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Presidential Address, 1996

DAVID PEARMAN

TOWARDS A NEW DEFINITION OF RARE AND SCARCE PLANTS

This address will review progress in recording over the last 40 years, with particular reference to Rare (found in not more than 15 10-km squares) and Scarce Plants (found in 16–100 10-km squares), and will suggest that the old definitions for these categories, whilst they might have been perfectly adequate at the time, are no longer the best we can do. They should be replaced by more precise measures of distribution and to that end I will examine the merits of tetrads (2 × 2 km squares) and 1-km squares, touch on sites and populations, and suggest what I think is the best of the alternatives.

As you all know recording by 10-km squares really took off with the *Atlas of the British Flora* (Perring & Walters 1962), for which fieldwork began in the early 1950s. Before this, maps showing distribution by vice-counties had been used, but it was the invention of the National Grid, and its general appearance on maps after the Second World War that gave the necessary impetus.

The first attempt to cover "Rare Plants" in Britain appeared in 1977 (Perring & Farrell 1977, 2nd ed. 1983), using the quite arbitrary (but perfectly acceptable in terms of a percentage of our native flora) definition of Rare as being in 15 10-km squares or fewer. Since then, the then Nature Conservancy Council (NCC) enshrined this definition in its Sites of Special Scientific Interest guidelines (Nature Conservancy Council 1989), and that for the less rare, now called Scarce, as being in 16–100 10-km squares. This last was equally arbitrary but, again, logical in that it covered another 20% of the native plants, and 100 squares is a nice round figure, and so on.

It is now 1996; 10-km grid squares and recording have been around for 40 years. The 1962 *Atlas* has spawned a mass of county Floras on a 2 × 2 km square and 5 × 5 km square basis, and a few area Floras have used 1 × 1 km squares. A mass of more detailed information is now available – on a 2 × 2 km (tetrad), 1 × 1 km (4 figure grid reference) and even, dare I say, on a site basis (6 figure grid reference), yet we continue to display, categorise and judge Britain's Rare and Scarce plants on the coarse basis of 10 × 10 km squares. On the other hand this is the appropriate approach for an overall view of our whole flora, as in our own new *Atlas 2000*. Here we need coverage, for the whole of the British Isles, of over 3000 species. We also need to know which may be increasing or declining, because even after the Scarce Species project we still have no idea what is happening to species that may be declining but which fell beyond its parameters. The Monitoring Scheme (Rich & Woodruff 1990), undertaken during 1987–8, has offered plenty of thoughts here. Also, since BSBI's pioneering 1962 *Atlas* many other groups, from birds to woodlice, have been covered at the 10-km range and thus we need a modern 10-km square Atlas as a baseline. But I am not remotely content to rest the *Red data book* and *Scarce plants* on this basis and I wish to expand on this.

The *Scarce plants atlas* (Stewart *et al.* 1994) covered 325 species. With not too much effort (mainly trying to ensure that the grid references would be fine enough where we had site details) a further 73 maps were produced showing the number of tetrads in which particular species were recorded within each 10-km square. Of course there are anomalies and imperfections here, in that:–

- some upland species may not be well enough recorded (but I think it probably works now for England and much of Wales and lowland Scotland);
- a tetrad may contain many records or just one;
- only numerals up to 9 (out of 25 in each 10-km square) fit elegantly on to a map. Extra numerals had to be shown by notes, although it would be possible to use more symbols;
- and, of course, as you will hear, the data we have are much less than adequate in terms of accurate grid references;

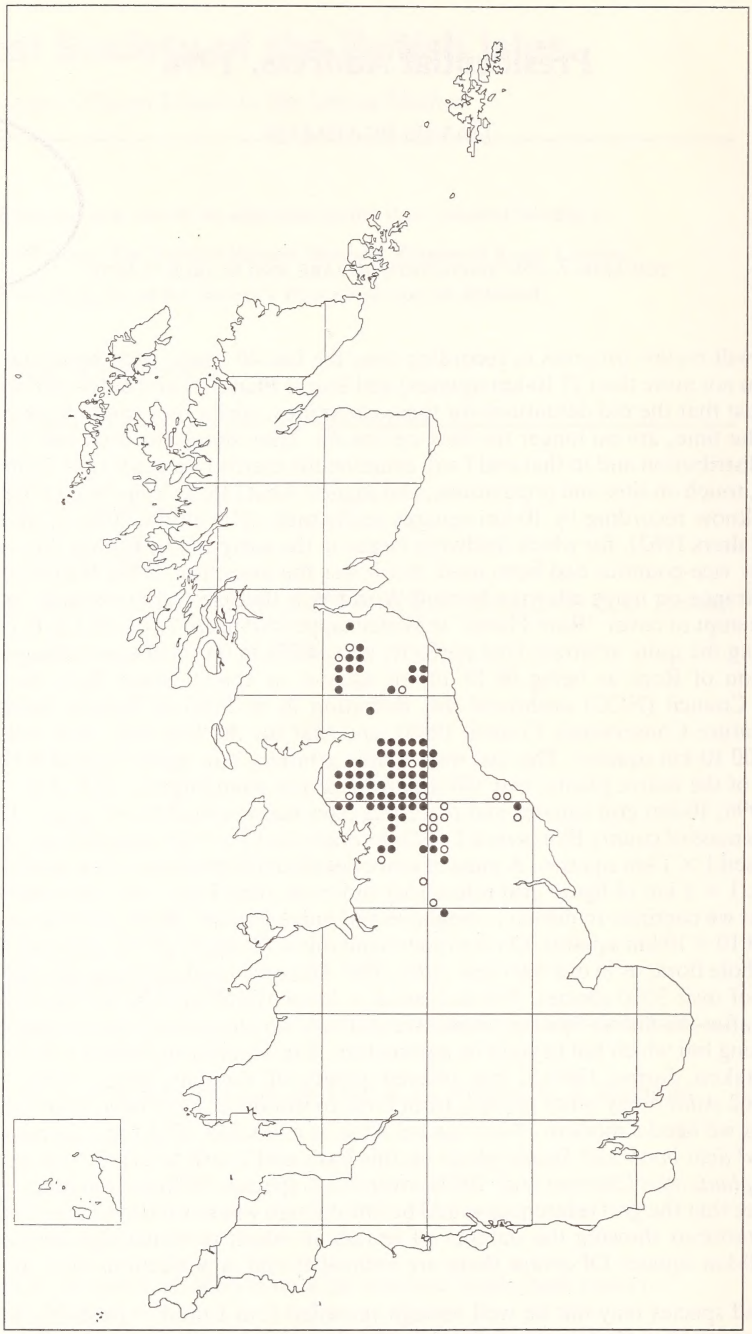
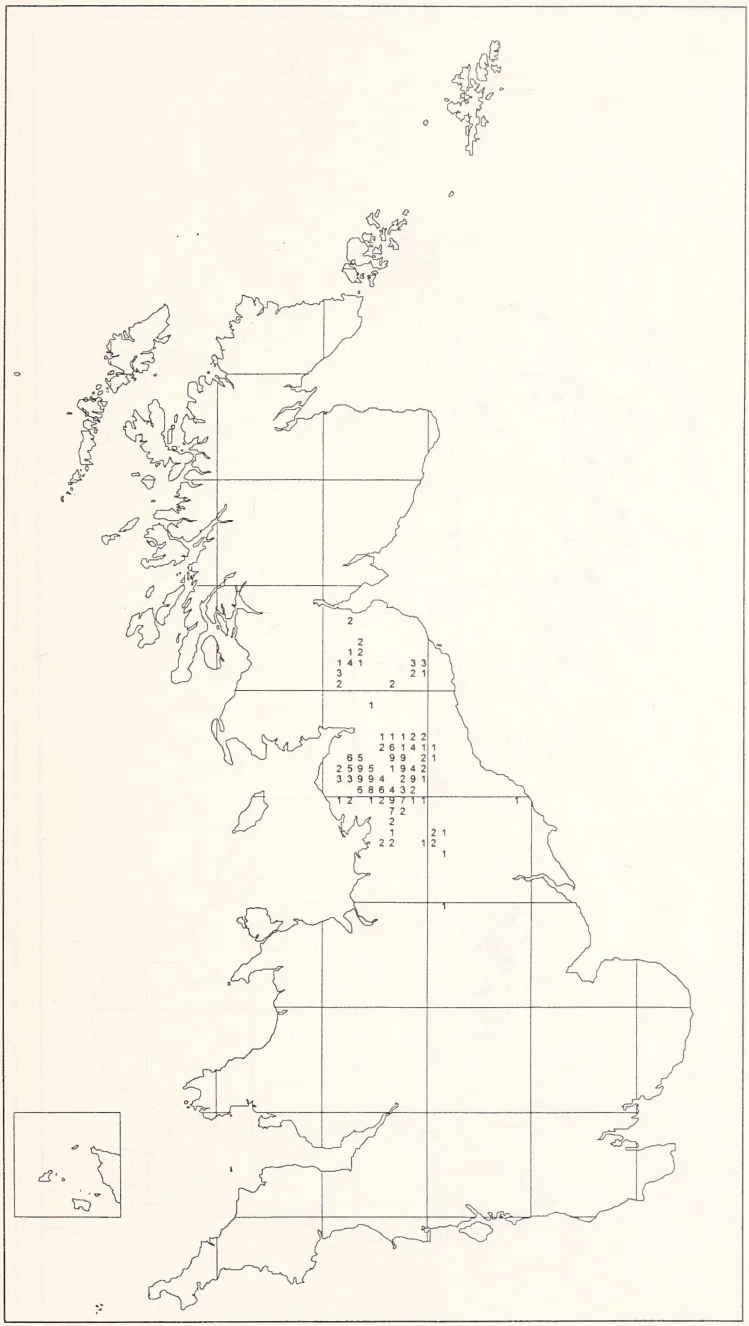


FIGURE 1. The distribution of *Myosotis stolonifera* in Britain at 10-km scale (left hand page) and tetrad distribution within 10-km squares (right hand page) (from Stewart, Pearman & Preston 1994).



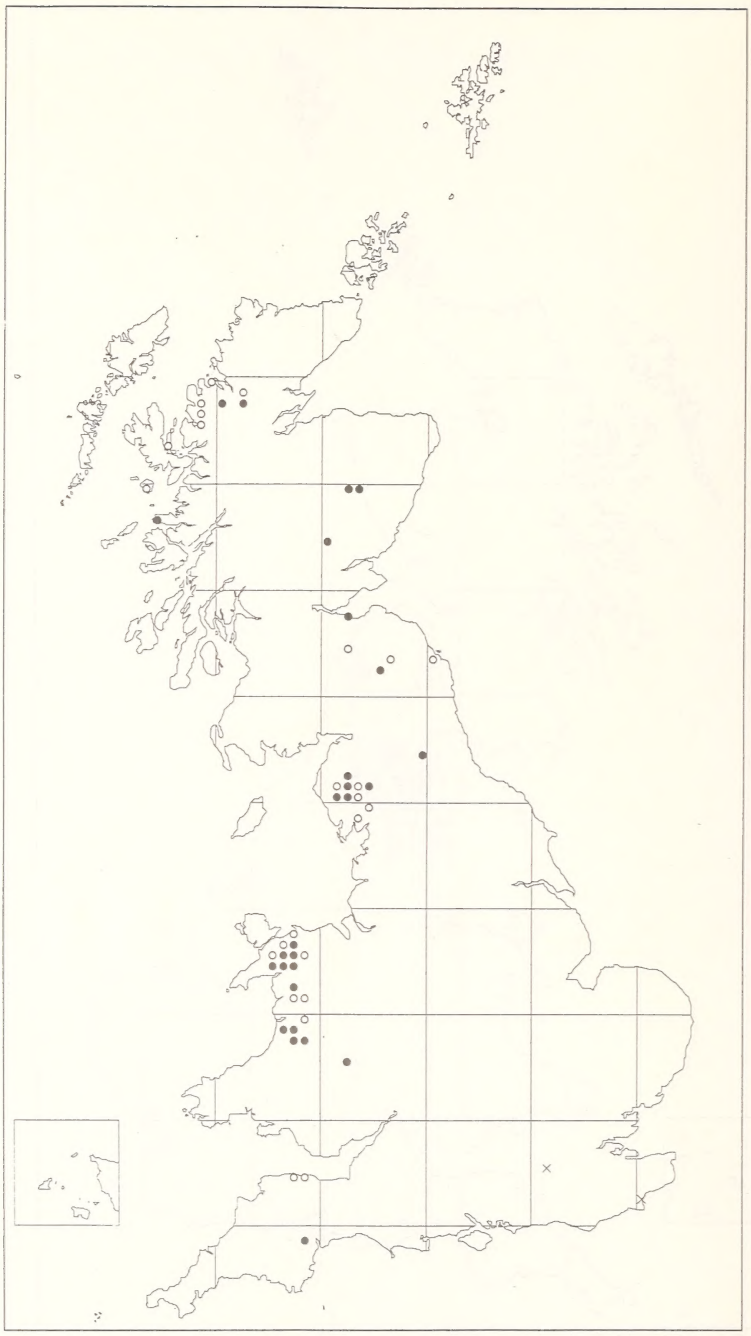
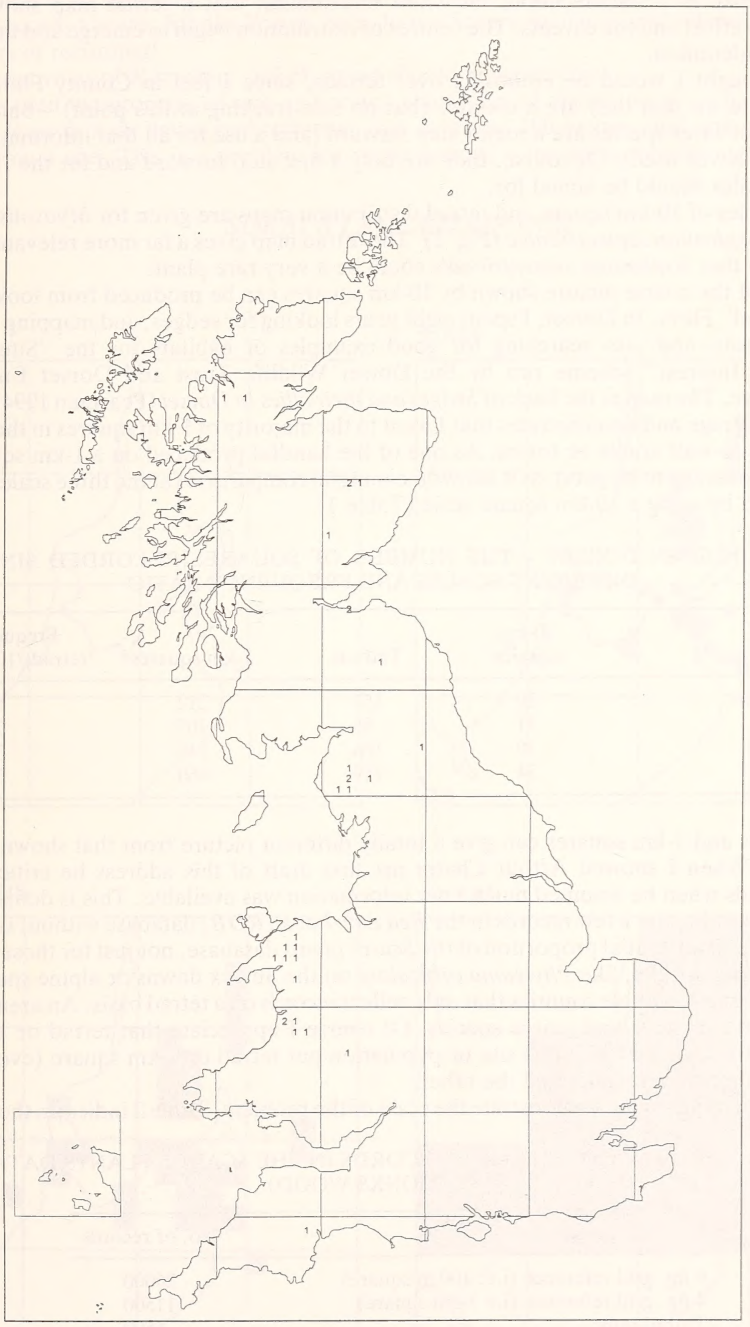


FIGURE 2. The distribution of *Asplenium septentrionale* in Britain at 10-km scale (left hand page) and tetrad distribution within 10-km squares (right hand page) (from Stewart, Pearman & Preston 1994).



but, as any map is a simplification, the extra information that a tetrad map shows definitely outweighs the effort and the caveats. The centres of distribution begin to emerge and the vulnerable areas can be identified.

I never thought I would be enthusing over tetrads, since I feel in County Flora terms and conservation terms that they are a disaster (but no side-tracking at this point) – but I think that tetrad maps for rarer species are a major step forward (and a use for all that information carefully gathered and never used). Of course, they are only a first step forward and for the rarest species much finer scales should be aimed for.

Two examples of 10-km square and tetrad distribution maps are given for *Myosotis stolonifera** (Fig. 1) and *Asplenium septentrionale* (Fig. 2). The tetrad map gives a far more relevant picture and it can be seen that *Asplenium septentrionale* could be a very rare plant.

Examples of the coarse picture shown by 10-km squares can be produced from looking at every County "tetrad" Flora. In Dorset, I spent eight years looking for sedges, and mapping them on a 1-km square basis, and also searching for good examples of habitats for the "Sites of Nature Conservation Interest" scheme run by the Dorset Wildlife Trust and Dorset Environmental Records Centre. The map at the back of *Sedges and their allies in Dorset* (Pearman 1994) shows the 1 km square coverage and demonstrates that I went to the majority of 1-km squares in the county that were not wall-to-wall arable or towns. As one of the handful produced on a 1-km square basis, I consider the coverage to be good, as it allows meaningful comparisons at the three scales, and shows what is hidden by using a 10-km square scale (Table 1).

TABLE 1. SEDGES IN DORSET – THE NUMBER OF SQUARES RECORDED SINCE 1980 AT DIFFERENT SCALES AND FREQUENCY RATIO

	10-km squares	Tetrads	1-km squares	Frequency ratio (tetrads/10-km squares)
Carex acutiformis	30	151	212	5·03
C. divulsa	31	86	107	2·77
C. riparia	30	106	149	3·53
C. remota	34	259	460	7·62

Thus tetrads and 1-km squares can give a totally different picture from that shown by a 10-km square atlas. When I showed Arthur Chater my first draft of this address he criticised me for choosing tetrads when he assumed much finer information was available. This is definitely not the case. There are still quite a few records in the *Red data book* (*RDB*) database without six figure grid references, and a substantial proportion of the *Scarce plants* database, not just for those species that might be common locally, like *Phyteuma orbiculare* on the Sussex downs or alpine species such as *Carex saxatilis*, but for whole counties that only collect records on a tetrad basis. An area of 2 × 2 km is far too coarse for rare and scarce species. Of course I appreciate that tetrad or 1-km square recording may be satisfied with one site or population per tetrad or 1-km square (even with a six figure grid reference) and ignore all the others.

Just out of interest, and to demonstrate the scale of the problem, Table 2 indicates the numbers of

TABLE 2. ACCURACY OF POST-1970 RECORDS IN THE SCARCE PLANTS DATABASE (BRC, MONKS WOOD)

Scale of recording	No. of records
6 fig. grid reference (i.e. 100 m square)	26000
4 fig. grid reference (i.e 1-km square)	11500
Tetrad only	5500
10-km square only	5500
Total	48500

* Nomenclature follows Stace (1991).

post-1970 records of different degrees of accuracy, held on the *Scarce plants* database at the Biological Records Centre, Monks Wood. 46% do not have a six figure grid reference, and this is after 40 years of recording!

The different roles of *Recording* and *Mapping* should be made clear.

Recording (and monitoring) of rare and scarce plants should always be on as fine a basis as is practical, at least to a six figure grid reference, i.e. to within 100 metres, and attempts should be made to define a site. This is a problem for many reasons – the spreading through rhizomes or

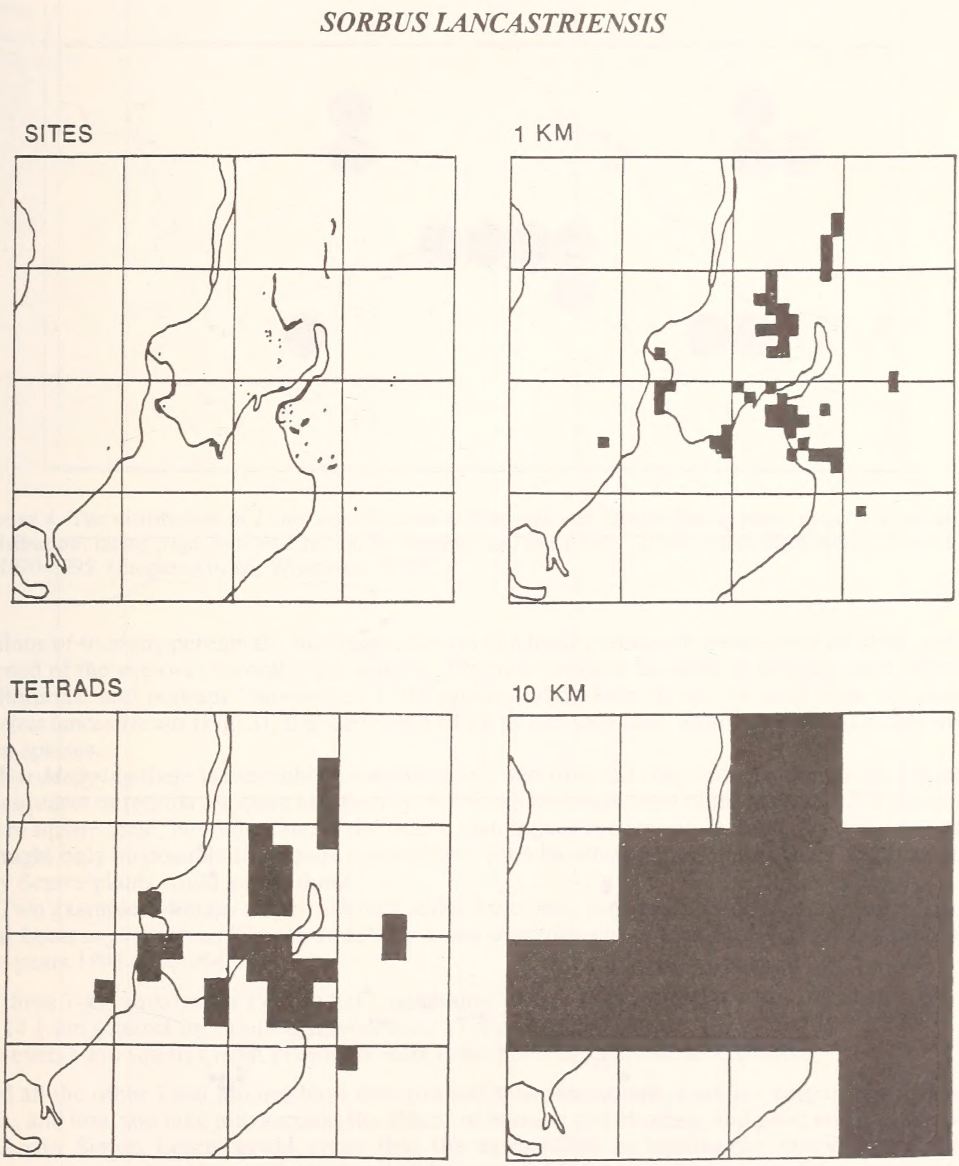
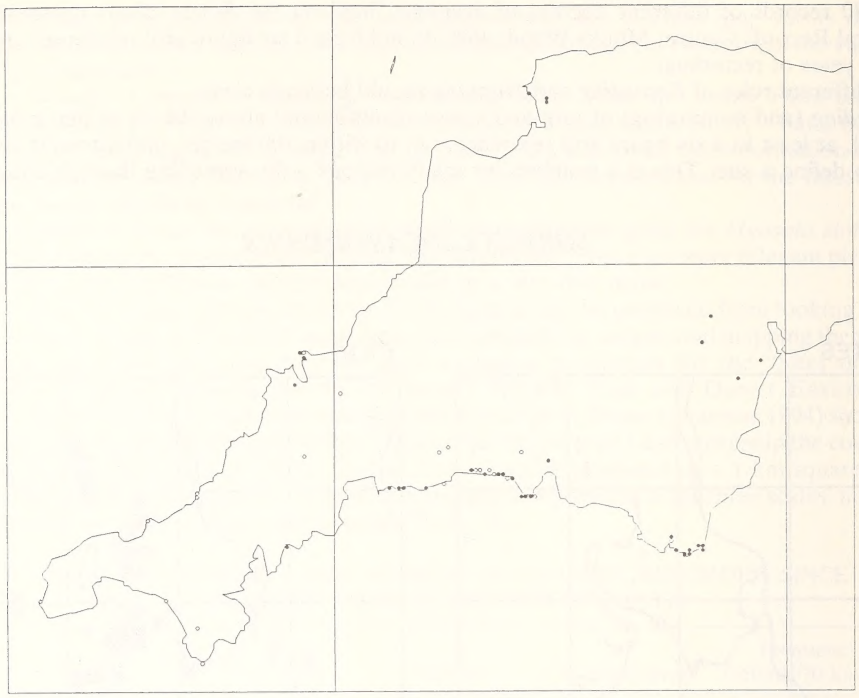
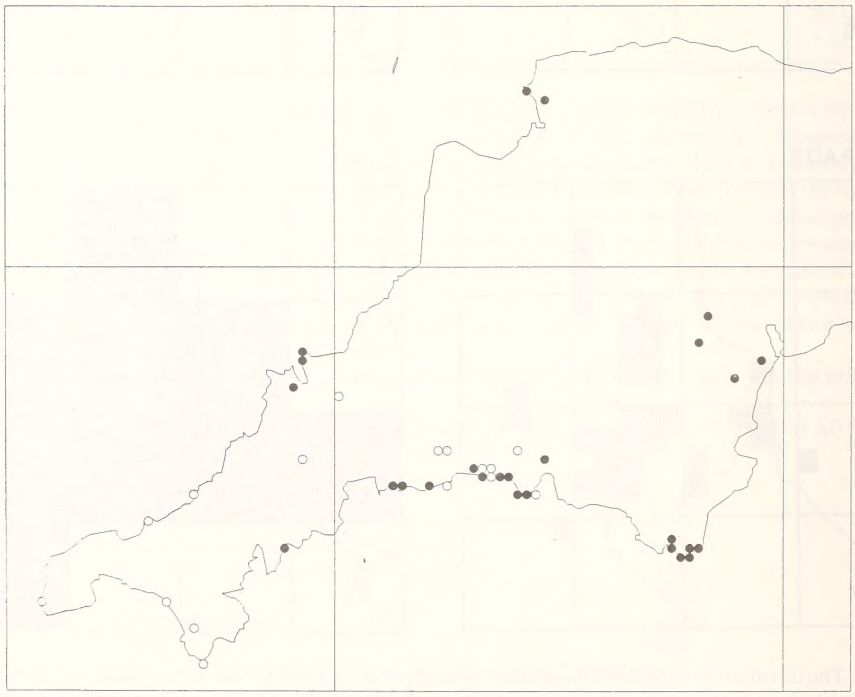


FIGURE 3. The distribution of *Sorbus lancastrienis* in Lancashire: upper left – site distribution; upper right – 1-km square distribution; bottom left – tetrad distribution; and bottom right – 10-km square distribution (prepared by T. C. G. Rich).





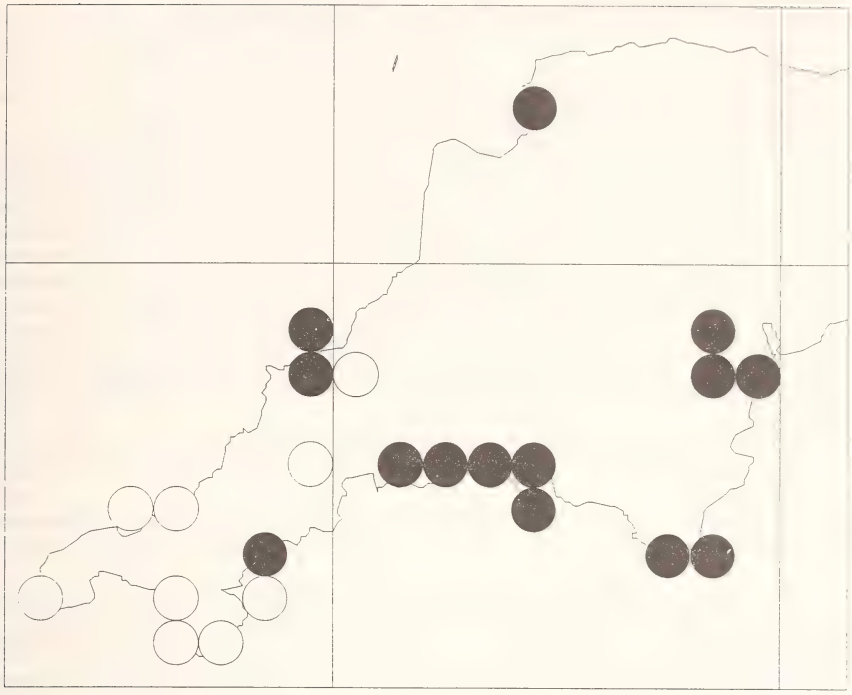


FIGURE 4. The distribution of *Lotus angustissimus* in Cornwall and Devon: facing page, upper – 1-km square distribution; facing page, bottom – tetrad distribution; and this page – 10-km square distribution. ○ pre-1970; ● 1970–1995. (Prepared by M. Wigginton, JNCC.)

stolons of so many perennials, the fragmentation of a locally common species over an area, and the spread of the site over several 1-km squares. Progress needs to be made in settling some arbitrary definitions, and perhaps "moveable" 1-km squares might help. It can be seen from the map of *Sorbus lancastriensis* (Fig. 3), that defining a site is not an easy task, although perhaps easier with a tree species.

For *Mapping* there is inevitably a simplification, and from the map of *S. lancastriensis*, I think 1-km squares or tetrads are quite satisfactory. It is feasible to map most of the current *RDB* plants at a 1-km square scale, but only some of the Scarce plants given the caveats in Table 2. At the site scale, it might only be possible to prepare maps of sites for a handful of *RDB* plants and I doubt whether any Scarce plants could yet be done.

Two examples of maps at the different scales have been prepared, *Sorbus lancastriensis* (Fig. 3) and *Lotus angustissimus* (Fig. 4). In fact for *Lotus angustissimus* one might go further and say that in the years 1993 and 1994:

- three 1-km squares for Pentire have seven sites and 200–300 plants;
- 14 1-km squares for South Cornwall have 15 sites and 600 plants;
- seven 1-km squares from Prawle to Start Point have 13 sites and 6500 plants;

and all the other 1-km squares have few sites and tiny populations. I am not certain how you map this, and how you take into account the effects of burning and clearing, and good and bad seasons.

Again Simon Leach would argue that the extra effort in looking for every site of *Lotus angustissimus* has put it over the national 10-km square *RDB* threshold, and possibly over what I am going to suggest as my tetrad threshold too, although it depends on which cut-off date you use! A difficult problem, but as I shall say later, one that we are close (well, fairly close) to overcoming.

These two sets of maps (Figs 3 & 4) show a valuable picture and I hope my successor in 2000 will

be standing here similarly demonstrating that *Asplenium septentrionale* really is restricted to only 40 sites in 'x' 1-km squares and 'y' 2-km squares whereas, say, *Carex rariflora*, little known to many of us, but an absolute gem to the aficionado, is wall-to-wall in the east Grampian mountains with huge sites with many thousands of plants over its restricted area. For the moment, then, tetrad maps are as fine as it is possible to go to obtain a meaningful comparison between species.

Chris Preston and the Biological Records Centre have kindly produced tetrad totals for all the Scarce species, and Martin Wigginton has done the same for all the *RDB* species. Although the details are available I have restricted the tables to only the rarest scarce and the commonest *RDB* species. All figures have been adjusted to post-1970 records and figures, and only the lowest tetrad numbers for Scarce species, and the highest numbers for *RDB* species are shown. Those from the *RDB* are inevitably slightly better recorded and the commoner Scarce species may not have been so conscientiously recorded. But the point I am trying to make is that the tetrads must be a more effective way of defining a rare plant, and the order of frequency is substantially different from that shown on a 10-km square sequence. The table of Scarce species found in low numbers of tetrads (Table 3) shows that many really are infrequent in each 10-km square, with frequency ratios ranging from 1·20 to 2·50.

On the other hand the table of Scarce species found in high numbers of tetrads (Table 4) demonstrates that some species that are found in low numbers of 10-km squares are much more frequent in tetrad terms.

In comparison, however, when one converts *RDB* species into tetrads rather than 10-km squares (Table 5) it will be seen that quite a few are more common than many of the so-called 'Scarce' species.

It is relevant at this stage to consider the 73 Scarce species which were also mapped as tetrads (Fig. 5). Some species have been omitted in the lower left section of the graph for clarity only. I have looked at the effect of under-recording, or not fine enough recording, on all species in the tables and this graph, and adjusted where I can. I do not think that lack of tetrad recording in upland areas will do other than slightly blur the picture, because these are better-recorded species.

At this point one could bring together the strands illustrated to date, and say:

- a small number of 10-km squares but high tetrad numbers indicates a local or restricted distribution, but not uncommon where it occurs, e.g. *Carex humilis* found in 28 10-km squares and 124 tetrads; whereas
- a small number of 10-km squares, but low tetrad numbers indicates scattered, possibly widespread even, but now with isolated sites and populations, e.g. *Asplenium septentrionale* and *Vulpia unilateralis*. These are the vulnerable species that we should be really concerned about.

Potentially interesting are those in quite a few 10-km squares, but with low tetrad numbers that one might not have thought of as vulnerable, e.g. *Silene gallica*, *Thelypteris palustris* and *Pilularia globulifera*.

There has been much work done, particularly in the bird world, on these ratios of tetrads to 10-km squares, and the resulting ratio has been usefully called a "frequency index".

Le Duc, Hill & Sparkes (1992) use this concept and the *New atlas of breeding birds in Britain and Ireland* (Gibbons *et al.* 1993) makes great use of "frequency" maps (p. 457 et seq.). The "frequency index" could be a valuable conservation tool, provided, of course, that the basic data are correct, or even that the basic data are available! I asked David Gibbons, one of the joint editors of the Bird Atlas, as to whether they had used low frequency ratios as a conservation tool. He replied that there was no need to, as they had population counts of all the rare and important species – totally different from the botanical experience. But for the common species, we can already use Monitoring Scheme data to plot similar maps and hope to use this technique in the new Atlas 2000.

I do not know whether it is relevant that for these 73 Scarce Species (Fig. 5), the average number of tetrads per 10-km square was 2·2 – i.e. there were records from only 2·2 out of a possible 25 tetrads for these species. I repeated the exercise for the 30 most common (in tetrad terms) of the *RDB* species, and found, to my surprise, that the average was 2·16. When all the Scarce species were included the average was 1·95, but all the caveats about locally common, coastal and upland species need to be taken into account.

TABLE 3. "SCARCE" SPECIES FOUND IN LOW NUMBERS OF TETRADS – 1970 ONWARDS TOTALS

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)	Comments
Corynephorus canescens	17	12	1·41	
Veronica spicata	20	16	1·25	
Carex vulpina	22	12	1·83	
Luzula arcuata	22	12	1·83	
Calamagrostis stricta	22	15	1·46	
Galium pumilum	23	19	1·21	
Cyperus longus	23	20	1·15	Picture confused by planting
Vulpia unilateralis	24	20	1·20	
Cystopteris montana	25	15	1·67	
Melampyrum sylvaticum	26	21	1·23	
Alchemilla glomerulans	27	24	1·12	Certainly under-recorded
Pulsatilla vulgaris	28	19	1·47	
Galium parisiense	29	19	1·53	
Mentha pulegium	29	20	1·45	
Ribes alpinum	29	20	1·45	
Lathyrus palustris	29	22	1·32	
Chenopodium chenopodiodes	30	12	2·50	Probably in at least 32 tetrads
Spiranthes romanzoffiana	30	18	1·66	
Phleum alpinum	30	21	1·43	
Circaea alpina	30	24	1·25	
Ophioglossum azoricum	31	24	1·25	Probably in >13 more 10-km squares and >15 tetrads
Asplenium septentrionale	31	27	1·15	
Najas flexilis	31	15	2·07	
Illecebrum verticillatum	32	16	2·00	
Elatine hydropiper	32	19	1·68	
Sagina saginoides	32	20	1·60	
Alopecurus borealis	32	24	1·33	
Crepis mollis	32	28	1·14	Probably in at least 43 tetrads giving ratio of 1·54
Carex appropinquata	32	21	1·52	
Marrubium vulgare	32	19	1·68	
Ranunculus tripatitus	33	19	1·73	
Juncus filiformis	33	20	1·65	
Atriplex longipes	34	27	1·26	
Daphne mezereum	34	24	1·41	
Ajuga chamaepitys	35	20	1·75	
Salix reticulata	35	17	2·06	
Allium schoenoprasum	36	17	2·12	Probably in at least 39 tetrads giving ratio of 2·29
Sorbus porrigentiformis	36	21	1·71	
Linum perenne	36	24	1·50	
Dianthus armeria	38	36	1·06	Probably in 33 tetrads, 31 10-km squares, giving ratio of 1·06
Silene conica	39	22	1·77	
Adiantum capillus-veneris	39	26	1·50	
Frankenia laevis	39	28	1·39	
Juncus biglumis	40	23	1·74	
Draba norvegica	40	24	1·67	
Polypogon monspeliensis	41	21	1·95	
Melampyrum cristatum	41	23	1·78	
Linnaea borealis	41	32	1·28	
Carex ericetorum	42	26	1·61	
Actaea spicata	42	22	1·91	

TABLE 3. (continued)

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)	Comments
Arabis glabra	42	31	1·35	15 tetrads are 1970–1979 only
Salix arbuscula	42	23	1·82	
Veronica alpina	42	28	1·50	
Juncus castaneus	43	24	1·79	
Sorbus devoniensis	43	24	1·79	
Helianthemum canum	44	17	2·59	
Carex maritima	44	41	1·07	Probably in at least 47 tetrads,' giving ratio of 1·15
Nuphar pumila	44	22	2·00	
Juncus balticus	44	39	1·13	
Juncus alpinus	45	28	1·61	
Trifolium occidentale	46	17	2·71	
Peucedanum palustre	46	22	2·10	
Minuartia sedoides	46	27	1·70	
Impatiens noli-tangere	47	16	2·94	
Cerastium arcticum	47	28	1·67	
Vicia bithynica	48	33	1·45	
Sonchus palustris	48	21	2·29	
Fallopia dumetorum	48	34	1·41	
Cerastium cerastioides	50	21	2·38	

TABLE 4. A SELECTION OF "SCARCE" SPECIES FOUND IN HIGH NUMBERS OF TETRADS AND LOW NUMBERS OF 10-KM SQUARES – 1970 ONWARDS TOTALS

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)
Cardamine bulbifera	81	19	4·26
Carex digitata	72	25	2·88
Carex humilis	124	28	4·43
Dryopteris submontana	85	27	3·15
Gentianella germanica	65	21	3·10
Orchis purpurea	57	20	2·85
Ornithogalum pyrenaicum	95	23	4·13
Primula elatior	92	27	3·41
Pulmonaria longifolia	83	20	4·15
Wolffia arrhiza	82	25	3·28

At this stage in 1996, I do not think there is sufficient information to draw conclusions from these ratios, but I really do believe it is a subject for future exploration. To me it seems extraordinary low. I would have thought we could acquire 1-km square data fairly easily for the rarer species, and then move to six figure grid references. But why are the figures so consistently low?

These figures might be put into context by looking at any County "tetrad" Flora to see what sort of frequencies one finds by including all plants. Perhaps Daisy and Dandelion and Nettle would tend towards the maximum of 25 and no doubt Jack Oliver from Wiltshire has done some work on this,

TABLE 5. *RED DATA BOOK* SPECIES FOUND IN HIGH NUMBERS OF TETRADS – 1970 ONWARDS TOTALS

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)
Fumaria occidentalis	84	27	3·11
Scrophularia scorodonia	77	29	2·66
Gastridium ventricosum	52	26	2·00
Erica ciliaris	49	15	3·27
Poa infirma	44	26	1·69
Genista pilosa	41	13	3·15
Ophrys sphegodes	36	14	2·57
Salvia pratensis	36	24	1·50
Cirsium tuberosum	35	14	2·50
Lotus angustissimus	35	25	1·40
Phleum phleoides	33	12	2·75
Potamogeton nodosus	33	11	3·00
Bunium bulbocastanum	32	12	2·67
Carex rariflora	32	15	2·13
Gentiana verna	30	4	7·50
Lithospermum purpurocaeruleum	30	15	2·00
Muscari neglectum	30	23	1·30
Silene otites	30	8	3·75
Carex ornithopoda	28	11	2·55
Cynodon dactylon	28	21	1·33
Bartsia alpina	26	13	2·00
Erica vagans	26	5	5·20
Euphrasia vigursii	26	15	1·73
Kobresia simpliciuscula	25	12	2·08
Orobanche purpurea	25	17	1·47
Physospermum cornubiense	25	9	2·78

FIGURE 5. The relationship between the frequency ratio (number of tetrads per 10-km square) and number of 10-km squares for Scarce Species. (Based on post-1970 records.)

but I would like to know what is the average. Because it is a small manageable suite I have produced a chart for Dorset Cyperaceae (Fig. 6), with the only caveat that no sedge is a really ubiquitous plant. The average frequency ratio here is 4·16 tetrads/10-km square. Interestingly enough, on a 1-km square: 10-km square basis the average only increases to 4·45. It would be useful to know if there was a predictable relationship between tetrads and 1-km square frequency ratios.

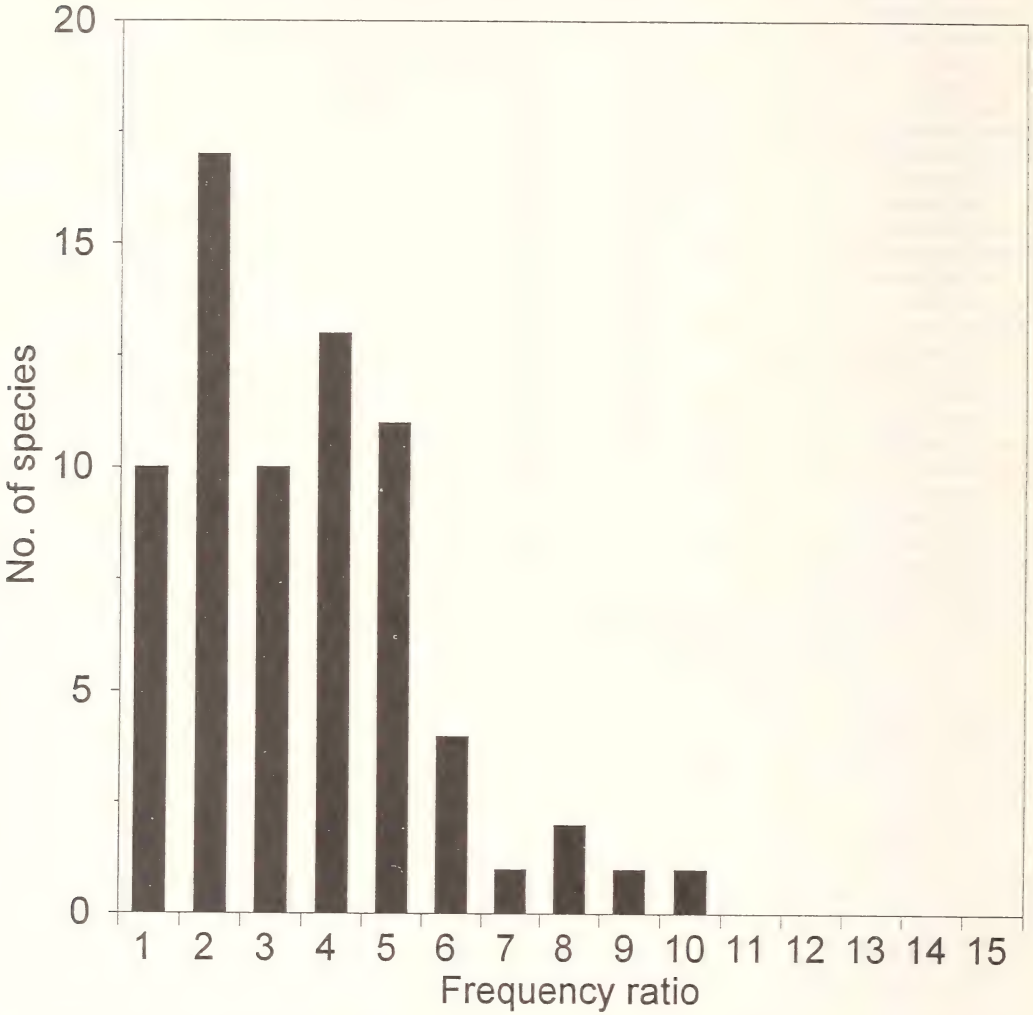


FIGURE 6. The number of species occurring in each band of the frequency ratios (tetrads per 10-km square) for Cyperaceae in Dorset.

Looking then at the tables (Tables 3, 4 & 5), there are some very interesting observations to be made. Many of the rarer Scarce species are really uncommon in areas they occur – a frequency ratio of under 1·5 – i.e. found in less than 1·5 tetrads (out of a possible 25) in each 10-km square, less than 6%. Most of the less rare *RDB* are much commoner – look at *Erica ciliaris, Potamogeton nodosus* and especially at *Gentiana verna*. Apart from the fact that it is very pretty and photogenic, why are we even considering putting conservation resources into this plant, which is six times more common where it occurs than *Asplenium septentrionale*? The further argument that they are both widespread

and frequent in Europe, is outside the scope of this address, but is something that JNCC, by adopting the new IUCN guidelines on *Red data book* plants, is beginning to address. I suppose cynics would quite fairly argue that "public appeal" must be brought into the equation, and that is why birds and dormice always win and *Gentiana verna* will always beat *Asplenium septentrionale*! But that is for the politicians in JNCC and the three country agencies, not for me!

Table 6 shows Scarce plants, which have been reliably recorded, that have the lowest frequency ratios. I would be very happy to use conservation resources on these species. *Cyperus longus* was on this list, but I have left it out as it is now much more common as a garden escape than a native. From personal experience they are locally rare, they are certainly scattered and they are more worthy in my mind of conservation effort than many *RDB* species. I appreciate that this begs another question. I am being simplistic in saying that 'x' species should be protected and 'y' species should not. The reality might be that all are protected in the parts of their range where they are most vulnerable or looked after in their core areas because they are core areas – another reason for acquiring more precise data. Some of these, particularly those lower in the list, may well be under-recorded, but again, there are some very interesting observations to be made about species

TABLE 6. "SCARCE" SPECIES WITH LOW FREQUENCY RATIOS – 1970 ONWARDS TOTALS (based on Stewart, Pearman & Preston 1994)

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)
Dianthus armeria	33	31	1·06
Festuca arenaria	55	52	1·06
Juncus balticus	44	39	1·13
Asplenium septentrionale	31	27	1·15
Carex maritima	47	41	1·15
Corallorrhiza trifida	76	65	1·17
Vulpia unilateralis	24	20	1·20
Galium pumilum	23	19	1·21
Centaurea cyanus	156	127	1·23
Melampyrum sylvaticum	26	21	1·23
Ophioglossum azoricum	46	37	1·24
Circaea alpina	30	24	1·25
Veronica spicata	20	16	1·25
Atriplex longipes	34	27	1·26
Linnaea borealis	41	32	1·28
Zostera marina	99	77	1·28
Deschampsia setacea	71	55	1·29
Equisetum pratense	117	89	1·31
Pyrola media	111	85	1·31
Arabis glabra	41	31	1·32
Lathyrus palustris	29	22	1·32
Alopecurus borealis	32	24	1·33
Limosella aquatica	73	55	1·33
Orobanche rapum-genistae	129	97	1·33
Ulmus plotii	44	33	1·33
Hammarbya paludosa	127	95	1·34
Lycopodium annotinum	105	78	1·34
Pyrola rotundifolia (all)	91	68	1·34
Dianthus deltoides	104	77	1·35
Thelypteris palustris	115	85	1·35
Mertensia maritima	136	100	1·36
Sorbus rupicola	76	56	1·36
Isoetes echinospora	108	79	1·37
Torilis arvensis	112	82	1·37
Scandix pecten-veneris	182	131	1·39
Silene gallica	82	57	1·43

seemingly widespread but apparently at very low frequency. I will return at the end to suggest how we might use this frequency ratio in conservation terms.

I am going to commit a major crime at this stage, and change the subject, before coming back for a final assault. The reason for this is that the more I delved into the *Scarce plants* database, the more avenues I found that could be explored using this discrete set of data, and it seemed a shame to miss this opportunity to share them with you.

One avenue I explored came from a table in *Scarce plants in Britain* (Stewart *et al.* 1994, Table 3) which listed the totals of Scarce plants that have ever been found in each vice-county, and compared them with the numbers recorded for that project, i.e. after 1970. I found it difficult to assimilate 112 vice-counties, and I thought it would be useful to interpose a third date, 1930, as that was the date for current records in the 1962 *Atlas of the British Flora* (Perring & Walters 1962). I have grouped the vice-counties into regions (the same as used by the Ecological Flora database in York), and shown the losses up to 1930, between 1930 and 1970, and after 1970 (Table 7). I have then shown them as a percentage of species lost, and alternatively, as a variation from the norm, because that shows the regional differences much better. There are, at least, a couple of caveats, as I have shown, but I think the figures are very interesting. In this case we are talking about an *absolute* loss of species in the *entire* vice-county, so, although the picture is perforce crude, it shows that we have lost almost a third of all the individual Scarce Species recorded in each of the vice-counties. The date classes allow you to see whether the losses have occurred recently or before 1930 and the variations from the norms show when was the worst in each region. More work could be done by looking at all the species listed by County Floras as becoming extinct – most Floras, even perfunctory tetrad Floras, contain at least this sop to the past.

This leads neatly on to the second part of my address; should we redefine 1–15 10-km squares and 16–100 10-km squares for the *RDB* and Scarce categories, in the light of 40 years of recording? I believe we should, and there are several ways of doing so.

Firstly, there is the concern of under-recording; Simon Leach elegantly expressed his concerns in a note in *BSBI news* last year (Leach 1995) where he said that greater recording effort only meant that Scarce Species were found in more squares, occasionally leading to tipping over the 100 10-km square barrier into being "not Scarce"!

Tim Rich in his Monitoring Scheme report (Rich & Woodruff 1990), estimated that the 1962 *Atlas* possibly under-recorded by a factor of 50%. Certainly, in preparing the *Scarce plants atlas*, we felt really concerned about species that showed a decline between 1962 and 1992, despite all the extra recording. I must say at this point that I have grave reservations about using statistics to extrapolate the distribution of rare plants, which often occur in restricted niches or have a very uneven distribution in the country as a whole. Tim Rich, using Monitoring Scheme data, has attempted to do this. Although my statistical knowledge was rudimentary, and a long time ago, and my admiration for him as being one of the few original thinkers on plant distribution knows no bounds, I think he is mistaken on this point. The Monitoring Scheme is excellent for evenly distributed and/or common plants, and is increasingly used nationally for work on these, but I do not think it can be used for Scarce and *RDB* plants or those with an uneven distribution.

Secondly, there is the concern that 10-km square recording fails to show historical losses. Information on this is very rare indeed. Because of the late arrival of the National Grid, and because intensive recording only started in the 1960s, we have few or no baselines with which to compare.

One of the only exceptions to this is again in Dorset, where the late Prof. Good recorded species from 7500 stands of vegetation in the 1930s. He marked these stands on a set of six inch Ordnance Survey maps, which made it possible to add the later National Grid. Andy Byfield and I thus were able to revisit more than 400 of his heathland sites, where he had recorded 41 heathland plants, which we chose because of their interest to an informed botanist looking at heaths. They included 18 Scarce plants and four *RDB* plants, so fitted nicely into my other work.

I doubt if Good went to all his sites on a random basis, but that he gravitated to the better sites, and he was actually looking at representative examples of habitats rather than all possible sites of particular species. For example, he looked at over 1000 heathland sites, including 30 on Hartland Moor alone, but still would not have looked everywhere.

The full results are at last being published (see Byfield & Pearman, 1994 for preliminary findings), but I use *Lycopodiella inundata* as an example here just to show how limited is 10-km square data. His data and our researches since are summarised in Table 8. This shows that an atlas produced in

TABLE 7. LOSS OF SCARCE SPECIES PER GROUPS OF VICE-COUNTIES (I.E. SUM OF TOTALS OF SPECIES PER V.C.)

Area	V.c. numbers	All records	Loss up to 1930	Records 1930+	Loss 1930–1970	Records 1970+	Loss ever
SW	1–6,9–11	741	81	660	103	557	184
SE	13–21	772	114	658	155	503	269
SC	7–8,12,22–24,30,32–34,36–38	786	145	641	164	477	309
E	25–29,31,53–54,61	671	112	559	109	450	221
NC	39–40,55–58	284	74	210	64	146	138
S. Wales	35,41–46	338	34	304	66	238	100
N. Wales	47–52	295	47	248	46	202	93
NW	59–60,69–71	302	51	251	53	198	104
NE	62–67	384	87	297	83	214	170
S. Scotland	68,72–85	436	115	321	61	260	176
E. Highlands	86–96	612	87	525	71	454	158
W. Highland	97–103	289	22	267	41	226	63
N. Scotland	104–112	417	20	397	72	325	92
	Totals	6327	989	5338	1088	4250	2077

		% Losses			Variation from norm		
Area	V.c. numbers	Up to 1930	1930–1970	1970+	Up to 1930	1930–1970	1970+
SW	1–6,9–11	10·9	13·9	24·8	+4·7	+3·3	+8·0
SE	13–21	14·8	20·0	34·8	+0·8	−2·8	−2·0
SC	7–8,12,22–24,30,32–34,36–38	18·5	20·8	39·3	−2·9	−3·6	−6·5
E	25–29,31,53–54,61	16·7	16·2	32·9	−1·1	+1·0	−0·1
NC	39–40,55–58	26·1	22·5	48·6	−10·5	−5·3	−15·8
S. Wales	35,41–46	10·1	19·5	29·6	+5·5	−2·3	+3·2
N. Wales	47–52	15·9	15·6	31·5	−0·3	+1·6	+1·3
NW	59–60,69–71	16·9	17·5	34·4	−1·3	−0·3	−1·6
NE	62–67	22·7	21·6	44·3	−7·1	−4·4	−11·5
S. Scotland	68,72–85	26·4	13·9	40·3	−10·8	+3·3	−7·5
E. Highland	86–96	14·3	11·5	25·8	+1·3	+5·7	+7·0
W. Highland	97–103	7·6	14·2	21·8	+8·0	+3·0	+11·0
N. Scotland	104–112	4·8	17·3	22·1	+10·8	−0·1	+10·7
	Average	15·6	17·2	32·8			

Notes
1. E.W. and N. Scotland very good even with poorer 1970+ recording;
2. Some of the pre-1930 figures might be skewed by poor early recording, etc.

TABLE 8. *LYCOPODIELLA INUNDATA* IN DORSET USING PROFESSOR GOOD'S DATA

	Good (1932–38)	B/P (1990–92)	Scarce (1970–92)	Now (1991–94)
No. of sites	48	6	28	20
No. of tetrads	34	5	26	25
No. of 10-km squares	10	3	10	6

1939 would have shown ten extant 10-km squares, and that the *Scarce Atlas* showed ten extant 10-km squares. But within that:

a. we only refound it in 3 out of 10 of *his* squares (we did not, of course, look as carefully for new sites as we did for old);
b. we only refound it in 6 out of 48 of *his* sites;
c. the scarce total of 10-km squares was the same, but the number of sites had declined from 48 to 28; and
d. the tetrad total still under-represented the known loss at site level (only down from 34 to 26).

There are at least three caveats:

a. I have not, of course, covered populations. It is possible (although not true in this case) that 99% of the Dorset population present in 1932–1938 is still present in 1994. I think, despite the difficulties, populations must be assessed. The broad bands that Dick David used for his *Carex* counts – A 1–20, B 21–100, C hundreds, D thousands are probably fine for most purposes;
b. some plants have better "mobility" than others. *Limosella* springs to mind. Again, I do not think this applies to *Lycopodiella*, but "mobility" must be borne in mind when considering plant trends; and
c. it is a long time ago! I have not mentioned this, but by using the 1970 baseline, which is probably the only practical one in a country of disparate habitats and spread of recorders – we are seriously out-of-date, and that there were another 15 years of agricultural improvement and heathland dereliction to go before any lessening of pressure on plant sites and populations.

So, in 1900, *L. inundata* was widespread and 10-km square mappings would have been adequate to show its decline. By the 1930s it had a very localised distribution in Britain, so it came into the category of localised species whose decline can be easily seen on a tetrad scale but scarcely on a 10-km scale. In addition the 10-km picture is inadequate because *L. inundata* has a localised distribution, but tends to be fairly common in areas it does occur in.

Many of us have felt that the national 10-km square picture, at least for the Scarce and Rare plants where we can prove it, increasingly represents a shroud – the dots are still there but the number of tetrads and populations inside each dot are diminishing. As I have said above, we have little or no comparative data. Good's Dorset data show this neatly, and, of course, I could do it for many other species from Dorset. Here the loss in the number of 10-km squares has barely started to show, years after a finer resolution would have shown the same. If other areas had similar data available for comparison then I am sure we would see the same pattern.

In September, 1995 JNCC adopted radically new guidelines for *RDB* plants based on IUCN criteria. These new guidelines are much stricter and more quantitative than the old and, I feel, are a major step forward in conservation terms. It is time-consuming to calculate and apply, but is exactly on the right lines. It will cover about 60% of the plants in the "old" *RDB* (Perring & Farrell, 1983) and will be an adjunct to what I am proposing as it will deal with only the most threatened plants.

To summarise my points then, I suppose there are three alternatives in defining *RDB* and Scarce plants:–

1. to accept that the 1962 *Atlas* considerably under-recorded and therefore double the Scarce Plant limit to 200 10-km squares;
2. to move to a tetrad basis so *RDB* species are those occurring in 1–50 tetrads and Scarce those in 51–250 tetrads; and
3. to decide, as did those who originally chose 1–15 10-km squares for *RDB* and 16–100 10-km squares for Scarce species, that the rarest 20% in tetrad terms of our 1500 native species are *RDB*, and the next 20% are Scarce. There is an interesting recent book on rarity (Gaston 1994) with many thoughts on this, which suggests 25%, but I feel that is academic at this stage.

This last alternative would have the extra advantages that individual species could not be reassessed without assessing all, and therefore there would be greater stability between resurveys, and perhaps a greater chance of catching declining species, as they are ranked in percentage terms.

There might of course be a political point here. Our excellent environmental masters might object to a fixed percentage of plants always being protected, always needing funding and blocking nice

new roads! However the day when rare plants are doing anything other than retreating is some way off and thus I feel a percentage figure is quite realistic at this stage.

I think that all these approaches – 10-km square, tetrad, 1-km square, site, post-1970, post-1987 etc., suffer from another drawback. They are numerical criteria based on a point in time. I am sure one needs a more subjective approach based on decline and threat, or a more objective approach based, say, on population size. But populations, as I have said earlier, are extremely difficult to count, and more difficult to map. The only readily available information now might be these frequency ratios that I mentioned earlier, which seem to me a relatively crude but valuable extra tool to go alongside and raw 10-km square or tetrad information. Something is needed to balance rarity with frequency, as in the two extreme examples I showed earlier of *Gentiana verna* and *Asplenium septentrionale* (Table 6).

The authors of the last edition of the *Red data book* (Perring & Farrell 1983) attempted something along these lines using "threat" categories, but it was much too subjective. We need a "rarity index" to express the fact that there is no need to worry about *G. verna* (unless they build a much bigger reservoir in Teesdale!!). Their *RDB* system awarded points for perceived threats, and to some extent the new IUCN guidelines do the same. I have made a first attempt at a new system, aimed primarily at Scarce Species, and those *RDB* species which are not covered by the new IUCN guidelines, falling into the Lower Risk (LR) category. I have dropped points used by Perring & Farrell (1983) for Attractiveness, Remoteness and Accessibility, since I do not perceive these to be threats today. I am totally convinced that today plants are lost almost entirely by ignorance and neglect; ignorance of their existence and neglect of their habitat. Apart from a handful of orchids and a couple of ferns I think that all references to threats of collecting should be routinely excised from any publication. I am also deeply sceptical about the success in protecting species in habitats protected by conservation agencies – note that I am saying species in their habitats rather than habitats. Our work in Dorset has shown little difference in protection whether the site is a NNR, a SSSI or has no protection, the species are still lost in large numbers (Table 9). The key to protection is management, management and management.

TABLE 9. MAINTENANCE OF PLANT SPECIES DIVERSITY ON PROTECTED AND UNPROTECTED HEATHLAND STANDS IN DORSET

	Number of indicator species recorded in 1991–1993 as % of indicator species recorded by Prof. Good (1931–1938)
SSSIs overall	57%
Reserves (NNR, RSPB, DWT)	50%
Other extant sites	35%
Destroyed sites – now Forestry	13%
now Agriculture	7%

My first attempt uses the frequency ratios I have been describing, and a figure for the rate of decline. To arrive at a figure for the decline, I have expressed post-1970 10-km squares as a percentage of post-1930 squares. I have had to use 10-km records as there are no historical figures of a finer resolution, but in time we should be able to improve on this. Thus *Corynephorus canescens* is found, post-1970, in 71% of the squares it was recorded in post-1930. *Ranunculus tripartitus*, on the other hand, is only found in 39% of its previous squares, and thus has declined more. I have then multiplied this percentage by the frequency ratios I have described earlier to give a Threat Index (Table 10). The lower the Threat Index figure, the greater the threat. I totally appreciate this is a first attempt, and that there is an element of rearranging the deckchairs in producing revised lists of rarity when the actual plants continue to vanish. But it is no use pretending that budget cuts do not exist, and whilst going for wider and more worthwhile goals we must improve the data we have available now.

I never thought I would be quite so keen on the division of NCC into country agencies, but we now have Chris Sydes in Scottish Natural Heritage and Andy Jones in Countryside Council for Wales actively trying to provide this information and who knows, English Nature might think about

TABLE 10. A NEW 'THREAT INDEX' FOR A SELECTION OF SPECIES

	1970+: 1930+ 10-km squares	%	Frequency Ratio	Index
Scarce				
Corynephorus canescens	12:17	71	1·41	100
Veronica spicata	16:17	94	1·25	118
Carex vulpina	12:21	57	1·83	104
Luzula arcuata	12:19	63	1·83	115
Galium pumilum	19:43	44	1·21	53
Chenopodium chenopodioides	12:23	52	2·50	130
Dianthus armeria	36:83	43	1·06	46
Asplenium septentrionale	27:35	77	1·15	89
Linum perenne	24:31	77	1·50	116
Cystopteris montana	15:18	83	1·67	139
Orchis ustulata	66:134	49	1·79	88
Pulsatilla vulgaris	19:40	48	1·47	70
Illecebrum verticillatum	16:19	84	2·00	168
Elatine hydropiper	19:21	90	1·68	152
Ranunculus tripartitus	19:48	39	1·73	68
Carex humilis	28:30	93	4·42	412
Commoner *RDB*				
Fumaria occidentalis	15:17	88	3·11	274
Gastridium ventricosum	25:41	61	2·00	122
Erica ciliaris	14:16	87	3·27	286
Genista pilosa	13:15	87	3·15	273
Ophrys sphegodes	15:26	57	2·57	148
Lotus angustissimus	24:34	71	1·40	99
Carex rariflora	17:17	100	2·13	213
Gentiana verna	4:6	67	7·50	500
Erica vagans	5:7	71	5·20	371

it before too long. If I was rewarded for every time I have been approached for information on *Gentianella anglica* in the past two years, I would be in the mountains in Turkey instead of here. Yes, it has declined in 10-km square totals, and yes it has retreated westwards, and yes it is an endemic (collect £200 and pass go) but 1994 surveys showed 3 million in the Isle of Wight and half a million in Dorset. We currently have no way of knowing if this is good or bad and whether resources should be put into this plant at the expense of others. Another favourite is *Dianthus armeria* (Table 11) which is suddenly on everybody's threat list. I am not certain why this is so, because I cannot trace careful investigative work on it. But for once somebody's hunch is right (Martin Wigginton says it is mine – but age dims memory and in fact I think it was Ro FitzGerald who suggested it to English Nature and me) and the figures are certainly dire – remember it had the lowest ratio in Table 9. But having gone so far, why haven't we up-to-date (post-1990) information, and as it is an easy matter to count an annual, why are there no population data?

I suspect that is another of my failings, that I'm a plodder, one who accumulates information, rather than somebody with vision (and poetic licence) who is sure *Dianthus armeria* or *Gentianella anglica*, and others are declining and need lots of Species Action plans. But these examples only

TABLE 11. RECORDS OF *DIANTHUS ARMERIA*

Recording scheme	Years	10-km squares	Tetrads	1-km squares	Sites
1962 *Atlas*	1930+	40			
Scarce plants atlas (adjusted)	1970+	31	33	33	34
	1970–79 only				10
	1980–89 only				14
	1990+				10

demonstrate that we already have or can complete more precise data within a very few years and that it is essential that we do so.

So in conclusion, I feel I must nail my colours to the mast, and I am recommending:–

1. a real campaign by JNCC and its allies to get complete 1-km square, six figure grid references and site data, and where feasible populations too, for all Rare and Scarce Plants;
2. that we re-define Rare and Scarce Plants on a tetrad basis, with the rarest 20% as *RDB*, and the next 20% as Scarce; and
3. that we weight these figures by a frequency ratio of tetrads/10-km squares, and endeavour to move to 1-km squares/10-km squares within five years. We should also explore the feasibility of combining these ratios with a "decline" rating as set out in Table 10.

The BSBI and I would be delighted to do the job.

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Gynodioecy in British populations of *Eriophorum vaginatum* L. (Cyperaceae)

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ABSTRACT

Gynodioecy is shown to be well-established and widespread in British populations of *Eriophorum vaginatum* L. Flowering and/or fruiting spikes were sampled from widely distributed populations and examined for the presence of aborted stamens. The proportion of male-sterile (functionally female) plants varied from 7% to 82%, with an overall frequency of 42%. Sexually intermediate (partially male–sterile) inflorescences appear to be extremely rare in Britain. Repeated observations at two localities suggest that female tussocks commence flowering slightly later than hermaphrodite tussocks. A preliminary assessment of seed set in three populations revealed considerable variation within and between populations, with no consistent differences in fecundity between sexual morphs. Pollination trials indicated that *E. vaginatum* is self-compatible; opportunities exist for geitonogamous (between flower) self-pollination, both between and within spikes on the same tussock. The findings provide baseline data for further studies on the evolution of gynodioecy in *E. vaginatum*; it is provisionally concluded that gynodioecy in this species is a stable form, with no clear evidence of a trend towards dioecy.

KEYWORDS: sexual dimorphism, male sterility, sex ratios, seed set, self-compatibility, tussock tundra.

INTRODUCTION

Eriophorum vaginatum L. (Hair's-tail Cottongrass) is one of the major components of ombrotrophic mire vegetation in the northern hemisphere, and is a common constituent of tussock tundra communities in the arctic zone. Commensurate with its ecological importance, several studies of its population biology have been carried out, primarily in North American tundra sites. These have shown that tussock longevity may exceed 100 years (Polozova 1970; Mark *et al.* 1985), that inflorescence and seed production show annual variation but can be prolific (Polozova 1970; Wein 1973; Chester & Shaver 1982; Gartner *et al.* 1986; Shaver *et al.* 1986), that a substantial seed bank may develop in tundra soils (e.g. McGraw 1980; Gartner *et al.* 1983), and that successful seedling establishment is particularly associated with micro-sites disturbed by frost heave, fire and other agencies (e.g. Wein & Bliss 1973; Gartner *et al.* 1986). The importance of sexual reproduction in maintaining natural populations has also been widely emphasised. Polozova (1970) concluded that reproduction in Russian populations occurs only by seed, and Forrest (1971) found no evidence for "budding" of young plants from old tussocks in blanket bog vegetation in northern England. Similarly, Gartner *et al.* (1986) found that recruitment from seed in Alaskan tundra was probably sufficient for natural replacement of mature plants. Nevertheless, tillers of *E. vaginatum* form adventitious roots (Goodman & Perkins 1968) and are capable of independent growth when detached from parent plants, so that the possibility of vegetative reproduction cannot be ruled out completely.

There have been few attempts to characterise the breeding system of *E. vaginatum*. Florets are borne in terminal solitary spikes, and there may be few to many spikes per individual tussock, although a proportion of plants in the population is often non-flowering. Each floret contains three stamens and a carpel with a single ovule. Like many other members of the Cyperaceae, *E. vaginatum* is wind-pollinated and protogynous, but we have traced no studies of compatibility relationships. Its sexual system is described as hermaphrodite in all major European and British Floras we have consulted, but in a previous note we recorded the occurrence of male-sterile (functionally female) plants, and consequently of gynodioecy, in a population from Borth Bog

(Cors Fochno) in Wales (Stevens & Blackstock 1993). Gynodioecy has also been reported by Raunkiaer in Denmark (Anonymous 1893), and by Polozova (1977) in the Taimyr peninsula in northern Siberia. Male-sterile plants have vestigial stamens, or staminodes, which are much smaller than the functional stamens of hermaphrodite plants and are devoid of pollen. In normal stamens, anthers are usually abscised from their filaments soon after pollen liberation, whereas staminode anthers fail to dehisce and are retained on short filaments as the nuts begin to ripen. Later in the fruiting period, after perianth bristles have elongated to form the familiar cotton-like heads, staminodes and normal filaments are shed, and eventually the spikes disarticulate. Both sexual forms produce seed, and Polozova (1977) found that females set fewer seeds per spike than hermaphrodites. No sexually intermediate (partially male-sterile) plants have been reported, but Polozova noted the presence in small quantity of separate female-sterile (functionally male) plants.

Few data are available on the extent or frequency of gynodioecy in different parts of its world distribution. Apart from the study by Polozova (1977) at a single site in northern Siberia, there are no published sex ratio data or sex-specific seed fecundity estimates. The main aims of the present study were to obtain data on the incidence of male sterility in *E. vaginatum* populations from a wide range of localities in Britain, and to compare seed set between hermaphrodite and female plants. In addition, pollination trials were carried out to examine compatibility relationships.

MATERIALS AND METHODS

SEX RATIOS

Flowering or fruiting spikes of *E. vaginatum* were sampled from 24 populations in England, Wales and Scotland in 1991–1993. Individual spikes were collected from separate tussocks separated by at least one metre, and wherever possible 100 or more plants were sampled. Early in the flowering season, female inflorescences are noticeably more slender than hermaphrodite spikes, but samples were collected without conscious bias towards one sexual form or the other. It was assumed that all flowering tussocks had an equal probability of being sampled, and therefore that inflorescence and flowering tussock sex ratios are equivalent. No variation in androecial type was observed between different inflorescences on the same tussock during many hours of field work.

In an ancillary study to test for temporal variation in the frequency of flowering female plants, populations at two Welsh mire sites were sampled repeatedly during the same flowering season. At Borth Bog, samples were collected on four separate occasions between mid-March and early June 1992. At Capel Curig, sampling was carried out during three visits between late March and early June 1993. Both populations had been previously sampled as part of the main study during 1991 when high frequencies of female inflorescences (82% and 56%, respectively) were recorded. At each site, tussocks were sampled along fixed linear transects.

All sampled inflorescences were sexed under a dissecting microscope, involving careful examination of at least three, and usually many more, florets in a range of positions from the base to the apex of each spike. Sexing was most difficult with mature fruiting spikes in which stamen filaments in hermaphrodites and staminodes in females were being shed, but with experience could be carried out up to the stage when spikes began to disarticulate. Almost all inflorescences could be unambiguously determined as hermaphrodite or female (as described in Stevens & Blackstock 1993), but a very few fruiting spikes with mixtures of putative staminodes and remnant elongated filaments (considered to be indicative of functional stamens) were classified as intermediate.

In the main study, female frequencies were tested for departure from 0·5 and for inter-population heterogeneity using G-tests (Sokal & Rohlf 1981), and were also related to four geographical and temporal variables (northing, easting, altitude and date of sample collection) using linear regression in an attempt to explain the variation observed. In the ancillary study, female frequencies in the repeat samples from Borth Bog and Capel Curig were analysed using G-tests to test for significant differences between sampling dates.

SEED SET

Fruiting hermaphrodite and female spikes sampled from each of three British populations (Capel Curig, Butterburn Flow and Silver Flowe) in June 1993 were scored for seed set. In each case, fruiting spikes were at an advanced stage of maturation with extensive bristle development but had

not yet started to disarticulate. After sexing, spikes were stripped down, and developing nuts were isolated and examined under a dissecting microscope. Seed viability was assessed by careful observation of nut size and structure rather than by germination tests; turgid nuts, most of which had ripe, dark brown testas, were scored as viable. Median numbers of seeds per spike were calculated for hermaphrodites and females in each population and compared statistically using Mann-Whitney U-tests.

POLLINATION TRIALS

Rooted portions of five hermaphrodite tussocks, each with several immature inflorescences, were collected from Capel Curig on 5 March 1992. Plants were grown in a mixture of ericaceous potting compost and *Sphagnum* in 16 cm plastic pots. The first flowering spikes appeared after two weeks. Virgin inflorescences were isolated in porous cellophane bags shortly before stigma lobes in any of the florets began to protrude beyond their subtending glumes, and were assigned to one of three treatments: a. "crossed", in which stigmas were dusted with fresh pollen from a separate plant; b. "selfed", in which stigmas were pollinated using another inflorescence belonging to the same plant; and c. "isolated", in which inflorescences remained bagged but were agitated daily to distribute pollen from dehiscing anthers. Spikes used for pollen donation were also isolated prior to anther exsertion to exclude the possibility of contamination with wind-blown pollen from other plants. Fruiting spikes were harvested four to six weeks after pollination, and developing nuts from ten florets were excised and examined under a dissecting microscope. Swollen ovaries, mostly 2·0–2·2 mm long, containing green turgid embryos, were considered to indicate successful fertilisation; shirvelled ovaries, usually 0·8–1·2 mm in length, with shrunken yellowish embryos, were taken to result from fertilisation failure or early zygote abortion.

One of the hermaphrodite plants was subsequently maintained in isolation and examined for seed production and viability in June 1995.

RESULTS

SEX RATIOS

Estimated frequencies of female (and sexually intermediate) tussocks in 24 British populations of *E. vaginatum* are given in Table 1. Sexual morph ratios are represented diagrammatically in Fig. 1. The sampled populations are widely distributed, covering 17 Watsonian vice-counties, with an ecological range which includes low and high altitude blanket bog and lowland raised mire habitats. Female individuals were present in each population at an estimated overall frequency of 42% (n = 2392), indicating that gynodioecy is a widespread and characteristic feature of *E. vaginatum* in Britain. Sexual intermediacy was very rare; only six apparently partially male-sterile spikes were recorded from three populations (overall frequency 0·2%).

Variation in female frequency between populations was considerable, ranging from 7% to 82%, and highly significant (G-value for heterogeneity = 511·9, d.f. = 23, $P<0.001$). There was a significant excess of female over hermaphrodite plants in five populations from widely scattered locations in England and Wales, and in eleven others there was no significant difference in the frequencies of the two sexual forms.

Regression analysis indicated that female frequency was strongly positively associated with date of sample collection, which explained 58% of the variation between populations (Fig. 2). Regressions of female frequency on northing (negative) and easting (positive) were also significant. However, after adjusting female frequency for variation in sampling date, only the regression on northing remained significant, explaining a further 19% of the inter-population variation in female frequency, and indicating that southern populations tend to have relatively high proportions of females.

Seasonal differences in flowering phenology between female and hermaphrodite tussocks were also detected within the Borth Bog and Capel Curig populations (Table 2). In each case, the ratio of female:hermaphrodite flowering tussocks increased during the main flowering period, which lasted from mid- or late March, when the first stigmas were exerted, to early May, when the last anthers had dehisced. After May, there was no further consistent change in female frequency. No instances of sex change were observed in tussocks of *E. vaginatum*, and these results suggest that females tend to come into flower slightly later than hermaphrodites in the same population.

TABLE 1. LOCALITIES, HABITAT CHARACTERISTICS, SAMPLING DETAILS AND ESTIMATED FREQUENCIES OF SEXUAL MORPHS FOR 24 BRITISH POPULATIONS OF *ERIOPHORUM VAGINATUM*

Site name (vice-county)	O.S. grid reference	Altitude (m)	Habitat*	Date of sample collection	No. of inflorescences scored	Estimated frequency of female tussocks	Estimated frequency of intermediate tussocks	Significance of G-test**
Cnwch (v.c. 42)	SN/93.63	300	BM	13 May 1991	27	0·44	0·00	n.s.
Foel Fadian (v.c. 47)	SN/83.95	500	BM	14 May 1991	41	0·44	0·00	n.s.
Migneint A (v.c. 49)	SH/76.44	450	BM	28 May 1991	120	0·34	0·00	P<0·001
Capel Curig (v.c. 49)	SH/70.59	270	BM	28 May 1991	71	0·56	0·00	n.s.
Lindow Common (v.c. 58)	SJ/83.81	80	WH	1 June 1991	97	0·25	0·00	P<0·001
High Peak (v.c. 57)	SK/08.86	535	BM	2 June 1991	110	0·55	0·01	n.s.
Eastern Moors (v.c. 57)	SK/26.78	370	BM	2 June 1991	109	0·43	0·00	n.s.
Leek Moors A (v.c. 39)	SK/01.65	380	BM	2 June 1991	106	0·57	0·00	n.s.
Leek Moors B (v.c. 57)	SK/02.70	490	BM	2 June 1991	106	0·80	0·00	P<0·001
Hallam Moors (v.c. 57)	SK/25.83	410	BM	2 June 1991	106	0·62	0·04	P<0·01
Tregaron Bog (v.c. 46)	SN/68.62	160	RM	7 June 1991	37	0·76	0·00	P<0·01
Great Shunner Fell (v.c. 65)	SD/84.97	710	BM	7 June 1991	103	0·50	0·00	n.s.
Great Whernside (v.c. 64)	SE/00.73	700	BM	8 June 1991	101	0·43	0·00	n.s.
Borth Bog (v.c. 46)	SN/63.91	5	RM	21 June 1991	108	0·82	0·01	P<0·001
Okehampton Common (v.c. 4)	SX/58.90	525	BM	24 June 1991	96	0·63	0·00	P<0·05
Taynuilt (v.c. 98)	NM/98.26	330	BM	25 March 1992	55	0·07	0·00	P<0·001
Machrihanish (v.c. 101)	NR/61.18	190	BM	12 April 1992	200	0·07	0·00	P<0·001
Migneint B (v.c. 49)	SH/76.43	465	BM	24 April 1992	103	0·14	0·00	P<0·001
Clachan (v.c. 110)	NF/83.65	25	BM	7 May 1992	100	0·15	0·00	P<0·001
Gress (v.c. 110)	NB/50.43	80	BM	11 May 1992	103	0·17	0·00	P<0·001
Balgowan (v.c. 96)	NN/62.95	320	BM	12 June 1992	99	0·46	0·00	n.s.
Callaly (v.c. 68)	NU/06.09	260	BM	1 May 1993	192	0·38	0·00	P<0·001
Butterburn Flow (v.c. 70)	NY/66.76	280	BM	11 June 1993	106	0·55	0·00	n.s.
Silver Flowe (v.c. 73)	NX/47.83	260	BM	22 June 1993	102	0·46	0·00	n.s.

* BM: blanket mire, RM: raised mire, WH: wet heath.
** Statistical tests for departure from 1:1 female:hermaphrodite sex ratio; n.s.: not significant.

FIGURE 1. Estimated frequencies of male-fertile (hermaphrodite) tussocks (white sectors) and male-sterile (female) tussocks (black sectors) in 24 British populations of *Eriophorum vaginatum*.

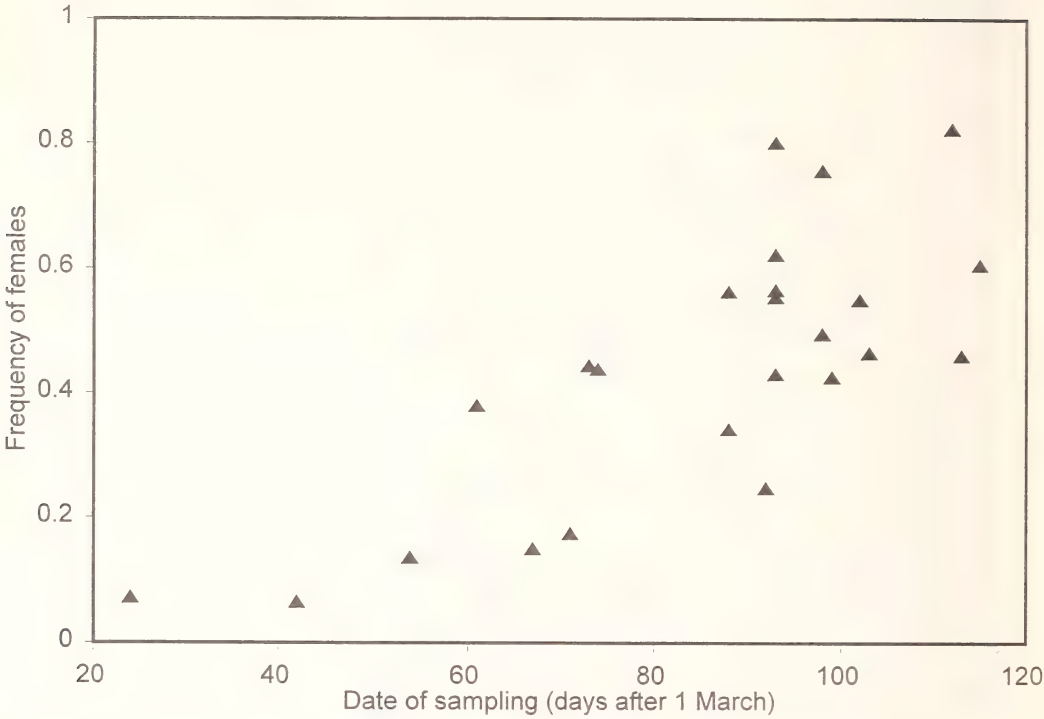

FIGURE 2. Relationship between estimated female frequency and date of sample collection in 24 British populations of *Eriophorum vaginatum*. The linear regression equation ($Y = 0{\cdot}007X - 0{\cdot}178$) is highly significant ($P<0{\cdot}001$).

TABLE 2. SEASONAL VARIATION IN THE RELATIVE FLOWERING FREQUENCY OF SEXUAL MORPHS IN TWO POPULATIONS OF *ERIOPHORUM VAGINATUM*

Site	Date of sample collection	No. of tussocks sampled	Estimated frequency of female tussocks
Borth Bog (v.c. 46, Cards.)	16 March 1992	120	0·117
	30 March 1992	130	0·277*
	10 May 1992	100	0·430*
	4 June 1992	94	0·553
Capel Curig (v.c. 49, Caerns.)	26 March 1993	92	0·163
	12 May 1993	122	0·402*
	8 June 1993	126	0·357

* Female frequency significantly ($P<0{\cdot}05$) greater than recorded in previous sample.

SEED SET

Seed output per spike varied considerably, both between spikes within populations and between populations. Fruiting spikes from Capel Curig contained on average about three times as many seeds as spikes from Butterburn Flow and Silver Flowe (Fig. 3). A significant difference in seed set between sexual morphs was detected only at Butterburn Flow, where hermaphrodite spikes produced an estimated 1·8 times as many seeds as female spikes (Mann-Whitney U-test, $U = 4{\cdot}37$, $P<0.001$).

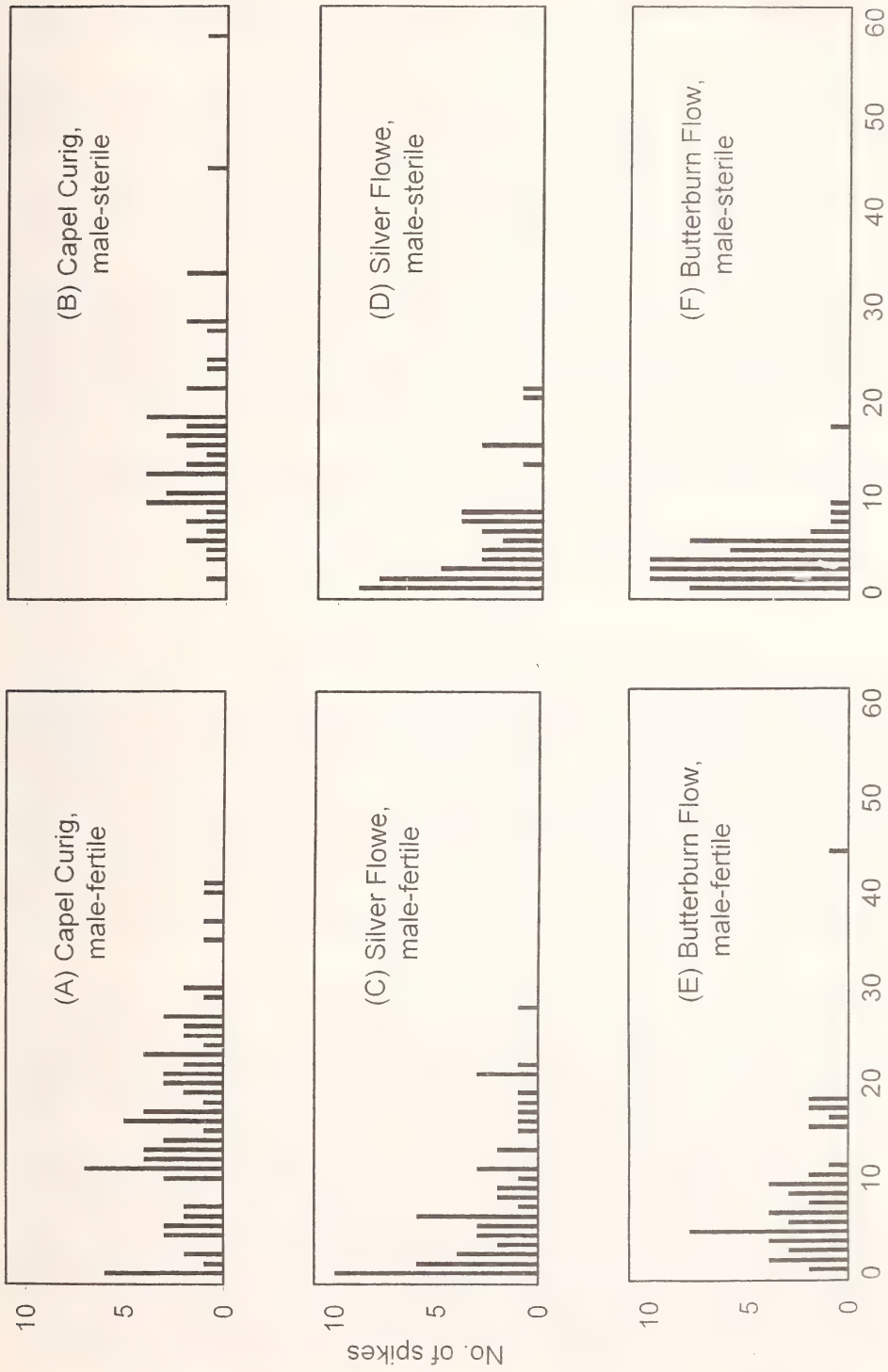

FIGURE 3. Frequency distributions of seed production in male-fertile (hermaphrodite) and male-sterile (female) spikes of *Eriophorum vaginatum* sampled from three populations in Britain. Median values are as follows: (A) 14·5, (B) 14, (C) 5, (D) 3, (E) 5·5, (F) 3.

TABLE 3. NUMBERS OF DEVELOPING EMBRYOS (OUT OF 10 SCORED) IN INFLORESCENCES OF *ERIOPHORUM VAGINATUM* FOLLOWING CONTROLLED POLLINATION TREATMENTS

	Maternal parent				
Treatment	1	2	3	4	5
Crossed	9, 5	0	8, 5, 0		7
Selfed	7, 0			8	
Isolated		0		1	7

POLLINATION TRIALS

Results of the pollination tests are shown in Table 3. Embryo development was recorded in two out of three selfed spikes of *E. vaginatum* compared with five out of seven crossed inflorescences. Asexual seed production seems unlikely in this gynodioecious species, and the results strongly suggest self-compatibility. Swelling ovaries were also noted in two out of three isolated inflorescences, indicating the potential for effective pollination of stigmas with pollen from the same spike. Gynoecia in some spikes under each of the three treatments failed to develop normally, probably due to sub-optimal culture conditions.

The hermaphrodite plant subsequently maintained in isolation generated 20 inflorescences in 1995, of which 18 developed ripe nuts. A total of 141 apparently fertile nuts was produced, and 100% germination success was recorded in a sample of 20 seeds sown on to filter paper discs in petri dishes. These results provide further evidence for self-compatibility in *E. vaginatum*.

DISCUSSION

DISTRIBUTION AND FREQUENCY OF GYNODIOECY

The occurrence of sexual dimorphism in British populations of *Eriophorum vaginatum* has been overlooked until recently. Stevens & Blackstock (1993) recorded the presence of male-sterile, functionally female, plants in mid Wales, and this extended study has shown that gynodioecy is a widespread and characteristic feature of the breeding system of *E. vaginatum* in Britain. According to Hultén (1962), populations of *E. vaginatum* in Europe and northern Asia represent *E. vaginatum* subsp. *vaginatum*, and it would be particularly interesting to establish whether gynodioecy also occurs in New World populations, especially in the ecologically well-studied *E. vaginatum* subsp. *spissum*. Many aspects of the population biology of this latter taxon have been studied recently in cottongrass tussock communities in North American tundra ecosystems, including its flowering behaviour and capacity for regeneration from seed (e.g. Gartner *et al.* 1986), but we are not aware of any accounts of its sexual system.

SEX RATIOS

High frequencies of female tussocks were found in most populations of *E. vaginatum* during the present study, occasionally exceeding 50%. Female frequencies of this magnitude are very unusual in gynodioecious species (see Couvet *et al.* 1990), and it is important to consider possible sources of bias in sex ratio estimation. Care was taken during field sampling to ensure that inflorescences were collected from separate tussocks and without conscious bias towards either sexual morph. Non-flowering tussocks were common in the sampled populations, and there is a possibility that sex ratio estimates have been influenced by differences between sexual forms in flowering propensity, although there is no evidence for this. At two sites, Borth Bog and Tregaron Bog, samples were collected late in the fruiting season when spikes had begun to disarticulate, and it is possible that earlier completion of fruit maturation in hermaphrodites could have inflated the estimates of female frequency. In all other populations, samples were collected before fruiting spikes began to break up, and in many of these females appeared to be present among flowering tussocks at genuinely high frequency. Low female frequencies were found mostly in populations sampled early in the flowering season and may have been underestimated because of the late flowering of female tussocks (see below).

Polozova (1977) recorded a female frequency of 17% (n = 483 tussocks) from a population of *E. vaginatum* in northern Siberia.

SEED SET

During the present study, seed set in *E. vaginatum* was found to be mostly low but highly variable, with median values for three populations ranging from four to 14 seeds per spike. We are not aware of any previous estimates of seed production in British populations, although Rawes & Hobbs (1979) noted that few seeds were produced in a population in the north Pennines. High levels of inter-population variation are also apparent from studies in North America, where average values of three to 82 seeds per spike have been reported (Wein 1973; Chester & Shaver 1982; Gartner *et al.* 1986). The genetic and environmental factors controlling seed set in *E. vaginatum* are poorly understood, although Gartner *et al.* (1983) found that spikes harvested early and late in the flowering season contained fewer seeds than those collected during the intervening period.

A significant difference in seed set was detected between sexual morphs in only one population, in which hermaphrodite spikes yielded 1·8 times as many seeds as female spikes. Polozova (1977) found a similar sex difference (male-fertile 30%, male-sterile 14%) in a Siberian population. Reduced seed output in females was attributed in that case to a lack of opportunities for geitonogamous (inter-flower) self-pollination, but no studies to confirm this were reported.

A full comparative assessment of seed output from the two morphs would need to take inflorescence production per tussock into account, as well as variation in annual fecundity at different life-history phases.

SELF-COMPATIBILITY

The establishment of self-compatibility in *E. vaginatum* contributes to characterisation of its breeding system. The results also accord with Molau (1993) who stated that very few tundra species are known to be fully self-incompatible.

The extent to which self-fertilisation takes place in natural populations of *E. vaginatum* must depend on the opportunities available for self-pollination. According to Hegi (1967), self-pollination is precluded by temporal separation of male and female function. However, our field observations suggest that protogyny is at best hemisynchronous (sensu Lloyd & Webb 1986), with overlap of pollen liberation and stigma receptivity between different inflorescences in the same tussock. Furthermore, Polozova (1977) found that there was typically an overlap of one to three days in the female and male stages of flowering within an inflorescence, and evidence for within-spike self-fertilisation was found during the present study. It is likely therefore that some degree of self-fertilisation takes place geitonogamously in hermaphrodite plants in the field, although further studies are required to assess its frequency.

FLOWERING PHENOLOGY IN HERMAPHRODITE AND FEMALE PLANTS

Flowering periods of female and hermaphrodite plants appear to be somewhat asynchronous in at least some British populations of *E. vaginatum*. A similar phenomenon was reported for gynodioecious *Gingidia decipiens* (Hook. f.) Dawson (Apiaceae) in New Zealand by Webb (1976), although in this species female plants peak and finish flowering before rather than after hermaphrodites in the same population. Early female flowering was interpreted as resulting from selection for fruit maturation before the onset of limiting winter conditions. In many British populations of *E. vaginatum*, environmental conditions are probably more important in controlling the beginning rather than the end of the flowering period, since hard spring frosts cause severe damage to exposed inflorescences (Goodman 1950), whereas seeds are shed around mid-summer well before end-of-season limitations become apparent. It is possible that in protogynous hermaphrodite plants selection against early flowering is countered by competition between pollen donors for fertilisation of the first available ovules. In male-sterile plants, there can be no such intra-sexual selection for early flowering, and females may flower as late as possible before pollen availability becomes limiting due to completion of flowering in hermaphrodite plants.

Interestingly, Polozova (1977) found that in the short summers of northern Siberia female plants usually finished flowering as pollen production by hermaphrodites reached its peak. The differences between sexual morphs in flowering period evident in British populations do not therefore appear to extend to arctic Siberia where unfavourable late-season conditions may impinge more directly.

MAINTENANCE OF GYNODIOECY

There has been considerable recent interest in the selective factors involved in the evolution and maintenance of gynodioecious polymorphisms. In *E. vaginatum*, such factors are largely unknown, as are the stages of the life cycle at which they are expressed. Phenotypic models of gynodioecy with nuclear genetic control of male sterility predict hermaphrodite-predominance (Lloyd 1975, 1976; Charlesworth & Charlesworth 1978), even with strong female advantage in seed production, unless sexual forms differ in their capacity for vegetative reproduction (Stevens & van Damme 1988) or in adult survival rates (van Damme & van Damme 1986). Differences in seed set per spike between sexual forms were established for two out of four populations studied by us and Polozova (1977), but in each case it was hermaphrodites rather than females that yielded the most seeds, pointing to a possible additional reproductive disadvantage of the latter. Other fitness components have not been studied. Vegetative reproduction is unlikely to be of major significance in *E. vaginatum*, but the possibility of differences between sexes in tussock mortality rate or flowering propensity cannot be excluded. It is also possible that other assumptions of the nuclear phenotypic models do not apply in this case. For example, male sterility may be wholly or partly under the control of cytoplasmic genes, or there could be overdominance for fitness at the sex-determining loci (or closely linked sites). A range of genetic and demographic effects has been demonstrated for *Plantago lanceolata* L. (Ribwort Plantain), which has many similarities with *E. vaginatum* in its inflorescence structure and pollination mechanism, by van Damme (1984) and van Damme & van Delden (1982, 1984). However, *E. vaginatum* differs from *P. lanceolata* in being self-compatible, so inbreeding depression as well as pleiotropic effects of male sterility genes may be involved in the maintenance of gynodioecy in the cottongrass. On the other hand, differentiation of hermaphrodite and female plants is more clear cut in *E. vaginatum*, and the genetic basis for male sterility may prove to be much simpler than the complex mechanism found in *P. lanceolata*.

EVOLUTIONARY STABILITY OF GYNODIOECY

The role of gynodioecy as a transitional stage in the evolution of dioecy from hermaphrodity has attracted considerable attention since Darwin (1877). Ross (1978) classified gynodioecy into two types: an unstable form in which hermaphrodites are partially female-sterile, and a stable form which shows no such tendency towards dioecy. Unstable gynodioecy was considered to be associated with simple nuclear genetic control of male sterility, and stable gynodioecy with more complex mechanisms of inheritance, particularly those involving cytoplasmic factors. In *E. vaginatum*, there appears to be little evidence for evolution from gynodioecy towards dioecy; a few fully male plants were reported by Polozova (1977), but they occurred at very low frequency, and we have found no comparable examples in British populations. It seems likely therefore that gynodioecy in *E. vaginatum* is of the stable type.

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A morphometric study of the woodrushes *Luzula campestris* (L.) DC., *L. multiflora* subsp. *multiflora* (Ehrh.) Lej. and *L. congesta* (Thuill.) Lej. (Juncaceae) in the British Isles

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ABSTRACT

A morphometric study of the three widespread taxa, *Luzula campestris* (L.) DC., *L. multiflora* subsp. *multiflora* (Ehrh.) Lej. and *L. congesta* (Thuill.) Lej. (section *Luzula*; Juncaceae) has revealed all three taxa to be distinct, each characterised by a unique character constellation and ecological 'preference'. Whilst overlap occurs in some of the character ranges, identification can still be afforded by using a combination of floral and/or fruit characters. A table of critical values is provided for each taxon for the identification of problematic specimens.

KEYWORDS: taxonomy, ecology, diagnostic characters.

INTRODUCTION

The genus *Luzula* DC. (Juncaceae) comprises over 100 species (Novikov 1990) which are widely distributed throughout much of the Northern Hemisphere (in particular Europe and Central Asia), with a few species extending into the Southern Hemisphere and the Tropics. It has been traditionally divided into the three subgenera, *Luzula* (syn. *Gymnodes* (Griseb.) Buchenau), *Pterodes* (Griseb.) Buchenau, and *Anthelae* (Griseb.) Buchenau on the basis of inflorescence, seed and leaf tip characters. Novikov (1990) further divided subgenus *Luzula*, the largest of the three subgenera, into two sections and nine subsections. Section *Luzula* is characterised by the possession of subumbellate inflorescences, with pedunculate or subsessile clusters on straight erect branches at anthesis (Kirschner 1991). It is usually regarded as a taxonomic complex containing a range of karyotypes (polyploids and agmatoploids), in which recognition has been variously afforded to the discrete entities at the ranks of species, subspecies or variety dependent on the taxonomic authority (see Fernald 1945; Voss 1966; Kirschner 1980, 1990; Kirschner & Křísa 1979). Buchenau (1890, 1906) regarded the section as a single polymorphic species, with varietal and subspecific status being applied to polyploid members. In contrast, Kirschner (1991) considered the section to contain up to 50 species, with a typically high proportion of continental endemics, of which 15 occur in Europe. Chrtek & Křísa (1980) recognised four species and three subspecies for their account in *Flora Europaea*.

In Britain and Ireland, the section is represented by the three closely related and widespread taxa *Luzula campestris* (L.) DC. (2n = 12), *L. multiflora* subsp. *multiflora* (Ehrh.) Lej. (2n = 36) and *L. congesta* (Thuill.) Lej. (2n = 48), in addition to the localised *L. pallidula* Kirschner, restricted to fenlands in Huntingdonshire (v.c. 31) (Stace 1991). Difficulties have been encountered mainly with the discrimination of *L. campestris* and *L. multiflora* subsp. *multiflora*, as a result of the considerable overlap in the character ranges of the two taxa (Wigginton & Graham 1981). In addition, there has been some dispute over the ranking of *L. congesta* in Britain and Ireland. Whilst this taxon has traditionally been treated as a subspecies of *L. multiflora* in many British Floras (Clapham, Tutin & Moore 1987; Stace 1991) and in *Flora Europaea* (Chrtek & Křísa 1980), a specific status has been argued for by Nordenskiöld (1956), Buchanan (1960) and most recently by Kirschner (1990) and Kirschner & Rich (1996). In an attempt to address these difficulties, a taxonomic reappraisal of the three taxa was undertaken, the results of which are reported in this paper. The objectives of the

study were to determine the discreteness or otherwise of the three taxa; to identify the characters of taxonomic value; and to appraise the ranking of the three taxa.

MATERIALS AND METHODS

Collections of single plants were made from all three taxa from a variety of locations throughout Cumbria (v.cc. 69, 70) and West Lancashire (v.c. 60). These were subsequently sorted into three groups on the basis of gross morphology using the gestalt method. The groups so formed were then used as the source material for a re-appraisal of all characters traditionally used in Floras and for the investigation of new diagnostic characters (see Table 1). Floral and fruit character (see Fig. 1) measurements, with the exception of pollen, were based on a sample size of 150 individuals from each of the three taxa, whereas vegetative characters were assessed on 25–40 individuals. This bias reflected the reported importance of floral and fruit characters in the discrimination of the three taxa (Wigginton & Graham 1981; Kay 1993), and the use of fruit characters to test the validity of the groupings (see below). All floral and fruit characters were measured using a monocular microscope at ×60, unless otherwise stated. Pollen dimensions and stomatal dimensions were taken from 40 individuals per taxon, measured at a magnification of ×450. For vegetative characters, 40 individuals were scored per group, with the exception of leaf thickness (25 individuals). Leaf width

TABLE 1. CHARACTERISTICS OF *LUZULA CAMPESTRIS*, *L. MULTIFLORA* SUBSP. *MULTIFLORA* AND *L. CONGESTA* (RANGE, MEAN AND STANDARD DEVIATION)

Character	*L. campestris*	*L. multiflora* subsp. *multiflora*	*L. congesta*
Habit	Loosely tufted/rosette	Densely tufted	Loose-densely tufted
Height-complete (cm)	6·4–25·6, 14·9±4·78	18·7–52·2, 31·6±7·89	20·8–85·0, 35·2±10·76
Height-culm (cm)	6·0–23·4, 15·1±4·51	15·1–46·5, 29·7±7·40	20·2–84·0, 36·9±14·89
Leaf			
Width (maximum) (cm)	2·0–4·5, 2·8±0·57	3·0–7·0, 4·3±0·85	–
Thickness (mm) (at 50% leaf length)	0·16–0·20, 0·18±0·01	0·20–0·28, 0·22±0·02	–
Colour	Light green, shiny	Dark green, dull	Bright green
Tip	Truncate	Rounded	Rounded
Guard cell length (mm)	44·0–63·0, 52·9±0·01	66·0–96·0, 77·4±0·01	–
Inflorescence			
Form	Loosely cymose	Subumbellate	Congested
Floral clusters			
Number	2–7, 3·6±1·23	3–17, 5·7±1·99	1–4 congested
Arrangement	1 sessile, 2–7 pedunculate	Pedunculate/subsessile	Subsessile/sessile
Number of flowers within	3–11, 5·8±1·62	6–18, 9·3±2·24	28–99, 52·4
Flowers			
Anther (mm)	1·13–3·23, 1·81±0·03	0·66–1·58, 1·16±0·20	1·52–1·67, 1·60±0·11
Anther length:filament length ratio	2·5–9·4, 5·1±1·56	1·0–3·5, 1·9±0·60	1·48–2·7, 2·05±0·29
Pollen grain diameter (μm)	33·3–44·4, 39·2±3·00	29·6–48·1, 38·6±5·20	27·8–58·3, 40·43±5·41
Perianth segment			
Length (mm)	2·7–4·1, 3·1±0·22	2·5–3·5, 2·9±0·18	2·5–3·5, 2·9±0·23
Width (mm)	0·76–1·32, 0·97±0·11	0·47–0·82, 0·65±0·08	0·50–0·92, 0·72±0·07
Bract length (cm)	0·6–3·0, 1·6±0·55	1·4–6·5, 2·9±1·30	1·0–4·7, 2·1±0·91
Fruit			
Capsule valve length (mm)	2·6–3·6, 2·9±0·20	1·8–2·6, 2·2±0·20	1·8–2·8, 2·4±0·2
Seed			
Length (l) (mm)	0·79–1·26, 1·04±0·09	0·79–1·32, 1·03±0·11	1·0–1·39, 1·21±0·08
Breadth (b) (mm)	0·74–1·10, 0·90±0·07	0·50–0·87, 0·73±0·07	0·60–1·03, 0·86±0·09
l/b ratio	1·0–1·3, 1·18±0·07	1·2–2·6, 1·44±0·22	1·3–1·9, 1·48±0·13
Caruncle (mm)	0·21–0·63, 0·45±0·08	0·16–0·74, 0·41±0·01	0·21–0·71, 0·4±0·08
Size (l×b)	0·66–1·31, 0·93±0·13	0·52–1·24, 0·81±0·01	0·68–1·40, 1·00±0·15
Weight (mg)	0·43–0·99, 0·67±0·13	0·18–0·56, 0·33±0·01	0·44–1·20, 0·66±0·12

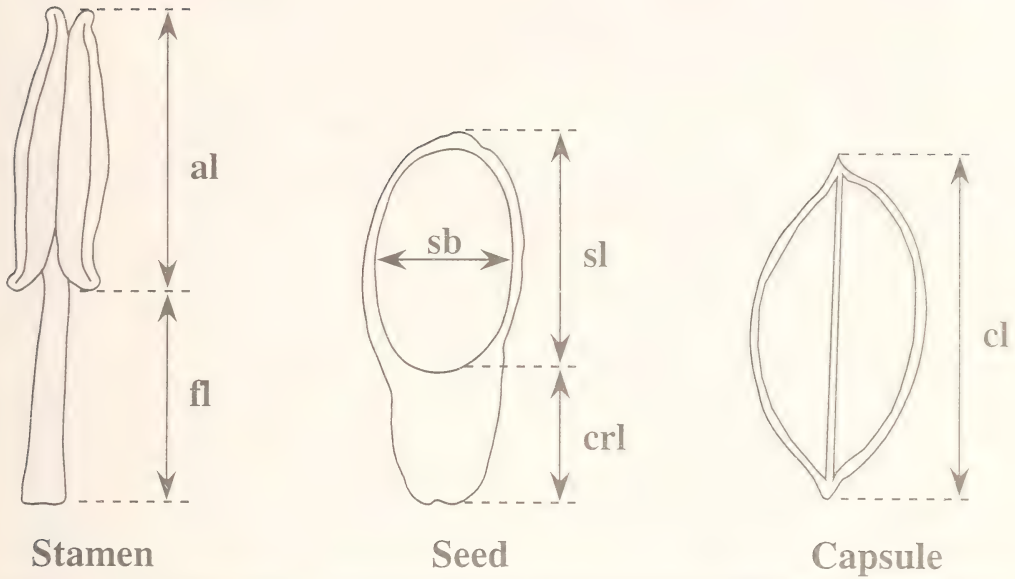

FIGURE 1. Some of the characters measured in the morphometric analysis of *Luzula* for which precise description is required. Stamen: al, anther length; fl, filament length. Seed: sl, seed length; sb, seed breadth; crl, caruncle length. Capsule: cl, capsule length.

measurements were made at three points along the total length (25%, 50% and 75% from the base), and leaf thickness at half-way along the leaf using a screw gauge micrometer. Measurements of stomatal dimensions were made from silicone impressions taken half-way along the leaf from material grown in the glasshouses at the University of Lancaster. In all cases the maximum dimensions of a character were used and measured to the accuracy indicated in Table 1, using a calibrated eye-piece or a ruler.

To verify the validity of the groups determined 'by eye', a canonical discriminate analysis was first performed using the fruit characters of seed length, seed breadth, seed weight, seed caruncle length and capsule length, and perianth width. In canonical discriminate analysis (CDA) combinations of the original variables are sought which maximise the ratio of between group to within group variation, such that functions of the original variables can be used to discriminate between the groups. The analysis was performed using the statistical package SAS in which all squared distances between group means are Mahalanobis D^2 statistics ($D^2_{(i/j)}=(x_i - x_j)\ \mathrm{cov}^{-1}(x_i - x_j)$).

On validation of the three groups, an analysis of variance was performed using a Tukey LSD (least significant difference) test on all the quantitative data. For selected quantitative characters (see below) ratios were also produced (i.e. anther length/filament length ratio, seed length/breath ratio and fruit index (= capsule length × perianth width)) and critical value tables constructed. The latter involved first dividing the total range of the character for all three taxa into 100 size classes. For example, if the character range varied from 1·80 mm to 3·60 mm, as for capsule segment length, the difference, 1·80 was divided by 100 to give 0·018. This value was then added to the smallest value (1·80) to give size class 01 a value of 1·800–1·818, and then successively to the culminating total to give size classes 02, 1·819–1·836, class 03, 1·837–1·872, class 04, 1·873–1·890 . . . class 100, 3·583–3·600. The means for each taxon were then replaced by their appropriate class number, which in the above case was 63 for *L. campestris* ($\bar{x}$ = 2·934), 22 for *L. multiflora* subsp. *multiflora* ($\bar{x}$ = 2·196) and 32 for *L. congesta* ($\bar{x}$ = 2·376) (see Table 2). Plus and minus signs were then allocated to characters to describe their relationship with respect to one another. The scoring method involved assigning a plus value to those characters which had a larger class value for *L. campestris*, and a negative value to those characters which showed the opposite tendency (a negative value was

TABLE 2. CLASS NUMBERS AND CRITICAL VALUES FOR *LUZULA CAMPESTRIS*, *L. MULTIFLORA* SUBSP. *MULTIFLORA* AND *L. CONGESTA* (SEE TEXT FOR DETAILS OF CALCULATIONS)

		Taxa		
Stage of development	Character	*L. campestris*	*L. multiflora* subsp. *multiflora*	*L. congesta*
Anthesis	Anther length/filament length ratio	+49	+10	+05
	Anther length	+46	+19	+07
	Perianth width	+60	+22	+29
	Leaf width	−15	−45	−53
	Summed totals	140	6	−12
Fruiting	Anther length/filament length ratio (dehisced)	+52	+14	+12
	Perianth width	+60	+22	+29
	Capsule length	+63	+22	+32
	Seed length	+41	+39	+70
	Seed breadth	+66	+39	+59
	Seed length/breadth ratio	−11	−27	−30
	Seed weight	+48	+16	+47
	Leaf width	−15	−45	−53
	Summed totals	304	80	166

assigned to both L. multiflora subsp. *multiflora* (–22) and *L. congesta* (–32) in the example). This procedure was repeated for a selected number of characters (selected for their large differences in mean expression and low levels of variation about the mean) and the character class numbers then combined to give a summed critical value for each group/taxon for a particular combination of characters (see results). The characters selected included perianth segment width, anther length and anther length/filament length ratio, capsule length, seed length, seed breadth, seed length/breadth ratio, seed size, seed weight, in addition to leaf width and leaf thickness. The rationale for this method is that whilst it may not be possible to use a single character to identify all samples encountered, this aim can be achieved through the use of several characters combined into a class number total (Whitehead 1954). This method was then tested on 'typical' and 'problematic' herbarium material not used in the analysis so far.

RESULTS

The gestalt method resulted in the production of three groups coincidental with the three taxa under investigation, plus a few specimens in which placement was not immediately obvious. The three groups could be clearly differentiated from one another and were characterised by unique character combinations.

The canonical discriminate analysis also supported the existence of group structure and found highly significant differences between the three groups (Table 3). The first canonical variate axis (CV1) accounted for 83% of the variation and the second canonical variate axis (CV2) for 17%. CV1 was able to discriminate all three taxa, but optimally *L. campestris* from *L. multiflora* subsp. *multiflora* and *L. congesta*, with seed breadth, seed weight, capsule length and perianth width being the most discriminatory characters (Fig. 2). CV2 primarily distinguished *L. congesta* from the other two, with seed length contributing most to the discrimination afforded. All characters, with the exception of seed caruncle length were found to have high discriminatory values. The significance of these group differences was further supported by multivariate analysis, for example Wilks' Lambda 0·044, F-ratio = 278·16, d.f. = 12,884, $p<0·001$.

The differentiation of these groups has been further supported by a Tukey LSD test on floral, fruit and foliar material (Table 4). From the scatter plots, it was also evident that combinations of fruit

TABLE 3. TOTAL CANONICAL STRUCTURE FOR *LUZULA CAMPESTRIS*, *L. MULTIFLORA* SUBSP. *MULTIFLORA* AND *L. CONGESTA*

	Canonical axis 1	Canonical axis 2
Canonical correlation	0·941	0·786
Approximate standard error	0·005	0·181
Eigenvalue	7·729	1·161
Proportion of total variance	0·827	0·172
Total Structure		
Seed length	0·142	0·853
Seed breadth	0·682	0·273
Seed weight	0·743	0·531
Seed caruncle length	0·163	−0·190
Capsule length	0·867	−0·246
Perianth width	0·852	−0·307
Class means on canonical variables		
L. campestris	3·479	−0·823
L. multiflora subsp. *multiflora*	−3·301	−0·965
L. congesta	−0·179	1·788

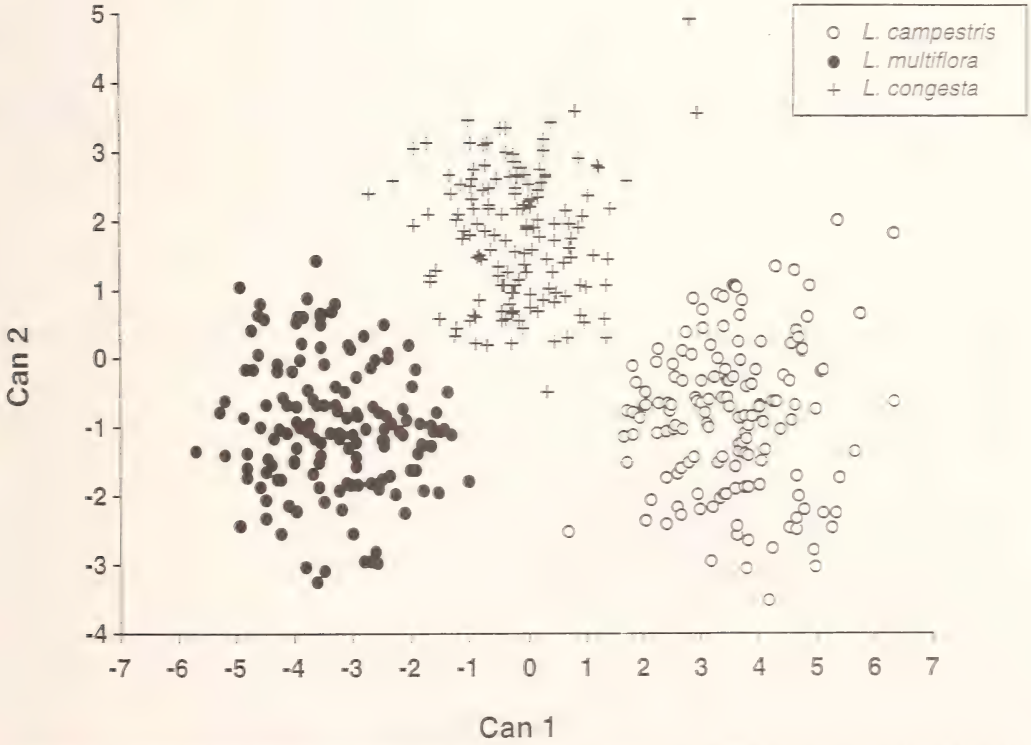

FIGURE 2. Plot of the first two canonical variate axes on seed characters of 150 individuals each from *Luzula campestris*, *L. multiflora* subsp. *multiflora* and *L. congesta*.

TABLE 4. CHARACTERS OF VALUE IN THE DISCRIMINATION OF *LUZULA CAMPESTRIS*, *L. MULTIFLORA* SUBSP. *MULTIFLORA* AND *L. CONGESTA*

All the following characters are significantly different ($p<0{\cdot}05$) between the appropriate pairs of taxa; the most diagnostic characters are indicated by an asterisk.

L. campestris/*L. multiflora*	*L. campestris*/*L. congesta*	*L. multiflora*/*L. congesta*
Anther length*	Anther length*	Capsule length
Anther/filament ratio*	Anther length/filament length ratio*	Inflorescence*
Capsule length*	Capsule length	Overall height
Guard cell length*	Height	Seed breadth*
Leaf apex*	Inflorescence*	Seed length
Leaf pubescence	Overall height	Seed size
Leaf thickness	Perianth segment width	Seed weight*
Leaf width	Rhizomes*	
No. of flowers in cluster	Seed length	
No. of floral clusters	Seed length/breadth ratio*	
Overall height	Seed size	
Perianth segment width		
Rhizomes*		
Seed breadth		
Seed length/breadth ratio*		
Seed weight*		

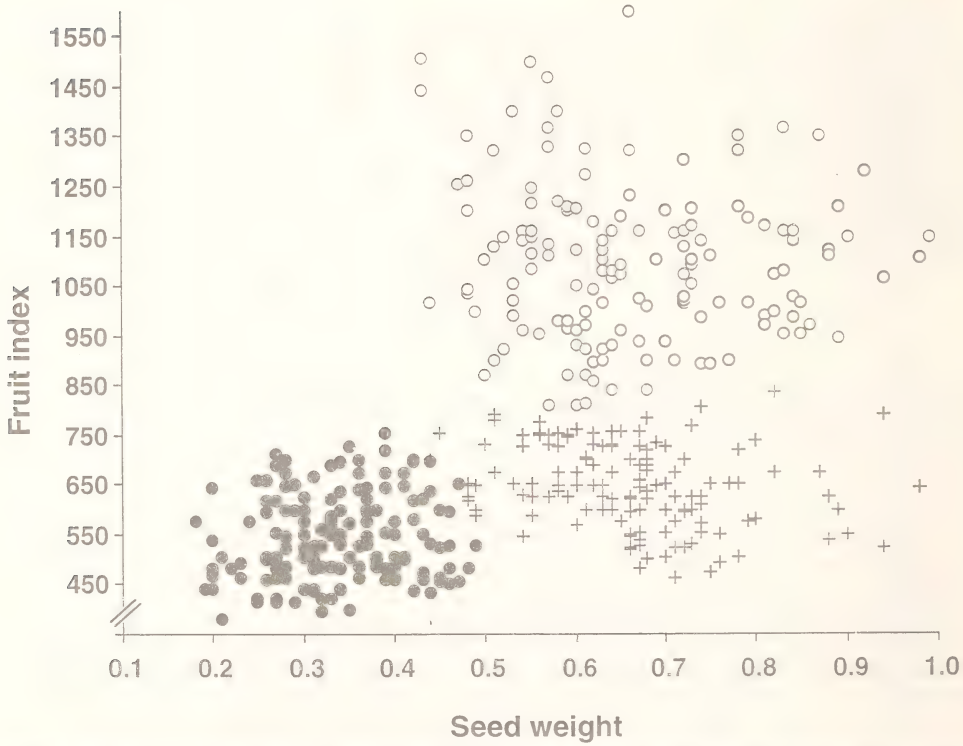

FIGURE 3. Bivariate scatter plot of fruit index (capsule length × perianth width) against seed weight (mg) for *Luzula campestris*, *L. multiflora* subsp. *multiflora* and *L. congesta*.

characters (and one perianth character) clearly separated the three taxa. Specimens of *L. campestris* were separated out from *L. multiflora* subsp. *multiflora* and *L. congesta* by seed length/breadth ratio against capsule length, seed length/breadth ratio against perianth width, fruit index against seed breadth, fruit index against seed weight, seed length/breadth ratio against seed weight and fruit index against seed length. Character combinations separating *L. multiflora* subsp. *multiflora* and *L. congesta* included seed length/breadth ratio against perianth width and seed length against seed weight. Characters providing good separation of all three taxa included seed length/breadth against seed weight, fruit index against seed length and fruit index against seed weight (Fig. 3). In many plots, a few of the outlier specimens were observed, but most specimens fell clearly within one of the three taxa.

Species polygons were constructed and also supported the value of such character combinations and the distinctness of the three taxa (Fig. 4). The characters of highest taxonomic potential for discriminating *L. campestris* from *L. multiflora* subsp. *multiflora* and *L. congesta* are fruit index, seed length/breadth ratio, anther length/filament length ratio and, to a lesser extent, capsule segment length and perianth width. Those of value for differentiating between *L. multiflora* subsp. *multiflora* and *L. congesta* are seed weight and seed length. Whilst the latter two taxa show overall similarity in their character constellations, *L. congesta* has intermediate ranges for some of its characters and some character states which are indistinguishable from *L. campestris*.

Character variation was found to be least in the characters of seed length, perianth width and seed size, greater in seed weight, anther length (particularly for *L. campestris*), capsule length and seed breadth (particularly so for *L. congesta*) and greatest in seed caruncle length. The latter proved to be highly environmentally plastic. *L. campestris* was found to be more variable than *L. multiflora* subsp. *multiflora* or *L. congesta* in a number of characters, including stamen dimensions and structure of the inflorescence, but not in leaf width. This situation contrasts with the findings of Nordenskiöld (1956).

By the appropriate selection of characters, summed totals were also obtained for character combinations which maximally differentiated the three taxa. This enabled all test specimens to be assigned to one of the three taxa based on the 'nearness' of the summed class numbers to one of the critical values for each taxon. The discriminatory value of the fruiting stage was found to be higher than that of anthesis, enabling fruiting specimens to be more readily and confidently assigned (see Table 2). Some specimens were more readily assignable than others; the difficult ones possessed intermediate dimensions or apparently anomalous character combinations. The character table statistics are presented in Appendix 1.

KEY TO TAXA

1 Plants loosely tufted or more usually forming a rosette, rhizomatous, leaf apex truncate; inflorescence loosely cymose, nodding, up to 26 cm long, more usually 15–20 cm; anther length/filament length ratio >2·5, seed globular with a length:breadth ratio ≤1·3 ..... *L. campestris*

1 Plants densely tufted, non-rhizomatous, leaf apex rounded; inflorescence subumbellate or congested, >20 cm long, and more usually 30–40 (–85) cm; anther length/filament length ratio <2·5; seeds oblong-ovoid with a length:breadth ratio usually >1·3 2

2 Inflorescence congested, up to 85 cm long; seed breadth >0·86(–1·4) mm; seed weight usually >0·6 mg ..... *L. congesta*

2 Inflorescence subumbellate, up to 60 cm long; seed breadth <0·86 mm; seed weight <0·5 mg ..... *L. multiflora* subsp. *multiflora*

Of the other related taxa, *L. pallidula* is distinguished from *L. multiflora* subsp. *multiflora* by the pale-yellow brown colour of its perianth segments, their smaller size (1·5–2·5 mm) (Stace 1991), the unequal length of the inner and outer segments and the densely papillose peduncles (Kirschner & Rich 1996). *L. multiflora* subsp. *hibernica* is distinguished by some of its peduncles being recurved, whilst others are flexuous and the leaves usually less than 3 mm wide (Kirschner & Rich 1996). The reported difference in capsule segment length for subsp. *hibernica* (1·9–2·2 mm) overlaps slightly with that of subsp. *multiflora* ((1·8–) 2·2 ± 0·20 (–2·6)).

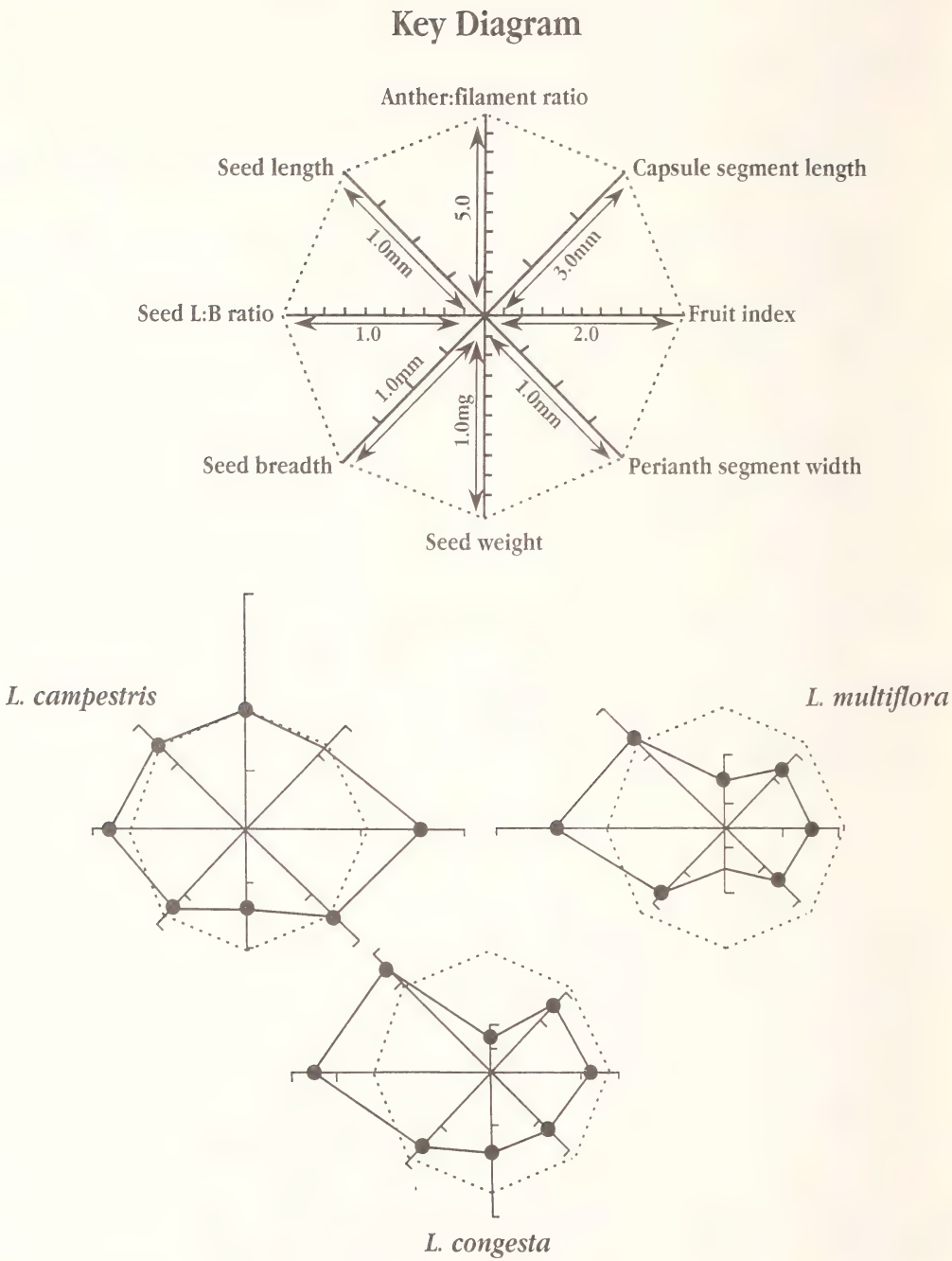

FIGURE 4. Character polygons of *Luzula campestris*, *L. multiflora* subsp. *multiflora* and *L. congesta* with key diagram showing the characters measured.

SPECIES DESCRIPTIONS

L. campestris (L.) DC. in Lam. & DC., *Fl. Fr.*, 3rd ed. **3**: 161 (1805). Field Woodrush. *Illustrations*: Butcher, *A new illustrated British flora* **II**: 673 (1961); Fitch & Smith, *Illustrations of the British flora*: 262 (1901); Ross-Craig, *Drawings of British plants* **30**: pl. 30 (1973).

A compact, rosette-habit perennial with shortly creeping rhizomes. Height in flower 5–23 cm. Basal leaves 2–5 mm wide, 0·15–0·20 mm thick, linear with small truncate swelling at apex, light yellow green, shiny, thinly covered with long colourless hairs which are especially concentrated towards base. Inflorescence loosely cymose or rarely slightly congested, usually nodding, consisting of a panicle of one sessile and 2–7 pedunculate, spherical-obovate clusters of 3–12 flowers, each subtended by 2 or 3 bracteoles. Branches of inflorescence ± curved, reflexed in fruit. Bracts 1–3 mm, shorter to longer than the inflorescence; leaf-like. Perianth segments 3·1–3·6 × (0·8–) 1·0–1·3 mm, ovate-lanceolate, chestnut-reddish-brown with pale margins, subequal or the inner somewhat shorter. Anthers 1·0–3·2 mm in length, 3–9 × as long as filaments. Style longer than ovary, filiform. Capsule 2·6–2·9 (–3·6) mm, cylindrical to obovoid, apiculate, dark reddish-brown, glabrous, shiny, shorter or as long as perianth segments. Seed 0·7–1·3 × 0·7–1·1 mm, nearly globose, 0·4–1·0 mg in weight, with an ovate-triangular, flattened or trigonous basal appendage (caruncle) up to half as long as seed. 2n = 12.

Common in grassland, meadows, dry pastures and sand dunes, usually on shallow soils of low organic content, though known to persist in relatively productive artificial habitats such as lawns (see Grime *et al.* 1988). Tolerant of a range of soil pH (4–9), although mostly found on acidic soils. Has a wide altitudinal range up to 1010 m (Grime *et al.* 1988). Survives optimally under grazing regimes.

L. campestris is distinguished from *L. multiflora* subsp. *multiflora* and *L. congesta* by its rosulate habit, presence of rhizomes, the truncate apical swelling of the leaves, an anther length/filament length ratio of 3–9, style longer than the ovary, capsule length greater than 2·6 mm, and globose shaped seeds.

L. multiflora subsp. **multiflora** (Ehrh.) Lej., *Fl. Spa.* **1**: 169 (1811). Heath Woodrush. *Illustrations*: Butcher, *A new illustrated British flora* **II**: 674 (1961); Ross-Craig, *Drawings of British plants* **30**: pl. 31 (1973).

Erect, densely tufted perennial with no rhizomes. Height in flower (15–) 30–55 cm. Basal leaves 3–4 (–7) mm wide, 0·20–0·28 mm thick, linear with small rounded swelling at apex, dark green, dull, sparsely covered with long colourless hairs which are concentrated towards the base. Inflorescence subumbellate with 1 (–3) subsessile and (3–) 6–13 (–16) pedunculate, ovate to elongate clusters of (6–) 9–15 (–18) flowers, each subtended by 3 bracteoles. Branches of infloresence usually erect in fruit, up to 4 cm long. Bracts (2–) 3–7 mm, shorter to longer than the inflorescence, leaf-like. Perianth segments 2·5–3·2 (–3·6) × 0·5–0·8 mm, broadly lanceolate, reddish-brown to pale brown with hyaline margins, subequal. Anthers 0·7–1·6 mm in length, 1–3 × as long as filaments. Style as long as ovary, filiform. Capsule 1·8–2·2 (–2·8) mm, obovoid to globose, apiculate, pale brown, glabrous, shiny, usually shorter than perianth segments. Seed 0·8–1·3 × 0·5–0·9 mm, oblong-ovoid, about twice as long as wide, 0·2–0·4 mg in weight, with ovate-triangular, flattened or trigonous basal appendage up to half as long as seed. 2n = 36.

Common in moist woods and moors mainly on acidic to neutral soils (pH range 4–7), of high organic and water content. Has a low altitudinal range, ascending up to 210 m.

L. multiflora subsp. *multiflora* is characterised by its tufted habit, absence of rhizomes, the rounded apical swelling of the leaf, subumbellate inflorescence with bract shorter than inflorescence, anther length/filament length ratio usually less than 2, seed oblong-ovoid. It is distinguished from *L. campestris* as described above and from *L. congesta* by its stalked infloresence, its perianth segments being about the same length as the capsule values, and the smaller size of its seeds (in terms of breadth and weight).

The description given here applies to the hexaploid cytotype of *L. multiflora* subsp. *multiflora*. Tetraploid cytotypes are more commonly associated with alpine habitats. However, recently, Kirschner & Rich (1996) have reported a tetraploid from Ireland, designated subsp. *hibernica*.

L. congesta (Thuill.) Lej., *Fl. Spa.* **1**: 169 (1811). Congested Woodrush.

Erect, densely tufted or single-stemmed stiff tillered perennial with no rhizomes. Height in flower

(20–) 35–84 cm. Basal leaves 3–6 mm wide, linear with a small rounded swelling at apex, bright green, sparsely covered with long colourless hairs. Inflorescence congested, rounded or lobed, often more than 1 cm in diameter, of 1–4 congested subsessile or sessile clusters of (28–) 50–100 flowers. Bracts (1–) 2–5 mm, longer than inflorescence, leaf-like. Perianth segments 2·5–3·5 × 0·5–1·0 mm, broadly lanceolate, reddish-brown, with broad hyaline margins, subequal. Anthers 1·5–1·7 mm, 1·5–3 × as long as filaments. Capsule 1·8–2·8 mm, obovoid to globose, apiculate, reddish brown, glabrous, shiny, shorter than perianth segments. Seed 1·1–1·4 × 0·6–1·0 mm, oblong/ovoid, about twice as long as wide, 0·4–1·2 mg, with ovate-triangular, flattened or trigonous basal appendage up to half as long as seed. 2n = 48.

Common on peaty soils in moist meadows, moors and bogs, with a broader tolerance range than *L. multiflora* subsp. *multiflora* and *L. campestris*, though intermediate in its requirements for pH (5–8) and organic content. Found in habitats associated with *L. campestris* i.e. the wetter areas of sheep grazed turf (cf. Kirschner 1991), where it is usually smaller and less tufted, and also together with *L. multiflora* subsp. *multiflora*. Has a broad altitudinal range, up to 500 m.

L. congesta is characterised by its large size up to 84 cm, congested inflorescence with a much longer bract, an anther length/filament length ratio of 1·5–2·0 (–3·0), perianth segments much longer than capsule values, the latter less than 2·8 mm long, and oblong/ovoid seeds with a mean length/breadth ratio of 1·5, and a mean seed weight of 0·66 mg.

DISCUSSION

TAXON STATUS

From the results obtained, it is evident that the taxa are well discriminated (supported by Wilk's Lambda) and that these can be separated on the basis of a few selected floral or fruit characters (Tukey LSD tests). Furthermore, the nature of the variation is such that whilst *L. congesta* exhibits character patterns most similar to *L. multiflora* subsp. *multiflora*, it is well circumscribed morphologically and has morphological characteristics and ecological preferences (see descriptions) which are frequently intermediate between *L. campestris* and *L. multiflora* subsp. *multiflora*, together with some that clearly place it with *L. campestris* (e.g. anther length, seed length, seed weight). On the basis of this pattern of variation it is maintained that the designation of *L. congesta* to the specific rank be supported, an opinion shared by Kirschner (1990).

CHARACTER ASSESSMENT

L. campestris/*L. multiflora* subsp. *multiflora*.

Characters traditionally used to discriminate between *L. campestris* and *L. multiflora* subsp. *multiflora*, include habit, height, number of floral clusters in the inflorescence, the nodding or straight inflorescence branches, relative length of the anther to the filament, the relative length of the style to the ovary, the relative length of the perianth to the capsule, seed shape and the presence of rhizomes (see Chrtek & Křísa 1980; Wigginton & Graham 1981; Clapham, Tutin & Moore 1987; Stace 1991). Only some of these characters were found to be consistently reliable, whilst the others were of use only at their extreme values. For material at anthesis, anther length and anther length/filament length ratio were found to be the most diagnostic, whilst at the fruiting stage, capsule length and seed shape were the most discriminatory. However, there is a small amount of overlap in both anther length and capsule length. The latter is usually expressed in Floras as a relative measure. The nodding tendency of the inflorescences of *L. campestris* is also a good diagnostic character. Of the vegetative characters, the morphology of the leaf apex (truncate versus rounded) and the presence of rhizomes in *L. campestris* have proved diagnostic, although the former needs to be assessed by comparison with standards of the two species to reduce subjectivity.

Of the other potential discriminating characters, these have proved to be of value only at the extreme values of each taxon. For example, the number of floral clusters and number of flowers within a cluster showed much more overlap than formerly acknowledged. The former character was only useful for specimens with eight or more floral clusters and twelve or more flowers within a cluster, in which case they belong to *L. multiflora* subsp. *multiflora*. However, specimens with stamen and fruit characters of *L. multiflora* subsp. *multiflora*, have been found with as few as four floral clusters. Similarly, height is often cited, with *L. multiflora* subsp. *multiflora* and *L. congesta*

given as being taller than *L. campestris*. Whilst specimens over 25 cm are usually either *L. multiflora* subsp. *multiflora* or *L. congesta*, height is environmentally plastic with considerable overlap occurring between the taxa. Similar tendencies (i.e. greatest values associated with *L. multiflora* subsp. *multiflora*) are also found for leaf width, leaf pubescence and leaf thickness.

In addition to the above characters, three new characters exhibited high diagnostic potential, being constant and with little or no overlap in their character ranges. These are capsule width, seed weight and guard cell length (see Tables 1 & 4), of which the latter character is correlated with the ploidy level. The first two characters are readily quantifiable on both field and herbarium material and their use is highly recommended. Guard cell length is less useful since the guard cells shrink to about half their fresh size on drying.

L. campestris/*L. congesta*

Of the characters usually cited for discriminating between *L. campestris* and *L. congesta*, the best were found to be anther length/filament length ratio and seed length/breadth ratio, the latter also being recognised by Wigginton & Graham (1981). The other characters of value usually showed some overlap in their ranges amongst the two species. *L. campestris* and *L. congesta* are most commonly distinguished on the basis of inflorescence shape, the former having at least two pedunculate clusters, the latter a much larger congested head. However, it should be noted that *L. campestris* is variable in this character, and may have either a lax or rarely a small and slightly congested inflorescence.

L. multiflora subsp. *multiflora*/*L. congesta*

In Britain, *L. multiflora* subsp. *multiflora* and *L. congesta* have traditionally been distinguished on the characters of inflorescence and relative capsule length (Clapham, Tutin & Moore 1987; Stace 1991). Kirschner (1990) also found the character of seed shape to be useful, and Kay (1993) cited anther length/filament length ratio and caruncle length as discriminatory. All these characters have been found to be useful (with the exception of caruncle length), with inflorescence type, seed breadth and seed weight being the best, the latter formerly unreported. Capsule length is also useful, although there is some overlap in character range between the taxa. Perianth length proved to be of little diagnostic value when used on its own, but it is useful as a relative measure.

Using the above diagnostic characters, little difficulty should be encountered in the identification of the majority of specimens. However, where a specimen is not easily identifiable, resort should be made to the summed critical values. Previously unidentifiable specimens (at either the flowering or fruiting stage) can successfully be assigned to one of the three taxa through the combined use of several characters, using the procedure outlined. The procedure will be particularly advantageous to those with little or no knowledge of the genus, and further offers the possibility of calculating the probability of correct identification (see Whitehead 1954). In addition, if information is absent for particular diagnostic characters, a re-summing of the class number can be made to take account of this absence. However, the omission of many characters is likely to reduce the size of the numerical gaps between the taxa, making identification more prone to error.

CONCLUSIONS

Considerable variation was found in the majority of the morphological characters previously used in discrimination such that their value in taxon diagnosis and identification was sometimes limited. Despite this, it was still possible to identify 18 characters which, when used in various combinations, allow the consistent separation of the taxa. Such characters expressed the greatest interspecific intraspecific variance ratios. Floral and fruit characters proved to be the most reliable, particularly the dimensions of the stamens, seeds and capsules and perianth width. It was found that no one character, either primary or derived, consistently allowed unequivocal identification of all specimens. In cases of doubt or difficulty, it is recommended that resort should be made to the summed critical value tables. It is further argued that *L. congesta* is distinctive in its morphology and ecology and, as such, warrants specific status.

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APPENDIX 1 – CLASS NUMBER STATISTICS USED IN THE CONSTRUCTION OF CRITICAL VALUES

Anther length/filament length ratio	0 = 1·000	100 = 9·380	increments = 0·083
Anther length/filament length ratio (dehisced)	0 = 0·510	100 = 4·580	increments = 0·041
Anther length (mm)	0 = 0·658	100 = 3·235	increments = 0·026
Capsule length (mm)	0 = 1·800	100 = 3·600	increments = 0·018
Leaf width (max.) (cm)	0 = 2·00	100 = 7·00	increments = 0·05
Perianth width (mm)	0 = 0·474	100 = 1·315	increments = 0·008
Seed breadth (mm)	0 = 0·500	100 = 1·105	increments = 0·006
Seed length/breadth ratio	0 = 1·000	100 = 2·620	increments = 0·016
Seed weight (mg)	0 = 0·180	100 = 1·200	increments = 0·010

Calluna vulgaris (L.) Hull dieback in Orkney, Scotland

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ABSTRACT

In recent years there have been occasional sightings of extensive *Calluna vulgaris* (L.) Hull dieback in communities of high nature conservation interest in Orkney (v.c. 111). The results of a systematic survey of dead stands are reported and the ability of *Calluna* to recover investigated.

KEYWORDS: heather dieback, Winter Moth, heather regeneration, conservation, moorland management.

INTRODUCTION

The *Calluna vulgaris* (L.) Hull (Ericaceae) (Ling, Heather) dominated communities of Orkney (v.c. 111) are of outstanding natural heritage interest providing breeding areas for Red-Throated Diver, Merlin, Golden Plover and Short-Eared Owl. All are listed in the *E.U. Directive on the conservation of wild birds* and the first two species are also protected by Schedule 1 of the *Wildlife and Countryside Act*, 1981. In Orkney areas of tall herb vegetation are found on open moorland yet in the rest of Scotland this vegetation is largely restricted to cliff ledges. In recent years regular muirburning has not been a feature of Orkney's moors and there are extensive areas of tall unmanaged *Calluna* which provide nest sites for one of the highest concentrations of breeding Hen Harriers in Britain (Batten *et al.* 1990). Thus the maintenance of areas of older heather is an important factor in retaining the natural heritage interest of the moors. Within the last decade there have been reports of extensive dieback in such stands ranging from one to 20 ha in size (Picozzi 1981). In the summer of 1993 the localities of all known outbreaks were mapped as part of the Scottish Natural Heritage funded project "Moorland Audit and Management in the Northern Isles". This included some areas previously identified by staff of Scottish Natural Heritage and the Royal Society for the Protection of Birds.

METHODS

Data from the Scottish Office Environment Department/Macaulay Land Use Research Institute project "The Land Cover of Scotland" were used to define the present extent of moorland on Orkney and a systematic search, using binoculars, was carried out during July and August 1993 on the islands of Mainland, Hoy, Rousay and Eday. Areas of dieback were highly visible from some distance and were confirmed by closer inspection. Locations were marked on 1:25,000 O.S. maps and transferred to a Geographic Information System (GIS). The distribution of dieback (Fig. 1) was compared with vegetation types from the Land Cover of Scotland data. Picozzi (1981) noted patches of heather dieback on Orkney and concluded that damage was caused by very high numbers of the larvae of Winter Moth (*Operophtera brumata*) and Dotted Border (*Agriopis marginaria*). As damage by Lepidopteran larvae can only be confirmed at a restricted period of time only sites at which larvae have been found were marked as such in Fig. 1 though all stands with dieback were

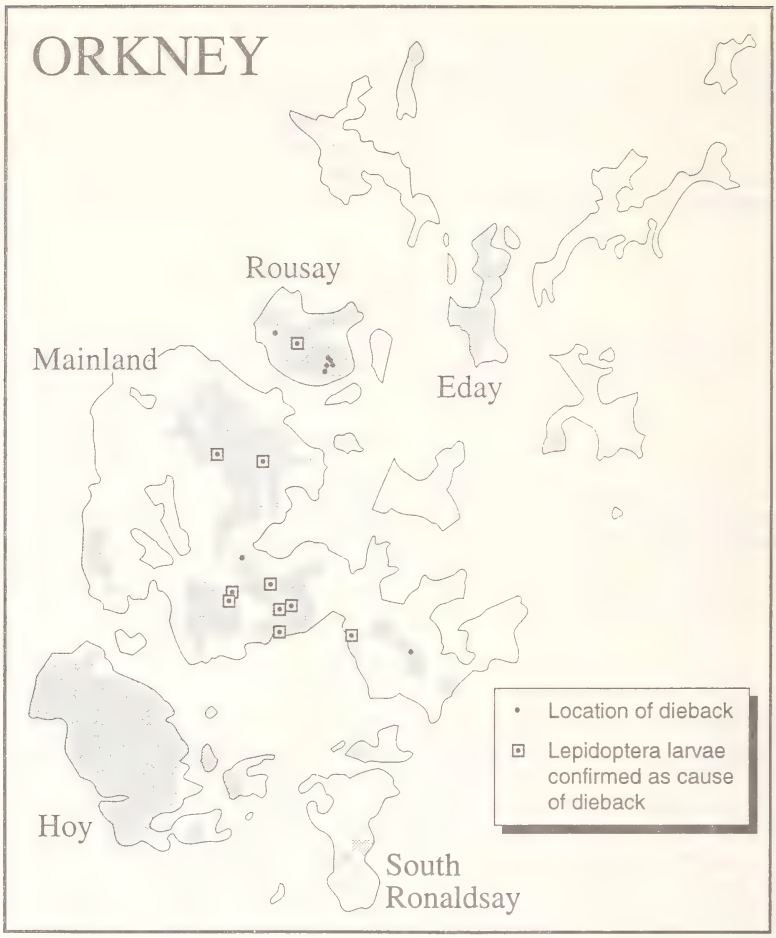

FIGURE 1. The distribution of stands of *Calluna vulgaris* dieback on Orkney (v.c. 111).

searched by walking through them looking for the larvae. The ability of *Calluna* to recover was subsequently investigated at a site at Queenamidda, West Mainland (HY/373.213) where dieback had occurred in 1980.

Using a random walk 100 8 cm × 8 cm quadrats were placed in the defoliated stand which was around 0·1 ha and the frequency of the following types of regeneration noted:

a. regrowth from near the tip of branches which had not been lethally damaged;
b. regeneration from the stem base such as occurs after muirburning (Miller 1980); and
c. new growth from "layering" stems buried in the litter layer (Beijerinck 1940; Scandrett & Gimingham 1989; MacDonald *et al.* 1995).

RESULTS

The locations of all known areas of dieback are shown in Fig. 1 and their relationship with communities derived from the Land Cover Data is summarised in Tables 1 & 2. Dieback had been recorded throughout the spectrum of dry to wet *Calluna* dominated communities though none had occurred in heather/grassland mosaics.

TABLE 1. OUTBREAKS OF *CALLUNA VULGARIS* DIEBACK ON ORKNEY IN RELATION TO THE LAND COVER OF SCOTTISH MOORLAND COMMUNITIES (MONTANE VEGETATION AND INDUSTRIAL PEAT WORKINGS HAVE NOT BEEN INCLUDED)

Land Cover Codes	Vegetation	Number of stands with *Calluna* dieback
110,114	Dry heather moor	3
130,134	Undifferentiated heather moor	4
120	Wet heather moor	1
180,182	Blanket bog	4
186	Areas of peat workings	3
370	Mosaic of undifferentiated heather moor and peat workings	0
657	Mosaic of peat workings and blanket bog	0
301,326,437,496,656	Heather/grassland mosaics	0
938	Blanket bog/grassland mosaics	0
1135	Mosaic of wet heather moor and point water	0
184	Blanket bog with dubh lochans	2
—	Boundary between undifferentiated heather moor and blanket bog	2
—	Boundary between dry and undifferentiated heather moor	1

TABLE 2. A SELECTION INDEX OF STANDS OF DEAD *CALLUNA* IN RELATION TO THE LAND COVER OF SCOTLAND COMMUNITIES

Vegetation	Area (ha)	Observed no. of stands with *Calluna* dieback (O)	Expected no. of stands if random selection (E)	Selection Index (O-E/ΣO)
Dry heather moor	1539	3·5	0·96	+0·14
Undifferentiated heather moor	13164	5·5	8·24	−0·15
Wet heather moor	1120	1	0·7	+0·02
Blanket bog	4897	5	3·1	+0·11
Areas of peat workings	5630	3	3·5	−0·03
Mosaic of undifferentiated heather moor and peat workings	66	0	0·04	–
Mosaic of peat workings and blanket bog	83	0	0·04	–
Heather/grassland mosaics	1823	0	1·08	−0·06
Blanket bog/grassland mosaics	5	0	0·002	–
Mosaic of wet heather moor and point water	205	0	0·1	–
Blanket bog with dubh lochans	211	0	0·1	–

(The occurrences on the boundaries of two types in Table 1 have been incorporated into this analysis by splitting equally between them.)

The frequencies of the different forms of regeneration at Queenamidda are shown in Fig. 2. Out of the total 100 quadrats some form of regeneration was taking place in each one. Regeneration from near the tip of branches was recorded in 39% of quadrats, from the stem base in 35% of quadrats and from layering stems in 36% of quadrats. Regeneration was only from the tip of branches in 21% of quadrats, only from the stem base in 26% of quadrats and only from layering stems in 34%.

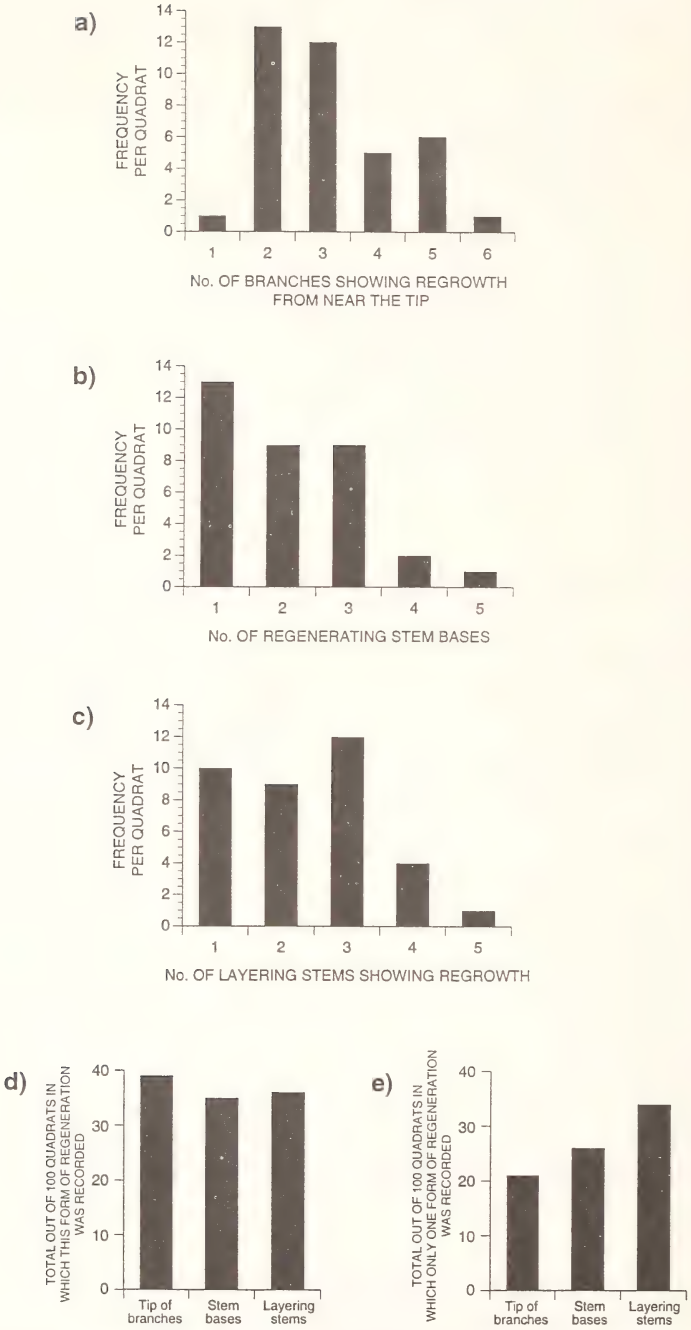

FIGURE 2. Frequency of regeneration of *Calluna* after defoliation by Lepidoptera from: a. regrowth near the tip; b. the stem base; c. layering stems; and d. the total number of quadrats in which a particular form of regeneration was recorded with e. total quadrats in which only one form of regeneration was recorded for 100 8 cm × 8 cm quadrats at Queenamidda, Orkney.

DISCUSSION AND CONCLUSIONS

Current data on *Calluna* dieback indicates that it can occur in both heather moorland and blanket bog though none was recorded in heather/grass mosaics of more heavily grazed areas.

Within recent years damage to *Calluna* stands by Winter Moth has been recorded from a range of sites in Scotland and recovery is often poor especially if the *Calluna* is old or there is high grazing pressure (Hartley & Kerslake 1995). The Orkney sites however contrast sharply with mainland Scotland where outbreaks have been found in *Calluna – Vaccinium myrtillus* moorland under heavy grazing pressure. In Orkney a wider range of *Calluna* communities have suffered from dieback and grazing has been light. With the importance of these areas for breeding Hen Harriers these outbreaks of dieback are a cause for concern.

The results in Fig. 2 indicate that recovery of *Calluna* cover proceeds very slowly so that if sheep numbers were increased on such sites conversion to grassland of lower conservation interest is likely to occur.

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Notes

JUNCUS CAPITATUS WEIGEL (JUNCACEAE) REDISCOVERED NEAR ITS ORIGINAL LOCALITY IN ANGLESEY (v.c. 52)

The dwarf rush, *Juncus capitatus* Weigel, is an annual with a predominantly southern distribution in Europe. It is known from the Channel Isles, the Isles of Scilly, the Lizard peninsula and a few other localities in Cornwall; the only other British records are from Anglesey where it is rare and elusive and recorded only from a few places in or near sand-dune systems on the south-west coast.

The first record of *J. capitatus* in Anglesey was made by Bolton King in August 1918. It was reported from near Rhosneigr "in good quantity over a limited area, but assuredly native, growing with the usual damp heath vegetation" (*Report of the Botanical Exchange Club* **5**: 402, 1918). Specimens were sent by King to G. C. Druce and in an accompanying letter (dated 13 August 1918), held with the material in **OXF**, he gave details of the locality at "the extreme northern edge of Towyn-Trewan, close to the S. corner of the encircling wall round a rocky mound called Carnau (?)". A few years later, Druce was sent a further Anglesey specimen of *J. capitatus* (in **OXF**) by Lady Kathleen Stanley who wrote on 25 June 1925 that "there was quite a lot of it at Tywyn Trewan quite close to Rhosneigr". Although precise details are not available, the latter locality is unlikely to be the same as King's and is probably to the south-east in another part of the extensive sand-dune and dune hinterland habitat at Tywyn Trewan.

In the 1940s, Tywyn Trewan was extensively modified by the construction of RAF Valley airfield, and as this encroached up to the wall of the Carnau mound (Roberts 1982) it had been assumed that *J. capitatus* was extinct at this locality. The site has been searched on various occasions in recent years, but always without success. It was thus a welcome surprise when *J. capitatus* was found nearby by one of us (T.H.B.) while recording bryophytes on 31 March 1995.

About 10–20 individuals were present on the sides of two adjacent small hollows within an old vegetated blow-out, in a stand of dune heath situated to the south-west of Carnau farmhouse, immediately to the west of the airfield perimeter fence. The deeper of the two hollows had a shallow depth of water, but the other was above the water table. The *J. capitatus* plants were in patches of very moist sand in a narrow zone above the base of the hollows, with only a very sparse cover of associated species, including *Carex flacca* Schreb., *Erica cinerea* L., *Lotus corniculatus* L., *Luzula* sp., *Pedicularis* (seedling), *Sagina* sp. and *Salix repens* L. The *Calluna-Cladonia* heath in the surrounding blow-out was interspersed with open bryophyte-covered patches, but no further plants of *J. capitatus* were detected in this or in other parts of the heath.

All the *J. capitatus* plants at this locality were already post-mature, brown and with few remains of basal leaves by the end of March 1995; the inflorescences were still intact, but the capsules had all dehisced and were empty. A few shoots were collected and have been deposited in **NMW**.

Elsewhere in Anglesey, there are records from two other dune systems. It was observed on a field excursion of the Botanical Exchange Club in June 1937 from "S.W. side of Newborough Warren" (*Report of the Botanical Exchange Club* **11**: 49, 1937); no further details are available, and *J. capitatus* has not been recorded again from this locality where its habitat may have been destroyed by the establishment of a conifer plantation. It has also been reported from Tywyn Aberffraw by J. G. Duckett and J. N. B. Milton, and a specimen (now in herb. **A. J. Byfield**) was gathered in August 1983 "on damp sand" with two of the liverwort specialities of the Aberffraw dune system, *Petalophyllum ralfsii* (Wils.) Nees & Gott. and *Southbya tophacea* (Spruce) Spruce. More recent searches at this site by R. H. Roberts and others have been unsuccessful.

J. capitatus has thus been recorded only very sporadically and locally in Anglesey from three sand dune systems. Viable seed of this species can remain dormant for at least 29 years (Coombe 1987), and its reappearance near Carnau demonstrates that it can persist unnoticed for over 50 years. Londo & van Leeuwen (1974) reported the appearance of *J. capitatus* at a new locality within a dune system in the Waddendistrict of The Netherlands following the creation (by excavation) of

depressions which were part-flooded in winter. A curious feature of the Anglesey records is their seasonal range; *J. capitatus* (presumably always with inflorescences) has been observed in March, June and August, suggesting variable phenological behaviour.

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We are very grateful to R. H. Roberts for details about Anglesey localities of *J. capitatus*, as well as for comments on this note in draft. Thanks are also due to A. J. Byfield, Dr D. E. Coombe, Professor J. G. Duckett and Gwynn Ellis for providing helpful information.

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RUBUS PANNOSUS P. J. MUELLER & WIRTGEN (ROSACEAE) IN BRITAIN

Watson (1958) described *Rubus gravetii* as "very rare; [v.c.] 15 (Bigbury to Chartham Hatch), [v.c.] 18, (Epping Forest, High Beach). Belgium, W. Germany." No search has yet been made for the plant in v.c. 15, E. Kent, but during the summer of 1995 A.L.B. studied intensively the Rubi of the whole northern half of Epping Forest, S. Essex (v.c. 18), on behalf of the Superintendent of Epping Forest (Corporation of London). The plant was already known to him from visits to the Forest in 1987 and subsequently. It had been determined by A.N. as "false *gravetii*" with the proviso that it had not been compared critically with the Continental European plant since Watson's time and could possibly be the same. Watson's Bigbury-Chartham (v.c. 15) specimen (**SLBI**) had, however, been compared with the type of *gravetii* by Newton and E. S. Edees in 1978, when its identity was rejected.

Interestingly, the "false *gravetii*" was met with only once in the northern part of the study area, whereas the closely related *Rubus fuscus* Weihe was frequent and occurred at nine of the study sites. In the southern and south-western part of the study area *R. fuscus* was only found once, but the "false *gravetii*" was abundant and often dominant in eleven sites. At this time the plant was accepted as being "probably a local endemic."

During August 1995, whilst revisiting the tetrads covered by the Norfolk B.S.B.I. recording weekend in June to record the Rubi, A.L.B. discovered "false *gravetii*" to be frequent on the Sheringham Park estate at NGR TG/1.4.

As it had now been established that the plant was not an Epping Forest endemic, a specimen was sent to Professor H. E. Weber (University of Osnabrück, Germany) with the request that if possible he compare it with the Continental *R. gravetii*. In his reply, he stated that he and Dr G. Matzke-Hajek (of Alfter, Germany) had independently examined the specimen and both had determined it without hesitation as *Rubus pannosus* P. J. Mueller & Wirtgen: however he wished to see photocopies of additional herbarium specimens. Among the photocopies sent to him were copies of specimens from both the Epping Forest and Sheringham Park populations. All of these were accepted by Weber as falling within the range of possible intraspecific variation.

After some discussion, A.N. offered to borrow specimens of *R. gravetii* and *R. pannosus* from **MANCH** for comparison. The sheets examined were as follows:
Rubi praesertim Gallici exsiccati (1895) no. 39, coll. F. Gravet (an isolectotype of *Rubus gravetii*).

Wirtgen Herb. Rubor. Rhen. ed. 2, fasc. 2 no. 77, *Glandulosi* Muell.: "Bopparder Walde hinter Waldesch bei Coblenz", 17. vii. 1859 (the holotype of *R. pannosus*).
G. Braun Herb. Rub. Germ. no. 134, coll. [Th.] Braeucker, "in der Rheinprovinz" (*R. eifelensis* Wirtgen).
Wirtgen Herb. Rubor. Rhen. ed. 1, fasc. 4, no. 94 (*R. eifelensis*).

The last-named sheet above was laid aside as being distinctly different from the other three, which were subjected to intense scrutiny. Syntypes of *R. pannosus* all belonging to set 77 had been sent from **BM** and **BR** and were included in the comparisons. It was concluded that, despite minor differences, chiefly with regard to leaf shape, all three belonged to the same species and that they matched the Epping Forest plant well. Thus, while Watson was correct in equating the Epping Forest plant with that distributed by Gravet in 1895, the name *Rubus pannosus* P. J. Mueller & Wirtgen has priority. *R. pannosus* should therefore be admitted to the British list with a known distribution of NGR: TL/4.9 and TL/4.0, Epping Forest (v.c. 18); TG/0.3, Holt Lowes (1972, **herb. A.L.B.**); and TG/1.4, Sheringham Park (both v.c. 27, E. Norfolk).

We have also studied the defective holotype specimen (**BR**) and other specimens of *Rubus cinerascens* Weihe ex Lej. sent from Belgium by H. Vannerom, which he considers to be conspecific with *R. pannosus* and *R. gravetii*, but this identity in our opinion cannot be sustained.

Rubus pannosus may be recognised by its villous stem, deep reddish-black in colour, the hairs covering dense, short, blackish glands. The prickles are short-based, straight, somewhat slanting, fairly many, and coloured like the stem. The leaves are digitate, softly pilose, especially on the veins beneath, which are pectinately hairy. The terminal leaflet is ovate or elliptical, acuminate, the base somewhat cordate or emarginate. The panicle is pyramidal, usually round-topped, the middle and lower branches long and spreading, the pedicels exactly patent when well developed, armed and coloured like the stem. The white-edged sepals may be loosely reflexed or patent, sometimes long pointed. The petals are narrowly obovate, mid-pink; the filaments are pink and a little longer than the deep red styles.

R. fuscus Weihe differs in the stem being not quite so densely hairy or glandular, but with fairly numerous pricklets. The leaves are more abruptly and shortly acuminate, and the margins less evenly serrate. The panicle of *R. fuscus* is longer and more symmetrically pyramidal than *R. pannosus*, and the petals in the Epping Forest population of the former are typically several shades darker than *R. pannosus*, often almost red.

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THE STATUS OF *PULICARIA VULGARIS* GAERTNER IN BRITAIN IN 1995

In 1990 the Hampshire Wildlife Trust undertook a national census of *Pulicaria vulgaris* Gaertner, Small Fleabane (Asteraceae). All surviving populations were identified and surveyed. The population was estimated at 10,000 plants. Of all the populations in Britain 98% were found in S. Hants (v.c. 11), the majority in the New Forest with outliers in the Avon Valley. The remaining

populations were found in the Thames Basin of N. Hants (v.c. 12) and Surrey (v.c. 17). A summary of the 1990 survey results was published in *Watsonia* **18**: 405–406.

Since 1990 there have been resurveys of selected populations by Wildlife Trust volunteers and a collation of population studies pre-dating 1990. These studies, together with informal observations of various sites, suggested that the plant may still be in decline in various localities. This general concern prompted the 1995 survey.

The 1995 survey was undertaken by Lady Rosemary FitzGerald, assisted by Geoffrey Field, Elizabeth Young, John Ounsted and Joyce Smith. The 1995 survey adopted the same methodology as the 1990 survey. Small Fleabane was refound at all of the sites identified in 1990. The plant was not refound in any sites whose populations were considered extinct by 1990, nor was it reported from entirely new sites. Since 1990 additional populations have been found within the immediate vicinity of known sites. Some of these extentions to populations identified were significant, particularly those associated with farmyards and enclosed lands in S. Hants.

The British population of Small Fleabane in 1995 was estimated at some 28,000 plants. The distribution of plants by vice-county was found to be very similar to the 1990 survey, with 98% of the population in the Hampshire Basin, S. Hants. (v.c. 11), with 87% in the New Forest and 11% in the Avon Valley. The Thames Basin supported 2% of the population, 1·5% in N. Hants. (v.c. 12) and 0.5% in Surrey (v.c. 17).

The 1995 populations were compared to the 1990 survey and a partial 1985 Nature Conservancy Council survey, together with other records for the sites. Some well recorded sites have been recorded up to 13 times over the last three decades.

Since the onset of detailed recording in 1985, only one area had entirely lost its population of Small Fleabane in Britain. This was a population formerly known from English Nature's Ashford Hill National Nature Reserve in N. Hants. As a result of the 1995 survey remedial works to revive the population have been adopted.

The population size in Britain as a whole has decreased by an order of magnitude from over 100,000 plants in 1985. This decline had occurred by 1990 and was not considered to be significant in conservation terms (Chatters 1991). The national decline is predominantly accounted for by changes in a single sub-site which still supports a healthy dynamic population.

Since 1990 four areas have experienced increases in their Small Fleabane population which are considered to be significant. In two sites the populations increased by one order of magnitude and in two other sites by two orders of magnitude. No sites have declined by one or more orders of magnitude.

Whereas Small Fleabane is usually associated with grazed village greens and heathland edges, the 1995 study found it in enclosed farm lands and within non-intensively managed farm-yards. Historic ecological studies revealed that these were former commons and greens or closely associated with the same. The farmyard habitats have not been described previously and pose unusual challenges to ensure continuity of management to conserve the population.

This survey would not have been possible without the financial assistance of English Nature's Species Recovery Programme and the Guinness Trust. We are also very grateful for the assistance of the many landowners and managers on whose private property Small Fleabane grows.

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A WOLLEY-DOD LETTER OF HISTORICAL INTEREST

The following letter from A. H. Wolley-Dod to the Rev. H. J. Riddelsdell was found in one of the folders of the **BM** British *Rosa* collection. It is reproduced here exactly as Wolley-Dod typed it, apart from the correction of a few obvious typing errors.

Glenrinnes,
Tadworth, Surrey.
18th Oct. 1920

Dear Mr. Riddelsdell,

I have not been many days over your roses, but that is not much indication of the number of hours spent. I have done little else since they came. My motives were partly selfish, because I had just started on a parcel for Dingler when they arrived. I fear I shan't get much out of him, and that not for some months. He finds British Roses very difficult and grudges the time they take.

As you anticipate, my criticism of your plants in general is that you have collected too indiscriminately. It is easy to go out and cut a specimen from every bush you see, but it is quite another matter to name them. Personally I pass over 50% of the bushes I see as unnameable, and only collect those which are in good condition and which present some marked feature. This of course is shirking my responsibilities but the difficulties are greater than I can face. Another result of indiscriminate collecting is the number of bad specimens; I mean those which are badly grown or in some way abnormal. In so difficult a genus only the best grown material gives a critic a chance, that is the stuff must be characteristic of the bush it is cut from, and that bush should be a well grown one. Someone once said that the average herbarium is a collection of freaks, meaning that botanists have a tendency to gather unusual looking specimens, just to show how species vary. That is all very well in general where the species and varieties are more or less easily recognisable, but it will not do in Rosa.

Another minor point, which concerns your own herbarium more than my determinations is the awkward shape of some of the specimens owing to your having cut pieces with the old stem not in the same plane as the flowering branches. Old stem is often desirable, since the prickles on the flowering shoots are often not characteristic of the specimen, but you can almost always get these of a less awkward shape. Some of your worst bits have not even prickles on them so that they are useless encumbrances.

One more suggestion is that you try and arrange your gatherings in Groups. No doubt you will make mistakes. I do so myself, but it is very helpful to have all of one affinity together, if only to facilitate reference to my own herbarium. Moreover the chances of my giving the same name to different varieties or conversely, is reduced.

I hope you won't mind these criticisms, but I hope they may help you as well as me.

I have got quite a lot of N.C.R.s for Gloster, but very few for Oxon as Druce has skinned that V.C. fairly closely. I am surprised at the absence or rarity of several of what I had regarded as our commoner forms e.g. viridicata, stenocarpa, adscita, andegavensis, urbica, trichoneura, jactata, Gabrielis, (the last 3 I think totally absent, but all very near urbica and semiglabra). Typical dumetorum is also absent, but I believe that to be rare. All Deseglisei, not a very common Group, also do not appear nor do Villosae (except one abnormal plant) and Rubiginosae. I am not surprised at seeing no Glaucae or Coriifoliae, as they thin out greatly as you go S.E., still Gloster is hardly S.E., nor is Oxon.

Do not be surprised at my nomenclature. I think in the last lot I did for you I followed that I had adopted in my last paper, but I am contemplating changes, not so much in names as in combinations, e.g. I shall probably drop R. lutetiana as a type, i.e. species name, and go back to R. canina. I have therefore in the main given you the names in the form their authors wrote them.

I am not sure that I am not wrong in attempting to name more than above 30% of what I see. The more I see of the genus the more new combinations of characters appear. Doubtless many of these have names, but they are unknown to me. I have at least 100 names from Sudre and Dingler which I do not use, since the specimens seem to me to be too near to other better known ones, or are probably those of individual bushes which I should not adopt unless they presented very striking features. I am getting stronger in the opinion that Roses are classified on wrong lines. They are much over-split, and the Subgroups, and even some Groups are based upon purely artificial characters, so that plants which have great natural affinities get widely separated. I believe we may have species

which may be glabrous or hairy, uniserrate or biserrate, glandular or not, with variations in the fruit, sepals and style. So you may say we have if I adopt R. caninae as a large aggregate species, but I mean its varieties should be associated on different grounds, abolishing most of its Subgroups, though how to do it beats me. If only I could find someone in England who knows roses well enough to discuss these matters, I should feel happier. As it is I fear I shall develop into a dictator, with no one able, if I may say so, to contradict me. The result may be disastrous. Still former rhodologists have differed so widely in their treatment of the genus that I may perhaps be allowed to be original, but I hope not comic or worse.

Yours sincerely
(signed) A. H. Wolley-Dod.

The main interest of this letter arises from the fact that it was written at a time more or less half way between the publications of Wolley-Dod's major papers: *The British roses* (1908 and 1910) and his *Revision of the British roses* (1930–31). It is plain from this letter that he was dissatisfied with the state of affairs at that time, if not actually bewildered by it. He came to distrust Sudre's determinations, and based his nomenclature on that of R. Keller, though realising that British material could not necessarily conform with the large numbers of named varieties and forms derived from Continental specimens. E. B. Bishop, on the other hand, working concurrently with Wolley-Dod, tried to follow Keller exactly, with the result that he grossly over-collected, as his large herbarium collection in **BM** shows: there are literally hundreds of specimens of *R. canina* from the small areas around Godalming in Surrey and near Ailsworth in v.c. 32 (Northants). This is one of the things which Wolley-Dod was warning Riddelsdell against in the letter here reproduced. When Wolley-Dod published his *Revision of the British roses* he reduced the species to a workable number, dividing some of the species into "groups" which though not strictly valid taxonomically, at least provided pigeon holes into which the majority of the roses could be placed. The varieties and forms which he retained were less satisfactory, as Wolley-Dod himself (1936) came to realise. Though Wolley-Dod's system can be criticized in the light of modern taxonomic opinion, he did produce some order out of chaos, and provided a workable system which served British rhodologists for 60 years.

It is a pity that Wolley-Dod would not admit the possibility of extensive hybridization in *Rosa*; he would only allow a rose to be a hybrid if it showed complete or partial sterility. Had he allowed for this, with his intimate knowledge of the British roses he could have arrived at a system more conformable with modern taxonomic opinion. Also it appears from his writings that he was aware of the researches of Blackburn & Harrison (1921) into the peculiar reproductive behaviour of the caninoid roses, but did not seem to realise their significance. It was not until 1975 that R. Melville, by the publication of his account of British *Rosa* hybrids, provided a basis for research (Melville 1975; Graham & Primavesi 1990). This made possible a complete revision of the British roses, as described in Stace's *New Flora* (1991) and *Roses of Great Britain and Ireland* (Graham & Primavesi 1993). Further research is still required, especially for the informal groups of *R. canina*, but at least it can be said that taxonomy of British *Rosa* is now placed on a firm and sound basis.

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ALIEN PLANTS AT FOYNES PORT, CO. LIMERICK (V.C. H8), 1988–1994

Despite their obvious potential as sites of plant introductions, there have been no published botanical surveys of ports in Ireland prior to the survey of alien plants made at Dublin Port for 1988–1994 (Reynolds 1996a). This note and list of established and casual alien plants at Foynes Port, Co. Limerick (v.c. H8), has been written to complement the list for Dublin Port.

Foynes Port (grid ref. R/25.51), on the Shannon estuary about 30 km west of Limerick city, is the largest public port in the west of Ireland, and the only west coast port with a substantial trade in animal feed. It has a land area of 52 ha and the annual total throughput was approximately 1 million tonnes in 1988, increasing to 1·5 million tonnes in 1994, with imports making up 88% of the total throughput in 1994 (M. V. O'Brien, pers. comm. 1996). Animal feed, including grain, made up 25% of imports in 1988, increasing to 43% in 1994. Over the study period, about 60% of the animal feed was imported from New Orleans, and the next most common sources were Indonesia and Malaysia. Some feed also came from China and more rarely Argentina. Other imports were coal, fertilizers, petrol, fuel oils and molasses. Although the port had been botanized regularly since 1977, there was no conspicuous influx of alien plants before 1988 (Reynolds 1990).

In 1988, there was a luxuriant growth of alien plants at Foynes Port, with many rare and new species, and the probable source was as seeds with the imported animal feed. Animal feed was normally unloaded by grab into lorries, stored in nearby warehouses and then transported from the port by road, so there was a certain amount of spillage at each stage. Open land at Foynes Port is largely unpaved, unlike Dublin Port, where there is little unpaved ground near the docks. At the eastern edge of Foynes Port, there is an area of newly reclaimed land, which has also been used as an unofficial dump since 1994.

Established and casual alien plants have been a botanical feature of Foynes Port since 1988, and a list of all those species found in the port area from 1988 to 1994 inclusive is given in Table 1. Detailed records for some of these have already been published (Reynolds 1990, 1992, 1993, 1994, 1996b). The alien species which occurred in the greatest numbers over the seven years were *Amaranthus retroflexus* and *Thlaspi arvense* while *Erucastrum gallicum*, *Setaria viridis* and *Erysimum cheiranthoides* were much less frequent. Many other species were found only in small numbers, such as *Amaranthus albus*, *A. hybridus*, *Chenopodium* spp., *Echinochloa crusgalli*, *Lepidium* spp., *Matricaria recutita*, *Sinapis alba* and *Sisymbrium loeselii*. On the newly reclaimed area in 1994, *Amaranthus retroflexus*, *Chenopodium ficifolium* and *Erucastrum gallicum* thrived, intermingling with potatoes (*Solanum tuberosum*), tomatoes (*Lycopersicon esculentum*) and other plants of local domestic or garden origin. *Hordeum distichon* has been exported from Foynes, hence plants occur casually.

Compared to the 66 species found at Dublin Port over the same period (including *Rapistrum rugosum* 1988–1994, which was inadvertently omitted from the Dublin Port list), 41 species were found at Foynes Port, with an overlap of 24 species (Table 1). Some plants which were very common at Dublin Port were not found at Foynes, for example, *Conyza canadensis*, *Melilotus officinalis*, *Rapistrum rugosum*, *Senecio squalidus*, *Sisymbrium orientale* and *Hordeum murinum*. *Hirschfeldia incana* has been abundant in parts of Dublin Port since at least the early 1980s (Rich 1988), but it was only seen for the first time at Foynes in 1992, where it is now well established particularly on stony ground.

TABLE 1. ESTABLISHED AND CASUAL ALIEN PLANTS FOUND AT FOYNES PORT, CO. LIMERICK, FROM 1988 TO 1994, WITH YEAR(S) WHEN FOUND.

Species	Years found at Foynes Port	Origin	Recorded at Dublin Port
Amaranthus albus	1989, 1990	Gr	
Amaranthus hybridus	1990	Gr	
Amaranthus retroflexus	1988–1994	Gr	D
**Avena fatua*	1988–1990, 1992, 1994		D
Avena sativa	1989, 1994	Cult	D
Bassia scoparia	1988, 1989	Gr	D
Brassica juncea	1993	Gr	
**Brassica napus*	1988, 1989	Cult	
**Buddleja davidii*	1993	Cult	D
**Camelina sativa* s.s.	1988, 1989		
**Chaenorhinum minus*	1993		D
Chenopodium capitatum	1988		
Chenopodium ficifolium	1994		
Chenopodium glaucum	1988–1990		D
Chenopodium leptophyllum	1990	Gr	
Chenopodium strictum	1988	Gr	
Crepis tectorum	1988–1991	Gr	
**Echinochloa crusgalli*	1990		D
**Epilobium ciliatum*	1989, 1993		D
Erucastrum gallicum	1988–1994	Gr	D
**Erysimum cheiranthoides*	1988–1993		D
**Hirschfeldia incana*	1992–1994	Gr	D
Hordeum distichon	1988, 1989, 1992, 1994	Cult	D
Hordeum vulgare	1989	Cult	
Lepidium ruderale	1990		
Lepidium virginicum	1989	Gr	
Lycopersicon esculentum	1993, 1994	Cult	D
**Matricaria discoidea*	1988–1994	Gr	D
**Matricaria recutita*	1988, 1989		D
**Phalaris canariensis*	1993	Gr	D
Pisum sativum	1992	Cult	D
**Senecio viscosus*	1993		D
Setaria viridis	1988–1993	Gr	D
**Sinapis alba*	1990	Cult	
Sisymbrium loeselii	1988	Gr	
Solanum tuberosum	1994	Cult	D
**Tanacetum parthenium*	1993	Cult	
**Thlaspi arvense*	1988–1994		D
**Trifolium hybridum*	1988	Gr, Cult	D
Triticum aestivum, unawned	1989, 1994	Cult	D
Tropaeolum majus	1994	Cult	

Nomenclature follows Stace (1991).
* = listed in Scannell & Synnott (1987) as an established alien in Ireland.
Gr = known grain alien (Clement & Foster 1994; Ryves, Clement & Foster 1996).
Cult = of garden or agricultural origin.
D = recorded at Dublin Port 1988–1994 (Reynolds 1996a).

Several species which are not considered to be 'certainly introduced', i.e. alien, in Ireland (Scannell & Synnott 1987), but which are almost cosmopolitan (Clapham, Tutin & Moore 1987), were likely to have been introduced with animal feed at Foynes Port, for example, *Descurainia sophia* (1988–1992) and *Spergula arvensis* (1988–1991). In addition, it should be noted that some species which are considered native or probably native in Britain and so excluded from Clement & Foster's (1994) list of aliens, may have arrived at Foynes Port as grain aliens, the grain being used for

animal feed. For example, *Thlaspi arvense* was abundant at the port and was found with other aliens on roadsides leading away from Foynes; it is otherwise rare in Ireland.

In 1995, despite some use of weedkiller, alien plants were again conspicuous. A new addition was *Malva pusilla*, a distinctive mallow with tiny pale flowers, which is unlikely to have been missed in previous years. As has been described elsewhere (Reynolds 1992), many alien plants found at Foynes Port have also been found on roadsides in Co. Limerick. Although some, such as *Amaranthus retroflexus*, *Setaria viridis* and *Thlaspi arvense*, are capable of setting seed successfully under Irish conditions, presumably there are also fresh introductions of aliens each year with spilt animal feed, mainly grain and feed nuts. Such plants are particularly noticeable where grass verges have been scraped back mechanically to expose new soil. So far there is no evidence that any of the plants recorded at Foynes Port are competing with the native flora or are becoming invasive in natural habitats.

ACKNOWLEDGMENTS

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THE PUTATIVE HYBRID BETWEEN TWO TEASELS, *DIPSACUS FULLONUM* L. AND *D. SATIVUS* (L.) HONCK. (DIPSACACEAE) IN DUBLIN (v.c. H21)

Dipsacus fullonum L., Wild Teasel, is native in the British Isles; it is common in south-east Britain and more local elsewhere. *D. sativus* (L.) Honck., Fuller's Teasel, is not native, and its origin is uncertain; it is grown for fulling (raising the nap on woollen cloth) in Somerset, and is also known as an escape from cultivation and a bird-seed alien (Stace 1991; Clement & Foster 1994). Topham (1968) and Ryder (1996) have written interesting accounts of Fuller's Teasel in Britain. In Ireland, Colgan (1904), quoting an earlier work published in 1772 which described the 'Manured Teasel' as

being "cultivated and dried for the use of the clothiers in Dublin", then commented that the wild teasel in Co. Dublin was "perhaps but a reversion from the plant once so cultivated". *D. sativus* (as *D. fullonum* subsp. *sativus*) has been recorded as a casual with *D. pilosus* in Co. Down (v.c. H38) in 1915 (Hackney 1992) and at one site in Co. Dublin (v.c. H21) since 1990 (see below). There are no specimens of *D. sativus* in the herbaria at the National Botanic Gardens, Dublin (**DBN**), Ulster Museum, Belfast (**BEL**) or Trinity College, Dublin (**TCD**).

In the past, the two taxa in question were frequently treated as subspecies of *D. fullonum* (e.g. Clapham, Tutin & Warburg 1962), but currently they are recognized as distinct species (Hansen 1976; Kent 1992). Recently, the status of *D. sativus* as a distinct species has again been questioned (Ryder 1996). I have not been able to discover any mention of the hybrid between these species in continental Floras despite most of them recognizing two separate species. However, the hybrid between *D. fullonum* and *D. laciniatus* L. has been found in a garden in England (Campbell 1993), and it is well known on the continent (C. A. Stace pers. comm., 1996).

In the British Isles, I am aware of only two possible occurrences of the putative hybrid between *D. fullonum* and *D. sativus*. Firstly, there is a record of *D. sativus* at Bradger's Hill in Bedfordshire "with intermediates with *D. fullonum*" (Dony 1953). Secondly, in a letter to C. A. Stace dated 27 June 1974, Dr J. T. H. Knight wrote that he had found "the putative *Dipsacus* hybrid near Langport in Somerset some two miles [3 kms] east of the town in 'Wagg Drove' which lies off the Langport-Wincanton road. It was mid-August [probably 1973] . . .". Dr Knight was attracted by the tallness of the plants and "certain features of the inflorescence". He also added that *D. sativus* was grown as a crop some five miles [8 kms] west of Langport. A slide of the putative hybrid taken by Dr Knight, and seen by me, resembles the plant found in Dublin (described below).

In Co. Dublin, *D. fullonum* is more common along the coast than inland. It has been abundant on an area of reclaimed land at the edge of Dublin Bay, known informally as 'Ringsend Dump' (Grid ref. O/19.33) since at least the early 1980s. In July 1990, a few plants of *D. sativus*, also a biennial, were found in one patch on a cleared gravel site at Ringsend Dump, with dense stands of *D. fullonum* within 100 m. A small number of *D. sativus* plants have been found in the same place every year since then. In 1994 a possible intermediate between the two species was seen, but not further

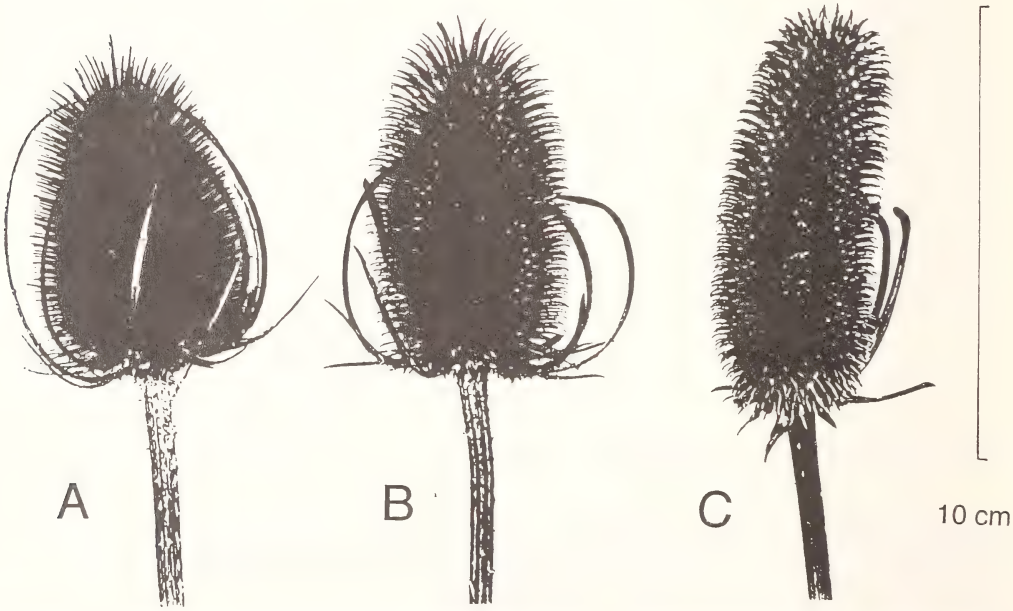

FIGURE 1. Mature, dried flower heads showing the involucral and receptacular bracts of: A. *Dipsacus fullonum*, B. the intermediate, and C. *D. sativus*, from Ringsend Dump, Dublin.

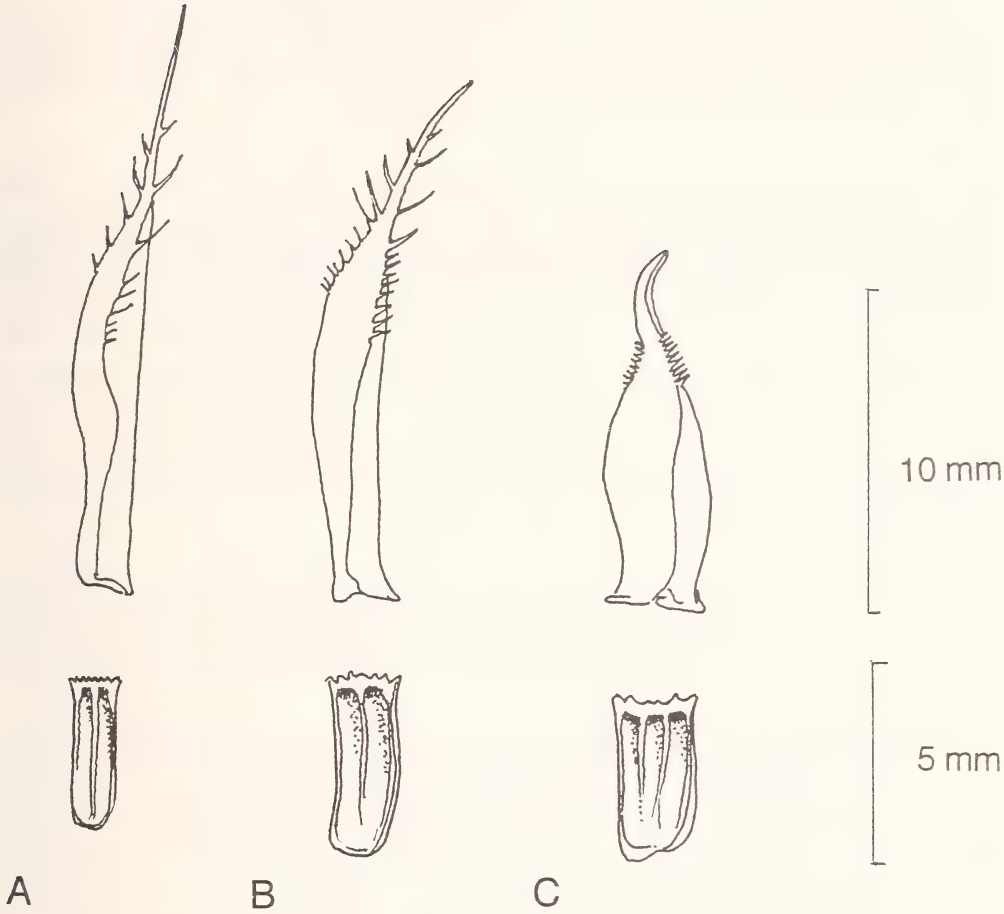

FIGURE 2. Drawings of the receptacular bracts (above) and seeds of: A. *Dipsacus fullonum*, B. the intermediate, and C. *D. sativus*, from Ringsend Dump, Dublin.

TABLE 1. LENGTHS AND WIDTHS OF MATURE SEEDS OF *DIPSACUS* FROM RINGSEND DUMP, DUBLIN (MEAN AND RANGE (IN BRACKETS) FOR 20 SEEDS OF EACH TAXON)

	D. fullonum	Intermediate	*D. sativus*
Mean length (mm)	3·7 (3·1–4·1)	4·6 (4·0–5·0)	4·3 (3·8–4·7)
Mean width (mm)	1·1 (0·9–1·8)	1·8 (1·3–2·2)	2·0 (1·7–2·3)

checked. The following year, when the site was visited with the Dublin Naturalists' Field Club on 9 August 1995, there were two plants of *D. sativus* and, beside them, one large plant with conspicuously intermediate characters between it and *D. fullonum*, particularly noticeable in the involucral and receptacular bracts, and stem leaves. This plant was 2 m tall with about 30 inflorescences. Presumably the more distant *D. fullonum* provided the pollen for this cross.

Further visits were made to the site later in August and in mid-September, when specimens were taken and seeds collected. Fig. 1 shows whole flower heads, and Fig. 2 shows details for the receptacular bracts and seeds. Descriptions of some characters of Ringsend Dump plants in fruit are given below for both parents and for the intermediate. Measurements were made on 20 mature seeds (Table 1). Voucher specimens have been deposited in **DBN**.

D. fullonum
Stems with many prickles; stem leaves with sharp prickles on underside of midrib; the longer involucral bracts spiny, curving upwards, usually as long as or exceeding the inflorescence; receptacular bracts with long straight flexible spines, conspicuously ciliate; seeds longer than wide, c. 3·7 × 1·1 mm, four-sided with one longitudinal ridge in the middle of each side, brown with appressed hairs.

D. sativus
Stems with fewer, shorter, blunter prickles than *D. fullonum*; stem leaves with no prickles on underside of midrib; the longer involucral bracts not spiny, spreading, much shorter than the inflorescence; receptacular bracts stiff, short with strongly recurved tips, inconspicuously shortly ciliate; seeds longer than wide, c. 4·3 × 2·0 mm, four-sided with one, two or occasionally three longitudinal ridges in the middle of each side, pale brown with silvery white appressed hairs, more densely hairy than *D. fullonum* or the intermediate.

Intermediate
Stems with fewer prickles than *D. fullonum*; stem leaves with prickles on underside of midrib; the longer involucral bracts curving upwards, usually shorter than the inflorescence, somewhat spiny; receptacular bracts stiff, slightly recurved at the tip, longer than in *D. sativus*, ciliate; seeds longer than wide, c. 4·6 × 1·8 mm, four-sided with usually one longitudinal ridge in the middle of each side, occasionally two, dark brown with appressed hairs.

It was noted that the length of the longest involucral bracts and degree of prickliness of the stems were variable on individual plants at Ringsend Dump. However, the structure of the receptacular bracts was much more constant for each taxon. Mature, dried seeds of *D. fullonum* were distinctly smaller and narrower than those of *D. sativus*, while the seeds of the intermediate were slightly larger and darker than those of the latter species. By mid-September, the seeds of all three taxa were mature and being released from the inflorescences. Seed-set was as good in the intermediate as it was in both parents. Seeds of the intermediate, planted outdoors in the author's garden in November 1995 had germinated by early April 1996, while others planted indoors on 5 April 1996 had germinated eleven days later.

As *Dipsacus* seeds are heavy and have no adaptation for wind dispersal, many will drop beneath the parent plants; hence *D. fullonum* may form dense stands. However, the number of *D. sativus* plants at Ringsend Dump has not increased since 1990. At that time, the site was more open than in August 1995 when it and the intermediate were growing among a dense cover of *Agrostis stolonifera*, *Dactylis glomerata*, *Cirsium arvense*, *Plantago lanceolata*, *Hypochaeris radicata*, etc. In September 1995, the area had been burnt leaving small patches of open ground. This may allow new plants to establish themselves more easily.

There are many plants of garden origin at Ringsend Dump, and it is possible that the *D. sativus* arrived here as seeds in garden refuse. The 1993 catalogue for Chiltern Seeds listed *D. fullonum*, "used by fullers", as "one of the most popular flowers for drying for use as flower arranging material", also attractive to bees and butterflies, and easily grown. It is also listed in the 1996 Thompson & Morgan catalogue, with *D. sativus* given as a synonym. The picture on the seed packet, only labelled 'Teasel', is that of *D. sativus*; however the seeds are not identical with those of that species collected at Ringsend Dump. The description on the packet says that the cylindrical heads are evenly covered by hooked spines used for raising the nap on cloth, but then goes on to describe this teasel as a "native" plant. The picture on the Suttons Seeds 'Teasel (*Dipsacus fullonum*)' packet appears to be of Wild Teasel, and the flower heads are described as large and spiny, "a valuable source of nectar for bees and butterflies" or to be cut and dried for winter decoration. The enclosed seeds are similar in appearance to those of Thompson & Morgan.

In conclusion, since fertile hybrids may be formed between two recognized species (Stace 1975), and since two distinct species, *D. fullonum* and *D. sativus*, are now recognized, then the plant found in Dublin with intermediate characters and mature, viable seeds should be considered the putative hybrid.

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I would like to thank Clive Stace for his very helpful and prompt responses to my enquiries about *Dipsacus* hybrids and for allowing me to quote from Dr Knight's letter; John Parnell for bringing Ryder's paper to my attention; David Nash for the photograph of the flower heads from which Fig. 1 was prepared; Conor Reynolds for help with Fig. 1; Julian Reynolds for drawing Fig. 2; and David and Julian for constructive comments on the manuscript.

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EARLY GENTIAN (*GENTIANELLA ANGLICA* (PUGSLEY) E. F. WARB.) PRESENT IN WALES

Gentianella anglica (Pugsley) E. F. Warb. is a rare endemic protected under Schedule 8 of the *Wildlife and countryside Act*, 1981 (as amended). It is also listed in Appendix 1 of the Council of Europe's *Bern Convention* and Annex II of the *E.U. Directive on the conservation of habitats and wild fauna and flora* ("*Habitats Directive*").

This short note documents the two records of Early Gentian, *Gentianella anglica* (Pugsley) E. F. Warb. for Wales, both from Pembrokeshire (v.c. 45) and determined by TCGR. The plant has previously been regarded as an English endemic and there are no published records for Wales.

1. Near Tenby, 17 May 1921, J. E. Arnett (**OXF**). The collection consists of one specimen with a corolla 18 mm, three internodes and a terminal internode forming 35% of the length of the stem. It was mounted on a sheet with other material named by G. C. Druce as *Gentiana amarella* var. *praecox*, but the record does not appear to have been published. The herbarium sheet was seen by N. M. Pritchard during his work at Oxford on *Gentianella* but he makes no reference to the specimen (Pritchard 1959).

Arnett's copy of 'On the botany of South Pembrokeshire' (Babington 1863) contains a pencil annotation to "*Gentiana amarella* var. *praecox*", which is what *G. anglica* was known as at the time.

but there are no additional specimens in Arnett's herbarium at Tenby Museum (**TBY**; S. V. Baldwin pers. comm., 1996).

I am aware that *Gentianella uliginosa* (Willd.) Börner also occurs in the Tenby area. All specimens seen have been collected flowering from July onwards and differ in morphology.

2. Stackpole National Nature Reserve, sparsely in dry hollow dominated by mosses and lichens, SR/984.944, 10 June 1994, A. Jones (**NMW**). The collection of three plants has a mean corolla length of 15 mm, a mean of 2·3 internodes and the terminal internode forms a mean of 63% of the length of the stem.

Odd '*G. amarella* (L.) Börner' plants were first shown to me on Stackpole Warren in 1990 by Bob Haycock. Plants collected for identification on 16 July 1990 mostly had four internodes and a slightly contracted terminal internode (measurements by S. B. Evans; specimens not seen). These may be hybrids between *G. anglica* and *G. amarella*.

The rediscovery and conservation of the Tenby locality is much to be desired. The plant should be searched for in short, dry, open, calcareous grassland in May or early June. Populations of *G. anglica* elsewhere are known to fluctuate markedly in abundance from year to year due to its biennial habit, so suitable sites may need to be investigated repeatedly.

ACKNOWLEDGMENTS

I would like to thank S. V. Baldwin for information about the collections at Tenby Museum and for tracing Arnett's annotations, Serena Marner for help and access to **OXF**, and Stephen Evans, Lynne Farrell, Bob Haycock and Andy Jones for help and information.

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NOTES ON SOME EARLY SUSSEX BOTANICAL RECORDS BY THOMAS SOCKETT (1777–1859)

Born into quite a humble family on 20 November 1777, Thomas Sockett was plucked from obscurity when he was about 14 years old by the poet William Hayley (Povey 1928).The young Sockett was helping to operate a device for generating static electricity for therapeutic purposes in Weston Underwood, Buckinghamshire. Hayley, who was interested in scientific gadgets in general and this machine in particular, encountered the boy while on a visit to fellow poet Cowper; so impressed was he with his natural intelligence that Hayley took Sockett back to his home in Eartham, West Sussex, to be preceptor and companion to his son. The arrangement evidently proved satisfactory and in 1794 Sockett assisted Hayley with the transcription of the autobiography of Edward Gibbon which was being prepared for publication by Lord Sheffield, and he was described as having a good education and being able to read Latin and French.

In 1795 he became preceptor to Lord Egremont's eldest son, and in 1797 was tutor at Petworth House. In 1806 he went to Exeter College, Oxford (presumably at Lord Egremont's expense) and was ordained in 1808. He graduated in 1810 and became Rector first of Tadcaster and then of North Scarle, Lincolnshire and of Duncton and Petworth in Sussex. He resided mainly at Petworth, and died on 17 March 1859. There is a monument to him in Petworth Church and a portrait in Petworth House (reproduced in Povey 1928).

Sockett was also godfather to F. H. Arnold, who wrote the first Sussex Flora (Arnold 1887).

Arnold's father was choir master in Sockett's church at Petworth. It is almost certain that Arnold learnt some of his plants from Sockett, and in his *History and antiquities of Petworth* thanked him for ten years of tuition (Arnold 1864). Oddly, there are no records attributed to Thomas Sockett in Arnold's *Flora of Sussex*, but he does include some records by one of his sons, Henry Sockett. Henry Sockett also entered the church and had the living of nearby Sutton for many years.

RECORDS FROM PETWORTH

In the Petworth House archive held at the West Sussex Office, there is an unpublished, incomplete manuscript from 1805 entitled "Mr Sockett's Journal" (no. 1679). This diary indicates that he regularly hunted, played Real Tennis and read many classical works in Latin, especially those of Horace. He also gives a fascinating account of seeing Lord Nelson on the Isle of Wight before he embarked on the HMS Victory prior to the Battle of Trafalgar. He was also a botanist and the fragment of his journal contain three specific plant records:
Thursday 19 September 1805 "went into the paddock [at Petworth] to get *Sedum telephium* to dry but it was all out of flower".
Wednesday 25 September 1805 "went into the pleasure ground to look for fungi – found *Asplenium dilatatum* [probably *Dryopteris dilatata*] which I have brought home and dried". The pleasure ground was a wild garden, walled on one side, to the north of Petworth House.
Saturday 5 October 1805 "went in a boat to Wiggonholt and brought back four plants of *Butomus* [*umbellatus*] which I planted in the pond". Wolley-Dod (1937) records *Butomus* from Petworth as "(introduced?)", and attributes the record to F. H. Arnold. This record is not listed in Arnold's (1887) *Flora of Sussex*.

The records for *Sedum* and *Butomus* predate the first localised records for Sussex given by Wolley-Dod (1937). Sockett is not mentioned in *British and Irish herbaria* (Kent & Allen 1984) and no herbarium specimens are known to survive. Arnold's herbarium at Christ's Hospital, Horsham (**HSM**) does not contain any of Sockett's specimens.

ORCHIS SIMIA IN SUSSEX

Wolley-Dod (1937) gives a record for *Orchis simia* "Petworth, Sussex, 1801, Mr Sokot, in F. Bauer's drawings of British orchids, pp. 69–70. This is the only record known and is no doubt a good one, though the species has never been recorded since in Sussex". This 'Mr Sokot' must refer to Thomas Sockett, the spelling being a corruption by Bauer.

Franz Bauer (1758–1840) was Kew's first botanical artist and was outstanding (Stewart & Stern 1993). His original drawings are held in the Botany Library at the Natural History Museum, London. The *Orchis simia* illustration is annotated at the bottom in black ink "Mr Sokot from Petworth, Sussex, June 4 1801". Other drawings are annotated in pencil, and the annotation appears to have been added at a later date.

There is no doubt about the identity of the drawing of the *Orchis simia*, but the origin of the plant is another matter. The most obvious reading of the wording in light of what is now known about Sockett is that it is he, and not the *Orchis simia*, that was from Petworth. Petworth is in the middle of the Weald, and the nearest suitable calcareous soils occur on the South Downs. Arnold (1864, 1887) makes no reference to the plant, which would surely have been of sufficient note for Sockett and he to have discussed in relation to Petworth. Unfortunately it has not been possible to trace where Sockett or the Egremont family were at the time the orchid was collected. The record of *Orchis simia* for Sussex is therefore rejected.

ACKOWLEDGMENTS

We would like to thank Lord Egremont for access to the Petworth House archive, Judith Magee for help with Bauer's drawings at the Natural History Museum, London, and Mary Briggs.

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Book Reviews

Flowers of Britain and Ireland. J. R. Akeroyd. Pp. 255. Harper Collins Publishers, London. 1996. Price £6.99. ISBN 000–220004–X.

This softback book is a member of the latest series from Collins, the "Collins Wild Guide". It is a photoguide that aims to introduce the interested reader to botany. With such a large taxonomic group as flowering plants the difficult task is to cover a sufficient number of commoner species, and yet produce a guide which is adequate in the field. This book achieves this in two ways. The rare and showier species (for example, the rarer members of the orchid family) are excluded from the book (unlike many other photoguides and wild flower books) and the common and less photogenic plants (for example, the plantains and thistles) are included.

The combination of good photographs and an "ID fact file" enables the reader to identify many common species encountered in a variety of habitats. In the cases of similar species, such as the St John's-worts (*Hypericum* spp.), identification of some species simply is not possible with this guide.

The inclusion of distribution maps is a good idea, but in practice they are of limited use since they are quite small and since the species in the book are common and therefore occur generally throughout Britain. The provision of information about the medicinal uses of plants is very interesting and gives the book a wider range of appeal.

For the beginner, the good photographs and the choice of plants makes this book an ideal purchase at £6.99.

M. Thomason

A natural history of Guernsey, Alderney, Sark & Herm. B. & J. Bonnard. Pp. xii + 160. Guernsey Press Co., Guernsey. 1995. Price £9.95. ISBN 0902550–60–8.

This is an excellent book covering the very different islands as well as space allows, embellished with some of Brian Bonnard's photographs. It starts with the formation of the islands, their pre-history and settlement, and then goes through the anomalously distributed forms of wildlife to animals, birds, fish, marine life, ecology, weather, conservation and all (including the Alderney Cow). Most of the special plants of all sorts are duly brought in. Brian Bonnard has been studying them closely in Alderney for several years and is their recorder. His knowledge of them is well brought out in his *Out and about in Alderney* which came out at much the same time from the same publishers for £4.95. Both are well worth getting, and using.

D. McClintock

The Flora of Hampshire. A. Brewis, P. Bowman & F. Rose. Pp. 408, 16 colour plates, 25 black and white plates, 13 figures and 579 maps. Harley Books, Colchester. 1996. Hardback £45.00, ISBN 0–946589–34–8. Paperback £25.00, ISBN 0–946589–53–4.

Hampshire has long been the only county on the south coast without a modern Flora, and in southern England only Oxford and Buckinghamshire now lack any post-war record. The *Flora of Hampshire* has been so many years in gestation that I must confess I was deeply sceptical as to the outcome, but, with only a few reservations, we now have a relatively up-to-date, superbly produced and well-balanced Flora.

The introductory chapters are excellent. Those on geology, climate and history are just the right length. The chapter on conservation is welcome and informative, and that on previous botanists is exemplary. But it is the writing on habitats that is almost worth the price of the book – a masterly

overview of the vegetation, with sensible grid references to allow one to find the places described. I am not sure how Hampshire came to annex the Allen Valley (p. 61) from deepest Dorset, but that is a small matter.

The chapter on Hampshire's flora vis-à-vis other counties is fun, is reminiscent of Victorian Floras and is mischievous! On balance I would agree that Hampshire's vascular flora is slightly richer than that of Dorset, but it is a desperately close-run thing. There are 28 species in widest political Dorset not in widest political Hampshire against 30 in Hants not in Dorset. And of course Dorset is much richer in lichens and Hampshire consists of two vice-counties. Readers will appreciate that this can run and run, but I think it is a useful chapter. Already v.c. 69 (Westmorland) claims more Cyperaceae than Dorset or Hampshire!

It is surely a mistake that one has to wait until page 80 before one discovers the area covered by the book. This turns out to be all of v.cc. 11 and 12, plus all the bits of surrounding vice-counties now part of political Hampshire, and seems the correct approach (and of course helps the richness!). The text and map of this chapter are first-rate and offer a convincing defence of the permanence of the vice-county system. In fact all the maps are excellent and clear, although I would have liked a bigger and more detailed general map of the county – Fig. 1 is just not good enough.

On to the heart of the book, the systematic accounts of the Flora. I found this admirable, with just the right balance of caution, where appropriate, over the status of species such as *Pulsatilla vulgaris*, *Erica ciliaris*, *Utricularia vulgaris*, *Cochlearia officinalis* and *Poa infirma*. *Briza minor* is properly treated as a cornfield weed rather than as an introduction as in Stace's *New Flora of the British Isles*. The tetrad maps are well-chosen rather than omnipresent, but they are post-1930, which is a very long time ago, and must be my major caveat over this book. There is just no way of telling whether the plants are still present, nor is there any indication of how thorough was the coverage of each tetrad. I can find only a few errors in this section, in that *Eleocharis parvula* is not in Dorset other than in v.c. 11, that *Rhynchospora fusca* is probably three times as common in Dorset rather than the other way about, and I thought everyone knew that the Isle of Wight recent record for *Centaurium tenuiflorum* was an error. Is *Persicaria mitis* an accepted new name? The treatment of aliens is excellent, with not too many ephemerals covered, and with a very useful date of first record, something that later workers will appreciate.

The lichen and bryophyte chapters are what they should be – concise coverage by 10-km squares, leaving the field free for a proper Flora as for Sussex.

Finally, the indexes are exemplary, although I might have put last that for vascular plants, on the grounds that it will be used most, or even combined all three. They have a clear integration of Latin and English names and are a pleasure to consult. I would have liked a gazetteer, but four-figure grid references are consistently given in the text.

To sum up then, we have this beautifully produced new Flora, of a sensible size rather than the clinical A4, with perfectly acceptable colour plates of relevant plants – special plants, beautifully photographed. I do not think I have ever spent more than a few seconds looking in any Flora at these now obligatory colour plates, but these are almost an exception. The long gestation which meant the relatively unsatisfactory position of the tetrad maps is probably outweighed by the excellence of both the introductory chapters and the systematic accounts. The price is a new high in county Flora terms, but, for one's money, one has what is probably the best produced county Flora.

D. A. Pearman

Flóra Chorca Dhuibhne. Aspects of the flora of Corca Dhuibhne. M. uí Chonchubhair, photographs by A. Ó Conchúir. Pp. xviii + 270 with 370 colour photographs and 75 line drawings. Oidhreacht Chorca Dhuibhne, Ballyferriter. 1995. Price IR£20.00. ISBN 0–906096–07–3.

Oidhreacht Chorca Dhuibhne (The Heritage of Corkaguiny) was founded in 1980 with the aim to make available to people of the locality all aspects of the information relating to the physical environment. An archaeological survey was published in 1983 and, following this, a study of the natural history was begun. The wealth of information generated forms the basis of the present Flora.

The field work was conducted throughout in Irish but for publication the section on the flora is bilingual. The Irish names are those in use in the Dingle peninsula. A glossary is provided.

The publication treats of the herbaceous flowering plants and ferns of Corca Dhuibhne, one of five baronies which make up South Kerry, and one third of the vice-county, H1. This east-west peninsula – the Dingle peninsula – is some 50 km long. The peninsula projects well into the Atlantic Ocean. Its extremity, Dunmore Head, is the most westerly land in Europe (Iceland excepted), and the Blasket Islands form an offshore extension of the ridge.

In the foreword the background to the study is set out. It was initiated to encourage local interest in natural history. Introductory chapters narrate in brief the history of the area. The soils are in the main acidic and blanket bog is widespread. We are informed that the "Neolithic people . . . began a process of altering the landscape that has continued to the present . . . the . . . total lack of natural tree cover in the area is one result of this". Elements in some place names provide evidence of woodland in times past.

The main chapter deals with some 300 common species of plants including naturalised aliens. Each page begins with a colour photograph accompanied by three columns of text, one in English. A page is devoted to a species, but in the case of grasses and sedges, there are four species per page. The short descriptions are followed by folk, medicinal and herbal notes. We learn that *Heracleum sphondylium* is known about Tralee as "the singer . . . from the whistling of the wind through the hollow stems in winter". *Fuchsia magellanica* is "widely planted as a durable hedge" – in places it seems to be the only hedging plant. Under *Euphorbia helioscopia* it is noted "Spurge has been used by poachers to . . . kill fish". *E. hyberna* (Irish spurge) is the plant used in the past in the south-west for this purpose, but it is not mentioned at all though it occurs in the extreme west. A hawthorn standing alone is believed "to belong to the Otherworld", to interfere with it would "invite disaster". There are few printing errors. The publisher has drawn attention to an error on p. 193, where *Cymbalaria muralis* carries an incorrect illustration.

Colour photography by Aodán Ó Conchúir is a feature of the *Flóra*. Most of the photography is of high quality, as in *Pinguicula grandiflora* (showing the overlapping lobes of the corolla lip), and a close-up of *Menyanthes trifoliata* (flower). Seeking to show the image and the habitat in the one frame does not always work as the pictures of *Lemna minor*, *Juncus effusus*, *Hyacinthoides non-scripta*, *Teucrium scordium* demonstrate.

Flóra Chorca Dhuibhne is not a Flora in the conventional sense. The lay-out is not in the standard format, species are not localised, records are not dated. The author choose "Flora" deliberately as "it provides a balanced flavour of the accessible flora of the region", but "is not exhaustive". *Flóra Chorca Dhuibhne* meets admirably the aims of the Oidhreacht. Great thought went into the production and all concerned are deserving of praise. The book is well printed and is firmly bound, but it is not a Flora for the pocket. Dr Caroline Mhic Daeid carried out a skilful job as botanical editor.

To the reviewer the publication is a manual of botany, providing plant instruction, ecology and a guide to the flora in one cover. The book is recommended to botanists and environmentalists.

M. J. P. Scannell

James Bolton of Halifax. J. R. Edmondson. Pp. 72. National Museums & Galleries on Merseyside, Liverpool. 1995. Price £12.95. ISBN 0–906367–80–8.

Between, on the cover, full-colour reproductions of his immaculate paintings of *Vaccinium oxycoccos* and *Amanita muscaria*, James Bolton is brought to life in a copiously illustrated account of his work as an 18th century naturalist and artist. He is shown to have acquired an intimate knowledge of his local flora of West Yorkshire, and to have added considerable impetus to the development of taxonomic thought in Britain and abroad. Through a wide circle of friends and correspondents, he was able to extend his interests to many parts of Britain. He illustrated, for instance, Relhan's (1785) *Flora Cantabrigiensis*, and explored as far afield as Snowdonia. Two centuries later, the accuracy of Bolton's work, as demonstrated by this book, still provides reliable base-line data of the kind which gives meaning to the aims of *Atlas 2000*.

Publication of this book was timed to coincide with an exhibition at Liverpool Museum, but it is by no means a mere catalogue. It stands alone as a gripping tale of Bolton's achievements and place

in the advancement of biological science, for Dr Edmondson has unearthed long-lost biographical detail and has had access to much of Bolton's original art-work, based on vascular plants, fungi, bryophytes, lichens and birds. Some of it is now published for the first time.

The book is well-presented and provides compelling reading. It also presents historians with tabulated information on James Bolton's contemporaries and associates, as well as the places he visited. Typographical errors are generally minor, although Bolton's patroness is said to have died in 1785 and 1786. I was particularly disappointed to be promised, on p. 36, a list of the moss-drawings in the unpublished manuscript, *Genera Muscorum*, only to be denied it. However, I am glad to dispel the author's doubt about the locality known to Bolton as Clattering Syke, a wonderfully evocative name that is still with us at SD/86.64.

Dr Edmondson is to be congratulated on producing a valuable and attractive addition to the literature. I enjoyed reading it, and have no doubt that others will, too.

M. E. Newton

Historical ecology of the British flora. M. Ingrouille. Pp. xi + 347. Chapman & Hall, London. 1995. Price £22.50. ISBN 0–412–56150–6.

In this book Ingrouille has attempted to provide an account of the historical ecology of the British flora that deals not just with the historical period normally considered by historical ecologists, nor even only with the Quaternary, but that begins with the earliest land plants of the genus *Cooksonia* found in Silurian rocks dating from over 420 million years ago in Tipperary. The book has only three chapters, each with numerous sections, and, as might be expected, the temporal resolution increases towards the present day. Chapter 1 (93 pp.) takes us from the Silurian up to the end of the last (Devensian) glaciation. Chapter 2 (109 pp.) then deals with the period from the late Devensian up to the mid-Holocene "elm decline", whereas the period since then, that is marked by intensifying human impact, is dealt with in Chapter 3 (107 pp.). The book is well illustrated, with numerous monochrome photographs and four sides of colour plates, and is rounded off by a useful bibliography and an adequately comprehensive index (15 pp.).

Unfortunately I found the prose did not stimulate the natural excitement that I have for palaeobotany; indeed much of the account of the earlier geological record was 'catalogue-like' and made great demands upon one's ability to maintain concentration. When I reached those sections dealing with the Quaternary and recent periods, about which I have greater knowledge and expertise, then I found the treatment wanting also in that it was somewhat dated in approach. That is not to say that recent literature is not cited, rather that it is interpreted and presented in a way that defines a view more in keeping with the prevalent views amongst Quaternary palaeoecologists perhaps a decade or more ago. In this respect the book singularly fails to reflect the growing importance of palaeoecology with respect to the need to understand the response of organisms to a changing environment. Section 3.6.5 on climate change is less than one page in length, and presents a minority view that suggests that there is uncertainty over "how carbon dioxide pollution might cause global warming", failing either to discuss or even hint at the records of natural change in "CO^2" (sic) levels in the atmosphere during the late Quaternary and their relationships to past climate changes, or to refer to the work and conclusions of the Intergovernmental Panel on Climate Change (IPCC).

Notwithstanding my reservations, the book is a useful compilation to which I shall want to refer first- and perhaps second-year undergraduates. It is unfortunate, however, that it fails to satisfy the demands that I would make of a senior undergraduate textbook, in terms of a rigorous and up-to-date treatment, whilst at the same time being written in prose that I for one was unable to read for any extended period, ruling it out as a successful 'popular' text. The author attempted a difficult task and in doing so has provided a useful addition to our library shelves. Perhaps it was inevitable, given the scope of his task, that academic reviewers would be likely to find the product wanting in some respects; I feel, however, that it could have been done more successfully and with a more up-to-date treatment, although this probably would have required more than one author in order to provide adequate depth across the entire time span to be considered.

B. Huntley

Obituary

CHRISTINA MAYNE DONY
(1910—1995)

Chris Dony (née Goodman) passed away peacefully on 23 May 1995. Although not in the best of health during the previous months, her death came as a great shock to her family and friends. I first met Chris in 1975, soon after I moved to Bedfordshire and became interested in the local flora. From that time onwards I joined some of the botanical exploits of Chris and her late husband John around the county. These were wonderful occasions and from both of them I learned much of my field botany. Chris herself was an excellent field botanist, with a keen eye backed up by a wealth of knowledge. She was particularly good at the grasses and her enthusiasm for wool aliens, encouraged by her friend Charles Bannister (1918–1984), was unbounded. She seemed to have a second sight for locations of unusual species, often leaving the beaten track for no apparent reason, and then one would soon hear the call to see a new species for the day's records. One of her most interesting finds, on a visit to an old railway line in north-east Bedfordshire, was the discovery of an extensive colony of a *Petrorhagia* sp. This, after much deliberation, was identified as *P. prolifera* which has recently been designated as a British native species. In the intervening years, with no protection, the site has been nearly destroyed by sand extraction with the plant apparently being eliminated from the site. However, earlier this year (1995) a few plants were discovered at the edge of the sand quarry but, sadly, Chris did not live to hear that the plant had been rediscovered. I hope that the colony can be conserved, perhaps in her memory.

Christina Mayne Goodman was born in Selly Oak in Birmingham, into a family of three older sisters and later they were joined by a brother. She was educated at Edgbaston High School for Girls in Birmingham and, after leaving school, went to work in the family business, a builders and coal merchant, in Selly Oak. She worked there from 1932 for 30 years, eventually becoming a director. During the last war she did voluntary work in the ARP and at the Birmingham Service Club, and, in addition, she worked nights once a week in an aircraft parts factory.

The Goodmans were a sporting family and Chris followed this course for many years with hockey being her main interest. She played centre forward for Edgbaston Ladies Club from 1929–1950, for the County of Warwickshire from 1939–1949 and for Midland Counties from 1932–1948. In 1935 she was a reserve for the England team and, finally, played for her country in 1937, 1946 and 1947, in the latter year being England vice-captain. Recently she reminisced to a reporter on the way international sport was conducted some 60 years ago ". . . we just turned up at the ground about an hour before the game and had dinner together afterwards" (*Daily Telegraph*, 12 May 1995). Although Chris had an early interest in natural history, it was to sport that much of her life was devoted at this time.

After the war, although continuing to play hockey, she became involved in natural history, joining the Birmingham Natural History Society in 1947. She served on its Council and was, for seven years, secretary of the Botanical Section. She was involved in recording for the Flora of Warwickshire up to 1965, and, in the Flora, when published in 1971, it was noted that she was one of the main contributors of the field records.

One of her early botanical interests was the study of the alien flora, in particular the wool aliens of Worcestershire and it was through this that she met her future husband, John Dony. They were married in 1962 and she was soon involved in the botany of her adopted county, Bedfordshire, an area where there was also a good diversity of wool aliens. However, Chris always maintained an interest in the botany of her home area. At the time of their marriage John was the Honorary Secretary of the Botanical Society of the British Isles (BSBI). Chris had joined the Society in 1948, but now became involved in the administration. She was Membership Secretary for ten years from 1964 and it was during her tenure that the Society's membership increased to over 2000. She sat on Council for four years and Meetings Committee for ten years. In 1975 she was elected an Honorary Member in recognition of her sterling work for the Society. This was the first and, I believe, only

time that both husband and wife have been accorded this honour. In later years, up to just before John's death in 1991, they both thoroughly enjoyed the annual Exhibition Meetings at the Natural History Museum, then known as the BM (British Museum (Natural History)) where they were able to meet up with many of their botanical friends and colleagues.

Chris joined the Wild Flower Society (WFS) in 1964 and immediately started her Diary. By 1967, and in record time, she had attained Valhalla, and, by 1972, Parnassus. In a notebook recording yearly totals since that year she noted that by 1988 the total had reached 2530 but that this was ". . . Our last year of active recording". By 1994 two more species had been added giving her final total as 2532.

Following John's retirement from teaching in 1964 they devoted their time to the study of the flora of Bedfordshire and Hertfordshire. During the recording season it was not unusual for six days a week to be spent in the field, and it was only at Chris' firm insistence that at least half a day per week was spent on housework and shopping! Certainly it was only by this single-minded approach that they were able to complete field work for the local Floras of these counties within a relatively short time period, an amazing six years for the *Bedfordshire plant atlas*. The work was definitely a team effort and John often told me that Chris really should have been a co-author of this and the Hertfordshire Flora. The *wild flowers of Luton* was published in 1991 and, indeed, Chris was accorded joint authorship.

Chris was involved in many important publications associated with the flora of Bedfordshire and the full references are detailed below. She carried out a detailed study of the spread of *Puccinellia distans* along the major routes through the county. In 1981 she started studying the dandelions of Bedfordshire and, in the following five years, with her co-workers, had recorded about 65 *Taraxacum* species for the county. This list was published jointly with Adrian Rundle and many additions were added in subsequent years. This study was one of the most important of recent years on the Bedfordshire flora, and it was due to her marvellous eye for detail that she became quite an expert in this difficult group. Following the publication of the *Bedfordshire plant atlas* in 1976 the study of the local flora did not stop and subsequent discoveries were duly published in a joint paper with John in *Watsonia*. Many important sites were resurveyed resulting in a comprehensive report detailing the important species present in virtually all the worthwhile sites of the county. This document is an invaluable local resource and, whilst it was written in John's inimitable handwriting, the content owes a great debt to Chris.

For many years the Donys, either separately or jointly, presented exhibits at the Society's Annual Exhibition Meetings on the local flora. In addition Chris presented her detailed study of the Society's membership from 1942–1972. Reports of all these were duly published in *Watsonia*.

When, recently, I tentatively started work on recording for a new Flora for Bedfordshire, Chris was very enthusiastic and, although somewhat frail, she took on the responsibility for the tetrad where she lived in Dunstable and was actively recording up to a few weeks before her death. She was still excited to be taken out to a favourite site to see that plants recorded many years ago were still flourishing. She was a mine of information on the sites for many rare local species.

In her last year she maintained an active interest in the botanical exploits in Bedfordshire and was always keen to hear about her friends still involved in the BSBI and WFS. Chris made an outstanding contribution to the Bedfordshire and Warwickshire floras and will be remembered with much affection by all who knew her.

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C. R. Boon

Report

ANNUAL GENERAL MEETING, 11 MAY 1996

The Annual General Meeting of the Society was held at the Jodrell Laboratory, Royal Botanic Gardens, Kew, by kind invitation of the Director Sir Ghillean Prance, at 11.30 a.m. The President, Mr D. A. Pearman took the Chair in the presence of 103 members.

Apologies for absence were read and Minutes of the 1995 Annual General Meeting, published in *Watsonia* **21**: 151–154 (1996), were accepted as correct, approved and signed by the President.

REPORT OF COUNCIL

The President took members through the Report of the Council, which had been previously circulated to members, commenting on the main achievements of the Society during the year, especially the launch of Atlas 2000 and the employment of Mr C. S. Crook as BSBI Co-ordinator and Dr T. Dines as Atlas 2000 organiser. Mrs M. Briggs was congratulated on producing another excellent report. The adoption of the Report was accepted unanimously.

HON. TREASURER'S REPORT AND ACCOUNTS

Mr M. Walpole, Hon. Treasurer, presenting the Accounts, invited queries. Dr T. G. F. Curtis asked about the possibility of setting up a credit card system to ease payment of subscriptions, by Irish and overseas members. The Treasurer reported that he was investigating the possibility. The adoption of the report was proposed by Mr R. M. Burton, seconded by Mr P. A. Harmes and carried unanimously.

ELECTION OF PRESIDENT-ELECT

The President took great pleasure in proposing Council's nomination of Mrs M. Briggs. She had been the Society's Hon. General Secretary for 24 years and a Council member for over 30 years as she had previously been Secretary of Meetings Committee. He could think of no other person, who had done so much for the Society over so many years, who was better fitted to be President. The adoption of Mrs M. Briggs as President-elect was proposed by Mrs M. Lindop, seconded by R. G. Ellis and carried with acclamation. On behalf of Council, the President then presented Mary with a gold brooch depicting the Society's bluebell emblem. Mary responded that she was "lost for words – almost."

ELECTION OF VICE-PRESIDENT

The President commented on the importance to the Society of having experienced members as Vice-Presidents who could assist the Chair when necesssary. There was one nomination, Dr R. J. Gornall. His election was proposed by the President, seconded by Mr R. G. Ellis and carried unanimously.

ELECTION OF HON. GENERAL SECRETARY

As Mrs M. Briggs had now been elected President-elect, the President stated that there was a vacancy for the post of Hon. General Secretary. Council had nominated Mr R. G. Ellis. His election was proposed by Mrs M. Briggs, seconded by Miss A. Burns and carried unanimously.

RE-ELECTION OF HON. TREASURER

The President paid tribute to the enormous amount of work carried out by Mr M. Walpole on behalf of the Society and his re-election was proposed by Mr D. E. Green, seconded by Dr N. K. B. Robson and carried unanimously with applause.

The President then warmly thanked the Editors of *Watsonia* and *BSBI news*, the compiler of *BSBI Abstracts*, and all Representatives on Council and other Committees for the hard work they carried out, voluntarily, on behalf of the Society. This was greeted by applause.

ELECTION OF COUNCIL MEMBERS

In accordance with Rule 11 nominations had been received for Mrs P. P. Abbott, Dr F. J. Rumsey and Dr M. C. Sheahan. Profiles had been published; election of these members was proposed by Comd. J. M. W. Topp, seconded by Mr P. A. Harmes and carried unanimously.

ELECTION OF HONORARY MEMBER

In nominating Mr R. G. Ellis, the President paid tribute to his work on behalf of the Society in Wales and especially as Editor of *BSBI news* as he had now produced 30 issues over ten years. He also mentioned that the nomination had been made before Mr Ellis' acceptance of nomination as Hon. General Secretary. The election was carried unanimously with warm applause.

PRESIDENT'S AWARD

David Bellamy (President, Wild Flower Society) and David Pearman (President, BSBI) had great pleasure in giving the award to Mr C. D. Preston for his *Pondweeds of Great Britain and Ireland* (BSBI Handbook No 8).

RE-ELECTION OF HONORARY AUDITORS

The President warmly thanked Grant Thornton, West Walk, Leicester, for their exemplary auditing of our accounts. Their re-election as Hon. Auditors was proposed by Mr P. H. Oswald, seconded by Mrs M. E. Perring and carried unanimously with appreciation and applause.

There being no other business, the meeting closed at 12.05.

GWYNN ELLIS

FIELD EXCURSION HELD IN CONJUNCTION WITH THE A.G.M.

WAKEHURST PLACE, SUSSEX (V.C. 14) 12 MAY 1996

Forty seven members attended this meeting at "Kew in the Country". After making friendly greetings in the car park we repaired to a lecture hall to hear Roger Smith, the Head of Seed

Conservation at Wakehurst, give us a potted history of Kew's arrival at Wakehurst followed by an interesting insight into the collection of seeds and their storage. This was followed by a visit to the Seed Bank where drying, sorting and packaging were demonstrated. An invitation to enter the −20° C storage chamber was declined, we preferring to stay in the comfort of the drying chamber.

Leaving the Seed Bank we were conducted around the newly laid out trial beds and greenhouses where seeds of rare and threatened species of our native flora are tested for viability. Some members were pleased to see *Veronica peregrina* (American Speedwell) as a weed in one of the plots.

After lunch we reconvened outside the mansion ready to tour the gardens. The party was divided up into three groups, each group covering the same areas but in different directions so as not to clash. Andrew Jackson, the Conservation and Woodland Manager at Wakehurst led one group whilst Chris Clennett the Nursery Manager took his group away in the opposite direction. Arthur Hoare a local BSBI member and frequent visitor to Wakehurst led the third party.

We stopped first at the Slips to admire the many patches of *Lathraea clandestina* (Purple Toothwort) which has been in the gardens since before Kew took on the lease 31 years ago. It is now appearing quite naturally in many places both in and outside the gardens. Also here was *Orchis morio* (Green-winged Orchid), introduced after a rescue operation from a redevelopment site in a nearby town. Close by *Orchis laxiflora* (Loose-flowered Orchid) was just coming into flower; this was an experimental introduction which has proved very successful and the plants are now increasing by natural regeneration.

Our next stop was to see *Hymenophyllum tunbrigense* (Tunbridge Filmy-fern) which for my group meant a fairly steep climb up a bank to pay homage to this last remaining patch within the confines of the garden although it is to be found in many other areas throughout the estate. Our president was rather pleased to be shown this as it was a new plant for him.

A number of sectors within the garden are being managed for the conservation of our native flora. It was at one of these sectors that we made our third stop, a sloping site with a few wet flushes mostly acidic but one which was slightly alkaline. This gave a diverse flora and kept the members happy for quite a while. With the season being a little late only a few plants were in flower; one, *Valeriana dioica* (Marsh Valerian) was much appreciated. It was the *Carex* in this sector that created the most interest with *C. laevigata* (Smooth-stalked Sedge), *C. pallescens* (Pale Sedge), *C. pendula* (Pendulous Sedge), *C. sylvatica* (Wood-sedge) and *C. viridula* subsp. *oedocarpa* (Yellow-sedge) all found and identified.

Continuing our perambulation past sandstone outcrops to a bank where *Luzula forsteri* (Southern Wood-rush), *L. pilosa* (Hairy Wood-rush) and their hybrid, *L.* × *borreri*, were seen all within a couple of metres of each other. This aroused the interest of some of our northern members who are unfamiliar with *L. forsteri*.

The meeting ended in the tea room for well earned refreshments and genial conversation.

Our thanks are due to Norman Robson for making the arrangements and to the various leaders for making this a most enjoyable day.

A. C. Hoare

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. Submission of copy on computer discs is acceptable but must also be accompanied by two hard copies of the text, double spaced throughout.

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 1991). Further details on format can be obtained from the Hon. Receiving Editor.

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.

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