st & 2nd records.

131/1.4. *SAMBUCUS EBULUS* **50**, Denbs.: Rhyd y Meudwy, SJ120507, BSBI group, 2001. 1st recent record.

131/2.1. *VIBURNUM OPULUS* **91**, Kincards.: Roadside in semi-natural woodland, Glenbogle, NO662957, D. Welch, 2001. Only extant site.

†131/2.3. *VIBURNUM TINUS* *29, Cambs.: Bassingbourn, TL34, P.D. Sell, 1991. 1 plant at thrush roost site, railway sidings, Chesterton, TL467613, G.M.S. Easy, 2000, **herb. G.M.S.E.** 1st & 2nd records; the latter the 1st for self/bird sown plants.

†131/2.4. *VIBURNUM RHYTIDOPHYLLUM* *46, Cards.: Suckering in mixed estate woodland, Old Cilgwyn, Adpar, SN315414, A.O. Chater, 1998.

†131/3.1. *SYMPHORICARPOS ALBUS* **44**, Carms.: Fruiting seedling in mortar of stone wall adjoining chapelyard, Christian Temple, Ammanford, SN631123, V. & A. Lewis, 2000. 1st record of self-sown plant.

†131/6.1. *LONICERA PILEATA* *29, Cambs.: 2 bird-sown plants at base of walls, in Trafalgar Road, Cambridge, TL454594, A.C. Leslie, 2001. 1 plant on old St Ives railway track, and 3 plants on railway tracks, Chesterton railway sidings, TL4661, A.C. Leslie, 2000, **herb. A.C.L.** 1st & 2nd records.

†131/6.3. *LONICERA INVOLUCRATA* *29, Cambs.: 1 bird-sown plant c.45cm tall (and having flowered) rooted under old railway line, Histon, TL430636, A.C. Leslie, 2001.

†131/6.6. *LONICERA JAPONICA* *29, Cambs.: Established in gravel pit, Milton, TL479623, G.M.S. Easy, 1970+. Hedgerow at Fen Road end of sidings, Chesterton railway sidings, TL4761, G.M.S. Easy & G. Crompton, 2000. 2nd record, (det. as cv. 'Halleriana')

†131/6.8xetr. *LONICERA* × *ITALICA* (*L. CAPRIFOLIUM* × *L. ETRUSCA*) *77, Lanarks.: Well established in abandoned industrial estate, Shettleston, Glasgow, NS6364, P. Macpherson & Hamilton Nat. Hist. Soc. 2000, **herb. P.M.** det. E.J. Clement.

†131/6.tat. *LONICERA TATARICA* *52, Anglesey: Bush overhanging stone wall, by the Menai Strait near Plas Llanfair, SH533710, I.R. Bonner, 2001, **herb. I.R.B.** Presumably originally planted.

†131/WEI.flo. *WEIGELA FLORIDA* *99, Dunbarton: Railway embankment, Rhu, NS2983, A. Rutherford, 1989.

132/1.1. *ADOXA MOSCHATELLINA* 29, Cambs.: Abundant to dominant all over a 3-acre derelict wood by the river, Little Shelford, TL448524, S. Hearle, 1995. 2nd native site, not seen for over 50 years.

133/1.2. *VALERIANELLA CARINATA* *29, Cambs.: Gravel Pits, Landbeach, TL4865, G.M.S. Easy, 1971. 10 plants, on NE side & SE end of Albert St, Cambridge, TL450594, C.D. Preston & P.H. Oswald, 1995. 1st & 2nd records.

133/1.3. *VALERIANELLA RIMOSA* 1, W. Cornwall: 2 plants at base of rocky outcrop by coastal path N of Hawker's Cove, near Padstow, SW913777, I.J. Bennallick, 1999, conf. D. Pearman. Over 20 plants, on area of rock erosion, on low cliff between arable field and the beach of Harbour Cove, N of Padstow, SW910770, I.J. Bennallick, 2000, conf. R.J. Murphy. 1st & 2nd recent records. 2, E. Cornwall: 6 plants, in Barley field with *Papaver hybridum*, near New Polzeath, SW945791, T.J. Dingle, 2000, conf. R.J. Murphy. 1st recent record.

†133/1.5. *VALERIANELLA ERIOCARPA* 1, W. Cornwall: Over 20 plants on area of rock erosion on low cliff between arable field and the beach, Harbour Cove, N of Padstow, SW910770, I.J. Bennallick, 2000, conf. R.J. Murphy. Only extant site.

133/2.3. *VALERIANA DIOICA* 48, Merioneth: In quantity in boggy ground, near Llyn Oror, Gwyddelwern, SJ0847, S.P. Chambers, 1996. Only extant site.

†134/1.2. *DIPSACUS SATIVUS* *39, Staffs.: Spoil bank, site of former Birchenwood Brickwork, Kids Grove, SJ855542, J.E. Hawksford & D.R. Larnier, 1998. Destroyed in 2000. Site of former colliery, Apedale Country Park, Newcastle-under-Lyme, SJ823481, I.J. Hopkins, 1998. 1st & 2nd records.

†134/1.lac. *DIPSACUS LACINIATUS* *58, Cheshire: Scrubland, Bidston Moss, SJ284910, V. Gordon, 2001.

†134/2.1. *CEPHALARIA GIGANTEA* 29, Cambs.: Large patch on trackside ditchbank of the green lane, from Rampton to Histon, TL421682, A.C. Leslie, 1998. 1st recent record.

†135/1.1. *ECHINOPS SPAEROCEPHALUS* *99, Dunbarton: Increasing on railway bank, Carrross, NS3477, A. Rutherford, 1997.

†135/1.1. *ECHINOPS BANNATICUS* *99, Dunbarton: Rough waste ground among grass, East Helensburgh, NS3083, A. Rutherford & A.McG. Stirling, 2001.

†135/1.2. *ECHINOPS EXALTUS* 99, Dunbarton: Rough waste ground, Helensburgh, NS3083, A. Rutherford & A.McG. Stirling, 1998. 2nd record; increasing in 2001.

135/6.3. *CIRSIIUM DISSECTUM* *47, Monts.: Wet meadows, Dolfor, SO08, C.A. Small, 2000.

135/7.1. *ONOPORDUM ACANTHIUM* *†113(A), Channel Is. (Alderney): 4 plants (casual) on derelict land, in Auderville, WA576074, B. Bonnard, 1991, det. D. McClintock. 2 plants (casual) in field, behind Catholic Cemetery, St Anne, WA585074, B. Bonnard, 1994. 1st & 2nd records.

†135/11.cin. *CENTAUREA CINERARIA* *113(A), Channel Is. (Alderney): 5 or 6 plants established on top of a high wall, below German Water Tower in Les Mouriaux, WA573074, M.A. R. Kitchen, 1995, det. A.C. Leslie. Still there in 2003.

†135/14.4. *ASTER NOVI-BELGII* *110, Outer Hebrides: Roadside, Shawbost, NB258477, R.J. Pankhurst, 2001, **E.**

135/16.3. *LEONTODON SAXATILIS* *91, Kincards.: Marsh in coastal grassland, Inverbervie, NO838725, D. Welch, 2001, **herb. D.W.**

135/17.2. *PICRIS HIERACIOIDES* *H6, Co. Waterford: 10 plants, on edge of disused tip, Carrick-on-Suir, S410214, P.R. Green, 2001.

135/22.1. *LACTUCA SERRIOLA* *†113(A), Channel Is. (Alderney): Established on bank, in Le Petit Val, WA568078, R. Waterman, 1986, det. D. McClintock. Frequent in Platte Saline area in 2002. Several plants, in Butes Lane & La Vallée, WA574076, B. Bonnard, 1989. 1st & 2nd records.

135/22.2. *LACTUCA VIROSA* **50**, Denbs.: Waste ground, Pensarn, SH942786, J.A. Green, 2000. 1st recent record. **58**, Cheshire: Demolished factory, Portwood, Stockport, SJ904914, L. Worthington, 2001. 1st recent record.

[†135/23.2. *CICERBITA MACROPHYLLA* **93**, N. Aberdeen: *Watsonia* **13**: 339 (1981) has been redetermined as *C. plumieri*].

†135/23.3. *CICERBITA PLUMIERI* ***93**, N. Aberdeen: Old railway, Rothienorman, NJ722355, D. Welch, 1978, **ABD** & 1998.

†135/23.4. *CICERBITA BOURGAEI* ***29**, Cambs.: One large clump under Lombardy Poplars on the W bank of Quay Water, just S of the Mill, Lode, TL530624, A.C. Leslie, 2001, **CGE**. ***88**, Mid Perth.: Edge of wood, N side of road, c.0.8km N of Kinnaird House, Balnaguard, NN9850, D.J. McCosh, 2001, det. D.J. McCosh.

135/24.1. *MYCELIS MURALIS* **91**, Kincardines.: Wall of kirkyard, Banchory Devenick, NJ906023, D. Welch, 1998, **ABD**. 1st recent record.

135/25.9. *TARAXACUM DUNENSE* ***46**, Cards.: Sandy pasture, Glan-gors, Ynys-las, SN608920, A.O. Chater, 1996, **NMW**, det. A.J. Richards.

135/25.11. *TARAXACUM FULVIFORME* ***113(A)**, Channel Is. (Alderney): Roadside, Route de Crabby, WA574081, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.55. *TARAXACUM BRACTEATUM* ***113(A)**, Channel Is. (Alderney): Roadside in Longis Road, WA580073, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.85. *TARAXACUM BOECKMANII* ***113(A)**, Channel Is. (Alderney): Churchyard, St Anne, WA574074, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.92. *TARAXACUM LAMPROPHYLLUM* ***113(A)**, Channel Is. (Alderney): Field, at Windy Corner, WA570069, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.98. *TARAXACUM PSEUDOHAMATUM* ***113(A)**, Channel Is. (Alderney): Grassy field, on Les Butes, WA575076, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.111. *TARAXACUM ANCISTROLOBUM* ***113(A)**, Channel Is. (Alderney): Roadside, Allée ès Féés, WA570073, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.118. *TARAXACUM CHLORITICUM* ***35**, Mons.: Forest trackside bank, Craig Gwent, ST259999, T.G. Evans, 2001, **NMW**, det. A.J. Richards.

135/25.121. *TARAXACUM CORDATUM* ***113(A)**, Channel Is. (Alderney): Gutter, by Sea View Hotel, Braye, WA577082, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.128. *TARAXACUM DIASTEMATICUM* ***35**, Mons.: Rail ballast, Pye Corner, ST275872, T.G. Evans, 2001, det. A.J. Richards.

135/25.130. *TARAXACUM DILATATUM* ***110**, Outer Hebrides: Waste ground by library, Stornoway, NB423328, R.J. Pankhurst, 1995, **E**, det. A. Dudman.

135/25.131. *TARAXACUM EKMANII* ***113(A)**, Channel Is. (Alderney): Grave edge, St Anne's Cemetery, WA572073, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.133. *TARAXACUM EXPALLIDIFORME* ***113(A)**, Channel Is. (Alderney): Grassy bank, on Les Butes, WA575078, R. Cook, 1986, det. A.J. Richards & C.C. Howarth.

135/25.142. *TARAXACUM INCISUM* ***35**, Mons.: New roadside bank, N. Tredegar, SO134013, T.G. Evans, 2001, **NMW**, det. A.J. Richards.

135/25.143. *TARAXACUM INSIGNE* ***113(A)**, Channel Is. (Alderney): Cliffs, near the rubbish tip at La Tchue, WA591073, R. Cook, 1986, det. C.C. Howarth.

135/25.162. *TARAXACUM MACROLOBUM* ***35**, Mons.: Grassy verge, W of A4042, Little Mill, SO317026, T.G. Evans, 2000, **NMW**, det. A.J. Richards.

135/25.163. *TARAXACUM MACULATUM* ***35**, Mons.: Rail ballast, Pye Corner, ST275872, T.G. Evans, 2001, **NMW**, det. A.J. Richards. Recorded elsewhere only by Merle Marsden v.c. 34.

135/25.186. *TARAXACUM POLYODON* ***113(A)**, Channel Is. (Alderney): Roadside at Ladysmith, WA568076, R. Cook, 1986, det. C.C. Howarth.

135/25.198. *TARAXACUM SEMIGLOBOSUM* ***83**, Midlothian: Waste ground, Leith, NT268766, R.J. Pankhurst, 2001, **E**, det. A.J. Richards.

135/25.204. *TARAXACUM SUBEXPALLIDUM* *44, Carms.: Narrow verge on E side of road, north approach to old railway bridge, Glangwili, SN430217, R.D. Pryce, 1997, **NMW**, det. A.J. Richards.

135/25.209. *TARAXACUM LEPIDUM* *110, Outer Hebrides: Ravine, Orosay, NF725174, E. Pilling, 1999, **E**, det. A.J. Richards & A. Dudman.

135/25.213. *TARAXACUM TENEBRICANS* *35, Mons.: Damp meadow, S of Coed Abergwenllan, SO324065, T.G. Evans, 2000, **NMW**, det. A.J. Richards.

135/25.219. *TARAXACUM VASTISECTUM* *35, Mons.: Verge of A472, Pantygasseg, ST256997, T.G. Evans, 2001, **NMW**, det. A.J. Richards.

135/25.akt. *TARAXACUM AKTEUM* *35, Mons.: Unimproved meadow over Old Red Sandstone, Fernlea, SO475015, T.G. Evans, 2000, **NMW**, det. A.J. Richards. 1st Welsh record.

135/25.haw. *TARAXACUM HAWORTHIANUM* *44, Carms.: Grey dunes, Pembrey Country Park, SS399999, R.D. Pryce *et al.*, 1997, **NMW**, det. A.J. Richards.

†135/26.rub. *CREPIS RUBRA* *29, Cambs.: 1 plant in gravel, by Parish Pump, Duck End, Girton, TL420618, H. Belcher & E. Swale, 1996; G. Crompton, 1996, **CGE**. 2nd British record since 1930.

†135/27.6b. *PILOSELLA AURANTIACA* subsp. *CARPATICOLA* *H6, Co. Waterford: Field bank, Ardmore, X188778, P.R. Green, 2001.

135/28.1. *HIERACIUM SABAUDUM* *95, Moray: Woodland, Regulas Wood, S of Forres, NJ001496, V. Jones, 2000.

135/28.3. *HIERACIUM RIGENS* *77, Lanarks.: Among vegetation on clinker of long abandoned railway line, Glenboig, NS721683, P. Macpherson, 2000, **herb. P.M.**, det. D.J. McCosh.

135/28.12. *HIERACIUM STRICTIFORME* *77, Lanarks.: Pathside between arable fields, W of Uddingston, NS6860, P. Macpherson, 2000, **herb. P.M.**, det. D.J. McCosh.

135/28.19. *HIERACIUM EBORACENSE* *47, Monts.: Trackside on MWT Reserve, Llanymynech Rocks, SJ267218, K. Thorne, 2001, det. D.J. McCosh.

135/28.29. *HIERACIUM PLACEROPHYLLOIDES* 44, Carms.: Small low cliffs, W end of Llyn-y-fan Fach, SN797216, T.C.G. Rich & A.D. Tipper, 1999, **NMW**. 1st recent record.

135/28.72. *HIERACIUM DIAPHANUM* 29, Cambs.: Group of 20 flowering plants, old railway, Milton, TL474608, G.M.S. Easy, 1995, **herb. G.M.S.E.** 2nd record & only extant site.

135/28.133. *HIERACIUM SUBCRASSUM* *64, Mid-W. Yorks.: Top of cliff above R. Wharfe, Boston Spa, SE423463, P.P. Abbott, 1999, det. V. Jones & D.J. McCosh.

135/28.143. *HIERACIUM SUBRUDE* 91, Kincards.: Boulder clay on raised beach, Stonehaven, NO890882, D. Welch, 2000, **ABD**, conf. D.J. McCosh. 1st recent record.

135/28.arg. *HIERACIUM ARGUTIFOLIUM* *29, Cambs.: Shaded piles of cinders & ballast, Whittlesey railway station, TL280962, J.O. Mountford, 1970, **CGE**, det. P.D. Sell.

135/30.1. *FILAGO VULGARIS* 64, Mid-W. Yorks.: Bare ground (?clinker from furnaces), in grounds of former Kirkstall Forge, Kirkstall, Leeds, SE246368, A.J. Woodall, 1994, det. P.P. Abbott, conf. T.C.G. Rich. Only extant site.

135/30.4. *FILAGO MINIMA* 66, Co. Durham: Thousands of plants on embankments of disused railway line, near Waskerley, NZ040454, G. Young, 2001, conf. F. Rose. 1st recent record.

135/33.6. *GNAPHALIUM LUTEOALBUM* 29, Cambs.: 40-50 flowering on bare ground, Chesterton Sidings, Milton, TL475611, G.M.S. Easy, 1999, **herb. G.M.S.E.**, with c.2000 flowering stems in 60×10m in 2000. Still present in quantity in 2002. 1st recent record. *H6, Co. Waterford: 8 plants, on waste ground, Ringnasilloge, Dungarvan, X254924, I.P. Green, 2001, **DBN**.

†135/34.pet. *HELICHRYSUM PETIOLARE* *29, Cambs.: 1 plant self-sown at base of wall (wedged between wall and cobbles), at back of parking area on N side of Melbourne Street, Royston, TL355407, A.C. Leslie, 2001. *113(A), Channel Is. (Alderney): Several large patches with seedlings established in scrub, Bluestone Hill, WA590078, B. Bonnard, 1994.

†135/35.ocu. *INULA OCLUS-CHRISTI* *52, Anglesey: Old asphalt heap, Plas Trefor, Llansadwrn, SH549775, B.F.T. Ducker, 2001, **herb. B.F.T.D.**

†135/40.4a. *SOLIDAGO GIGANTEA* subsp. *SEROTINA* *113(S), Channel Is. (Sark): A few plants, probably planted or possibly a garden outcast, on verge of unmetalled track, near Petite Genetière, WV466768, R.M. Veall, 2000, **herb. Société Sercquaise**.

†135/40.5. *SOLIDAGO GRAMINIFOLIA* *4, N. Devon: Very small patch in E verge of forest track, Narracott Plantation, East Putford, SS365186, W.H. Tucker, 2001. 2nd record.

†135/41.3x4. *ASTER* × *VERSICOLOR* (*A. LAEVIS* × *A. NOVI-BELGII*) *110, Outer Hebrides: Island in lochan, Urgha, NG176996, M.E. & P.F. Braithwaite, 2001, **E**.

†135/41.4x5. *ASTER* × *SALIGNUS* (*A. NOVI-BELGII* × *A. LANCEOLATUS*) *†44, Carms.: Casual in station approach road, Kidwelly, SN401065, G. Hutchinson, 1993, **NMW**, det. P.F. Yeo. *110, Outer Hebrides: Tolsta Chalois, NB195385, R.J. Pankhurst, 2001, **E**. *H6, Co. Waterford: Small patch on bank of R. Suir, Gracedieu, S584136, P.R. Green & I.P. Green, 2001, det. P.F. Yeo.

†135/42.1. *ERIGERON GLAUCUS* 46, Cards.: Sandy sea shingle, 100m SW of Borth Station, SN608900, A.O. Chater, 2000. 2nd record. *113(A), Channel Is. (Alderney): Frequently established along coastal dunes and seaside garden walls, as near Crabby, WA572080, B. Bonnard, 1986, det. D. McClintock.

†135/43.4. *ERIGERON KARVINSKIANUS* *29, Cambs.: Wicken Fen, TL57, A.S. Shrubbs, 1875 & 1878, **DHM**. Pavement, outside Cambridge Botanic Garden, TL4557, G.M.S. Easy, 1987. 1st & 2nd records.

†135/43.spe. *ERIGERON SPECIOSUS* *29, Cambs.: Rail track, Six Mile Bottom, TL578568, G.M.S. Easy, 1994, **herb. G.M.S.E.**

†135/44.2. *CONYZA SUMATRENSIS* *64, Mid-W. Yorks.: Waste ground, Central Leeds, SE303333, M. Wilcox, 1999. *113(A), Channel Is. (Alderney): Several plants established in quarry, Mannez, WA603088, M. Long, 2000. Previously overlooked here and at other sites as *C. canadensis*.

†135/44.bil. *CONYZA BILBAOANA* *29, Cambs.: Garden, Panton St, Cambridge, TL453575, P.D. Sell, 1999. *H6, Co. Waterford: 1 plant, on waste ground, Ringcrehy, Dungarvan, X250921, P.R. Green, 2001.

†135.45.3. *OLEARIA TRAVERSII* *113(A), Channel Is. (Alderney): Established and self-seeding (to 7m tall), in old salt resistant hedges, along E coast, St Esquère Bay, WA607087, B. Bonnard, 1987, det. D. McClintock.

†135.45.3. *OLEARIA TRAVERSII* *113(A), Channel Is. (Alderney): Established and self-seeding (to 7m tall), in old salt resistant hedges, along E coast, St Esquère Bay, WA607087, B. Bonnard, 1987, det. D. McClintock.

†135/45.avi. *OLEARIA AVICENNIIFOLIA* *113(S), Channel Is. (Sark): From roots or rhizomes of bush on other side of, roadside wall, Clos à Jaôn, WV466762, R.M. Veall, 1999, **herb. Société Sercquaise**, det. R.A. Waterman.

†135/45.avixmos. *OLEARIA* × *HAASTII* (*O. AVICENNIIFOLIA* × *O. MOSCHATA*). *41, Glam.: Self-seeded in rock cutting, near The Knab, Mumbles, SS628875, A.S. Lewis, 2000.

135/49.1. *SERIPHIDIUM MARITIMUM* 49, Caerns.: Top of rock on beach, near Tudweiliog, Lleyn Peninsula, SH236385, C. Forster-Brown, 2001. 2nd record.

†135/50.6. *ARTEMISIA ARBROTANUM* *52, Anglesey: Casual, by entrance to car-park, Tywyn Fferam, SH3371, V. & A. Lewis, 2001. *99, Dunbarton: Shingly sand above HWM, East Bay, Helensburgh, NS3081, A. Rutherford *et al.*, 1998. Disappeared after storm.

†135/50.dra. *ARTEMISIA DRACUNCULUS* *29, Cambs.: On waste heaps by old cement works chalk pits near railway, Shepreth, TL395483, G.M.S. Easy, 1984. Large numbers around rubbish tip, Witchford rubbish tip, TL495775, G.M.S. Easy, 2000. 1st & 2nd records.

†135/50.lud. *ARTEMISIA LUDOVICIANA* *29, Cambs.: On recently dumped soil on roadside bank, on N side of old Newmarket Road (A1303) between Quay Water Bridge and Quay Church, TL511595, D.E. Coombe, 1996, conf. J.E. Cullen.

135/55.3. *ANTHEMIS COTULA* 44, Carms.: 1 plant in grazed horse pasture, S of Garn Farm, Mynydd-y-Cerrig, SN513142, I.K. Morgan, 1999. 2nd record.

†135/58.lacxmax. *LEUCANTHEMUM* × *SUPERBUM* (*L. LACUSTRE* × *L. MAXIMUM*) *110, Outer Hebrides: S of B895, North Tolsta, NB5546, L.S. Garrad, 1998.

135/62.1x10. *SENECIO* × *ALBESCENS* (*S. CINERARIA* × *S. JACOBAEA*) *39, Staffs.: Verge of track adjacent to school playing fields, with *S. jacobaea*, Harpfields, Newcastle-under-Lyme, SJ855457, I.J. Hopkins, 1994. Site since destroyed.

135/62.10x11. *SENECIO* × *OSTENFELDII* (*S. JACOBAEA* × *S. AQUATICUS*) *39, Staffs.: Damp pasture by river bridge, near Ecton, SK092578, D.R. Larner, 2000.

†135/62.3. *SENECIO* *INAEQUIDENS* 13, W. Sussex: Lay-by on W side of A283, in quantity, Upper Beeding, TQ196098, R. & B. Clough, 2001. 1st established record. *49, Caerns.: Hundreds of plants on waste ground, Industrial Estate, Llandudno Junction, SH798780, W. McCarthy, 2000.

†135/62.4. *SENECIO* *FLUVIATILIS* 96, Easternness: Drainage channel & edge of saltmarsh, Nairn, E. Beach, NH9057, M. Barron, 2000. 2nd record.

†135/73.1. *CALENDULA* *OFFICINALIS* 50, Denbs.: Seeded field, Llandulas, SH920783, J.A. Green, 2000. 2nd record.

†135/78.1. *RUDBECKIA* *HIRTA* *29, Cambs.: Gravel pit, Waterbeach, TL483687, G.M.S. Easy, 1971, **herb. G.M.S.E.** Waste ground, Chesterton railway sidings, TL474607, G.M.S. Easy, 1994-2001, **herb. G.M.S.E.** 1st & 2nd records.

†135/79.1. *HELIANTHUS* *ANNUUS* *42, Brecks.: Waste ground around new car-park, Brecon, SO049284, M. & C. Porter, 2000. *113(A), Channel Is. (Alderney): Remnant from crop established in old untended fields, Watermill Farm, WA566078, B. Bonnard, 1988.

135/81.1. *BIDENS* *CERNUA* 1, W. Cornwall: In two of the ditches between valley fields; Mawgan Porth, SW850670, P.R. Green, 2000. 2nd extant record for Cornwall.

†135/CAT.cae. *CATANACHE* *CAERULEA* *64, Mid-W. Yorks.: Car park, Fairburn Ings RSPB reserve, SE451277, E. Ellis, 2000, det. E.J. Clement.

†135/CYN.car. *CYNARA* *CARDUNCULUS* *H6, Co. Waterford: 3 plants self-sown, on sea cliffs, Monatray Middle, X122765, P.R. Green, 2001. As var. *cardunculus*. *113(A), Channel Is. (Alderney): Several plants (remnant from crop) established in old untended fields, Robin Rock, WA567078, B. Bonnard, 1988. (As var. *scolymus*).

†135/GULaby. *GUIZOTIA* *ABYSSINICA* *35, Mons.: Bird seed alien in cracks in patio paving stones, Orchard Cottage, SO502012, Mrs A. Booker, 2000, det. T.G. Evans.

†135/OST.juc. *OSTEOSPERMUM* *JUCUNDUM* *113(S), Channel Is. (Sark): Probably planted originally, but appears to be spreading on verge of unmetalled road, near Petite Genetière, WV466768, R.M. Veall, 2000, **herb. Société Sercquaise**.

137/4.2. *ALISMA* *LANCEOLATUM* *†47, Monts.: Wet fields below Montgomery Canal, Vyrnwy, British Waterways Reserve, SJ253198, S. Whild & R.V. Lansdown, 1997. Montgomery Canal, SJ225069, R.V. Lansdown, 1998. 1st & 2nd records; possibly introduced into the Vyrnwy Reserve from the Montgomery Canal.

138/1.1. *HYDOCHARIS* *MORSUS-RANAE* 64, Mid-W. Yorks.: Ditch beside former tip, now being landscaped, Burley-in-Wharfedale, SE156466, F.D. Draper, 1994. Only extant site.

138/2.1. *STRATIOTES* *ALOIDES* *†41, Glam.: In small pond in field, near Cilibion Wood, Gower, SS520921, Q.O.N. Kay, 2001.

†138/3.1. *EGERIA* *DENSA* *35, Mons.: Numerous plants in Monmouth-Brecon Canal, Five Locks, Pontnewydd, ST288970, Mrs B. Chapman, 2001, NMW, conf. T.G. Evans.

†138/4.1. *ELODEA* *CANADENSIS* *113(A), Channel Is. (Alderney): Established in pond, Corblets Quarry, WA596088, B. Bonnard, 1986, det. D. McClintock.

142/1.1x2. *POTAMOGETON* × *GESSNACENSIS* (*P. NATANS* × *P. POLYGONIFOLIUS*) *43, Rads.: Little pool in river below overhanging rockface by waterfalls, Gilfach, SN963715, S.P. Chambers, 1997, conf. C.D. Preston. 3rd British record.

142/1.1x5. *POTAMOGETON* × *FLUITANS* (*P. NATANS* × *P. LUCENS*) 29, Cambs.: 1 clump growing amongst *P. pectinatus* with *Callitriche* spp., *Lemna minor*, *Sagittaria sagittifolia* & *Zannichellia palustris*, Engine Drain, Chear Fen, Cottenham, TL492708, J. Fant & C.D. Preston, 1996, **CGE**. 1st recent record.

142/1.5. *POTAMOGETON* *LUCENS* *H6, Co. Waterford: Plentiful in lake, Pouldrew Bridge, S507118, P.R. Green, 2001.

142/2.5×6. *POTAMOGETON* × *ZIZII* (*P. LUCENS* × *P. GRAMINEUS*) **29**, Cambs.: Engine Drain, Chear Fen, Cottenham, TL492708, C.D. Preston, 1995; J Fant & C.D. Preston, 1996, **CGE**. Only extant site.

142/1.14. *POTAMOGETON OBTUSIFOLIUS* **64**, Mid-W. Yorks.: Fishing pond, Paul's Pond, Cookridge, Leeds, SE261413, Yorkshire Naturalists' Union, 2001, det. P.P. Abbott. 2nd record.

142/1.16. *POTAMOGETON TRICHOIDES* **39**, Staffs.: Staffordshire & Worcestershire canal, Gailey, SJ919103, P.P. Abbott, C.N. Smith & M. Smith (BSBI Meeting), 2001. 2nd record & only extant site.

142/1.17. *POTAMOGETON COMPRESSUS* **39**, Staffs.: Many thousands of plants, ornamental arm of River Sow, Shugborough Park, SJ990223, S.J. Whild & A.J. Lockton, 2000. Only extant site.

146/1.3. *ZOSTERA NOLTEI* ***45**, Pembs.: Inter-tidal mud flats, E side of Angle Bay, SM896023; Inter-tidal mud flats, Sandy Haven Pill, SM864087; both S.B. Evans, 2000, det. F. Rumsey. 1st & 2nd published records; all previous records of *Zostera angustifolia* from the vice-county are now believed to be *Z. noltei*.

†147/4.1. *ZANTEDESCHIA AETHIOPICA* ***44**, Carms.: Several plants in flower beside footpath, Bynea, SS554985, V. & A. Lewis, 2001. Origin unknown, presumably planted. ***113(A)**, Channel Is. (Alderney): Garden escape, Val de Vert Côté, WA571077, B. Bonnard, 1990.

†147/5.2b. *ARUM ITALICUM* subsp. *ITALICUM* ***52**, Anglesey: Clump on road verge, near Brynteg, SH4983, I.R. Bonner, 2000. ***77**, Lanarks.: Established just within a small wood, Milnwood, near Bellshill, NS7459, P. Macpherson, 2001, **herb. P.M.** Established at edge of long abandoned railway line, Allanton, by Hamilton, NS7453, P. Macpherson & Hamilton Natural History Society, 2001. 1st & 2nd records.

†147/6.1. *DRACUNCULUS VULGARIS* **113(A)**, Channel Is. (Alderney): Cottage garden (casual), in St Anne, WA575075, D. McClintock, 1982. 2nd record; several other records 1986-2000.

†147/7.1. *ARISARUM PROBISCIDEUM* ***99**, Dunbarton: Increasing in hedge base, West Helensburgh, NS2882, A. Rutherford, 1998. None cultivated nearby.

148/1.1. *SPIRODELA POLYRHIZA* **44**, Carms.: Freshwater ditch, Millennium wetlands, WWT Penclacwydd, Llanelli, SS5398, I.K. Morgan, 2001. 2nd & 1st recent record. ***H6**, Co. Waterford: Very little, in pond, Dromana, X105948, P.R. Green, 2001.

148/2.1. *LEMNA GIBBA* **51**, Flints.: Abundant, covering shallow pool c.10×5m, Golf course, by Coppas House, S of Buckley, SJ277614, S. Chambers, 2001. 2nd recent record.

†148/2.4. *LEMNA MINUTA* ***39**, Staffs.: Pool, near river, Hamstall Ridware, SK105196, P.P. Abbott & S. Burton, 1999. Pool, in wood, by canal, Little Onn, SJ846154, R.A. Dawes & S. Burton, 1999. 1st & 2nd records. ***77**, Lanarks.: Many clumps in can basin, Firhill, Glasgow, NS5867, P. Macpherson, 2000, **herb. P.M.**, conf. C.D. Preston. ***113(A)**, Channel Is. (Alderney): Possibly native, in pond, Clonque Quarry, WA562074, B. Bonnard, 1993, det. D. McClintock. In quantity in both ponds, on Platte Saline, WA566079, B. Bonnard, 1996. 1st & 2nd records. **H6**, Co. Waterford: Pond, Dromana, X105984, P.R. Green, 2001. 2nd record.

†149/1.2. *TRADESCANTIA FLUMINENSIS* ***41**, Glam.: Persistent in shrubbery by multi-storey car-park, in central Swansea, SS655926, A.S. Lewis, 2000.

151/1.12. *JUNCUS ALPINOARTICULATUS* **96**, Easternness: Scattered over several stony mires, Carn A'Chuilinn, Glendoe, NH40, A.G. Payne, 2000. 2nd & 1st recent record.

151/1.13×14. *JUNCUS* × *SURREJANUS* (*J. ARTICULATUS* × *J. ACUTIFLORUS*) **45**, Pembs.: Wetland, Bristgarn near Llanwnda, Strumble Head, SM925395, S. Chambers, 2001. 1st recent record.

151/1.3. *JUNCUS COMPRESSUS* **39**, Staffs.: Wet meadow, Swynnerton Army Training Area, SJ850328, E.M. Woolrich at BSBI Meeting, 2000. 2nd recent record.

151/1.8. *JUNCUS AMBIGUUS* ***†42**, Brecks.: Verge of B4560 (probably regularly salted in winter), 2km NW of Bryn-mawr (Mynydd Llangatwg), SO167136, S.P. Chambers, 2000, conf. T.A. Cope. ***79**, Selkirks.: Galashiels, NT43, I.M. Hayward, 1911, **E**, det. D.R. McKean.

151/2.1. *LUZULA FORSTERI* **46**, Cards.: Roadside hedgebank, by Y Ferwig chapel, SN185496, A.O. Chater, 2000, **NMW**. 2nd & 1st recent record.

152/1.2. *ERIOPHORUM LATIFOLIUM* ***93**, N. Aberdeen: Flush, Whitehill, Ruthven, NJ5146, M. Smedley, 1993. Flush, Hill of Towanreef, NJ460237, M. Smedley & D. Welch, 2001, **ABD**. 1st & 2nd records.

152/2.2a. *TRICHOPHORUM CESPITOSUM* subsp. *GERMANICA* *77, Lanarks.: Bank of reservoir, Glengavel, NS6634, M.E. Braithwaite, 2000, **herb. P. Macpherson**. 1st record for subsp.

152/2.2a×2b. *TRICHOPHORUM CESPITOSUM* nothosubsp. *FOERSTERI* (*T. CESPITOSUM* subsp. *CESPITOSUM* × subsp. *GERMANICUM*) *35, Mons.: A few plants in boggy peat with pools, Mynydd Maen, ST259966, T.G. Evans, 2001, conf. G.A. Swan. 48, Merioneth: Frequent with subsp. *germanicum*, *Myrica* and *Calluna* on raised bog, Arthog Bog, SH6314, P.M. Benoit, 1999, **NMW**, conf. G.A. Swan. 2nd & 1st recent record. *60, W. Lancs.: Blanket bog, Summit plateau, Gragareth, Leck, SD693802, E.F. Greenwood & J.M. Newton, 2000, **LIV**, det. G.A. Swan. *77, Lanarks.: Bank of reservoir, Glengavel, NS6634, M.E. Braithwaite, 2000, **herb. P. Macpherson**. 81, Berwicks.: Raised bog, Dogden Moss, NT6949, M.E. Braithwaite, 2000. 2nd record.

152/2.2b. *TRICHOPHORUM CESPITOSUM* subsp. *CESPITOSUM* *81, Berwicks.: Flush at edge of raised bog, Dogden Moss, NT691492, M.E. Braithwaite, 2000, conf. G.A. Swan. Small colony at transition from raised bog, Longmuir Moss, NT471504, M.E. Braithwaite, 2000. 1st & 2nd records. 83, Midlothian: Small colony at transition from raised bog, Longmuir Moss, NT471504, M.E. Braithwaite, 2000. 1st recent record.

152/5.1. *SCIRPUS SYLVATICUS* 91, Kincardines.: Bank of R. North Esk, Morphie, NO719618, D. Welch, 1999. Only extant site.

152/9.1. *ELEOGITON FLUITANS* 39, Staffs.: In ditches, within and surrounding Biddulph's Pool and No Man's Bank, W of Burntwood, SK030103, A. Leak, 2000. 2nd recent record.

152/11.1. *CYPERUS LONGUS* *†H6, Co. Waterford: Single clump, on river bank, Carrick-on-Suir, S396217, P.R. Green, 2001.

†152/11.2. *CYPERUS ERAGROSTIS* 46, Cards.: Pathside, near Biochemistry Dept. UCW campus, Aberystwyth, SN595818, S.P. Chambers, 2000. 2nd record.

152/16.5×15. *CAREX* × *PSEUDAXILLARIS* (*C. OTRUBAE* × *C. REMOTA*) *46, Cards.: Bank of drainage ditch, 500m N of Lodge Farm, Tre'r-ddol, SN654936, A.O. Chater & A.D. Hale, 2001, **NMW**.

152/16.8b. *CAREX MURICATA* subsp. *LAMPROCARPA* 91, Kincardines.: Trackside at sand pit, Crathes, NO/745962, D. Welch, 1998, **ABD**, conf. A.O. Chater. 1st recent record.

152/16.9a. *CAREX DIVULSA* subsp. *DIVULSA* 64, Mid-W. Yorks.: Limestone grassland, Studley Royal, SE279691, M.J.Y. Foley & M.S. Porter, 1999. 2nd recent record.

152/16.9b. *CAREX DIVULSA* subsp. *LEERSII* *†80, Roxburghs.: Pathside in wood, Harestanes Walk, Monteviot, NT646248, M.E. Braithwaite, 1993, **herb. R.W.M. Corner**, conf. M.S. Porter. Almost certainly an introduction.

152/16.10. *CAREX ARENARIA* *†42, Brecks.: Molinia heath, between Ystradgynlais and Penrhos, SN795104, M. Porter, 2001.

152/16.11. *CAREX DISTICHA* 50, Denbs.: Very wet mire, Rhyd Lydan, SH895503, W. McCarthy, 2001. 1st recent record. *113(A), Channel Is. (Alderney): Large area established round old well, in Mannez Quarry, WA603087, M. Long, 1996, det. C. Jermy.

152/16.25×65. *CAREX* × *SUBGRACILIS* (*C. ACUTIFORMIS* × *C. ACUTA*) *43, Rads.: Edge of lake, Llanbwchllyn, SO117463, S.P. Chambers, 1998, conf. A.C. Jermy.

152/16.26. *CAREX RIPARIA* 77, Lanarks.: Stagnant pool in wood, Auchenshuggle, NS6362, K. Watson, 2001, **GL**. 1st recent record.

152/16.28×29. *CAREX* × *INVOLUTA* (*C. ROSTRATA* × *C. VESICARIA*) *77, Lanarks.: Marshy ground by loch, Possil Marsh, Glasgow, NS57, K. Watson, 1995, **GLAM**, conf. A.O. Chater *et al.* 1st confirmed record. *79, Selkirks.: With both parents in fen, Ettrick Marshes, Ettrick, NT272143, R.W.M. Corner & M.S. Porter, 2001, **herb. R.W.M.C.**, conf. A.O. Chater.

152/16.41. *CAREX DISTANS* 35, Mons.: River Severn meadow inundated by Spring tides, Sutton Farm, W Usk Lighthouse, ST302817, T.G. Evans, 2001, conf. A.O. Chater. Only extant site. 67, S. Northumb.: Edge of saltmarsh, Seaton Sluice, NZ3376, A. & G. Young, 1998. 2nd recent record.

152/16.42. *CAREX PUNCTATA* 52, Anglesey: Upper saltmarsh, near Llanfairyrneubwll, SH2976, I.R. Bonner, 2001, **herb. I.R.B.**, conf. A.O. Chater. 1st recent record. H6, Co. Waterford: Abundant, on wet, dripping sea cliffs, Muggort's Bay, X297876, I.P. Green & P.R. Green, 2001. 2nd record.

- 152/16.43. *CAREX EXTENSA* **50**, Denbs.: By sea wall, Glan Conwy, SH801712, J.A. Green, 2000. 1st recent record.
- 152/16.46c. *CAREX VIRIDULA* subsp. *VIRIDULA* ***1**, W. Cornwall: At edges of rivulets flowing through coastal saltmarsh, Chapel Porth, SW698494, R.J. Murphy & M.J. Sibley, 2001, det. A.O. Chater. New to Cornwall. **67**, S. Northumb.: N shore, of Hallington Reservoir, NY966763, J. Young, 1999, **herb. G.A. Swan**. 2nd recent record.
- 152/16.47. *CAREX PALLESCENS* **93**, N. Aberdeen: Rideside, Bin Forest, Cairnie, NJ496447, D. Elston, 2001, **ABD**. 1st recent record.
- 152/16.48. *CAREX DIGITATA* **64**, Mid-W. Yorks.: Over 150 plants, in rock-strewn limestone grassland below woodland, Mackershaw, SE286691, M.J.Y. Foley & M.S. Porter, 1999.
- 152/16.69. *CAREX BIGELOWII* ***46**, Cards.: 2 small patches, flowering well, on NNE-facing slope, 400m SSW of Craig y March, Pumlumon, SN803877, S.P. Chambers, 2000, **NMW**. The southernmost site in Britain.
- 152/16.71. *CAREX PAUCIFLORA* ***47**, Monts.: Wet moor and bog, Trannon, SN911952, B. Averis, 2000.
- †153/3.1. *SASA PALMATA* **50**, Denbs.: Old well and stream, Wigfair, SJ029711, J. Phillips, 2000, det. J.A. Green. 2nd record.
- 153/12.12. *FESTUCA HUONII* ***113(A)**, Channel Is. (Alderney): Rocky scree, Saye Bay, WA590090, B. Bonnard, 1987, det. D. McClintock.
- 153/12.6. *FESTUCA ARENARIA* **46**, Cards.: SW corner of Penyrergyd dunes, Gwbert, SN160485, A.O. Chater, 2001, **NMW**. 2nd record.
- 153/12.7b. *FESTUCA RUBRA* subsp. *JUNCEA* ***68**, N. Northumb.: Rocky seashore (whin), Newton Point, NV245251, G.A. & M. Swan, 2000, **herb. G.A.S.** det. C.A. Stace. Rocky seashore (whin), N of Cullernose Point, NV261189, G.A. & M. Swan, 2000, **herb. G.A.S.**, det. C.A. Stace. 1st & 2nd records.
- 153/12.7d. *FESTUCA RUBRA* subsp. *COMMUTATA* ***39**, Staffs.: Roadside verge, Wombourne, SO863929, C.B. Westall, 2000. †**46**, Cards.: Margin of strawberry field, Penlan-las, Rhydyfelin, SN607772, S.P. Chambers, 2000. 2nd record. ***64**, Mid-W. Yorks.: Deepdale, SD85, J. Allinson, 1999.
- 153/12.1×13.2. *×FESTULOLIUM BRAUNII* (*FESTUCA PRATENSIS* × *LOLIUM MULTIFLORUM*) **61**, S.E. Yorks.: Arable margin, thought remnant of sown ley grass, East Clough, Patrington, TA323194, P.J. Cook, 1999, **herb. P.J.C.** 2nd record.
- 153/13.1×2. *LOLIUM* × *BOUCHEANUM* (*L. PERENNE* × *L. MULTIFLORUM*) ***64**, Mid-W. Yorks.: Waste ground, Leeds, SE308331, M. Wilcox, 1999, det. T.A. Cope. ***77**, Lanarks.: New industrial complex, Kirkwood, SW of Coatbridge, NS7063, P. Macpherson, 2000, **herb. P.M.**, det. E.J. Clement. ***113(A)**, Channel Is. (Alderney): Ladysmith, WA568076, B. Bonnard, 1986, det. D. McClintock.
- 153/14.3. *VULPIA MYUROS* ***93**, N. Aberdeen: Railway siding, Kennethmont, NJ553293, D. Welch, 1999, **ABD**, conf. C.A. Stace.
- †153/14.4a. *VULPIA CILIATA* subsp. *CILIATA* ***64**, Mid-W. Yorks.: Waste ground, Leeds, SE314325, M. Wilcox, 1999, det. C.A. Stace.
- †153/15.2. *CYNOSURUS ECHINATUS* ***113(A)**, Channel Is. (Alderney): Dunes, Corblets Bay & East Coast path, WA596088, B. Bonnard, 1995.
- 153/16.2. *PUCCINELLIA DISTANS* †**42**, Brecks.: Road verge, 2km SW of Gilwern, SO222125, G.S. Motley, 2000. 2nd record.
- 153/16.2a. *PUCCINELLIA DISTANS* subsp. *DISTANS* ***91**, Kincards.: Muddy pool, Nigg Bay, NJ967044, D. Welch, 1997, **ABD**. Recorded as *Catabrosa* in error. Specimen re-examined after finding *P. distans* at same site.
- †153/17.2. *BRIZA MINOR* ***113(A)**, Channel Is. (Alderney): Casual on railway line by Battery Crossing, Braye Common, WA584079, B. Bonnard, 1986, det. D. McClintock.
- †153/17.3. *BRIZA MAXIMA* **45**, Pems.: Roadside verge, St Davids, SM749251, S.B. Evans, 2001. 1st recent record. ***95**, Moray: Base of wall, Grantown-on-Spey, NJ0327, R.M. Stokes, 2000. ***113(A)**, Channel Is. (Alderney): Scattered in grass (garden escape), on Platte Saline, WA568079, Wild Flower Soc. visit, 1986, det. D. McClintock.

153/18.1. *POA INFIRMA* *29, Cambs.: Waste ground used as car park, between Station Road & Hills Road, Cambridge, TL460572, A.C. Leslie, 2001. Frequent and growing with *Poa annua* at edge of verge on E side of A1134 & under Botanic Garden railings, Cambridge, TL452564, A.C. Leslie, 2001. 1st & 2nd records.

153/18.6. *POA ANGUSTIFOLIA* 50, Denbs.: Wall top in town centre, Colwyn Bay, SH8479, W. McCarthy, 2001, det. T. Cope. 2nd record. *113(A), Channel Is. (Alderney): S-facing grassy bank, in La Corvée, WA579072, T.C.G. Rich & E. Nic Lughadha, 1990.

†153/18.7. *POA CHAIXII* 93, N. Aberdeen: Policy woodland, Leith Hall, NJ543296, D. Welch, 1998, **ABD**. 2nd record.

153/18.9. *POA COMPRESSA* *41, Glam.: Dry open grassland, on Baglan Moor, SS748915, C.R. Hipkin, 2000. 1st native record.

†153/18.imb. *POA IMBECILLA* *83, Midlothian: Pavement/garden wall, Bellevue Crescent, Edinburgh, NT255747, D.R. McKean, 1998, **E**. 1st recorded escape from RBG Edinburgh where it is a pernicious rock garden weed, known since last century in area

[153/20.1. *CATABROSA AQUATICA*, 91, Kincards.: Muddy pool close to HWM, Nigg Bay, NJ967044, D. Welch, 1997, **ABD**. Delete record in *Watsonia* 23(4): 587 (2001) and replace with *Puccinellia distans* subsp. *distans*.]

153/24.2×3. *GLYCERIA FLUITANS* × *G. DECLINATA* *29, Cambs.: S end of central stream, Coe Fen, TL448572, C.D. Preston, 1999, **CGE**, det. C.A. Stace.

†153/30.1pur. *TRisetum FLAVESCENS* subsp. *PURPURASCENS* *29, Cambs.: The most widespread grass over perhaps 50 acres of sown grassland, Magog Trust, Stapleford, TL4753, P.D. Sell, 1995, **CGE**. Constituent of the 'native' seed mixture sown when this site was converted from arable land to grassland.

153/32.1b. *DESCHAMPSIA CESPITOSA* subsp. *PARVIFLORA* *43, Rads.: Abundant on damp, shady, rocky slopes in wood below waterfall, Water-break-its-neck, New Radnor, SO184600, A.O. Chater, 2000, **NMW**.

153/33.1×2. *HOLCUS* × *HYBRIDUS* (*H. LANATUS* × *H. MOLLIS*) *46, Cards.: Pasture, 200m SSE of Rheidol Falls, SN710786, A.O. Chater, 2000, **NMW**. The rhizomatous form of *H. lanatus*, var. *soboliferus*, grows nearby.

†153/38.3. *PHALARIS CANARIENSIS* 110, Outer Hebrides: Waste ground, Lews Castle, Stornoway, NB422331, R.J. Pankhurst, 2001. 2nd record.

153/39.2×4. *AGROSTIS GIGANTEA* × *A. STOLONIFERA* *61, S.E. Yorks.: Garden border, Driffield, TA022586, E. Chicken, 1999, **herb. E.C.**

†153/39.3. *AGROSTIS CASTELLANA* *46, Cards.: Grassy slope reconstructed and reseeded in 1993, NE of Glanrafon Bridge, Llanbadarn Fawr, SN610805, A.O. Chater, 2000, **NMW**. The true plant, with strongly pubescent lemmas in the terminal spikelets.

†153/39.9. *AGROSTIS SCABRA* 83, Midlothian: Possibly re-seeded verge of path from church, to S. Bank Wood, SW Penicuik, NT231597, D.R. McKean & S. Maxwell, 1998, **E**.

153/39.4×46.1 ×*AGROPOGON LITTORALIS* (*AGOSTIS STOLONIFERA* × *POLYPOGON MONSPELIENSIS*) *64, Mid-W. Yorks.: Disused sandstone quarry, Woodside Quarry, Ireland Wood, Leeds, SE254383, M. Wilcox, 1999.

153/40.2. *CALAMAGROSTIS CANESCENS* *67, S. Northumb.: Wet area near edge of forest road, near Wind Hill, Kielder Water, NY686891, G. Simpson, 2001, **herb. G.A. Swan**, det. H.J.M. Bowen. 68, Cheviot: Cannonmill Bog, NT904313, I. Douglas, 2001, **herb. G.A. Swan**. Only extant site.

†153/40.arg. *CALAMAGROSTIS ARGENTEA* *64, Mid-W. Yorks.: Self-seeded from nearby flower bed, at edge of pavement, Cross Belgrave Street in Central Leeds, SE303343, M. Wilcox, 1999, det. T.B. Ryves. 1st British record.

†153/43.1. *LAGURUS OVATUS* 113(A), Channel Is. (Alderney): Well established, Platte Saline, WA568079, B. Bonnard, 1990. 2nd & 1st recent record.

153/46.2. *POLYPOGON VIRIDIS* 113(A), Channel Is. (Alderney): 5 plants (possibly native), in gutter, in St Martin's, WA573071, M.A.R. Kitchen, 1995. 2nd & 1st recent record.

- †153/46.mar. *POLYPOGON MARITIMUS* *29, Cambs.: 1 plant with numerous stems in a pot of *Allium*, Monksilver Nursery, Oakington Road, Cottenham, TL436663, A.C. Leslie, 2001.
- 153/47.2x4. *ALOPECURUS* × *HAUSSKNECHTIANUS* (*A. GENICULATUS* × *A. AEQUALIS*) *5, S. Somerset: With both parents on margins of reservoir, Clatworthy Reservoir, ST031307, I.P. Green, 2000, det. T.A. Cope.
- 153/47.6. *ALOPECURUS MYOSUROIDES* 2, E. Cornwall: In headland of barley field, Clitters Park, S of Luckett, SX386723, A. Atkinson, 2000, **herb. R.J. Murphy**. 1st recent record.
- 153/50.4b. *BROMUS HORDEACEUS* subsp. *FERRONII* *68, N. Northumb.: Base of sea-cliff (whin), The Heugh, Holy Island, NV127416, G.A. & M. Swan, 2000, **herb. G.A.S.**, det. C.A. Stace & T.A. Cope.
- 153/50.4lon. *BROMUS HORDEACEUS* subsp. *LONGIPEDICELLATUS* *29, Cambs.: Footpath beside meadow, Brinkley (near Six Mile Bottom), TL581569, G. Crompton & J. Bulleid, 2000, **CGE**. Waste ground on roadside verge, Histon, TL442.625, G. Crompton, 2000, **CGE**. 1st & 2nd records. *35, Mons.: Several plants on sea wall, Sudbrook, ST499874, T.G. Evans, 2001. *51, Flints.: Sandy grassland in coastal dunes, Talacre Warren, SJ124851, M. Wilcox & W. McCarthy, 2000. *77, Lanarks.: Rough grassland at side of minor road between Uddingston and Bothwell, NS699596, P. Macpherson, 2001. *113(S), Channel Is. (Sark): Beside grassy path, near Siver Mines Chimneys, Little Sark, WV454735, M. Long, 2000, **herb. Société Sercquaise**. Meadow, S of Dosedane, WV461761, M. Long, 2000, **herb. Société Sercquaise**. 1st & second records. All records det. or conf. L.M. Spalton.
- †153/50.7. *BROMUS SECALINUS* 46, Cards.: With *Lolium multiflorum* and *Hordeum distichon* in old stable yard, by Hafod Mansion, 2km E of Pontrhydy-groes, SN759732, A.O. Chater & J.P. Woodman, 2000, **NMW**. 1st recent record.
- †153/50.1an. *BROMUS LANCEOLATUS* *29, Cambs.: On verge of strip field growing ornamental flowers and grasses, Soham, TL582705, G.M.S. Easy, 1999. Edge of cornfield, Soham, TL581708, W.G. Last, 2000, **K**, det B. Ryves. 1st & 2nd records.
- 153/51.2. *BROMOPSIS BENEKENII* 64, Mid-W. Yorks.: Woodland on Magnesian limestone, Hetchel Wood, YWT Reserve, SE378423, B.A. Tregale, 1990, conf. R.M. Payne. 2nd record. *67, S. Northumb.: Slope at base of Raven Crag, with *B. ramosa*, Allen Banks, NY798629, G.A. & M. Swan, 2001, **herb. G.A.S.**, det. L.M. Spalton. *77, Lanarks.: Steep grassy bank above R. Clyde, Corra Castle, Falls of Clyde, NS8841, A.B.G. Averis, 1997, **herb. P. Macpherson**, det. L.M. Spalton.
- 153/51.3. *BROMOPSIS ERECTA* 49, Caerns.: Several places on limestone grassland, Great Orme, Llandudno, SH78, W. McCarthy, 2000. 1st recent record. †58, Cheshire: Canal bank, Coole Pilate, SJ649462: Canal bank, Baddington, SJ641484; both G.M. Kay, 2001. 1st & 2nd recent records. Questionably native at both sites. *113(A), Channel Is. (Alderney): Several plants in dunes & trackside, near the Targets, Longis, WA600082, E. McDowell, 1998.
- †153/51.4. *BROMOPSIS INERMIS* *39, Staffs.: Disused railway, Wombourne, SO870928, B.R. Fowler & C.B. Westall, 1984. Side of lane, Swynnerton, SJ859382, R. Higgins, 1989. 1st & 2nd records. *52, Anglesey: Garden weed, Rhosneigr, SH321736, W. McCarthy, 2001, **herb. I.R.B.**, det. E.J. Clement.
- †153/51.4a. *BROMOPSIS INERMIS* subsp. *INERMIS* 83, Midlothian: 1 small patch only, on waste ground, Musselburgh Racecourse, NT358731, S. Maxwell, 2001, **E**, det. D.R. McKean. Last seen nearby in 1976 at Fisherrow Harbour.
- †153/52.1. *ANISANTHA DIANDRA* 2, E. Cornwall: Many plants, on hedge walls on the E side of the B3273, near London Apprentice, SX0049, P.R. Green, 2000, **herb. R.J. Murphy**. 1st recent record. *39, Staffs.: Canal towpath, Wolverhampton, SO918988, B.R. Fowler, 1988. Old gateway near brewery, Burton-on-Trent, SK235231, J.P. Martin, 1991, conf. P.J.O. Trist. 1st & 2nd records. 46, Cards.: Large colony on waste ground by road, 2.5km E of Synod Inn, SN431542, A.O. Chater, 2000, **NMW**. 2nd record.
- †153/52.2. *ANISANTHA RIGIDA* *61, S.E. Yorks.: Margin, barley crop, Near East Lutton, SE9696, P.J. Cook, 2000, **herb. P.J.C.** Margin of arable crop, W of Kilnwick, SE981498, E. Chicken, 2000. 1st & 2nd records.

†153/53.1. *CERATOCHLOA CARINATA* *47, Monts.: Casual only on roadside by gate into pasture, Berriew, SJ189009, P.M. Benoit & C.A. Small, 2001. Growing with *Erodium moschatum*: both probably the result of original garden dumping.

153/54.1. *BRACHYPODIUM PINNATUM* 58, Cheshire: Questionably native on, canal bank, Coole Pilate, SJ649462, Cheshire Recording Group, 2001. 1st recent record.

†153/54.2rup. *BRACHYPODIUM PINNATUM* subsp. *RUPESTRE* *44, Carms.: Many plants along track, Pembrey Burrows, SN398003, Q.O.N. Kay, 1997, **NMW**, det. T.C.G. Rich. 1st localised record of subsp. & 2nd record of species.

153/55.1. *ELYMUS CANINUS* *†113(A), Channel Is. (Alderney): Casual only on Braye Common, WA586082, B. Bonnard, 1987, det. D. McClintock.

153/56.1x3. *ELYTRIGIA* × *LAXA* (*E. REPENS* × *E. JUNCEA*) *81, Berwicks.: Sand dune fragment, Pease Bay, NT793708, M.E. & P.F. Braithwaite, 2000. *95, Moray: Edge of saltmarsh/sand dunes, at edge of Culbin Forest, NW of Forres, NH984630, M. Wilcox, 2001, conf. T.A. Cope.

153/57.1. *LEYMUS ARENARIUS* 46, Cards.: N tip of Ynys-las Dunes NNR, SN606946, J.P. Lyons, 2001. 2nd extant native site.

†153/59.3. *HORDEUM JUBATUM* *52, Anglesey: Single clump in field, Gwydryn-Hir, SH493678, T.W.J.D. Dupree, 2001.

153/59.4. *HORDEUM SECALINUM* 77, Lanarks.: Manure heap, W of Hamilton, NS6854, P. Macpherson, 2000, **herb. P.M.** 1st recent record.

†153/62.1. *CORTADERIA SELLOANA* *29, Cambs.: Farm dump, Malton, TL377475, P.D. Sell, 1988, **CGE**. Self-sown in cracks at edge of car park, Union Lane, Cambridge, TL462599, A.C. Leslie, 2000. 1st & 2nd records. *41, Glam.: Several clumps on waste ground at disused docks, Briton Ferry, SS737936, A.S. Lewis, 2001. *52, Anglesey: West end of shingle bank, Cemlyn, SH3393, G. Battershall, 1994. *113(A), Channel Is. (Alderney): Self-seeded plants established, at Essex Hill, WA595078, B. Bonnard, 1987. *113(S), Channel Is. (Sark): Originally planted beside a garden (no longer in existence), on roadside bank, Port à la jument, WV458760, R.M. Veall, 1998, **herb. Société Sercquaise**, det. R.M. Payne.

†153/66.1. *CYNODON DACTYLON* *44, Carms.: Grass verges in housing estate and children's playground, Burry Port, SN451005, E.J. Clement & P. Stanley, 2000.

†153/67.1x3. *SPARTINA* × *TOWNSENDII* (*S. MARITIMA* × *S. ALTERNIFLORA*) *46, Cards.: Upper saltmarsh, Dyfi estuary, 600m E of mouth of Afon Leri, SN623936, P.M. Benoit & BSBI Field Meeting, 2000, **NMW**. Mentioned as occurring in the Dyfi estuary in several publications by E.H. Chater, but without definite localities.

†153/68.1. *ECHINOCHLOA CRUS-GALLI* *99, Dunbarton: Among garden waste, Adelaide Street, Helensburgh, NS3181, A. Rutherford, 2001, **E**, det. A.McG. Stirling.

†153/70.1. *SETARIA VIRIDIS* *45, Pems.: Six flowering plants, producing seed, in maize field, Norton Farm, Manorbier, SS061989, S. Bosanquet, 2000. 48, Merioneth: In great quantity on E platform, Barmouth railway station, SH6115, P.M. Benoit, 1999, **NMW**. 1st recent record. *113(A), Channel Is. (Alderney): 3 plants (casual), on Platte Saline, WA568079, B. Bonnard, 2000, det. M. Long.

†153/70.par. *SETARIA PARVIFLORA* *29, Cambs.: Tip, Romsey, TL479577, G.M.S. Easy, 1982, **herb. G.M.S.E.**

†153/70.pum. *SETARIA PUMILA* 99, Dunbarton: Shore above HWM, East Helensburgh, NS3081, A. Rutherford & R. Tran, 1998, **herb. A.McG.S.**, det. A.McG. Stirling. 1st recent record. *113(A), Channel Is. (Alderney): Casual only in gravel at Old Barn, Longis, WA594078, M. Long, 1992.

†153/71.san. *DIGITARIA SANGUINALIS* *29, Cambs.: In a carrot field, between Kennett Church and Kennett Station, TL76, J.E. Raven, 1945, **CGE**, det. P.J.O. Trist (1986). Cottage garden, Lolworth, TL36, P. Hastings, 1964, **CGE**, det. S.M. Walters. 1st & 2nd records.

†153/72.1. *SORGHUM HALEPENSE* *113(A), Channel Is. (Alderney): On tipped soil, Platte Saline, WA568078, B. Bonnard, 1992, det. D. McClintock. 1st confirmed Channel Is record.

- †153/72.bic. *SORGHUM BICOLOR* *113(A), Channel Is. (Alderney): By seats, Braye Bay, WA586082, D. McClintock, 1992.
- †153/PAN.mil. *PANICUM MILIACEUM* 99, Dunbarton: Garden centre car park, Ardencaple, Rhu, NS2882, A. Rutherford & A. McG. Stirling, 2000. 2nd record.
- †153/ZIZ.lat. *ZIZANIA LATIFOLIA* 13, W. Sussex: Abundant along S edge adjacent to road, Patching, TQ088056, O. & M. Hollins, 2000. 1st recent record.
- 154/1.1. *SPARGANIUM ERECTUM* 113(A), Channel Is. (Alderney): 2 clumps in pond, Longis, WA597084, M. Long, 1996. 3rd & 1st recent record.
- 155/1.2. *TYPHA ANGUSTIFOLIA* †44, Carms.: In flushed trackway on N side of re-vegetated tip, Pont-y-Clerc Tip, Penybanc, Ammanford, SM615114, I.K. Morgan, 2000, NMW, conf. G. Hutchinson. 1st recent record. *113(A), Channel Is. (Alderney): Large area in pond, Mannez Quarry, WA604087, B. & J. Bonnard, 1986, det. D. McClintock. Previously recorded as *T. latifolia*.
- †158/5.1. *HEMEROCALLIS FULVA* *46, Cards.: Naturalised on disturbed ground by path, just W of Pont Glanyrafon, Llanbadarn Fawr, SN609804, S.P. Chambers, 2001.
- †158/6.2. *KNIPHOFIA PRAECOX* *41, Glam.: Large clump on waste ground, E side of Afon Tawe, Swansea, SS662935, A.S. Lewis, 2001. *113(A), Channel Is. (Alderney): Scattered garden escape in several places, E coast, as at Longis, WA598082, B. Bonnard, 1987, det. J. Taylor.
- †158/6.tuc. *KNIPHOFIA TUCKERII?* *113(A), Channel Is. (Alderney): Garden escape, surviving over 40 years round several forts, as at Fort Tourgis, WA563077, B. Bonnard, 1988, det. J. Taylor.
- †158/10.1. *TULIPA SYLVESTRIS* 91, Kincardines.: Policies, Inverey House, Banchory, NO697941, J. Jackson, 1998, conf. D. Welch. 2nd record and furthest north in Britain.
- †158/10.3. *TULIPA GESNERIANA* *113(A), Channel Is. (Alderney): Probable garden escape on grass bank in Crabby Bay, WA574081, R. Barrett, 1994.
- †158/14.1. *POLYGONATUM MULTIFLORUM* *113(A), Channel Is. (Alderney): Planted in garden, St Vignalis, WA564073, B. Bonnard, 1993.
- †158/14.1x2. *POLYGONATUM* × *HYBRIDUM* (*P. MULTIFLORUM* × *P. ODORATUM*) *41, Glam.: Long established patch at foot of limestone scarp in Cwm Ivy Wood, SS441938, A.S. Lewis, 2000.
- †158/23.1. *MUSCARI NEGLECTUM* *29, Cambs.: Hills near Cherry Hinton, TL45, W.L.P.G [arnons], 1825, SWN.
- †158/23.2. *MUSCARI ARMENIACUM* *113(A), Channel Is. (Alderney): 12 plants in scrub 200m from rubbish tip (probable garden escape), South cliffs, Longis Bay, WA598072, B. Bonnard, 1997.
- 158/24.1. *ALLIUM SCHOENOPRASUM* *58, Cheshire: Grassland, Bidston, SJ288910, G.K. Watson, 1996. Pavement, New Brighton, Wirral, SJ314935, R. Goodchild, 2000. 1st & 2nd records.
- †158/24.3. *ALLIUM ROSEUM* subsp. *BULBIFERUM* 113(A), Channel Is. (Alderney): 3 plants flowering on Platte Saline, WA568079, J. Bonnard, 1998, det. B. Bonnard. 2nd record.
- †158/24.5. *ALLIUM SUBHIRSUTUM* 113(A), Channel Is. (Alderney): Quarry, Clonque, WA562074, M. Long, 1986, det. D. McClintock. 2nd & 1st recent record.
- †158/24.6. *ALLIUM MOLY* *58, Cheshire: Casual only in grassy waste area, Bidston Moss, SJ291914, R. Goodchild, 2000. *66, Co. Durham: 1 plant by side of track adjacent to rubbish tip, near Sunderland, NZ385602, G. Young, 1991, conf. A. Coles.
- †158/24.7. *ALLIUM TRIQUETRUM* *29, Cambs.: Great Eversden, TL364536, R.G.H. Cant, 1995. 1 clump in corner of car park on W side of road, S end of Green's Road, Cambridge, TL450595, C.D. Preston, 1999. 2nd record. Present for at least 5 years and flowers annually but only spreads very slowly, still there and flowering, 2002.
- 158/24.13. *ALLIUM AMPELOPRASUM* 6, N. Somerset: Grassy bank, Kenn Moor, Clevedon, ST434683, F. Moulin, 2001, det. P. Wilkin. 2nd record. *58, Cheshire: Amid bracken by old railway, Heswall, SJ258816, R. Goodchild, 2001.

158/24.14. *ALLIUM SCORODOPRASUM*. *†46, Cards.: Naturalised on roadside verge, Penyrangor, Aberystwyth, SN581808, A.O. Chater & C.D. Preston, 2001. Known here for at least 15 years and conf. W.T. Stearn in 1988.

†158/24.15. *ALLIUM SPHAEROCEPHALON* *113(A), Channel Is. (Alderney): Garden escape on top of wall, in Le Petit Val, WA567078, B. Bonnard, 1987, det. D. McClintock.

†158/24.cep. *ALLIUM CEPA* *99, Dunbarton: Sandy shingle above HWM, East Bay, Helensburgh, NS3081, A. Rutherford *et al.*, 1998. Det. as var. *viviparum*; subsequently removed by storm. 113(S), Channel Is. (Sark): 2 casual plants on roadside verge, near Mon Plaisir, Rue du Sermon, WV462760, R.M. Veall, 2001, **herb. Société Sercquaise**.

†158/26.1. *NOTHOSCORDUM BORBONICUM* *41, Glam.: On site of long-demolished glasshouses, Hendrefoilan House, SS612937, A.S. Lewis, 2001.

†158/27.1a. *AGAPANTHUS PRAECOX* subsp. *ORIENTALIS* *113(S), Channel Is. (Sark): 1 plant with flowers, several smaller plants nearby without flowers (apparently not planted), on roadside bank, near Hunter's Lodge near La la Fregondée, WV457756, R.M. Veall, 2000, **herb. Société Sercquaise**.

†158/28.1. *TRISTAGMA UNIFLORUM* *29, Cambs.: 2 clumps, at base of fence (spread from garden on other side), on E side of Granta Terrace, Stapleford, TL467518; 1 flowering bulb in disturbed ground along footpath, on W side of A1309, just S of old railway bridge, Trumpington, TL443542; both A.C. Leslie, 2001. 1st & 2nd records. *113(A), Channel Is. (Alderney): Established on dry stone bank, Essex Hill, WA595076, B. Bonnard, 1988, det. D. McClintock.

†158/29.1. *AMARYLLIS BELLADONNA* *113(A), Channel Is. (Alderney): Established & spreading on roadside bank, Braye Road near the School, WA573075, J. Page, 1985. *113(S), Channel Is. (Sark): 1 plant (probable accidental introduction), in middle of pasture, near Mill Lane, WV465758, R.M. Veall, 1998, **herb. Société Sercquaise**. 1st record outside garden.

158/31.1. *LEUCOJUM AESTIVUM* *†58, Cheshire: Casual only on waste ground, Bromborough Port, SJ352839, R. Goodchild, 2000.

†158/32.2. *GALANTHUS ELWESII* *46, Cards.: Naturalised on roadside verge, Abermeurig, SN563562, A.O. Chater, 2001, **NMW**.

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 Sercquaise**.

†159/1.1. *LIBERTIA FORMOSA* *41, Glam.: Self-sown on walls, at Hendrefoilan House, Swansea, SS612936, A.S. Lewis, 2000. *113(S), Channel Is. (Sark): Probably bird sown (nearest plant about 200m away), in mixed woodland near footpath, L'Écluse, WV461766, R.M. Veall, 1999, **herb. Société Sercquaise**, det. D. McClintock.

†159/2.3. *SISYRINCHIUM CALIFORNICUM* *99, Dunbarton: Foot of wall, West Helensburgh, NS3081, A. Rutherford, 1998, det. A.McG. Stirling.

†159/2.5. *SISYRINCHIUM STRIATUM* *4, N. Devon: Extensively surviving outside garden in maritime scrub, Middleborough, Croyde, SS428400, W.H. Tucker, 2001. *H6, Co. Waterford: Abundant, over 100 plants on waste ground, Greenan, S196216, P.R. Green, 2001.

†159/5.1. *IRIS GERMANICA*. *46, Cards.: Naturalised on sand dunes, Penyrergyd, Gwbert, SN161486, A.O. Chater *et al.*, 2001. Known for at least 15 years.

†159/5.1. *IRIS GERMANICA* *113(A), Channel Is. (Alderney): Established for over 10 years on quarry verge, Mannez, opposite the Lighthouse, WA603089, B. Bonnard, 1989.

†159/5.7. *IRIS ORIENTALIS* *29, Cambs.: Gravel pit, Milton, TL46, G.M.S. Easy, 1970-1992, **herb. G.M.S.E.** *58, Cheshire: Wasteland, Bidston Moss, SJ291914, R. Goodchild, 2000.

†159/5.fil.xtin. *IRIS* × *HOLLANDICA* (*I. FILIFOLIA* × *I. TINGITANA*) *113(A), Channel Is. (Alderney): 1 large clump established in hedge, old crop remnant, Petit Val, WA567078, B. Bonnard, 1993.

†159/8.3. *CROCUS NUDIFLORUS* *80, Roxburghs.: 47 flowering heads, on riverside banks, of R. Tweed upstream from Carryweil Pool, Tweedbank, Galashiels, NT513348, A. Bramhall, 1995, det. R.W.M. Corner. Up to 100 heads, on riverside banks, of R. Tweed at Melrose, NT540344, A. Bramhall, 1996, det. R.W.M. Corner. 1st & 2nd records.

†159/8.8. *CROCUS SPECIOSUS* *64, Mid-W. Yorks.: Several large patches naturalised in grassland and under trees, Meanwood Valley, Leeds, SE280375, D. Hunter, 1998.

†159/10.2. *IXIA PANICULATA* *113(A), Channel Is. (Alderney): 3 plants flowering in scrub (garden escapes), bank above Bluestone Hill, WA586075, B. Bonnard, 2000.

†159/11.1. *SPARAXIS GRANDIFLORA* *113(S), Channel Is. (Sark): 1 plant, on roadside bank, Rue Lucas, WV469761, M.H. Marsden, 1998, **herb. Société Sercquaise**. Not in an adjoining garden; accidental or deliberate discard.

†159/13.1. *CROCOSMIA PANICULATA* *52, Anglesey: By concrete roadway to former MoD base, Ty-croes, SH3269, BSBI meeting, 2001. *77, Lanarks.: Established colony, in rough grassland, Glaikhead, NS8136, P. Macpherson, 1999. 2nd record as established.

†159/13.3. *CROCOSMIA POTTII* *5, S. Somerset: Several clumps, on bank of lane leading to car park, Simonsbath, SS774393, I.P. Green, 2000. *49, Caerns.: On shingle island, River Llugwy, near Betws-y-Coed, SH739570, J. & H. Lowell, 2001. *H6, Co. Waterford: Rough grass area, Mt Melleray Monastery, S099038, P.R. Green, 2001. Area now planted with trees.

†159/SCH.coc. *SCHIZOSTYLIS COCCINEA*. *46, Cards.: About 60 plants scattered over 2 areas c.10×8m & 8×4m, naturalised in scrubby waste ground, 200m WNW of Aber-porth church, SN254512, A.O. Chater, 2000, **NMW, LTR**. Not planted; surprisingly not recorded as naturalised before in Britain.

†160/2.1. *AGAVE AMERICANA* *113(A), Channel Is. (Alderney): 3 large specimens suckering (probably planted), along East coast as at St Esquère Bay, WA607088, B. Bonnard, 1986, det. D. McClintock.

†160/3.1. *CORDYLINE AUSTRALIS* *H6, Co. Waterford: Several, self-sown, on waste ground, Ringnasilloge, Dungarvan, X254924, I.P. Green & P.R. Green, 2001. 1st record of self-sown plants.

†160/4.1. *PHORMIUM TENAX* *113(A), Channel Is. (Alderney): Established on bank between two fields, La Petite Blaye, WA563071, B. Bonnard, 1988.

162/3.1. *EPIPACTIS PALUSTRIS* 51, Flints.: Sloping field with stream, between Cefn-y-bedd and Plas Maen, SJ306562, S. Taylor, 1999. 1st recent record.

162/13.1. *PLATANThERA CHLORANTHA* 51, Flints.: Tall grass and scrub on limestone, Pantymwyn, SJ195651, M. Brummage, 2000. 1st recent record.

162/15.1. *PSEUDORCHIS ALBIDA* 93, N. Aberdeen: Rocky grassland, Cairnie, NJ4844, J. Warren & M. Ford, 1998. 1st recent record.

162/15.1×16.1. *×PSEUDADENIA SCHWEINFURTHII* (*PSEUDORCHIS ALBIDA* × *GYMNADENIA CONOPSEA*) *96, Easterness: Juniper/*Calluna* scrub, Whitewells, Rothiemurchus, NH914088, Mr & Mrs D.M. Thomas, 2000, det. F. Rose.

162/16.1c. *GYMNADENIA CONOPSEA* subsp. *BOREALIS* *81, Berwicks.: Damp grassland slope near small stream, near The Cromwells, NT595503, D.G. Long, 2000, det. M.E. Braithwaite.

162/18.3c. *DACTYLORHIZA INCARNATA* subsp. *PULCHELLA* *81, Berwicks.: 3 plants in flushed grassland, Fangrist Burn, NT694482, M.E. Braithwaite, 2000, det. R. Bateman.

162/18.7. *DACTYLORHIZA TRAUNSTEINERI* *46, Cards.: Dune slack, Ynys-las Dunes NNR, SN606936, S.P. Chambers, 2001, conf. I. Denholm.

162/22.1. *HIMANTOGLOSSUM HIRCINUM* 13, W. Sussex: 1 plant on S verge of lane running along N side of chalk pit museum, Amberley Mount, TQ031123, S. Mockford, 2000. 1st recent record.

Book Reviews

The history and natural history of Lugg Meadow. A. Brian & P. Thomson. Pp. viii + 56. Anthea Brian in association with Logaston Press. 2002. Paperback. £4.95. ISBN 1 873827 38 5.

This delightful booklet seeks to highlight the national importance of Lugg Meadow near Hereford, the largest surviving Lammas meadow in England (132 ha). The first chapter provides an historical overview of the development of meadow systems since the Bronze Age, with particular reference to the Lower Lugg Valley. This is followed by two engaging and comprehensive chapters detailing the medieval system of land management and tenure still observed on Lugg Meadow today. These are based on the rich corpus of archival material held by Hereford Cathedral, some of which dates back to the eleventh century, together with the history embodied in the mere and dole stones of the meadow itself. In contrast only a short section is devoted to the meadow's natural history (12 of the 56 pages) and much of the botanical discussion is understandably focused on ancient flood meadow indicators (e.g. *Fritillaria meleagris* and *Oenanthe silaifolia*). There is however a useful appendix listing the plants of the meadow.

This book provides an extremely informative account of the geological and cultural heritage of an ancient Lammas meadow and is therefore of relevance to anyone involved or interested in the development, ecology or conservation of traditional hay-meadows.

C. PINCHES

Oaks, dragonflies and people. N. W. Moore. Pp. 132. Harley Books, Colchester. 2002. Paperback £15.95. ISBN 0 946589 71 2.

Norman Moore described aspects of his long and distinguished career in nature conservation in his perceptive commentary on the science and politics of conservation, *The bird of time*, published in 1987. *Oaks, dragonflies and people* is a more personal memoir based around the small, private nature reserve at his home in Cambridgeshire. The first half of the book covers the establishment and management of the reserve since the Moore family moved to Swavesey in 1961. The reserve was created from a pasture field on heavy calcareous clay and now includes grassland, a planted wood (dominated by *oaks*), and a large pond (or mere as Moore prefers to call it) excavated in 1983. A quarter of the book describes the colonisation of the reserve by animals, especially *dragonflies* on the mere. Two chapters on planning and planting the wood and the mere contain most of the botanical interest, together with the appendix listing plant species mentioned in the text. A section of 36 colour plates divides the chapters on the reserve from the second half of the book. This consists of seven short chapters. Each is an essay on important themes in nature conservation and environmental policy and practice, including a new concept termed 'Future Care' politics. Each chapter starts from the local scale of his Swavesey reserve, but then ranges widely to embrace global issues, always from an unambiguous, personal standpoint. True to its title, throughout this book *people* (family, friends, neighbours and colleagues) form a distinctive thread in his story. The book includes several appendices, a glossary, a short bibliography and a comprehensive index, covering topics as diverse as Dutch Elm Disease, grandchildren and the Kyoto Treaty! It is illustrated with the author's line drawings, maps and a few monochrome photographs, in addition to the colour section.

P. T. HARDING

The Broads: the people's wetland. B. Moss. Pp. 392. Harper Collins, London. 2001. Hardback ISBN 000 220163 1, £34.99; paperback ISBN 000 712410 4, £19.99.

In this book, Brian Moss describes the most famous British lowland wetland. "A set of around 50 very small lakes linked with four rivers, on a world scale tiny, and the equally miniscule remnants of a mosaic of wetlands, they have a remarkable prominence in national sensibilities, and a key role in the scientific research literature". The emphasis of his account is deliberately ecological. Moss explains that this is not "a traditional naturalist's book, emphasising lots of species, and

delighting in the appearance of this or that flower". The author is an environmental scientist, whose greatest enthusiasm comes when writing about water chemistry, "an intensely interesting subject", and limnology. This approach is somewhat unexpected in the *New Naturalist* series, but the book is well planned to complement George's superbly encyclopaedic *The land use, ecology and conservation of Broadland* (1992) and Williamson's land-use history *The Norfolk Broads* (1997). Together, these three books replace the earlier *New Naturalist* volume *The Broads* by Ted Ellis (1965), long outdated but increasingly valuable as an historical account of a vanished Broadland.

In the first half of the book, the gradual development of the Broadland Ted Ellis knew as a young man is described. Geological history, the vegetation and water chemistry of the pristine river systems, the origins of the lakes as medieval peat-cuttings and the development of the grazing marshes are all covered. The detailed account of events in the rather isolated Broadland area is set in its national context. In theory this is a good idea, but unfortunately it takes the author well outside his field of expertise. Thus the Anglo-Saxon Chronicle is described as a "book written ... by a monk, the Venerable Bede", Britain is said to have been drawn into the Second World War "by movements of hostile forces into Belgium and now also Holland in 1939" and Arthur Bennett, who collected charophytes in Broadland in the 1880s, is depicted as a clergyman and a member of the leisured Victorian middle-classes.

The really important part of Moss's book is the description of developments after the Second World War (pp. 186 onwards), a period when the area "was to suffer almost all of the ills to which freshwater systems are prone under severe human pressure". In particular, the aquatic macrophytes and fringing communities of both lakes and rivers declined and reedswamps ceased to be managed and became overgrown. At first boats were blamed for the changes to the water bodies, or indeed regarded as the obvious culprits; they were highly visible whereas increasing levels of nitrate and phosphate were not. The long research programme undertaken by Brian Moss and his colleagues from the 1970s onwards to establish the true reasons for the changes is clearly and honestly described. The current understanding of the ecology of the Broadland waters was achieved gradually, using both experimentation and the intelligent interpretation of chance events. This understanding relies on the idea of alternative stable states. The aquatic systems of the Broads might be either turbid and phytoplankton-dominated or clear waters with flourishing macrophytes, even under the same environmental conditions, and there are a number of possible switches from one state to the other. This raises the possibility of reversing the changes by reducing nutrient levels followed by "biomanipulation". The latter includes planting aquatic macrophytes, protecting them from grazing and reducing fish populations (to reduce predation on zooplankton, and thus increase their consumption of phytoplankton). The many ecological and institutional obstacles to achieving this restoration are clearly outlined, the greatest of all being the absence of any body with powers to manage the whole catchment. (An interesting chapter analyses the organisations of Broadland as if they were species under evolutionary constraints.) Moss concludes that the best we can expect in the future is "isolated nuggets of high quality in a bedrock of mediocrity". The pressures on grazing marshes, which for a period were threatened with conversion to arable land, are less ecologically complex, but in viewing the present situation Moss has "a sense of impermanence, of waiting to see what might happen next" as both fens and grazing marshes "are artefacts of history and history has changed".

This account of the complex ecology of Broadland is well-written and, although I found that it required concentrated reading in places, it is not difficult to understand. It is an engrossing account of the difficulty of understanding the complex ecology of the area, and then of putting this hard-won knowledge into practice. It provides a description of Broadland as it really is, and a very stimulating (though not necessarily encouraging) read for anyone interest in the environment and seeking to get beyond the soundbites of pressure groups and the posturing of politicians.

C. D. PRESTON

* Regrettably, although this book was received for review in *Watsonia* it was never reviewed, for circumstances beyond the editors' control. I therefore take this opportunity to recommend it wholeheartedly.

The flora of Ely. R. M. Payne. Pp. 30. Privately published at King's Lynn, Norfolk. 2002. Paperback £4.50 incl. p. & p. from Summerfield Books. No ISBN.

This attractively produced booklet describes the results of a survey of the urban part of the city of Ely in 2001–2002, analysing, by habitat and frequency, the occurrence of 416 species in 103 recording units. There are numerous interesting notes on individual taxa, such as *Myosoton*, *Humulus*, *Duchesnea* and an apparently unnamed fertile *Senecio* hybrid. As in most other urban floras, annuals, Asteraceae and Poaceae are disproportionately well represented in comparison with the rest of the county or country. The base of walls was the richest habitat, with 191 species, and walls themselves had 157. The author's thoroughness can be judged from the list of 38 species from such an inaccessible habitat as roofs and gutters. There have been a number of accounts of urban floras in recent years, including those of Dublin, Belfast, Hull, Cambridge, Aberystwyth and Payne's own of King's Lynn. It is with the latter that the Ely flora is chiefly compared, with for example *Sagina procumbens* being strikingly more abundant in King's Lynn, and *Parietaria* even more so in Ely. Lack of earlier detailed records means that no changes over time have been described, but a very good baseline has now been set for any future resurvey. More analysis of the ecological and climatic requirements of the species might perhaps have been worth while, but as it stands this booklet is strongly recommended to B.S.B.I. members both for its intrinsic and original botanical information and as an inspiration to produce similar surveys of other urban floras. The more such accounts are available, the more we will learn about the nature of this very human environment and the differences between one town and another. It also demonstrates that, for the observant botanist, a day in town can be just as productive as one in the countryside.

A. O. CHATER

New Atlas of the British and Irish Flora. Edited by C. D. Preston, D. A. Pearman & T. D. Dines. Pp. xi + 910. Oxford University Press, Oxford. 2002. Hardback £99.95. ISBN 0 19 851067 5.

The changing flora of the UK. C. D. Preston, M. G. Telfer, H. R. Arnold, P. D. Carey, J. M. Cooper, T. D. Dines, M. O. Hill, D. A. Pearman, D. B. Roy & S. M. Smart. Pp. 36. Department for Environment, Food and Rural Affairs, London. 2002. Paperback. Available on www.defra.gov.uk/wildlife-countryside/index.htm. ISBN 08459 556000.

A peaceful army of 1600 botanists spread out all over Britain and Ireland during the last half decade of the 20th century under the leadership of the Botanical Society of the British Isles. It must be rewarding for them to see that the results of their careful field observations have been put together so quickly and yet so thoroughly in one heavy volume: the *New Atlas*. It was an excellent idea of DEFRA (Department for the Environment, Food and Rural Affairs), who provided the main funding for the project, to bring out the separate booklet *The Changing Flora of the UK*, which explains important parts of the mapping project to a wide public, including the policymakers themselves. (Despite the title, most of its maps cover records in the Isle of Man as well). This finely and adequately illustrated booklet should be used at schools and universities, not least because it shows the effects of the degradation of the countryside (especially) in England very clearly, pointing to modern agriculture and traffic as the wrong-doers. It becomes very obvious, too, that the changes in the English temperate flora are equal quantitatively and qualitatively to the changes in the temperate lowland floras of Western Europe.

The *New Atlas* treats all species in Stace's *New Flora* and covers the whole of the British Isles (Britain, Northern Ireland, Republic of Ireland, Isle of Man and the Channel Islands). The distributions are marked by the presence of dots in the 10 × 10 km squares of the Ordnance Survey National Grid, of which there are over 3800 in the British Isles. However, not all the maps are printed in the book itself; a CDROM has been included for the missing species (all introduced species in fewer than 50 squares). The CD also contains all the maps from the book, allowing one to make species selections from parts of the country. However, when trying to find the map of a certain species, one has to know already whether it is also depicted in the book or only in the CD: there is no complete index from which one can start. I did not fully understand why the CD does not contain maps of *Hieracium* sections (or of *Rubus*, *Taraxacum*), yet other aggregates (like *Euphrasia*) are treated fully in the book. But these are only minor points. The CD works quickly, and allows all kind of comparisons not easily done with just the book to hand.

The more than 2,400 maps in the book are presented in a good size (three to a page), with the records sorted out in two categories: native (blue) and introduced (red). Very often a map has blue as well as red dots, indicating that part of the records are considered as introductions. The records are divided into three time classes: pre-1970, 1970–86, and 1987–99, presented with increasing contrast, the pre-1970 records having been printed so faintly that one needs a good illumination to see them. The best characteristic of the atlas is the combination of map and text. The species accounts are concise but very informative, and commendably uniform in content and style. The accounts include brief information on habitat, trends in the distribution inside the British Isles, altitudinal limits and key references. A very important tool to illustrate the trends is the change index, which is presented for every species; it compares the present day distribution with that of the results of the 1962 *Atlas of the British Flora* (after all kinds of statistical exercises), ranging between +4.70 and –7.86. Important information is also presented on the history of the species in the British Isles, not only giving information on the first date of introduction and the first record in the wild, but also the much more relevant information on the period of real naturalisation. Before going deeper into this matter, I must confess that I missed one aid: an overlay with ecologically important factors like altitudinal ranges, rainfall, frost days, etc.

Because the individual change index number is presented, together with precise dates of historical relevance, I did an exercise to compare the data of all Atlas species from England which also occur in the Netherlands with our national data and with those recently presented for Germany and the Czech Republic. The preliminary results of this comparison are amazing in several respects. Firstly, there is a great similarity between dates of introduction and expansion of many temperate species in these countries. The fact that Britain is an island is not very apparent for those plant species of lowland man-influenced habitats: many introduction and expansion events occurred almost simultaneously with those of 'the Continent'. Secondly, and this may be bad news for Dutch botanists, the change index leads to comparable results with data collected for a 10×10 km grid as for our the Dutch 1×1 km grid. Perhaps it would be a good idea to repeat this promising exercise less hurriedly. And thirdly, there may be reason to discuss the biologically important distinction between 'native' and 'alien' in treatises on flora and fauna, because, and this is my only real point of criticism on the New Atlas, I feel that the black-and-white distinction between the blue and the red dots has gone too far. Not only is it difficult to interpret archaeological data, but to me it seems odd to treat a species like *Verbena officinalis* as alien, despite it already being known in the Stone Age! Many species now treated as alien are known from the Bronze age (*Silene latifolia*, *Lithospermum arvense*, *Hyoscyamus niger*) or the Iron Age (*Agrostemma githago*, *Ballota nigra*, *Anthemis cotula*, *Centaurea cyanus*). Another interesting result of this distinction between native and alien is the fact that many maps of native species have many red dots, reflecting changes in the recent distribution that are considered to be more influenced by man than the old distribution patterns. To take one example, a quarter of the dots for *Clematis vitalba* are in red. Also in the Netherlands, Traveller's-joy (its name alone!) has been expanding rapidly in recent decades outside its traditional habitat. Because of its ability to form monocultures, it was usually eradicated outside woodlands on limestone. When this practice stopped, it was free to colonise shrubbery in cities, railway borders and waterway edges, and it did so successfully! I feel it unnecessary to consider its London localities as alien, those of Greater London as native.

Another minor point of criticism is the taxonomic order of presentation, which exactly follows Stace's sequence in his *New Flora*. Especially in the present exciting era wherein DNA research leads to a better understanding of evolution, resulting in some considerable changes of position and circumscription of some families and orders, it might have been better to present the Atlas taxa alphabetically by binomial.

It is really amazing that the whole Atlas project has been finished within only seven years. Not only the B.S.B.I. field botanists are to be praised, but also the whole group of scientists behind the raw data are to be congratulated on this fine result. Undoubtedly, this Atlas is the best that has ever appeared in Europe, and it will lead to a better understanding of the British and the European flora. Hopefully, policymakers will also understand that it is necessary to support organisations like the B.S.B.I., and that they must invest in measures which will lead, eventually, to landscapes with a great diversity of wild flowers. The next atlas might reveal this in another 40 years.

R. VAN DER MEIJDEN

Rare Plants of Shetland. W. Scott, P. Harvey, R. Riddington & M. Fisher. Pp 166. Shetland Amenity Trust, Lerwick. 2002. Hardback £21.75 (£19 to B.S.B.I. members if ordered directly from Shetland Amenity Trust). ISBN 0 9543246 0 9.

This concise, accurate and well-produced work focuses on Shetland's rarest plants. The information provides a useful update to that contained in the superb *The flowering plants and ferns of the Shetland Islands* of 1987 by Walter Scott and Richard Palmer. There are three very informative introductory chapters. The first charts the discovery of the Shetland flora, beginning with James Robertson in 1769, then documents the achievements of the most notable botanists such as Thomas Edmondston (who died aged 20 not 21 as stated), William Hadden Beeby, George Claridge Druce and, not least, Walter Scott and Richard Palmer. This is followed by an account of the conservation of the flora of Shetland and a useful section on the legal provision for the protection of wild plants in Great Britain. These two chapters provide very useful background information.

The accounts of the 138 taxa are arranged botanically and each taxon is assigned to one or more of seven conservation categories that are stated in colour below the name of the plant in each account. A few categories seem to be omitted from the accounts where a plant belongs to more than a single category or sub-category (e.g. several of the *Hieracia*). The accounts are succinct, giving date of first record and notes on distribution, habitat and threats. Each taxon is mapped at tetrad scale where possible, otherwise at hectad scale. Date classes for records follow that of the recently published *New atlas of the British and Irish flora*.

The stated aim of the book as an essential reference for planners and conservationists is admirably achieved as the clarity and high quality of the layout makes the information extremely accessible. A selection of colour photographs further increases the attractiveness of the work. This is a high quality work in all respects but this is what we have come to expect from Shetland botanists.

P. LUSBY

Plant Life of Edinburgh and the Lothians. Edited by P. M. Smith, R. O. D. Dixon & P. M. Cochrane. Pp. xii + 545. 2002. Hardback £25.00. ISBN 0-7486-1336-6.

This is a handsome and inexpensive volume that handles well. Within its covers lie a compendium of papers and fine photographs by 22 authors with sharp contrasts in style and content, and indications of an editorial struggle for compression.

This book is much more than a flora, it has an educational mission to present as broad as possible a picture with the physical and historical background, an inventory of all forms of plant life, and papers to add analysis and to cover related topics. This mission is largely evangelised by Philip Smith and colleagues at the University of Edinburgh. Balanced against this are the highly scientific but equally accessible contributions by the enviable team of botanists at the Royal Botanic Garden Edinburgh in relation to fungi, lichens, bryophytes, ferns and flowering plants. As if that were not enough in itself there is also a full bryophyte flora and a vascular plant flora that includes a report on a massive and complex field survey by a considerable army of volunteers backed up by historical records and further field work by three able B.S.B.I. Vice-county Recorders, Jackie Muscott, Douglas McKean and Helen Jackson.

The administrative region of the Lothians does not coincide with that encompassed by the three vice-counties on which the botany is based. This has led to a mismatch between the maps of physical features and those of the floras, which is a pity. Otherwise the physical background is informative and I enjoyed the portrayal of the toposequence of Lammermuir soils and the insight into the mosaic of soils near the coast. In the historical section I was delighted to see acknowledgement of Albert Long's pioneering work on the fossil plants and appreciated the section on the old lochs of Edinburgh.

Microfungi are illustrated by familiar examples. Roy Watling presents an inventory of the macrofungi and an overview packed with lively anecdotes and the provocative statistic that the 1,238 species recorded so far might potentially rise to 7,500 in the future. Eutrophication is suggested as the reason for the loss of 4 of 9 charophytes, but the last records were in 1821, 1897, 1935 and 1961 so other factors may be involved. Seaweeds are introduced to the reader and an

inventory is given. In contrast Brian Coppins is not allowed to list his 591 lichens but this does mean space for a compelling overview.

David Chamberlain's Bryophyte Flora is a major work which I am not competent to review, but I can applaud the presentation of the meticulous field work over 30 years, much of it in a productive partnership with David Long. Full records are given for the rarer taxa and for local taxa, found in 8 or fewer 10 km squares, at least one detailed record is given for each square. Thus *Marchantia polymorpha* ssp. *polymorpha* is recorded in square '46 – damp soil by stream, Birns Water, near Stobshiel, 28 July 1974, D. G. Long 3632'. 3632 appears to be a herbarium reference rather than a grid reference, though this is not stated. The ferns have a comprehensive separate review, though I looked in vain for comment on the spread of *Phyllitis scolopendrium* mentioned in the flora.

The Botany of the Lothians Project had the ambitious goal to record in detail one 1 km square in each tetrad, some 555 squares, which has virtually been achieved over 14 years. For each taxon its frequency in the square as a whole was estimated together with each habitat occupied, choosing from a standard list of 41 habitats. In a Scottish context 1 km recording on this scale is unparalleled. The resulting flora presents maps of about 400 taxa with the frequency shown as shading over the tetrad containing the 1 km square sampled. Unfortunately the shading is not self-explanatory as rare appears more deeply shaded than occasional and abundant, in solid black, stands out more strongly than the rather poor consistency of the underlying data would appear to warrant. The habitat information is used in the species accounts. Thus *Buddleja davidii* is noted from 'waste ground, roadsides, woodland, quarries, buildings' but not, strangely, from railways, seemingly because the standard habitat 'railway embankments/cuttings' appears to exclude railway sidings and the like.

The species distributions are given by vice-county as '*Hypericum pulchrum* – WL: widespread especially in W.; ML, EL: widespread in S. local in N.'. This adds nothing to what is evident from the map. For scarcer species the Vice-county Recorders have provided a list of current (1981–2000) and historical localities. These cover the whole area, not just the project sample. There is no general commentary at all, so we learn nothing of fine populations of scarce plants, nothing to set the Lothians populations in a Scottish or British context, and find no background to the lost localities and extinctions. Commentary is left to later chapters. Alien species coverage is exemplary, no doubt aided by the services of the herbarium at the Botanic Garden. Thus Malvaceae includes 12 species (compared to 6 in the Glasgow Flora) and *Quercus* 7 taxa (4 in Glasgow). This coverage exacts a toll in terms of pages.

Extensive notes on the rarer casual aliens follow the flora before the all-too-brief overviews of each vice-county by its B.S.B.I. Recorder. These nevertheless portray vividly the flora of some features of the area, such as the bings, Holyrood Park, Roslin Glen, the Union Canal, the East Lothian Coast and the volcanic outcrops. A chapter on phytogeography focuses excessively on species with only a toehold in the area. This seems to result from following the work of J. R. Matthews rather than that of C. D. Preston and M. O. Hill, which does not get a mention.

The presentation of the project's results recognises twenty distinct plant distribution patterns, but these do not, unfortunately, appear in the species accounts. A surprise to me was a group of familiar species, such as *Achillea ptarmica* and *Senecio aquaticus*, with a distribution even more concentrated in the west than the New Atlas data would suggest. Interesting gaps in distribution at 1 km scale occur in the intensive arable areas for some very widespread species such as *Anthoxanthum odoratum* and *Veronica serpyllifolia*. Statistics are strangely absent from the account and I could not even trace the total number of taxa recorded. These may follow once the CD-Rom of the underlying data is available, as promised at the book's launch.

The worthy chapter on land use is map free, which is a shame, as I had hoped to be able to compare data from forestry and agricultural sources to the interesting maps of different crop types obtained from the species habitat data. The finale on ethnobotany taught me that *Isatis tinctoria* was in commercial use to the end of the eighteenth century and that *Salix myrsinifolia* has had a place in osier beds.

This is a book that Scottish and northern botanists will not wish to be without.

M. E. BRAITHWAITE

Obituaries

MARGARET CANNON

(1928–2002)

Nunquam otiosus: There is no other way to sum up such a varied, interesting, active and creative life as was Margaret's, and words fail me to express adequately her warmth of character, her gift for friendship, her generous hospitality and her readiness to help whenever the need arose. This is not the place to describe in depth the range of what may be called her extracurricular activities as a veritable amateur craftswoman, working in wood, silver and silk, as well as other materials. Her selfless work for Oxfam and other charitable causes should be mentioned, as well as her devotion to both her local community and the parish church.

From an early age Margaret showed a great interest in natural history. No wonder that after leaving school, she trained and worked as a physiology technician in the University of London; this at a time when students still learned through real hands-on blood and guts biology, rather than virtual reality techniques. Her skills in preparing life specimens were said to have been exemplary. Later, having married John Cannon, she decided to enter higher education and embarked on a degree course in botany, also her husband's subject.

After graduation however, she fell back on her second subject, human physiology, and worked for several years in the pathology department of a large children's hospital.

While still a student Margaret joined the B.S.B.I. in 1951. In that same year she attended the conference at which the proposal for the first Mapping Scheme was put forward, and the epoch-making demonstration of the way in which mechanical data could be handled using punched cards and tabulator, was given. Together with John, who became Keeper of Botany of the then British Museum (Natural History), she became involved in the Society's activities and served on the Meetings Committee for eight years (1986–1993). After the pressures of family life ceased – she brought up three children – Margaret resumed regular research work and became a botanical Associate of the Department of Botany.

Here she started by helping the late Oleg Polunin with the selection of both species and descriptive texts for a projected volume in his well-known series of illustrated field guides for the flora of Europe. As a result of his untimely death, alas, this project never came to fruition. She then produced a monograph of the Morinaceae – a small family related to the Dipsacaceae. Moreover, jointly with Steve Blackmore, she studied the remarkable spaceship-like pollen of this family. Margaret also contributed the account of the Dipsacaceae for Flora Zambesiaca, and of several families including the Umbelliferae, for the Flora of Madeira which was produced by the Department of Botany. Her most important contribution, however, was the Araliaceae for the Flora Mesoamerihcana project, which covers the whole of tropical Central America where this family is well represented (there are no fewer than 45 species in tiny Costa Rica alone). Margaret also wrote associated accounts for the Floras of Guatemala and Costa Rica.

Her enquiring mind was always keen to explore new avenues of discovery, and this mainly in the field of applied botany. Her amateur involvement with many aspects of textile crafts led her to research in plants used for dyeing before modern chemistry dominated the field, and the result of her labours was the book *Dye Plants and Dyeing*, which appeared first in 1994. It was illustrated by her old friend Gretel Dalby-Quenet and has just been published in a second edition. Many members of the Society will remember Margaret's demonstration of her techniques at one of the Exhibition Meetings in the Botany Department of the Museum.

Visitors to the house in the charming village of Rodmell in Sussex to which she and John had retired in 1990, will bear witness to Margaret's keen interest in gardening – there cannot be many private gardens in which so many species of scientific interest are seen growing together.

Margaret and her husband travelled widely, mainly in southern France and in America, where they visited all but one of the States. Their rich harvest of botanical specimens will be found in the herbarium of the Department of Botany at The Natural History Museum in South Kensington.

EDMUND LAUNERT

JOYCE SMITH

(1920–2002)

For more than 20 years Joyce Smith was the B.S.B.I. recorder for Surrey (v.c. 17) and to many she represented the very model of a county recorder. Her reports were frequently amongst the first to arrive, they were accurate, detailed and up-to-date. She knew her county. In person at Recorders Meetings she could be forthright and challenging but was unfailing good company in the bar afterwards, cigarette and whisky glass in hand. As an ambassador for the county one could not have wished for more.

Joyce Eva Smith (née Aldous) was born on 6 June 1920 at Isleworth, Middlesex. She was one of twins but sadly her sibling was stillborn. At school she specialised in Geography, English and Botany, and in the last subject it is recorded that 'her field work was exceptional'. She was also a gifted artist, and although unable to do justice to this interest at school, it stayed with her all her life. She painted in watercolours and once won first prize at a local flower show with a landscape painted whilst on holiday in Spain. In later life Joyce was rather reticent about this talent and few seemed to be aware of it. On leaving school her headmistress observed that it was a pity her parents were unwilling to allow her to study for a science degree and 'admired her determination to enter the teaching profession'. This she duly did, qualifying in 1940 and going on to teach 6–15 year-olds who were "blue babies" and often Down's Syndrome. Her subjects were geography, biology and advanced art. The evidence from this period testifies to her enthusiasm, an ability to inspire and her happy spirit, characteristics her later botanical colleagues will confirm.

In 1945 Joyce married Aubrey Smith who spent his working life in the paint industry (when not playing golf), latterly as sales director for Blundell Permoglaze. A daughter, Jennifer, was born at Wimbledon in 1948 and went on to qualify as a nurse. She now lives with her husband in New Zealand. The Smith family moved to Claygate in 1955, where Joyce remained for the rest of her life and where, after a long and happy marriage, Aubrey died in 1990.

Jenny recalls that there was never a time when her mother was not botanising to a greater or lesser degree and family holidays and outings were often centred on some botanical quarry. An old black vasculum accompanied every outing and rarely came back empty. Thus, by close examination of the day's gatherings, did an earlier generation really get to know their plants. Her daughter's most vivid botanical memory is of a holiday near Tongue in the far north of Scotland in the late 1960s. Aubrey and Jennifer went out with Joyce with the edict ringing in their ears to find *Primula scotica*. The search lasted most of the morning and father and daughter were about to give up when a cry came from Joyce that she had found one in flower. She was found sitting down exclaiming over it and clearly over the moon! They could not understand how anyone could get so excited about such a small plant.

In 1962 she took a new direction in undertaking the role of company secretary for the newly formed Surrey Trust for Nature Conservation (now the Surrey Wildlife Trust). It was perhaps characteristic of Joyce that she was as concerned and interested in the practical conservation of rare plants as she was in their recording. During her time with the Trust she played a significant role in the complex negotiations to purchase Thursley Bog, now a National Nature Reserve. Her efficient organisation and her professionalism in dealing in a no-nonsense way with landowners in the county were skills soon to be appreciated by the B.S.B.I. and Surrey Flora Committee. Joyce had joined the B.S.B.I. in 1955 and in 1963 took over from Barbara Welch as secretary of the Surrey Flora Committee. She was one of the original S.F.C. recorders (or 'helpers' as she always liked to refer to us) and remained as secretary for the next 32 years. In 1979, following the death of Cecil Prime, she accepted the additional challenge of becoming B.S.B.I. recorder for Surrey. It is hard to overemphasize how hard she worked on behalf of both organisations and with what determination she fought to record and protect the county's flora. Not that her efforts were merely administrative. Her name is listed as a contributor to the 1962 B.S.B.I. *Atlas* and its successor published in 2002. Indeed, she co-ordinated the county return for the 2002 edition. The S.F.C. records are packed with entries in which the initials 'JES' play a part. In the early years these would be accompanied by the likes of JEL (Ted Lousley), ECW (Ted Wallace), RAB (Ron Boniface) or WEW (Wilf Warren). By the 1980s she had established a regular, weekly outing with

fellow S.F.C. helper Sheila Wenham and it was on one of these trips near Pirbright in 1985 that Sheila was shot dead right beside Joyce, victim of a stray bullet from nearby rifle ranges. This deeply shocking event, combined with the press interest and an inquest, must have severely tested Joyce and would have put a weaker character off fieldwork for good. But Joyce recovered and eventually re-established the almost year-round weekly outings, this time in company with Ken Page and Julia Leslie. This trio have ranged all over the county, producing a plethora of new records and responding to numerous requests for surveys from landowners and other interested organisations. At times the other two almost seemed to have converted Joyce to an appreciation of alien plants, something she was wont to decry vociferously in others!

Joyce published relatively little herself but as SFC secretary was responsible for the annual Newsletter which contained pithy accounts of field meetings, details of significant new finds, exhortations to take part in various surveys and inevitably a string of obituaries. Together these reports add up to a considerable archive of recent Surrey botany and botanists. These Newsletters also covered the group's finances since in addition to her other duties Joyce acted as Treasurer. Sometimes at Committee meetings it felt as if she was chairman as well! It therefore came as no surprise that when she finally retired it took three people to carry on with the work she had been doing.

Joyce's botanical interests extended beyond flowering plants, for she was a competent bryologist with many good records to her credit. Francis Rose remembers visiting classic bryological sites on Box Hill in her company and recalls her great enthusiasm, cheerful personality and her great, distinctive laughter. Physically a small figure, she could be a commanding presence in the field. In private she could be a wonderful mimic.

In her last years Joyce had moved to a small terraced house in Claygate and soon became the matriarchal figure in Station Road. Despite her protestations that 'I'm a botanist not a horticulturist' she was soon widely consulted for gardening advice. It is a pleasure to record that her very considerable efforts on behalf of Surrey botany did not go without official recognition, for in 1990 she was one of the first to receive a Surrey County Council Award for Achievement for nature conservation. Four years later even this was eclipsed by the award of an M.B.E. for her services to the environment as secretary of the Surrey Flora Committee. At her funeral we were treated to the photograph of Joyce (plus hat!) outside Buckingham Palace proudly displaying her insignia together with a huge smile. It was a fitting reminder of a life devoted to plants and of her service to others.

I would like to express my thanks to Jennifer Phillips (daughter), Francis Rose, Mary Briggs, Derek Hill and John Montgomery for material included in this account.

A. C. LESLIE

JOHN CHARLES BOWRA

(1918–2002)

John Bowra was born in Reigate, Surrey. His childhood included a few years in Canada, a boarding school in Devon and then quite a long, settled period in Suffolk. While working in a Jersey solicitor's office he met Winifred: their Diamond Wedding was celebrated most happily in April 2000.

When the Germans occupied Jersey, at the start of the war, John was already in uniform. Having returned to the island on a short leave to see if his new wife was safe, he was forced to surrender. Thereafter, he spent five years (1940–1945) as a P.O.W. in camps, being moved from France right across Europe, eventually to Poland. Life was hard, with poor diet although it was a feast compared to what Win had to survive on in Jersey. He had to do arduous work such as stone-breaking and forestry, but later admitted that through these tribulations he grew from callow youth to become very strong both physically and mentally, and came to enjoy hard work. His experiences were not as bad as might be imagined and he said that the treatment was fair; reasonably regular Red Cross parcels and (censored) letters to and from home kept a link with Win and the outside world. His considerable musical talent was put to good use, organising camp

productions, dances and concerts using whatever musical instruments and willing performers he could muster - very important in keeping up spirits.

When peace finally came, John returned home to England and began working for H. M. Customs & Excise, with various postings, notably Newhaven on the Sussex coast and Felixstowe in Suffolk just 10 miles from his childhood home of Ipswich. He ended his working days in the V.A.T. office in Coventry, which is how he came to live in Warwick. He was in his 40s when he started botany, a hobby to keep his daughters Cleone and Denise interested on their regular Sunday afternoon walks; the girls eventually grew out of it, but John's interest continued, and gardening was another serious hobby. Planning ahead for his retirement, John took a correspondence course and passed A level Botany; in 1978 he joined the B.S.B.I. and he also offered himself as a volunteer at the Warwickshire Museum. For one and a half days a week, over the next twenty years, he worked in the attic of the Market Hall Warwick, checking wild plant identifications and entering many thousands of details into the Warwickshire Biological Records Centre. As Keeper of Biology in the Warwickshire Museum Service, I gained so much from the generosity of his time, his expertise and his friendship over all those years that we worked together.

Ever one to 'grasp the nettle' he applied himself to understanding several particularly tricky plant groups, and then transmitted his knowledge to others locally by means of articles, talks and field meetings. Over the years he became an acknowledged county expert on such difficult groups, as Grasses and Sedges, Willows and Ferns.

He made detailed surveys of several local sites, notably Burton Dassett Hills S.S.S.I., Stockton Nature Reserve, Debdale Wood, Southam Salt Spring and Emscote Old Power Station site.

It was this Emscote site which presented the opportunity for his most exciting work. In the 1960s plants of *Oenothera* which did not fit the taxonomy in the Floras had been found on the sandy coasts of S. Wales. Specimens were sent to the *Oenothera* expert Professor Krzysztof Rostanski at the Silesian University, Katowice, Poland. Puzzled by these, Prof. Rostanski came to Wales to study the *Oenothera* populations, and was based at the National Museum, Cardiff for some months. In 1977 he described the new species as *Oenothera cambrica* Rostanski. Meanwhile in the 1950s a deep fire in the Emscote Power station's coal stocks had been extinguished using train loads of sand from the dunes at Margam in South Wales. A population of sand dune plants was later spotted growing at Emscote - most of these maritime species were completely new to Warwickshire and several still survive fifty years on. However the star turn was the Welsh Evening Primrose *Oenothera cambrica*, and John also noticed that this was hybridising with two other *Oenothera* species, *O. erythrosepala* and *O. biennis*, already present on the now derelict site. He chronicled records for some ten years, marking, counting and analysing thousands of hybrids and reading extensively around the subject; from this he began to study the immensely complex inheritance method of this genus. He was appointed B.S.B.I. *Oenothera* Referee in 1986. The series of articles which John wrote in *BSBI News* and in the *Annual Reports of the Warwick Natural History Society* show the development of his arguments, his conclusion being reached in 1999. In the course of this personal research John took part in lively, indeed sometimes heated debate, standing his ground tenaciously. He corresponded with botanists in this country and abroad, and with Professor Rostanski he also explored their overlapping paths in Poland during the war. Incidentally, this serious dialogue and mutual respect between professional and amateur botanists is one of the most rewarding benefits of membership of the Botanical Society of the British Isles (and is almost unique amongst the learned Scientific Societies).

In recent years John's hearing deteriorated severely, causing him great frustration in lectures and social gatherings. Then in his 80s, his eyesight also began to fail due to cataracts, and he had to give up many activities which had given him a lifetime's pleasure, although two successful eye operations gave a little remission. John died in August 2002, only a few days after his beloved wife. A spray of *Oenothera*, gathered by his daughters, decorated his coffin. A great botanist and a great friend - may he rest in peace.

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PAMELA J. COPSON

PROFESSOR NORMAN ALAN BURGES, C.B.E.

1911–2002

The death of Alan Burges can be said to mark the end of an era in British botany. Although born and bred in Australia, he spent most of his professional career in Britain. He was one of a distinguished group of British botanists who spent some of their formative years in the University of Cambridge in the 1930s, such as Tom Tutin, David Valentine, Roy Clapham and John Gilmour, and when they went their different ways –Tutin to Leicester, Valentine to Durham, Clapham to Sheffield, Gilmour to Kew and Wisley before returning to Cambridge and Burges to Liverpool and Coleraine (after a period in Sydney, Australia) – they still retained their friendship. Several of them were later to become involved on the Flora Europaea project. He outlived them all in years.

Norman Alan Burges was born in East Maitland, NSW, Australia on 5 August 1911. He was educated there and obtained his BSc Hons in 1931 and his MSc in 1932 in the Botany Department of the University of Sydney. He then came to Emmanuel College, Cambridge and worked at the Botany School, University of Cambridge where he submitted his PhD thesis on ‘On Some Aspects of the Host and Parasite Relations in Plant Disease’ in 1937. He stayed on in Cambridge, where he was elected to a Research Fellowship at Emmanuel College in 1938 and took part in the celebrated Cambridge Botanical expeditions to the Cairngorms in 1938 and 1939. On the outbreak of war in 1939 he joined R.A.F. Bomber Command where he served until 1945, attaining the rank of Wing

Commander, and was mentioned in despatches. After the war, Burges returned to Cambridge where he was appointed a Demonstrator in Botany in 1946 and in 1947 he returned to Australia to become Professor of Botany in the University of Sydney (1947–52) and Dean of the Faculty of Science (1949–1952). He then returned to Britain in 1952 to take the Holbrook Gaskell Chair of Botany in the University of Liverpool and spent the remainder of his career there and subsequently in Coleraine, Northern Ireland. I first met him in Paris in 1954 at the International Botanical Congress where he was one of a group of British botanists who attended the session on Progress in studies on European Floras during which David Valentine, in his introductory lecture, stated ‘a European Flora, though an immense undertaking, must be regarded as one of the aims of the future’. My own contribution to the session was entitled ‘Progress and problems in the Spanish flora’ as I was then based in Spain and had the previous year completed my PhD at Cambridge on the flora and vegetation of the Sierra de Cazorla in S.E. Spain. A discussion on Valentine’s suggestion of compiling a European Flora was rejected by the participants as premature and unrealistic but this led to the celebrated meeting in a bar on the banks of the Seine opposite Notre Dame at which a group of mainly British botanists, including Burges, Tutin, Valentine, Gilmour, Clapham and myself, decided there and then that we should indeed go ahead and make plans for writing a Flora of Europe. Subsequently when I applied for a lectureship in botany at Liverpool I found that Alan Burges had set things up after discussions with Clapham, Tutin and Valentine, so that when appointed I would be expected to play a major role in the planned European Flora.

With the full support of Burges I was charged with establishing the secretariat of what came to be known as Flora Europaea in the Hartley Botanical Laboratories and the rest is history. Alan always said that Flora Europaea would change the course of European botany for decades to come and he enjoyed his role in the Editorial Committee as an ‘honest broker’. Although not a taxonomist, he religiously attended most of the meetings (and hosted many of them both in Liverpool and later in Coleraine). His equanimity and unflappability were great assets as fierce arguments raged at the editorial meetings and with his anglicised Australian drawl he would soothe the bruised egos and suggest a pragmatic solution. Indeed this ability of his to keep calm in the face of adversity and persuade others to seek a sensible compromise served him in great stead in his role as Head of Department and later as Vice-Chancellor. I often remarked that the only sign of emotion he showed in the heat of an argument was that his glasses would slightly steam up! He did not arouse strong feelings in others and his ability to get on well with a wide range of colleagues both in academia and outside characterised most of his career. At Liverpool, Burges strongly supported the decision to convert the extensive gardens of A. K. Bulley at Ness on the Wirral into the University’s botanic garden, arranging for the first director to be appointed, and played a significant role in its development. Also while at Liverpool, Burges developed his research into soil microbiology and the chemical processes in the soil involved in the formation of humus – popularly known in the Department as ‘dirty black stuff’ – and built a substantial research team in this field. His little book ‘Micro-organisms in the soil’ published in 1958 was well received and he was co-author of *Soil biology* (1967). He was elected president of the British Mycological Society in 1962, and played a substantial role in the International Biological Programme, as Chairman of the British P.T. (Terrestrial Productivity) section, and a member of the British national I.B.P. Committee. He was President of the British Ecological Society in 1960, and had been General Secretary of the Australian and New Zealand Association for the Advancement of Science. It was in retrospect not surprising (although at the time it came as a shock) when he came into my office one day in 1964, shortly after I had been appointed to the second chair of Botany at Liverpool, to tell me that he had been made acting Vice-chancellor and was leaving the Department in my hands. I saw little of him in the Department after that, except socially, as he then became Pro-Vice-Chancellor at Liverpool 1965–66 and was subsequently appointed the first Vice-chancellor of the New University of Ulster, Coleraine, in 1966, a post he held until his retirement in 1976. Planning and setting up the new university was an enormous challenge but one that Alan Burges relished. His remarkable success in getting the complex series of operations off the ground, often in difficult circumstances, so that the university opened to students in 1968, has perhaps not been widely enough acknowledged. The renewal of civil unrest in Northern Ireland not only added to the difficulties but tended to draw attention away from his achievement. I visited him several times during this period and he took great delight in showing off the latest buildings and developments. At meetings of the Flora Europaea editorial committee held in Coleraine one would meet senior politicians and other local notables.

Alan Burges' skills as a moderator and his ability to get people to work together led to his appointment as Chairman of various government committees, notably the Northern Ireland Advisory Council for Education which published reports on primary and secondary education in the province. He was also Chairman of the Board of the Ulster American Folk Park near Omagh from 1975 until 1988.

In his retirement he maintained his interests in Northern Ireland affairs and for a period was chair of the Northern Ireland National Trust Committee, of the Northern Ireland American Bicentennial Committee, and of the Scots Irish Trust. He was a Fellow of the Australian & New Zealand Association for the Advancement of Science and Council member of the World Innovation Foundation. He was appointed C.B.E. 1980 and received various honorary doctorates.

He married Evelyn Moulton in 1940, by whom he had three daughters; she was a great source of support to him in all his activities. After retiring, they remained in Northern Ireland, living near Coleraine until 1991. They bought a small house in Spain and spent periods there each year. He continued to maintain a great interest in Flora Europaea and attended nearly all the Editorial meetings. He was concerned about the future of the project and wrote to me expressing his worries and several times came over to visit me in Reading for discussions. He fully approved of the decision not to continue the conventional revision of the first edition and supported the aim of developing an electronic database and information system which became a reality in the Euro+Med PlantBase project; and he was present at the meeting held in one of the basement rooms of the Linnean Society when it was decided to disband the Editorial Committee and establish a Flora Europaea Residuary Body.

Alan Burges died in Shaftesbury, Dorset on 4 October 2002 at the age of 91.

VERNON HEYWOOD

ENID MARY HYDE

(1925–2002)

Enid Hyde, who died on 5 September 2002, was a keen botanist, serving as county recorder for Suffolk with Francis Simpson from 1986 to 1995.

She was born in Birmingham on 18th June 1925 to a radical family. Her father was president of the National Union of Teachers; mother taught classes in the poorer areas of Birmingham. Mother came from Worcester and it was from her that Enid was initiated into a love and appreciation of flowers.

She went to King Edward's High School in Birmingham, where she was an outstanding scholar. She was offered, after her sixth form career, places at both Newnham College, Cambridge and Lady Margaret Hall, Oxford. In choosing the latter, she said it was because it had a better rail connection than Cambridge. At school she had also been outstanding at sport, captaining the school team at rounders and hockey.

At Oxford, she read modern languages (German and French) and took up bell ringing. After this she worked on the Control Commission in Berlin as an officer in naval intelligence. It was a very stressful time. In 1948, she was flown out in the "Berlin Airlift" in a dilapidated Dakota. She was no sooner back home than she applied for a teaching job in Switzerland. For two years she lived in the hills above Montreux. Her love of alpine flowers began here.

A stay in England was followed by marriage and life in rural Quebec where in isolation and in an extreme climate, she again encountered flowers. Her son Mark was born there and brought up in a log cabin, devoid of water and electricity. What did that matter when there were *Trillium*?

She returned to England in 1958 and, with her husband Jim, settled in Woolverstone by the Orwell estuary in Suffolk. For a while in the exciting world of the Suffolk flora, there was regular botanising, but it was not until 1971 that she began systematic recording. For the next 30 years, on every possible occasion, she was recording plants. From Shotley to Burgh Castle to Newmarket, not much of Suffolk got missed. With her son Mark, (also a keen botanist, now living in Zimbabwe), with Francis Simpson or with Jim, she always had her notebook.

As a consequence came her herbarium, her annual plant list for Suffolk Naturalists' Society, her contributions to the Ipswich and District Naturalists Society and to leading the botanical trips of many other local societies.

Her greatest contribution to Suffolk botany was the enormous amount of work she put into getting *Simpson's Flora of Suffolk* (1982) finished and published. The project had languished for over 20 years with little hope of publication; Enid, with her son Mark brought the recording up-to-date. Her patient and meticulous approach to the work was in contrast to Simpson's (by his own admission) abrupt and cantankerous manner and this was of great help in getting the manuscript completed. It is typical of her modest attitude that her name is not on the cover. During her time as Recorder she established a network of volunteer contributors with whom she corresponded regularly. She was very careful to acknowledge all records sent in and spent a lot of time identifying specimens for others. She co-ordinated work in Suffolk for the B.S.B.I. Monitoring Scheme (1987-88) and spent many hours compiling data for the Scarce Plants Project, including much research in old literature and herbarium sources.

Her own recording was, of course, exemplary and you could be absolutely confident that all her records were accurate and properly documented. She passed on to me a brilliantly maintained archive of Suffolk records when she retired as Recorder in 1995.

Although her own publications were few (outside of annual reports) she did publish papers (in *Suffolk Natural History*) on the inland spread of maritime species, Calamints, *Oenanthe pimpinelloides* (which she had discovered in 1975 at a site near Ipswich) and Mistletoe. Her study of languages and teaching experience had provided her with excellent grammatical skills and these were put to good use in editing and proof reading many of the publications of the Suffolk Naturalists' Society. The Society recognised her contributions by electing her as a Rivis Vice-President in 1995.

She was very keen on the conservation of the Suffolk countryside and looked after a local protected roadside verge which harboured a colony of Orpine, *Sedum telephium* (illustrated in Simpson's Flora). I can remember her consternation when she discovered the plants were being consumed by the larvae of a scarce micro-moth!

As her herbarium shows, she was acquainted with the alpenes of Austria, Italy, Switzerland and the Pyrenees. She collected in Spain where she botanised on much of the coastal areas from the French frontier to Andalucia – and Corfu. She also collected vouchers for many of her Suffolk records and of many unusual aliens. The collection has been passed to Cambridge University where it will be accessible for public and academic study - I am sure she would have been particularly pleased to know that her herbarium was being well curated and used.

Her last holiday was in the Valais of Switzerland. In the Val d'Hérens, at 1500 m in the mayan of a Swiss friend who, knowing her interest in flowers, had delayed the hay making, she was deliriously happy.

The funeral and burial in the pretty churchyard alongside Woolverstone Hall (where she had taught for many years) was attended by family and friends. Amongst the straight, dark yews I spied a sprig of the cut-leaved bramble *Rubus laciniatus*, a plant Enid would have appreciated.

My thanks to Jim and Mark Hyde for providing much of the material in this account.

M. N. SANFORD

INSTRUCTIONS TO CONTRIBUTORS

Scope: Authors are invited to submit Papers and Notes concerning British and Irish vascular plants, their taxonomy, biosystematics, ecology, distribution and conservation, as well as topics of a more general or historical nature. Authors should consult the Hon. Receiving Editor for advice on suitability or any other matter relating to submission of manuscripts.

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