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Ranunculus penicillatus (Dumort.) Bab. in Great Britain and Ireland

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ABSTRACT

A reinvestigation of the morphology, ecology and distribution of the varieties of *R. penicillatus* (Dumort.) Bab. in Britain and Ireland is reported and the implications for the taxonomy of the group are discussed. Evidence from field and herbarium work and cultivation experiments supports the recognition of two subspecies, subsp. *penicillatus* and subsp. **pseudofluitans** (Syme) S. Webster, **comb. nov.**, the latter comprising two varieties, var. **pseudofluitans** (Syme) S. Webster, **comb. nov.** and var. *vertumnus* C. Cook. The typification and nomenclature of the relevant taxa are outlined. A key to the taxa recognized, descriptions, and distribution maps are given.

INTRODUCTION

Ranunculus penicillatus (Dumort.) Bab. comprises a group of aquatic buttercups in subgenus *Batrachium* which occur predominantly in swiftly flowing water in rivers and streams but have also been recorded from canals, ditches, lakes and pools. The *R. penicillatus* group is widespread throughout Britain and Ireland and elsewhere in Europe except in the Balkan peninsula and the extreme north (Cook 1966).

Cook (1966) suggested that *R. penicillatus* is a collection of segmental allopolyploids that have arisen from hybrids of *R. fluitans* Lam. with *R. peltatus* Schrank, *R. trichophyllus* Chaix, and possibly *R. aquatilis* L. This analysis is supported by the morphological variation exhibited by the group, which extends from plants that resemble *R. peltatus* to ones that superficially resemble *R. fluitans*, by the predominance of the hexaploid chromosome number ($2n = 48$), together with sterile triploid, tetraploid and pentaploid plants (Cook 1962, 1966, 1970; Turala 1970; Turala-Szybowska 1978) and by the observed breeding behaviour of other members of subgenus *Batrachium*. Sterile hybrid plants of *R. fluitans* × *peltatus*, *R. fluitans* × *trichophyllus* and *R. aquatilis* × *trichophyllus* are known from a number of rivers in Europe where they replace their parent species, and it seems likely that plants such as these gave rise to the allopolyploids in the *R. penicillatus* group, but Cook also considered it possible that further evolution of the parent plants took place following the original hybridizations. The exact parentage of the group remains obscure.

According to the most recent monograph of the group (Cook 1966), *R. penicillatus* comprises the varieties *penicillatus*, *calcareus* (Butcher) C. Cook and *vertumnus* C. Cook. Butcher (1960) separated his *R. calcareus* from *R. pseudofluitans* (Syme) Newbould ex Baker & Foggitt on the basis of the absence of laminar leaves in *R. calcareus*. However, the type of *R. pseudofluitans* also lacks laminar leaves and is clearly the same taxon, so that *R. calcareus* is, in fact, a later name for the same species. In order to maintain a consistent nomenclature throughout the paper, this taxon is referred to as *R. penicillatus* var. *pseudofluitans* throughout. The necessary combination is made below.

Holmes (1979) considered that var. *penicillatus* and var. *pseudofluitans* merited recognition at specific rank, but that var. *vertumnus* was no more than a variant of var. *pseudofluitans* linked to

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typical material via a continuous series of intermediates. Similarly, Haslam (1978) and Haslam & Wolseley (1981) continued to recognize var. *pseudofluitans* [*R. calcareus*] at specific rank and gave no recognition to var. *vertumnus*. Haslam (pers. comm. 1980) did not consider var. *vertumnus* to be an entity with ecological relevance, whatever its genetic basis. This paper reports the results of a reinvestigation of these taxa in order to clarify their taxonomy and elucidate their ecology and distribution in Great Britain and Ireland. This investigation is based on field work, growth experiments and herbarium specimens examined in **ABN**, **BEL**, **BM**, **CGE**, **DBN**, **DEE**, **E**, **K**, **LANC**, **LIV**, **LTN**, **LTR**, **NMW**, **OXF**, **RAMM**, **RNG** and **TCD**. Full details of the herbarium specimens I have examined have been deposited at the Biological Records Centre, Monks Wood Experimental Station.

MORPHOLOGY

R. penicillatus sensu lato invariably possesses capillary leaves with suborbicular stipules and usually at least 100 (often over 200) segments. The flowers are normally large (petals 10–20 mm) with pyriform nectar-pits and a densely hairy receptacle.

VAR. *PENICILLATUS*

R. penicillatus var. *penicillatus* differs from vars. *pseudofluitans* and *vertumnus* in being heterophyllous (Fig. 1). In addition to the capillary leaves, which are present throughout the year, var. *penicillatus* produces laminar leaves in the summer and these leaves are normally present during the flowering period. Heterophylly in subgenus *Batrachium* has been studied experimentally in some detail (Cook 1966, 1968, 1969). The production of laminar leaves is normally controlled by an autoregulatory mechanism activated by a photoperiodic stimulus. *R. penicillatus* var. *penicillatus* is thought to show an essentially similar pattern of response to *R. aquatilis*, in which a 16-hour photoperiod under submerged conditions initiates the production of laminar leaves. However, Cook (1966, p. 66) considered it possible that some form of heteroblastic development may take place in *R. penicillatus*. That is, there might be, to some extent, a developmental sequence of the kind which is common in other heterophyllous plants. This possibility has not been investigated in the present study as it has not been possible to hold var. *penicillatus* in cultivation over long periods of time, but it is an area which requires further investigation.

The laminar leaves of var. *penicillatus* may be crenate or dentate, and frequently bear capillary appendages, the tips of the leaf-lobes being extended into fine points (Fig. 1). Var. *penicillatus* superficially resembles *R. peltatus*, which also produces laminar leaves and large flowers with pyriform nectar pits. However, in *R. penicillatus* var. *penicillatus* the capillary leaves are always flaccid and generally longer than the adjacent internodes, whereas, at least at the time of flowering, those of *R. peltatus* are normally rigid and divergent and shorter than the internodes (often less than half the length of the internodes) (Fig. 2). This character must be used with caution since the capillary leaves of *R. peltatus* show a seasonal pattern of variation, and leaves produced in mid-summer are shorter and more rigid than those produced throughout the autumn, winter and spring. Thus, although flowering shoots of *R. peltatus* bear short, rigid leaves which are shorter than the internodes, they revert after flowering to a growth form with longer, more flaccid leaves that often exceed the internodes (Fig. 3). It is also important to compare fully expanded leaves and internodes; towards the shoot apex, where the internodes are not fully elongated, the capillary leaves exceed the internodes in both species. Thus, specimens consisting only of a short terminal portion of a flowering shoot cannot be determined.

R. penicillatus tends to have slightly larger flowers than *R. peltatus*, with more stamens and carpels, but this character is subject to environmental modification and cannot be used as a reliable diagnostic indicator (Cook 1966). According to Dr G. Wiegleb (pers. comm. 1982) and Wiegleb & Herr (1983), *R. peltatus* and *R. penicillatus* are more difficult to separate in Germany than in the British Isles, as they show greater intergradation. There is little other published work on variation within var. *penicillatus*. Casual observations suggest that Irish plants of both *R. penicillatus* var. *penicillatus* (Fig. 1) and *R. peltatus* (Fig. 2) tend to have laminar leaves which are more truncate at the base than British plants, but this also requires further investigation.

FIGURE 2. Silhouette of *R. peltatus* from a mill-race in Galway City, N. E. Galway, v.c. H16, in mid-July, 1984. Late-flowering shoot showing capillary leaves shorter than internodes, truncate laminar leaves and large flowers.

FIGURE 1. Silhouette of *R. penicillatus* var. *penicillatus* from the River Bush at Seneirl Bridge, County Antrim, v.c. H39, in June 1986, showing capillary leaves longer than internodes, truncate laminar leaves, some lobes bearing capillary appendages (indicated by arrows), and large flowers.

FIGURE 3. Silhouette of *R. peltatus*. Vegetative shoot taken from the same plant as in Fig. 2 on the same day, showing reversion to winter growth-form with capillary leaves exceeding the internodes.

FIGURE 4. Silhouette of *R. penicillatus* var. *pseudofluitans* collected from the River Frome at East Stoke, Dorset, v.c. 9, cultivated in fast-flowing water in an artificial stream, and pressed in August 1982. Divergent morphotype, showing "untidy", divergent leaves which are shorter than the internodes.

FIGURE 5. Silhouette of *R. penicillatus* var. *pseudofluitans* from the Salisbury Avon at Durrington, N. Wilts., v.c. 8. Holmes morphotype showing sparsely divided, flaccid leaves which exceed the internodes.

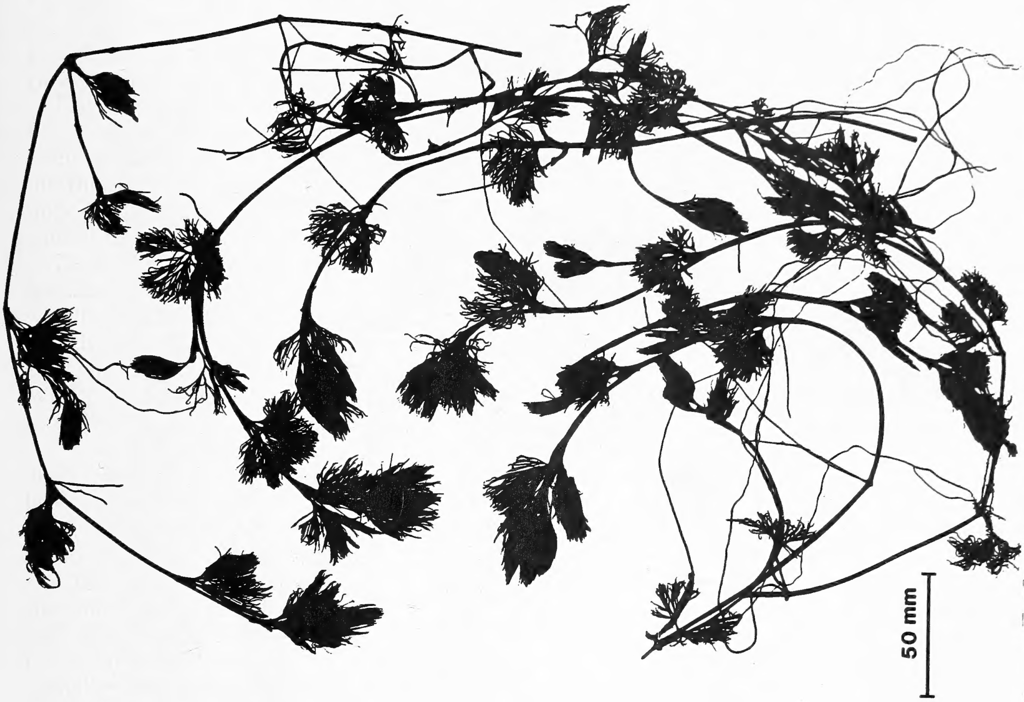

FIGURE 6. Silhouette of *R. penicillatus* var. *vertumnus* collected from the River Coln at Bibury, E. Gloucs., v.c. 33, cultivated in fast-flowing water in an artificial stream, and pressed in August, 1982. This plant shows the short, rigid globose leaves which are typical of var. *vertumnus* in the summer.

FIGURE 7. Silhouette of *R. penicillatus* var. *vertumnus* from the River Whitewater, Greywell, N. Hants., v.c. 12, in April 1981. This plant shows the longer, more flaccid leaves produced by var. *vertumnus* during the winter months.

VAR. *PSEUDOFLUITANS* AND VAR. *VERTUMNUS*

Both *R. penicillatus* var. *pseudofluitans* (Figs. 4, 5) and var. *vertumnus* (Figs. 6, 7) produce only capillary leaves. Butcher (1960) included in his diagnosis of *R. calcareus* (*R. penicillatus* var. *pseudofluitans*): "only submerged leaves present, tassel-like, flaccid, ultimate segments 60–120." Cook (1966) did not refer to the negative character, the absence of laminar leaves, describing *R. penicillatus* var. *pseudofluitans* as "like var. *penicillatus* but divided leaves obconical in outline, equal to or shorter than mature internodes, segments rigid or flaccid with up to 150 ultimate segments." This description is at variance with the key (Cook 1966, p. 86) which permits the leaves to be "as long as or longer than" the internodes.

It is generally acknowledged that there is a wealth of variation within var. *pseudofluitans*. For example, Holmes (1979, 1980) has drawn attention to plants of this variety which resemble *R. fluitans* in producing very long (often up to 250 mm), sparsely divided leaves which exceed the internodes (Fig. 5). These plants are distinguished from *R. fluitans* by their densely hairy receptacle, although this separation is difficult in some cases. In addition, the leaves in var. *pseudofluitans* normally undergo at least six levels of division, whereas in *R. fluitans* the leaves rarely undergo more than four levels of division. Other variants are described below.

The character of leaf-length compared with internode-length has caused some confusion between var. *penicillatus* and var. *pseudofluitans*. Plants of var. *pseudofluitans* have sometimes been misidentified as var. *penicillatus* on account of having leaves which are longer than the internodes. However, the presence of leaves which are longer than the internodes is only important in separating var. *penicillatus* from species such as *R. peltatus* and *R. aquatilis* and cannot be used to separate var. *penicillatus* from long-leaved plants of var. *pseudofluitans*.

There are few records of plants which are intermediate between var. *penicillatus* and var. *pseudofluitans*. This is almost certainly a result of the all-or-nothing nature of the single character which separates the two taxa. I have seen one population in the River Nanny at Duleek, Co. Meath, v.c. H22, which may be morphologically intermediate; at the time of collection, in July 1981, no fully laminar leaves were formed and only capillary and intermediate leaves were seen. Wiegleb & Herr (1983) reported plants of var. *penicillatus* growing in the rivers Lachte and Aschau in Lower Saxony, W. Germany, which only rarely form laminar leaves.

Cook (1966) reduced *R. calcareus* to the level of variety within *R. penicillatus* at the same time as describing var. *vertumnus* as a new variety. Var. *vertumnus* was described as "like *penicillatus* but lacks entire leaves; divided leaves globose to reniform, shorter than mature internodes, segments rigid, divergent, much branched with more than 200 ultimate segments" (Figs. 6, 7). However, the globose to reniform shape of the leaves of this variety is not used in his key.

Although var. *vertumnus* was described as a new variety in 1966, examination of herbarium specimens shows that this variety had been recognized more or less consistently as a distinct entity by earlier botanists. Many collections referable to this taxon have been labelled as *R. sphaerospermus* Boiss. & Blanche, but Cook (1966) considered that this name correctly applied to a smaller-carpelled species which occurs in eastern Greece, Asia Minor, Kashmir and Nepal, and from which only the diploid chromosome number ($2n = 16$) has been reported. Other specimens are labelled "*R. pseudofluitans* var. *minor* Pearsall". This is a problematic name which is considered further below, but it is not an earlier synonym of var. *vertumnus*.

OBSERVATIONS AND MEASUREMENTS OF VAR. *PSEUDOFLUITANS* AND VAR. *VERTUMNUS*

In order to assess the reliability of different characters in separating var. *pseudofluitans* and var. *vertumnus*, and the extent to which these varieties intergrade, plants of both varieties were sampled from a large number of field sites throughout England between March and July 1981. The plants were provisionally assigned to either var. *pseudofluitans* or var. *vertumnus* using not only the key, but also the descriptions and illustrations in the monograph by Cook (1966). During this preliminary survey, both varieties were occasionally found growing side by side in a habitat, as in the River Coln at Bibury (E. Gloucs., v.c. 33). The plants at these sites were observed for three years, and remained distinct over this period, a fact which suggested that var. *vertumnus* was genetically distinct, and not merely a phenotypic state of var. *pseudofluitans*.

In addition to var. *vertumnus*, a number of distinctive variants of var. *pseudofluitans* were recorded. The term 'morphotype' was adopted for these variants since the extent to which they were genetically distinct was not known. The first of these morphotypes superficially resembled var. *vertumnus* and, according to the monograph key (Cook 1966, p. 83), conformed to this variety. These plants had leaves which were shorter than the corresponding internodes with rigid, divergent segments, often numbering more than 200, and sometimes over 300, but they differed from the description and illustration of var. *vertumnus* in having leaves which were distinctly obconical and not globose. These plants were recognized by the distinctive, untidy appearance of the leaves when the water was shaken from them, with segments that appeared to end at different lengths (Divergent morphotype; Fig. 4). Other plants had flaccid, tassel-like leaves which were longer or shorter than the internodes with from 75 to 335 ultimate segments (Flaccid morphotype). A further variant consisted of the plants described above which resemble *R. fluitans* with long, flaccid leaves and few (sometimes 70 or fewer) parallel or subparallel segments (Holmes

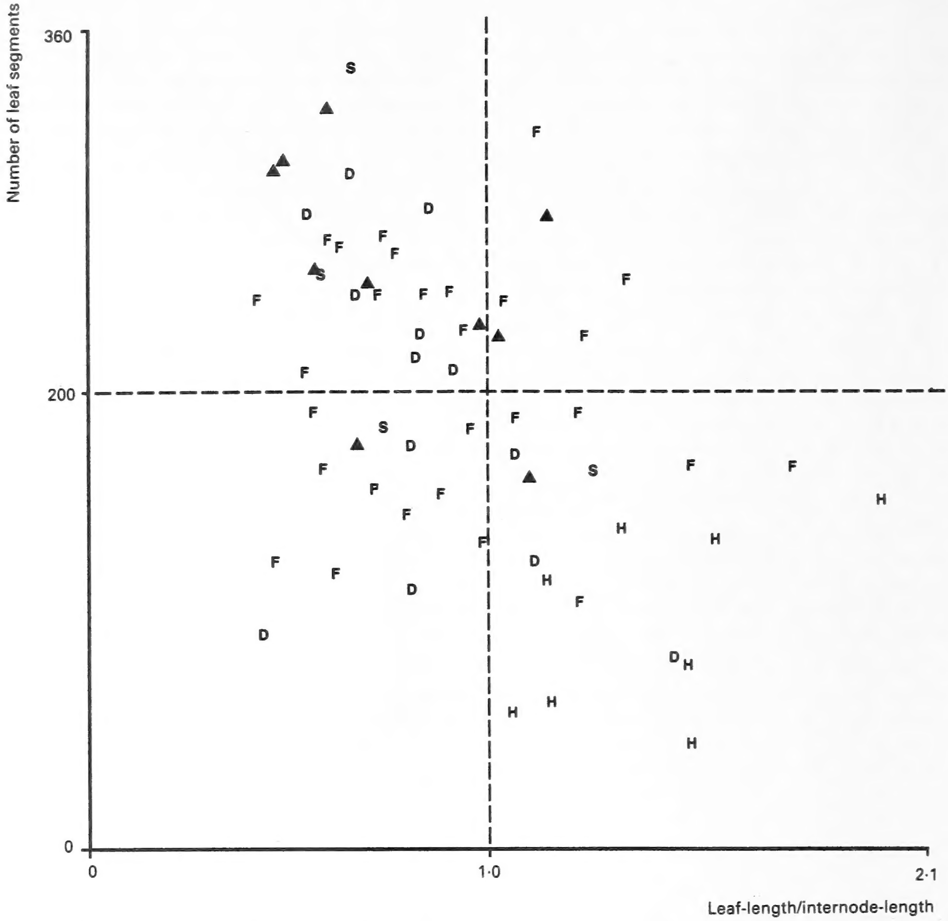

FIGURE 8. Scatter diagram of number of leaf-segments plotted against the ratio of leaf-length to internode-length in var. *vertumnus* and morphotypes of var. *pseudofluitans* (untransformed scales on both axes). ▲: var. *vertumnus*; **D**: var. *pseudofluitans*, Divergent morphotype; **F**: var. *pseudofluitans*, Flaccid morphotype; **H**: var. *pseudofluitans*, Holmes morphotype; **S**: semi-rigid plants.

morphotype). In addition, some plants had semi-rigid leaves of varying lengths with a variable number of slightly divergent segments (described as semi-rigid plants).

Leaf-length, internode-length, and number of segments per leaf were measured on four leaves on each of 63 plants comprising ten assigned to var. *vertumnus*, and 53 assigned to var. *pseudofluitans*; 13 to the Divergent morphotype of this variety, 28 to the Flaccid morphotype, eight to the Holmes morphotype and four semi-rigid plants. In order to ensure that the leaves sampled from each plant were fully expanded and comparable between plants, these measurements were made on leaves arising from the fifth to eighth internodes away from the shoot apex. The characters were plotted as scatter diagrams using three different pairs of axes. Since segment-number and the ratio of leaf-length to internode-length have been used diagnostically to separate var. *vertumnus* from var. *pseudofluitans*, the three plots used were: (i) number of segments against the ratio of leaf-length to internode-length (untransformed scale on both axes; Fig. 8), (ii) number of leaf segments against the ratio of leaf-length to internode-length (logarithmic scale on both axes; Fig. 9) and (iii) the ratio segment-number: leaf-length plotted against leaf-length (logarithmic scales on both axes; Fig. 10). The scales used were chosen to achieve the greatest degree of linearity.

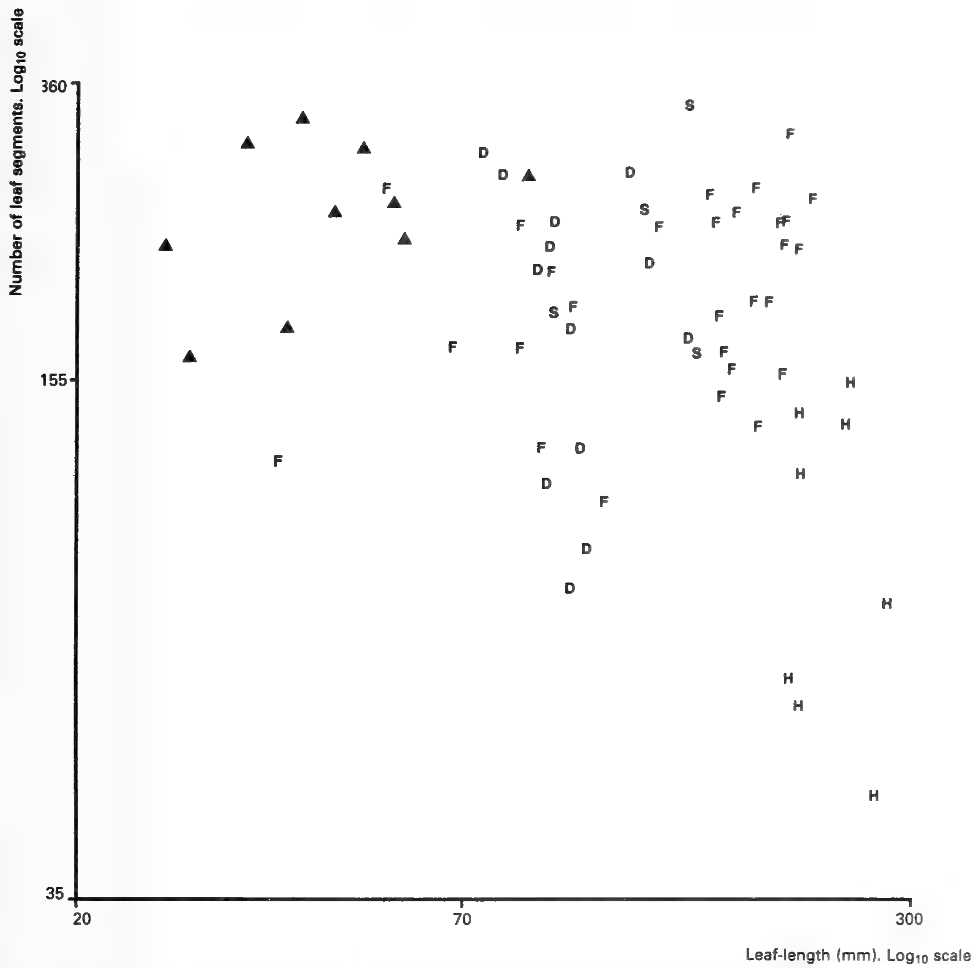

FIGURE 9. Scatter diagram of number of leaf-segments plotted against leaf-length in var. *vertumnus* and morphotypes of var. *pseudofluitans* (logarithmic scales on both axes). See Fig. 8 for explanation of symbols.

From these scatter diagrams it is clear that none of the above combinations of characters separates the two varieties or the morphotypes of var. *pseudofluitans* perfectly and there is some degree of overlap in all cases. In the first plot (Fig. 8), separation is poor mainly because of the large number of segments (up to 347) recorded in plants conforming to var. *pseudofluitans*, of both the Flaccid and Divergent morphotypes, and also because var. *vertumnus* tended to have not only shorter leaves, but also shorter internodes. It is thus not possible to make a clear separation between var. *vertumnus* and var. *pseudofluitans* using a combination of segment-number and leaf-length:internode-length ratio. In the second and third plots (Figs. 9, 10), separation of var. *vertumnus* from morphotypes of var. *pseudofluitans* is improved. In the third plot (Fig. 10), the ratio of segment-number to leaf-length provides a measure of 'frequency of branching' and when this was plotted against leaf-length, it resulted in the most linear separation of field-collected plants.

This suggests that leaf-length in itself, and the number of segments relative to leaf-length, are more important characters in separating var. *vertumnus* than the ratio of leaf-length to internode-length. In both the second and third plots, the Holmes morphotype also appears as a distinct grouping.

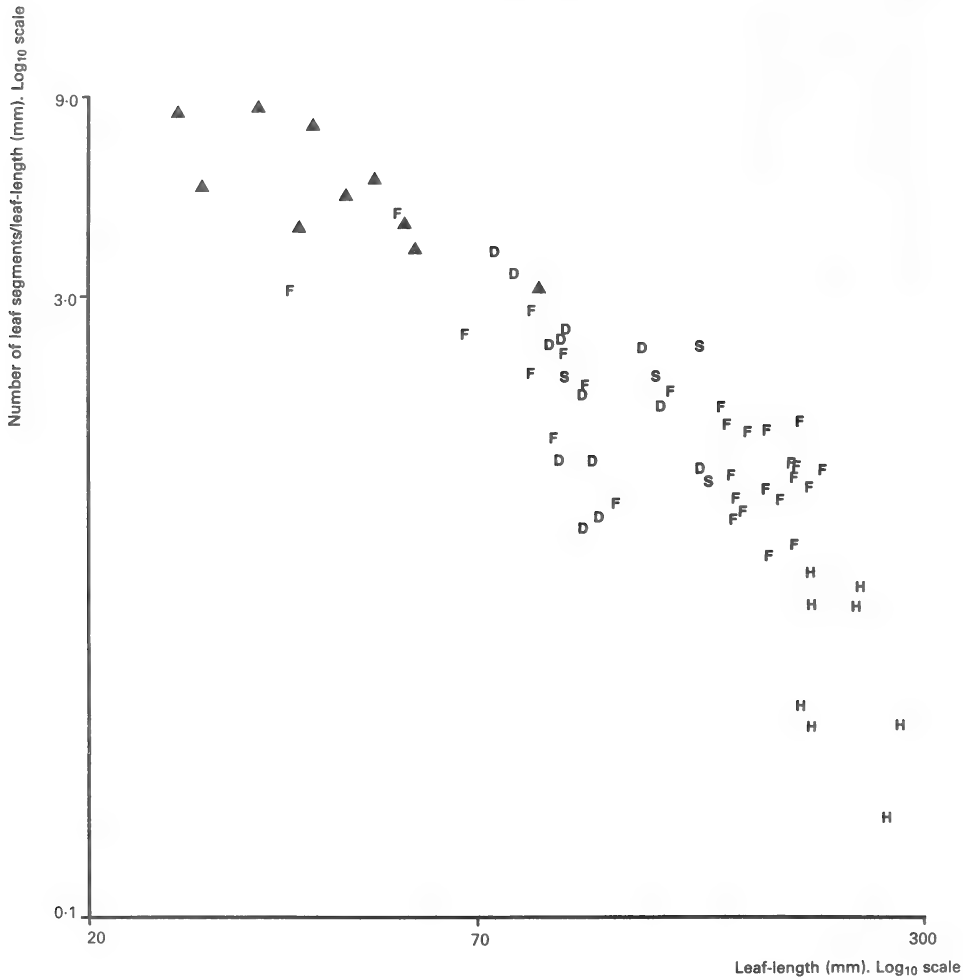

FIGURE 10. Scatter diagram of number of segments/leaf-length plotted against leaf-length (logarithmic scales on both axes). See Fig. 8 for explanation of symbols.

CULTIVATION EXPERIMENTS

METHODS

Selected plants from the preliminary survey described above were cloned and cultivated in different flow-rates and light-regimes at the Freshwater Biological Association's experimental station in Dorset, and sampled at different times of year. In this experiment the set of characters measured was extended to include petiole-length and the shape and rigidity of the leaves. Full details of the experimental design are given in Webster (1984).

RESULTS

The plants showed marked changes in response to different cultivation conditions and seasonal stimuli and the pattern of response was similar to that observed in the field in *R. peltatus*: shorter, more rigid leaves were produced in summer, in the absence of shade and in fast water velocities compared with those produced during the winter or in shaded or slowly flowing water. As a result of these changes the total ranges recorded for var. *pseudofluitans* and var. *vertumnus* showed a degree of overlap in all the characters recorded. In addition, two of the cultivated clones were more or less intermediate between the two varieties and the affinities of these clones to either variety depended on their seasonal changes, which followed the same pattern of response as for the other plants.

However, because var. *pseudofluitans* and var. *vertumnus* showed the same direction of phenotypic response, there was no progressive convergence between the two varieties in cultivation, and certain statistically significant differences were maintained in spite of these changes. Thus, var. *vertumnus* retained a significantly shorter lamina, a higher ratio of leaf segments to leaf-length and a smaller ratio of leaf-length to internode-length than any morphotype of var. *pseudofluitans*, when comparing data both over different cultivation conditions and over different times of year. Var. *vertumnus* also had a significantly shorter petiole and total leaf-length (including petiole) than var. *pseudofluitans* in summer when plants grown in all cultivation conditions were compared; however, because the leaves and petioles become elongated during the winter months, these differences are not significant throughout the year. Var. *vertumnus* had the largest number of leaf-segments and the shortest internodes, when the plants were compared both over different cultivation conditions and over different times of year, but was not significantly different from the Flaccid morphotype in these characters.

Within var. *pseudofluitans*, the morphotypes described above showed greater continuity; the phenotypic changes were so great that several clones alternated between the Divergent morphotype – exhibited in swiftly flowing water in unshaded conditions during the summer months – and the Holmes morphotype – seen in shaded or slowly flowing water during the summer and in all cultivation conditions in the winter. The Flaccid morphotype had a significantly shorter lamina than the Holmes morphotype throughout different cultivation conditions and seasons, and in a constant cultivation regime it retained a shorter leaf- and petiole-length than the Holmes morphotype and a larger number of segments relative to leaf-length irrespective of seasonal changes. These were the only statistically significant differences observed between the morphotypes. The differences between the Flaccid and the Holmes morphotypes in terms of leaf- and petiole-length and the ratio of segment-number to leaf-length were over-ridden by the responses of the plants to different cultivation conditions and neither morphotype was statistically different from the Divergent morphotype. There were no significant differences between the morphotypes in terms of petiole-length, internode-length, leaf-length:internode-length ratio, or number of segments.

The relative distinctness of var. *vertumnus* compared with the morphotypes of var. *pseudofluitans* was due in part to its relative lack of phenotypic plasticity. Var. *vertumnus* showed less phenotypic plasticity in response to cultivation conditions than var. *pseudofluitans* in terms of leaf-, petiole-, lamina- and internode-length.

The globose shape of the leaves in var. *vertumnus* was retained as long as the leaves remained rigid. However, in winter and in slow water velocities and shaded conditions, the leaves became longer and flaccid, as in other plants (Fig. 7), and it became impossible to distinguish them by their shape.

When grown in shallow, still water, both var. *vertumnus* and var. *pseudofluitans* produced prostrate states, rooting at each node, which have not been reported before in these varieties. These cultivation experiments will be described in more detail in a further paper.

ECOLOGY AND DISTRIBUTION

VAR. *PENICILLATUS*

Var. *penicillatus* has a western distribution in Britain and Ireland (Fig. 11). It generally occurs in rivers over base-poor Palaeozoic and igneous rocks including granite, Tertiary basalt, Ordovician, Silurian, Devonian (Old Red Sandstone) and Upper Carboniferous series, and New Red Sandstone. In the Irish midlands, var. *penicillatus* also occurs over Carboniferous Limestone at a number of localities, including several well documented sites on the River Liffey. Var. *penicillatus* frequently forms large clones and dominates major sections of the rivers where it occurs. The rivers which this variety occupies in Great Britain are base-poor, with an alkalinity which is normally

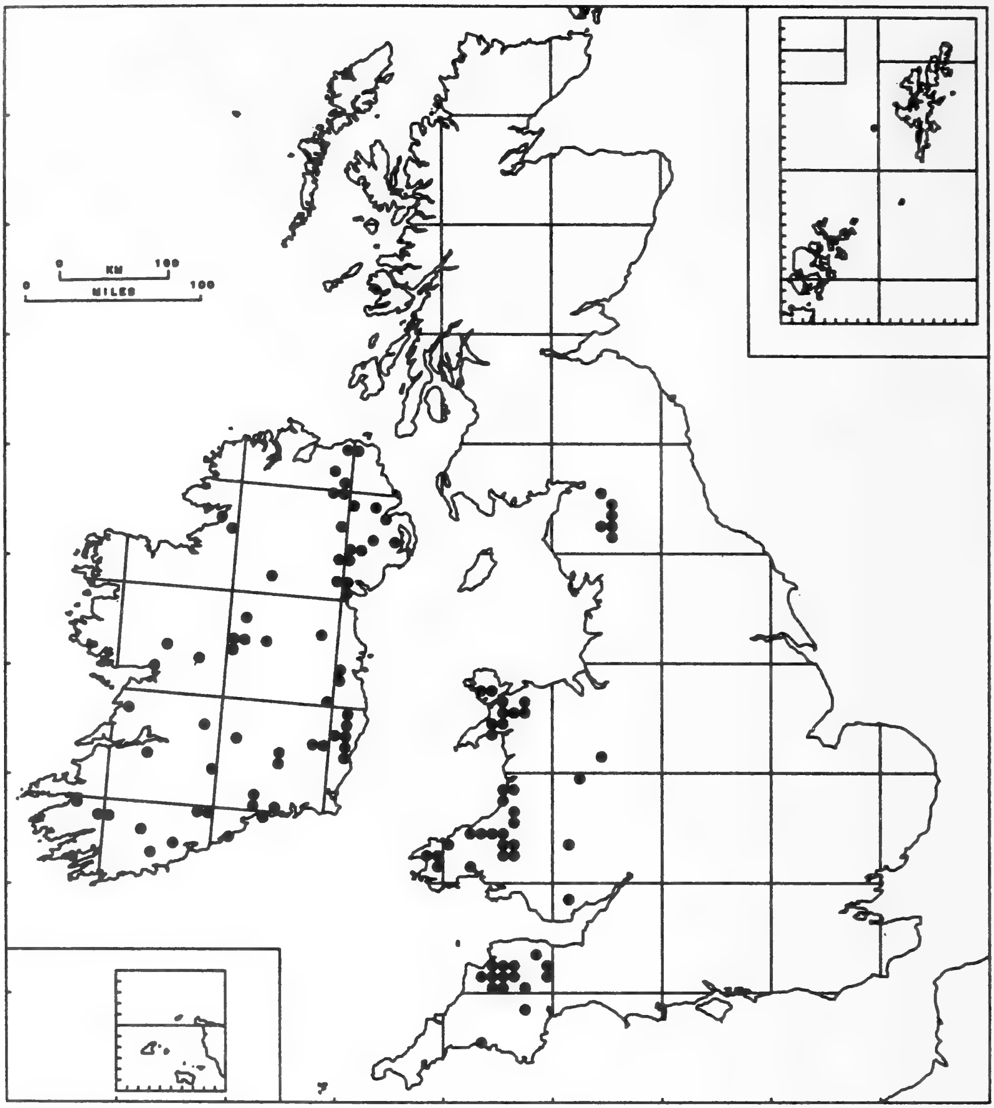

FIGURE 11. Distribution of *R. penicillatus* var. *penicillatus*. All records are based on material which has been seen by either N. T. H. Holmes or S. D. W.

within the range 8–60 mg l^{-1} $CaCO_3$, a pH of 5·7–7·9 and a low conductivity (30–200 μS cm^{-1}). It appears to be absent from base-rich rivers in Britain; reports of this variety from chalk streams in southern England (Goriup 1979) are based on misidentified var. *pseudofluitans* or *R. peltatus*. Little ecological work has been published on var. *penicillatus* in Britain, perhaps because it is rather local. Var. *penicillatus* is recorded from only 52 10-km squares in Great Britain and 57 10-km squares in Ireland. Interestingly, recent records of this variety include ones from the rivers Teign and Exe in the South West Water Authority Area, where Palmer & Newbold (1983) described var. *penicillatus* as "not recently recorded as native but may spread naturally into the area or be refound in old sites, when special protection will be necessary", as well as in the Welsh and North West Water Authority Areas where they describe it as in need of special protection throughout the area. Newbold & Palmer (1979) considered the usual distribution of var.

penicillatus in relation to trophic status to be within the range oligotrophic/mesotrophic to eutrophic (0·005–0·10 mg l^{-1} total phosphorus; 0·2–0·65 mg l^{-1} inorganic nitrogen; alkalinity 10 to greater than 30 mg l^{-1} $CaCO_3$; pH from below 6 to above 7) although it occurs only uncommonly at the more oligotrophic end of the above ranges. In his classification of British rivers according to their flora, Holmes (1983) recorded var. *penicillatus* in both his types B (meso-eutrophic plant communities associated with Sandstone and Carboniferous Limestone) and C (oligo-mesotrophic communities over resistant rocks). Var. *penicillatus* was recorded in all four groups of communities recognized within each of these types. It was absent from types A (lowland nutrient-rich communities) and D (oligotrophic upland communities).

Caffrey (1985) included var. *penicillatus* in his sensitivity grouping A (forms most sensitive to organic pollution) when considering indicators of water quality in the River Suir in Ireland. In Ireland, var. *penicillatus* appears to occur over a wider range of alkalinities than in Great Britain and is found both in extremely base-poor rivers, such as the Avonmore River (alkalinity 10–15 mg l^{-1} $CaCO_3$; pH 6·1–6·8) and, over Carboniferous Limestone, in more base-rich rivers such as the Liffey (120–200 mg l^{-1} $CaCO_3$; pH 7·8–8·2), the Deel (225–285 mg l^{-1} $CaCO_3$; pH 8·2–8·6), and the Inny (180–235 mgl $^{-1}$ $CaCO_3$; pH 8·2–8·5).

Some 76% of field- and herbarium records of var. *penicillatus* are from rivers and 18% from streams, but it has occasionally also been recorded from loughs in Ireland, from the Grand Canal in Dublin, and from ditches in Cards., v.c. 46, and Caerns., v.c. 49, in Wales. Material from the following vice-counties has been seen by N. T. H. Holmes or S. D. W.: 2–5, 41, 42, 44, 45–47, 49, 50, 52, 69, 70, H2, H3, H5, H6, H8–13, H17, H19, H20–25, H31, H33, H34, H37–39.

VAR. *PSEUDOFLUITANS* AND VAR. *VERTUMNUS*

Var. *pseudofluitans* is distributed throughout Great Britain, occurring over Tertiary, Mesozoic and Palaeozoic rocks (Fig. 12). Its centre of distribution is in southern England, where it occurs predominantly over Chalk, Great Oolite, London and Oxford Clays and other, mainly calcareous, deposits. Elsewhere, it occurs over Carboniferous Limestone, New and Old Red Sandstone and Silurian rocks. It becomes scarcer further north and there are rather few records from Scotland, mainly from rivers over Middle and Devonian Old Red Sandstone. Like var. *penicillatus*, var. *pseudofluitans* is frequently dominant over large stretches of river where its resistance to flow often causes backing-up and flooding, and each summer land drainage interests require the expenditure of considerable resources to remove excessive growths of this variety from rivers by biological, chemical, and mechanical means (Barrett & Murphy 1982; Dawson 1978; Dawson & Kern-Hansen 1978, 1979; Soulsby 1974; Westlake 1968; Westlake & Dawson 1982). Var. *pseudofluitans* is capable of invasion and rapid spread in rivers; this process is described by Holmes & Whitton (1977a,b) in both the River Tees and the River Wear.

Marshall & Westlake (1978) and Luther (1983) have drawn attention to the importance of macrophytes not only as weeds but as primary producers with a major role in energy input and nutrient cycling in aquatic ecosystems. On account of this dual significance, the ecology, productivity and nutrient relationships of var. *pseudofluitans* and the rivers and streams in which it occurs have received a great deal of attention (Butcher 1933; Casey & Downing 1976; Casey & Ladle 1976; Casey & Newton 1972; Casey & Westlake 1974; Dawson 1976; Edwards & Owens 1960; Holmes & Whitton 1975a, b, 1977a, b; Holmes *et al.* 1972; Ladle & Casey 1971; Owens & Edwards 1961, 1962; Raven *et al.* 1982; Westlake 1968, 1975, 1982). The large growths of this variety are capable of causing dramatic changes in the physical and chemical characteristics of rivers; Owens & Edwards (1961) described how the utilization of carbon dioxide by var. *pseudofluitans* can bring about the precipitation of calcium carbonate by raising the pH, and there have been a number of recent studies of the way in which the plants cause hydraulic roughness in waterways (Dawson & Robinson 1984; Hydraulics Research Ltd 1985). The rivers which *R. pseudofluitans* occupies are generally base-rich, with alkalinities normally within the range 100–300 mg l^{-1} $CaCO_3$, a pH of 7·2–8·8 and a generally high conductivity (200–1400 $\mu S\ cm^{-1}$). It occasionally occurs in less base-rich rivers, notably the Tweed (alkalinity 64–145 mg l^{-1} $CaCO_3$; pH 7·3–8·8) and the Usk (15–96 mg l^{-1} $CaCO_3$; pH 7·3–8·5). Haslam & Wolseley (1981) placed *R. penicillatus* var. *pseudofluitans* in the same nutrient status band as *Veronica beccabunga*, *Apium nodiflorum*, *Berula erecta* and *Nasturtium officinale*; plants in this grouping have a preference for mesotrophic sites and, in lowland watercourses such as clay streams, they

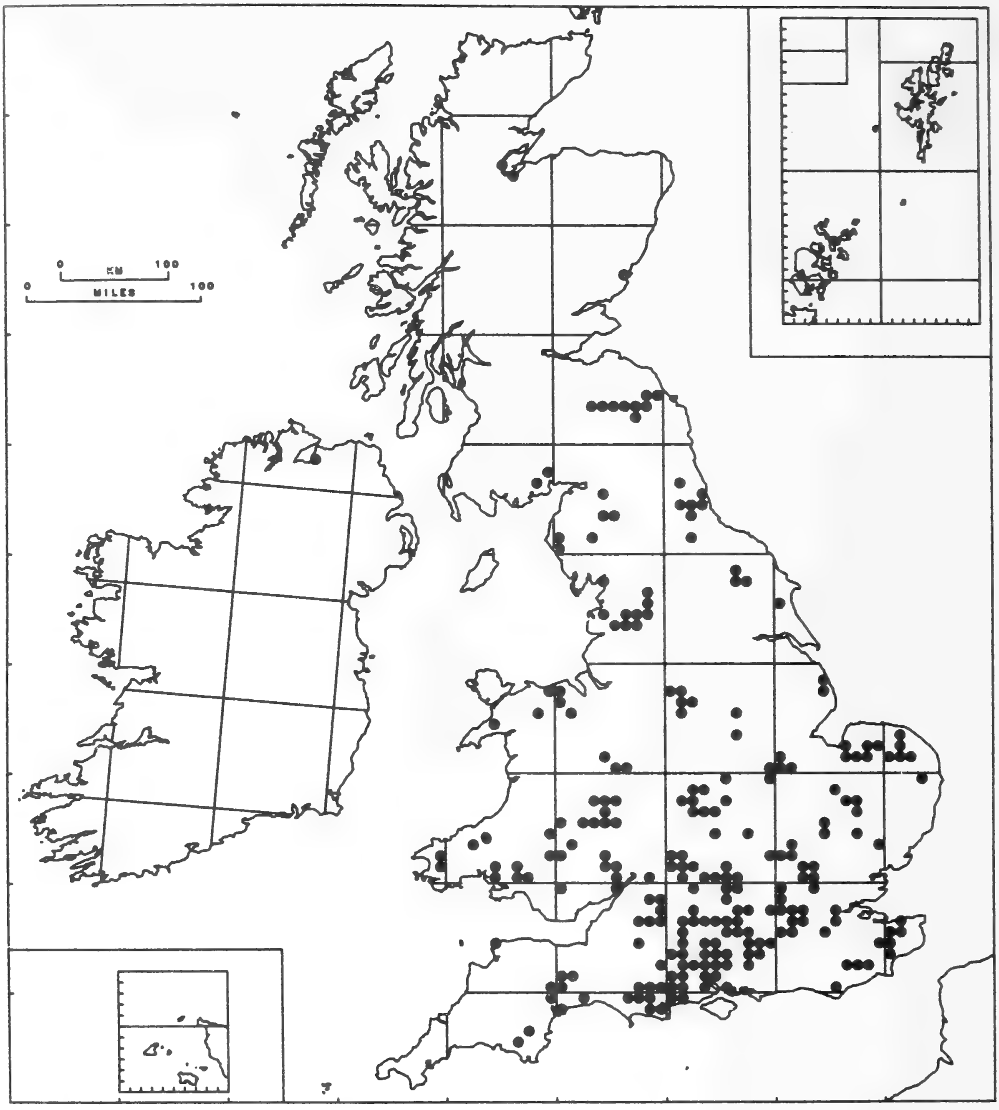

FIGURE 12. Distribution of *R. penicillatus* var. *pseudofluitans*. All records are based on material which has been seen by either N. T. H. Holmes or S.D.W.

indicate clean water, giving way to plants such as *Potamogeton perfoliatus*, *P. lucens*, *P. crispus*, *P. pectinatus*, *Myriophyllum spicatum* and *Ceratophyllum demersum* in more eutrophic stretches. Haslam (1978) considered the distribution of *Ranunculus* species in general to be correlated with the lowest nitrate (below 1 mg l^{-1}) and phosphate (below 0·3 mg l^{-1}) levels. Newbold & Palmer (1979) considered var. *pseudofluitans* to be distributed in waters of a trophic status from mesotrophic to eutrophic (0·01–0·03 mg l^{-1} total phosphorus; 0·3–0·65 mg l^{-1} inorganic nitrogen; up to, or exceeding 30 mg l^{-1} $CaCO_3$; pH from 6·0–7·0 to above 7·0), whilst it is absent from the more oligotrophic end of the range occupied by var. *penicillatus*. This view is endorsed by Holmes (1983) who recorded var. *penicillatus* in all four groups within his types A (lowland nutrient-rich communities), from which var. *penicillatus* was absent, and B (meso-eutrophic communities associated with sandstone and Carboniferous Limestone). Var.

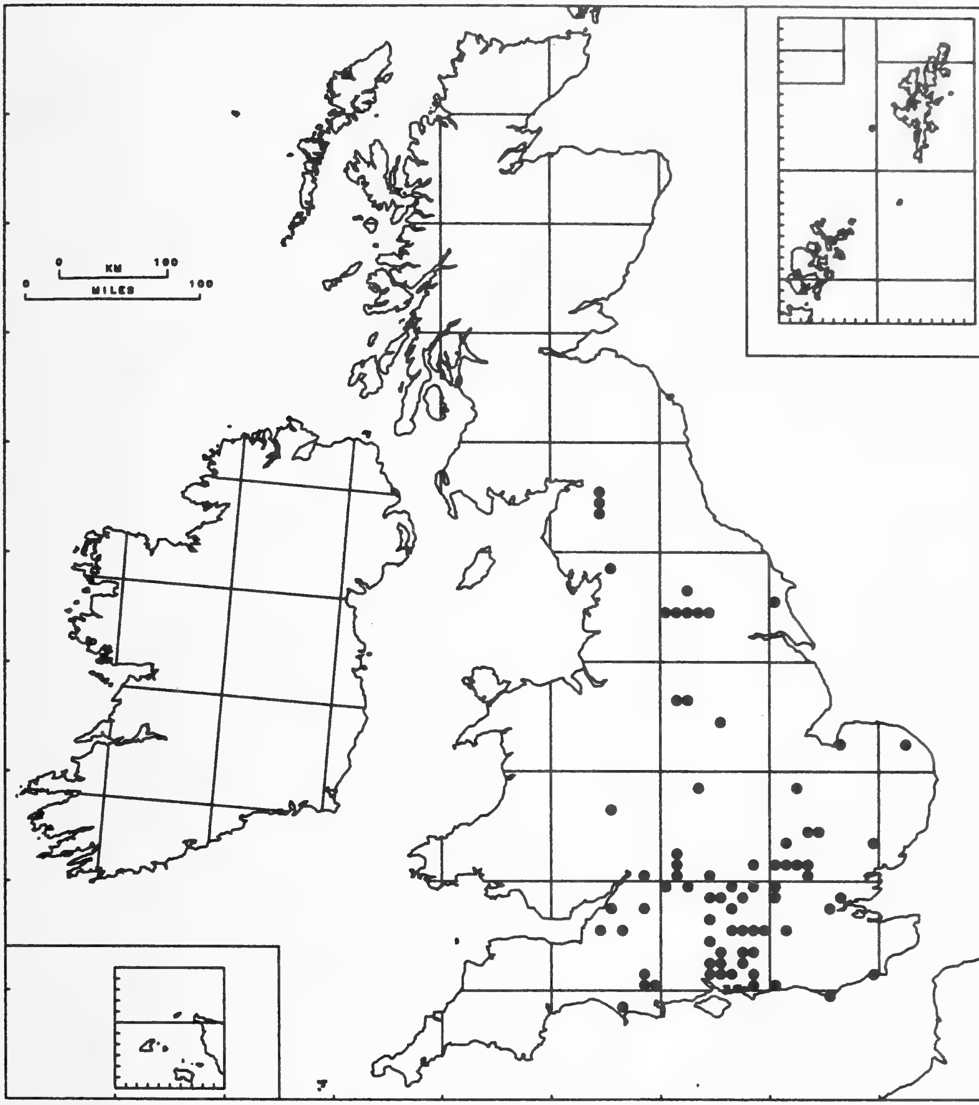

FIGURE 13. Distribution of *R. penicillatus* var. *vertumnus*. All records are based on material which has been seen by N. T. H. Holmes or S.D.W.

pseudofluitans was absent from both the oligo-mesotrophic communities of type C in which var. *penicillatus* occurred and type D (oligotrophic upland communities).

Var. *pseudofluitans* has been recorded from 240 10-km squares in the British Isles. Over 90% of the records used in this study were from rivers and streams. This variety has occasionally been reported from ditches, pools and lakes, and once, in 1884, from a canal. Material from the following vice-counties has been seen by N. T. H. Holmes or S.D.W.: 3, 6–9, 11, 12, 14–17, 19–30, 32–36, 38–46, 49–51, 53–57, 59–62, 64, 68, 70, 78–81, 90, 96 and 106. There is a single Irish record from H40 (see below).

Var. *vertumnus* has a similar distribution to var. *pseudofluitans*, but it is scarcer and more local throughout the distributional range and records from Scotland and Ireland are completely lacking. It has been recorded from 74 10-km squares in England and Wales (Fig. 13). Like var.

pseudofluitans, in southern England var. *vertumnus* occurs principally over Chalk, and also over Great Oolite, Oxford Clay and other Mesozoic and Tertiary rocks. Further north, it occurs over Carboniferous Limestone and New Red Sandstones. Less information on water chemistry is available for var. *vertumnus* than for the other two varieties, but the evidence suggests that var. *vertumnus* also grows mainly in base-rich water, as in the River Rother (alkalinity 60–155 mg l^{-1} $CaCO_3$; pH 6·7–9·1).

Var. *vertumnus* is occasionally found growing side by side with var. *pseudofluitans*, particularly in rivers such as the Coln and Windrush over the Great Oolite, and the two varieties have frequently been recorded from the same river system, as, for example, in the Rivers Lea and Mimram in Herts., v.c. 20, the River Bure in E. Norfolk, v.c. 27, the River Wye in v.c. 57, the Rivers Wey and Rother in N. Hants., v.c. 12, and the River Kennet in Berks., v.c. 22. However, they appear to have different ecological ranges. Whereas 84% of the records for var. *pseudofluitans* are from rivers and only 8% from streams, only 49% of the records for var. *vertumnus* are from rivers, with 16% from streams and 16% from canals. There is also a considerable number (about 15%) of records of var. *vertumnus* from pools and ditches. The type locality for this variety is on the Basingstoke Canal in N. Hants., v.c. 12, and it has also been recorded from canals in Bucks., v.c. 24, Warwicks., v.c. 38 and S. Lincs., v.c. 53. The ecological range of var. *vertumnus* may be determined more by a requirement for clear, rather than flowing water. Such a requirement could arise from its highly branched leaves, which are readily congested by algae, debris and any other particulate matter carried by the water, and which exhibit a relatively weak capacity to be modified by environmental conditions. Leaves congested in this way would be less efficient in photosynthesis and would cause a physical drag on the plant in running water. Habitats in which this variety is known to have been dominant over many years, such as the Ewelme Brook in Oxon, v.c. 23, and the Basingstoke Canal at Odiham, N. Hants., v.c. 12, are characterized by their clear water, whereas var. *penicillatus* and var. *pseudofluitans* appear to be more tolerant of the frequently turbid conditions which prevail in many of the larger rivers in the British Isles. Material from the following vice-counties has been seen by N. T. Holmes or S.D.W.: 6, 7, 9, 11–14, 16, 18, 20, 22–24, 26–30, 33, 34, 38, 40, 56, 57, 61, 64, 69 and 70.

Neither var. *pseudofluitans* nor var. *vertumnus* has previously been recorded from Ireland. In 1984 I searched rivers over the Carboniferous Limestone in Counties Galway and Clare for these varieties, and in stretches of these rivers which supported *Ranunculus*, only *R. peltatus* was present. For example, *R. peltatus* was found at sites on the River Fergus at Corrofin and Ennis (Co. Clare, v.c. H9); Gort River at Gort and the Dunkellin River at Craughwell (S.E. Galway, v.c. H15); in mill races in inner Galway (W. Galway, v.c. H16); in the Bunowen River at Ahascragh, River Clare at Tuam and Abbert River at Pallas Bridge (N.E. Galway, v.c. H17). It is possible that the *R. fluitans* hybrids which are believed to have given rise to vars. *pseudofluitans* and *vertumnus* never became established in a habitat for long enough to give rise to the hexaploids. There is no habitat in Ireland comparable with the permanent chalk streams in Britain since the occurrence of chalk is limited to narrow outcrops near the coast in Counties Antrim (v.c. H39) and Derry (v.c. H40). Rivers over the Carboniferous Limestone are sometimes of a temporary nature, welling up from the ground as springs and disappearing into a swallow-hole a few kilometres downstream, and in these habitats *R. peltatus*, which is less dependent on permanently flowing water, would be at a competitive advantage.

In June 1979 Mr P. Hackney collected specimens (**BEL**) from a population which apparently conforms morphologically to var. *pseudofluitans*, from the River Roe above Limavady in Co. Derry, v.c. H40. The specimens were collected when the plants were in full flower and at a time of year when var. *penicillatus* would normally be expected to form laminar leaves, but no laminar leaves were observed in the entire population. I examined this population in June 1986 and again failed to find any laminar leaves. At this point the River Roe flows over schist and gneiss and is base-poor, with an alkalinity range of 20–108 mg l^{-1} $CaCO_3$ (average 63·1), conductivity 77–404 $\mu S\ cm^{-1}$ (average 190·8), and a pH range of 6·8–8·9 (average 7·64). It is a swiftly flowing river with a bouldery substrate, and the habitat is closer to that of var. *penicillatus* than to that in which var. *pseudofluitans* normally grows in Britain. The nature and origin of this population requires further investigation, but it is tempting to suggest that it has arisen as a population of var. *penicillatus* which has lost the capacity to form laminar leaves.

DISCUSSION AND CONCLUSIONS

R. penicillatus var. *penicillatus* is morphologically distinct from var. *pseudofluitans* and var. *vertumnus* in producing laminar leaves in the summer. The significance of this character, which shows such dramatic phenotypic plasticity related to seasonal changes, is difficult to evaluate. The availability of this character only at certain times of year is not, I believe, a serious impediment to its use and is consistent with normal practice in flowering plant taxonomy, in which attention is often focussed on floral characters which are, in most groups, only seasonally available. The possibility that some form of heteroblastic development of laminar leaves may take place lends additional weight to this analogy.

This morphological discontinuity alone was seen by Holmes (1979) as favouring separation of var. *penicillatus* from the other two varieties at the level of species. However, there are good reasons for preferring subspecific rank. Firstly, the production of laminar leaves in var. *penicillatus* is the only morphological feature in which there is discontinuity between this variety and var. *pseudofluitans*. Although var. *penicillatus* differs from var. *pseudofluitans* and var. *vertumnus* in lacking the capacity to form short, rigid, divergent capillary leaves, var. *pseudofluitans* frequently produces capillary leaves which, in being flaccid and longer than the internodes with subparallel segments, are similar to those of var. *penicillatus*. All three varieties are similar in terms of their stipules, the size and shape of sepals and petals, nectar-pit shape, stamens, carpels and receptacle.

Secondly, evidence from *R. aquatilis*, in which the control of heterophylly has been studied in greater detail (Cook 1966, 1968, 1969), suggests that complete reliance cannot be placed on this character. Certain races of this species have apparently lost the capacity to produce laminar leaves (Cook 1968). It seems likely that *R. penicillatus* var. *penicillatus* could produce similar variants, which would be morphologically identical to var. *pseudofluitans*, and the anomalous population in the River Roe above Limavady may well have arisen in this way.

Var. *penicillatus* also has a different ecological and geographical distribution from the other two varieties, since it occurs mainly in base-poor water and has a western distribution in the British Isles, extending into Ireland, where it is widespread. There is, however, some degree of overlap between var. *penicillatus* and the other two varieties, in both ecological and geographical range; in Great Britain, var. *penicillatus* is confined to base-poor waters, but in Ireland, in the usual absence of var. *pseudofluitans* or var. *vertumnus*, it extends into more base-rich habitats. Both var. *penicillatus* and var. *pseudofluitans* have been recorded from the rivers Exe, Eden, Teifi, Afon Dwyfach and Western Cleddau, but the two varieties are rarely found growing together.

This broad ecological and geographical separation, although not complete, supports the recognition of var. *penicillatus* at subspecific rank. Plants of *R. penicillatus* are largely self-compatible and the incidence of cross-pollination is presumed to be extremely rare. Correspondingly, little weight is attached to the requirement for complete geographical isolation as a barrier to gene exchange, which has been stressed by some authors as a criterion for subspecific rank (Du Rietz 1930).

There is no clear-cut morphological, geographical or ecological discontinuity between var. *pseudofluitans* and var. *vertumnus*. Plants conforming to var. *vertumnus* exist in distinct populations which are local but widespread throughout most of southern Britain and as far north as Cumberland, v.c. 70. Cultivation experiments show that var. *vertumnus* cannot be viewed merely as representing small plants of var. *pseudofluitans* produced by growth in small streams (cf. Holmes 1979, p. 15) and it should, in my opinion, continue to be recognized as a distinct taxon. However, despite their statistical differences, the two varieties show overlapping ranges in all characters and combinations of characters investigated. This is particularly so because of the seasonal variation shown by the plants in cultivation. Some plants are intermediate between the two varieties in the field and remain so in cultivation; the affinities of these plants to either variety depend on their seasonal changes. Further, it is not always easy to distinguish the two varieties using herbarium material, since the three-dimensional nature of the plants is lost.

Var. *vertumnus* has a similar geographical distribution to var. *pseudofluitans* although it is much more local. Although the two varieties show certain ecological differences, they have frequently been recorded from the same river system, and are occasionally found growing together.

In view of the relative continuity between var. *pseudofluitans* and var. *vertumnus* in morphological, geographical and ecological characteristics, I propose to retain var. *vertumnus* at varietal rank within a second subspecies. A pragmatic advantage of this system over the current one is that plants which are intermediate between var. *pseudofluitans* and var. *vertumnus* can at least be assigned at subspecific rank to a taxon which conveys some morphological and ecological information within *R. penicillatus*. This system also enables workers who do not wish to recognize var. *vertumnus* to assign a name at subspecific rank which is inclusive of both var. *vertumnus* and var. *pseudofluitans* without ambiguity.

Recognition of subspecies within *R. penicillatus* will also facilitate more accurate and meaningful recording of ecological, distributional and biosystematic data. The importance of critical recording below the level of species in this group is illustrated not only by the different trophic ranges of var. *penicillatus* and var. *pseudofluitans*, but also by the special nature conservation status accorded to var. *penicillatus* by Palmer & Newbold (1983), which var. *vertumnus* perhaps also deserves in Great Britain, in contrast to var. *pseudofluitans*, which is justifiably considered a weed. (To some extent this situation is reversed in Ireland, where it is var. *pseudofluitans* which is the rarity!) This applies all the more strongly since many of the current standard Floras deal only with taxa recognized at and above the level of subspecies.

TYPIFICATION AND NOMENCLATURE

The nomenclature of the group is beset with a number of unfortunate circumstances. *R. aquatilis* subsp. *peltatus* var. *pseudofluitans* Syme, and combinations based on this name, have previously been assumed to be synonymous with *R. penicillatus* var. *penicillatus*. This assumption is almost certainly based on Syme's description of the taxon (Syme, in Sowerby, 1863) in which he stated, ". . . floating leaves very rarely present, resembling those of var. α [*vulgaris*] or β [*floribundus*]". However, I have found only three sheets in Syme's herbarium (**BM**) labelled "*Ranunculus peltatus*, *pseudofluitans*", all of which lack laminar leaves. (One sheet bears a small apical portion of a shoot with laminar leaves but this is referable to *R. aquatilis* or *R. peltatus*). I have designated one of these the lectotype, of which details are cited below. I have also examined similar material collected by Syme in **CGE**. *R. aquatilis* var. *pseudofluitans* is thus not synonymous with *R. penicillatus* var. *penicillatus*, but is a heterotypic synonym of Butcher's *R. calcareus*. Syme's *pseudofluitans*, in the combination *R. heterophyllus* Weber subsp. *pseudofluitans* (Syme) Moore & More, is the earliest epithet to have been applied to this taxon at subspecific rank and now applies at this rank within *R. penicillatus*.

Butcher (1960) cited the holotype of his *R. calcareus* as "Herb. Butcher, No. 21, R. Lea, Hertfordshire". The type was later cited by Cook (1966) as bearing the collection number 4, although he had not seen the specimen. I have examined material from Butcher's herbarium, which was remounted on fresh sheets after it was presented to **BM**, and I have been unable to find any specimen labelled by Butcher as *R. calcareus*. Only one specimen was found from the River Lea, but this did not bear the collection number 4 or the number 21. It is "*R. pseudofluitans* Baker & Foggit, type of illustration number 15 [in Butcher & Strudwick, 1930], in the River Lea, Essex Herts 6.6.1924 R. W. Butcher." In the absence of any other material, I assume that this is the holotype of *R. calcareus*. However, the specimen is inadequate and it is not possible to assign it either to var. *pseudofluitans* or to var. *vertumnus*, although it may be closer to the latter variety. *R. calcareus* (*R. penicillatus* var. *calcareus*) is therefore cited below as synonymous with subsp. *pseudofluitans*, as this is the lowest rank at which it can be determined.

As mentioned above, a large number of specimens of var. *vertumnus* are labelled "*R. pseudofluitans* var. *minor* Pearsall". These include specimens determined by W. H. Pearsall himself, and the name appears in Exchange Club Reports, e.g. Groves (1921), for specimens referable to var. *vertumnus*. The name is a problematic one, since Pearsall (1919) described *R. pseudofluitans* var. *minor* as a new combination without citing a basionym, but giving *R. pseudofluitans* Hiern *pro parte* as a synonym. In the absence of any other evidence, I have assumed that Pearsall's combination is based on Hiern's *R. hydrocharis* "form" *fluitans** var. *minor* (Hiern 1871, p. 104). It is not clear what Hiern meant by var. *minor* since there is no type and the only material in Hiern's herbarium in **RAMM** labelled var. *minor* was collected some 26 years after the

*A. O. Chater (pers. comm., 1986) regards Hiern's "forms" as segregate species, so that this extraordinary name is not discounted as invalid on nomenclatural grounds.

publication of the name. In the absence of any material collected and annotated by Hiern before 1871, var. *minor* can only be typified by the synonym, which Hiern gives as *R. bachii* Wirtg. This is the hybrid *R. fluitans* × *trichophyllus* (Cook 1975). *R. pseudofluitans* var. *minor* is not, therefore, an earlier synonym of *R. penicillatus* var. *vertumnus*.

KEY TO SUBSPECIES AND VARIETIES OF *R. PENICILLATUS*

1a. Plants heterophyllous; capillary leaves produced all the year round; submerged shoots producing laminar leaves during the summer in response to long photoperiods. Capillary leaves exceeding corresponding internodes on mature stems. Leaf segments flaccid, subparallel .... subsp. *penicillatus* var. *penicillatus*

1b. Plants homophyllous; only capillary leaves produced all the year round; laminar leaves never produced, even by submerged shoots in summer. Capillary leaves shorter than, equalling or exceeding corresponding internodes on mature stems. Leaf segments rigid or flaccid, divergent or subparallel 2

2a. Leaves rigid or flaccid; segments *30–350*, divergent or subparallel. Leaf-shape *obconical* whether rigid or flaccid, rigid leaves having an untidy appearance. Leaves *48–385 mm*, shorter than, equalling, or exceeding corresponding internode on mature stems, and occasionally up to four times the length of the internodes. Petioles *12–148 mm long*. .... subsp. *pseudofluitans* var. *pseudofluitans*

2b. Leaves normally rigid (semi-rigid or flaccid in winter), with divergent segments. Segments rarely less than 100, *frequently exceeding 400*, and occasionally over 900. Leaf-shape when rigid invariably *globose or reniform*, leaves becoming obconical only when flaccid. Leaves normally *30–70 mm*, occasionally up to 132 mm in winter, usually shorter than the corresponding internodes and never exceeding twice their length. Petioles *5–15 mm, rarely exceeding 20 mm* (up to 32 mm in winter) .... subsp. *pseudofluitans* var. *vertumnus*

DESCRIPTIONS

RANUNCULUS PENICILLATUS (Dumort.) Bab., *Man. Br. Bot.*, 7th ed., 7 (1874).

Batrachium penicillatum Dumort., *Bull. Soc. Bot. Belg.*, **2**: 216 (1863). *R. hydrocharis* Spenner "form" *penicillatus* (Dumort.) Hiern, *J. Bot., Lond.*, **9**: 46 (1871). TYPE: specimen collected from Flandre by Scheidweiler. Without locality or date of collection, but annotated "*Batrachium penicillatum* Nob." in Dumortier's handwriting. Determined as *R. penicillatus* by C. D. K. Cook, 1968. (Holotype: **BR**).

Long-lived perennial, stem up to 3 m long in flowing water. Capillary leaves invariably present; laminar leaves present or absent. Stipules suborbicular to ovate, adnate to petiole for 0·75 or more of their length. Capillary leaves shorter than, equalling or exceeding corresponding internode on mature stem; petiole 5–148 mm long; lamina elongate-obconical to globose, 23–284 mm long; segments (26) 100–934, rigid or flaccid, subparallel or divergent. Peduncle in fruit 50–100 mm long. Sepals 3–7 mm long, spreading. Petals (5) 10–15 (22) mm long, broadly obovate, contiguous during anthesis; nectar-pits elongate, more or less pyriform. Stamens (8) 20–40. Carpels (15) 50–80, hairy or glabrous; style lateral to subterminal. Receptacle distinctly hairy, remaining globose in fruit.

RANUNCULUS PENICILLATUS subsp. *PENICILLATUS*
R. aquatilis subsp. *marizii* Cout., *Fl. Port.* 231 (1913).
Icones: Fig. 1 above; Cook, *Mitt. bot. StSamml., Münch.*, **6**: Fig. 26, p. 157 (1966).

Laminar leaves alternate when present; petiole 50–100 mm long; lamina up to 46 mm wide and 25 mm long, reniform to suborbicular, occasionally cuneate at base, 3- or 5-lobed, lobes cuneate, sinus two thirds the length of the lamina or less. Margin of lobes entire, crenate or dentate, frequently with capillary appendages. Capillary leaves invariably flaccid, exceeding the corresponding internode on mature stem; petiole 5–60 mm long; lamina elongate–obconical, 703–200 mm long, segments 100–150, subparallel. Peduncle in fruit usually longer than petiole of opposed laminar leaf.

R. PENICILLATUS subsp. **PSEUDOFLUITANS** (Syme) S. Webster, **comb. nov.**

R. aquatilis subsp. *peltatus* var. *pseudofluitans* Syme in Sowerby, *Engl. Bot.*, 3rd ed., **1**: 20 (1863). TYPE: "*Ranunculus peltatus, pseudofluitans*. Putney, Surrey, *J. T. Syme*, June 1853." (Lectotype: ex. herb. J. T. I. Boswell-Syme, **BM**, designated here.)

R. calcareus Butcher, *Naturalist, Hull*, **1960**: 125 (1960). *R. penicillatus* var. *calcareus* (Butcher) C. Cook, *Mitt. bot. StSamml., Münch.*, **6**: 158 (1966). TYPE: "In the River Lea, Essex Herts, 6.6.1924, R. W. Butcher." Labelled "*R. pseudofluitans* Baker & Foggit, type of illus. no. 15". (Holotype: **BM**).

Laminar leaves invariably lacking.

R. PENICILLATUS subsp. *PSEUDOFLUITANS* var. **PSEUDOFLUITANS** (Syme) S. Webster, **comb. nov.**

R. aquatilis subsp. *peltatus* var. *pseudofluitans* Syme in Sowerby, *Engl. Bot.*, 3rd ed., **1**: 20 (1863). *R. pseudofluitans* Newbould ex Syme, *Engl. Bot.*, 3rd ed., **1**: 20 (1863), nom. in syn. *R. pseudofluitans* (Syme) Newbould ex Baker & Foggitt, *Thirsk Nat. Hist. Soc. Bot. Exch. Club. Cur. Rep.*, **1864**: 5 (1865), and *J. Bot., Lond.*, **3**: 115 (1865). *R. heterophyllus* Weber subsp. *pseudofluitans* (Syme) Moore & More, *Cybele Hibernica* 5 (1866). *R. hydrocharis* Spenner "form" *pseudofluitans* (Syme) Hiern, *J. Bot., Lond.*, **9**: 46 (1871). *R. aquatilis* subsp. *pseudofluitans* (Syme) Clapham in Clapham, Tutin & Warburg, *Fl. Br. Isl.* 99 (1952). *R. peltatus* subsp. *pseudofluitans* (Syme) C. Cook in Clapham, Tutin & Warburg, *Fl. Br. Isl.*, 2nd ed., 81 (1962); comb. invalid, basion. non. cit. TYPE: as above.

Icones: Figs. 4, 5 above; Cook, *Mitt. bot. StSamml., Münch.*, **6**: Fig. 27, p. 159 (1966); Holmes, *A guide to the Batrachium* Ranunculus *species of Britain.* Chief Scientist's Team Notes, **14**. London, Nature Conservancy Council: p. 28 (1979).

Capillary leaves shorter than, equalling or exceeding the corresponding internode on mature stem; petiole 12–148 mm long; lamina elongate-obconical, 50–284 mm long, segments occasionally as few as 26 in winter and in poor growth conditions, but normally 70–347, rigid or flaccid, subparallel or divergent.

R. PENICILLATUS subsp. *PSEUDOFLUITANS* var. *VERTUMNUS* C. Cook, *Mitt. bot. StSamml., Münch.*, **6**: 160 (1966) (as var. of *R. penicillatus* (Dumort.) Bab.). TYPE: "In the Basingstoke Canal where it meets the River Greet, Greywell, about 8 km east of Basingstoke, Hampshire, England. *C. D. K. Cook*, 18 May 1958". (Holotype: **K**).

R. sphaerospermus auct. non Boiss. et Blanche in Boissier, *Diagn. Pl. Or. Nov.*, **3** (5): 6.

R. pseudofluitans var. *minor* sensu Pearsall, *Rep. botl. Soc. Exch. Club Br. Isl.*, 5: 423–441 (1919), non *R. hydrocharis* Spenner "form" *fluitans* (Lam.) Hiern var. *minor* Hiern, *J. Bot. Lond.*, **9**: 104 (1871).

Icones: Figs. 6, 7 above; Cook, *Mitt. bot. StSamml., Münch.*, **6**: Fig. 28, p. 161 (1966).

Capillary leaves normally shorter, and never exceeding twice the length of the corresponding internode on mature stem; petiole 5–32 mm long; lamina globose when rigid, becoming obconical when flaccid, normally 23–70 mm long, but occasionally reaching 105 mm in winter. Segments (65) 100–934, normally rigid and divergent, becoming flaccid during winter months and in shaded conditions.

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The *Potamogeton* L. taxa described by Alfred Fryer

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ABSTRACT

The twelve *Potamogeton* L. taxa described by Alfred Fryer (1826–1912) are listed, their lectotypes cited, Fryer's reasons for regarding them as new discussed and their subsequent taxonomic treatment outlined. The composition of Fryer's *Potamogeton* herbarium at the time of his death is indicated and its later fate described. The work of J. E. Dandy and G. Taylor on the genus is briefly reviewed.

INTRODUCTION

Alfred Fryer (1826–1912) became interested in the genus *Potamogeton* L. in the early 1880s. For the next twenty years he studied the Pondweeds growing in the Fenland around his home at Chatteris in Cambridgeshire, observing them in the field and cultivating them in his garden. His own fieldwork was almost confined to Fenland, but plants were sent to him from further afield by other botanists. After 1900 his studies became less intensive, although he remained interested in the genus until his death at the age of 85. I have prepared a reassessment of his work on *Potamogeton* for publication elsewhere (Preston, in press). In the following account numeral superscripts refer to the 'Notes' at the end.

During the course of his studies Fryer described twelve new *Potamogeton* taxa.[1] The first three were based on material from Fenland. As he came to know the local forms in this area, he realized that several did not correspond with the usual forms of species then recognized. When describing these variants as new, he was faced with the problem of choosing the most appropriate taxonomic rank for them. This is discussed in one of his early papers, in which he concluded that it was most convenient to allocate full specific rank to each variant that was worthy of separation (Fryer 1886). He reiterated this view three years later (1889b), when he wrote "what is a *distinct species* in *Potamogeton*? No one really knows . . . let us name all definable forms the origin of which we cannot reasonably trace; this will lead to their examination and study, and possibly to direct experiment in crossing certain species, by which alone many questions can be solved". As this implies, Fryer was aware that his arrangement was a provisional one, "leaving the final settlement of their rank to the time when the whole genus shall be better known" (Fryer 1889a). Amongst the local variants which Fryer described were *P. varians* (1887), *P. falcatus* (1889c) and *P. crassifolius* (1890c).

By 1890 Fryer had realized that hybridization was more significant in *Potamogeton* than had hitherto been realized (Fryer 1890a). He reinterpreted as hybrids several of the Fenland plants with which he was familiar, and described as new *P.* × *billupsii* (1893). At the same time he was becoming known as a national authority on the genus, and so began to receive material collected by other botanists. He thus came to describe the hybrids *P. undulatus* var. *cooperi* (1891, but recombined as *P.* × *cooperi* in 1897), *P.* × *bennettii* (1895) and *P.* × *lintonii* (1900b).

Fryer decided to treat variants of hybrids at the rank of *forma* "when a distinct result is obtained by the interbreeding of the same parents, or in cases where the parents are reasonably supposed to be the same" (Fryer 1898a). (The 'notho-' prefix would be used in such cases today.) He described *P. nitens* f. *involutus* (1896), *P. crassifolius* f. *verrutus* (1898a) and *P. polygonifolius* f. *cancellatus* (1898a).

No comprehensive account of Fryer's taxa has been published. The purpose of this paper is to outline the history of Fryer's herbarium and to list all the taxa described by Fryer, detailing their typification and modern taxonomic treatment. In doing this I have relied to a considerable degree on the taxonomic revision of the British *Potamogeton* species carried out over many years by the late J. E. Dandy and Sir George Taylor. I have therefore included a brief review of their work, with particular emphasis on the unpublished sources of information about it.

FRYER'S HERBARIUM

Fryer collected his first specimens of *Potamogeton* on 16 June 1880. He subsequently amassed a large herbarium, mainly of plants he collected himself. These were beautifully pressed and accurately annotated. Fryer was not unaware of the scientific value of this material (Evans & Britten 1912), and he explained his strong views about its future to James Britten of the British Museum's Botany Department:[2]

"I hope shortly to send you a parcel of specimens of these plants for the Museum Herbarium. You may perhaps be able to call to mind that I once said my collection of Pots would ultimately be placed there. Now it has acquired such importance in my eyes that I am unwilling that it should be broken up or *distributed through a general collection.* If you could see my Herbarium of these plants and have the method on which it has been collected explained to you I think you would quite understand how the value of such a set of plants would be destroyed by dispersing it through another Herbarium. For instance *P. varians* is followed up *year after year* and **month after month** in various localities round Chatteris until 3 or 400 sheets are filled with its states and forms. Miss out of (*sic*) ten of these specimens (of little value separately) would be called *duplicates* in any Herbarium arranged in the usual manner – but as I have them (and hope *some one will keep them*) they show all sorts of curious facts in life-history as *a hot week*; *a rainy week*; *artificial irrigation*; etc. etc. all facts of inestimable value in showing *why Pots vary* – and how our so-called 'species' are formed."

When Fryer died in February 1912 his *Potamogeton* specimens were given to Charles Bailey, the Manchester amateur botanist, for his lifetime, then to the British Museum (Evans & Britten 1912). Bailey, having enumerated the 5450 specimens of *Potamogeton* and allied genera (see Appendix), decided to pass the collection to the Museum without further delay. By 24 May 1912 he was able to write that "the Potamogetons have all gone to South Kensington [**BM**] so that the authorities there may settle what they wish to retain. Owens College [**MANCH**] gets the next choice, and then Cambridge University [**CGE**]".[3] The specimens which remained after these institutions had taken what they wanted were widely distributed, some even to private collectors (e.g. S. H. Bickham, whose herbarium was eventually donated to **CGE**).

Eighteen months after her father's death, Miss Rose Fryer was disappointed when she visited the British Museum to see his collection:[4]

"A fortnight ago I went to Cromwell Rd and had the temerity to ask to see the Fryer Potamogetons. I was informed they were not yet arranged for the use of students, but on giving my name, Mr Baker took me to a room where the collection was lying in a big heap on a bench – covered with a cloth. The methods at the Brit. Museum of Nat. History seem somewhat dilatory – but I suppose 'Red Tape' pervades anything. I could not help thinking of the excessive care my poor father had bestowed upon his collection and I can only trust it may be useful 'some day'."

She subsequently wrote to G. C. Druce "Please do use all your great influence, and the weight of your opinion, in order that justice may be done in this matter".[5] In view of the poor relations between Druce and the British Museum botanists (Allen 1986), it is unlikely that Druce's representations would have been well received.

The typification of Fryer's names is complicated by the fact that some specimens of *Potamogeton* were destroyed and others badly damaged when the British Museum was hit by incendiary bombs on 9 September 1940 (cf. Stearn 1981). In addition to specimens belonging to **BM**, those on loan to Dandy and Taylor from some other institutions were affected. Some specimens cited as being at **BM** in the Dandy Index, including at least one Fryer lectotype, cannot now be found in the herbarium. I have assumed that these were destroyed in the war. Many specimens which were damaged but not destroyed are stored separately, not incorporated into the herbarium. Other Fryer specimens which are undamaged but unmounted are kept with them. If any of the specimens that I have assumed were destroyed are ever discovered, the decisions I have made about typification may have to be reviewed. Because of the doubt about the continued existence of specimens seen by Dandy and Taylor before the War, I have used the symbol '!' to indicate that I have seen a specimen of the collection cited.

Fryer's specimens of other genera were split between Bailey and Druce. Bailey thought that these Fenland plants would be most appropriately placed in Cambridge, and suggested to Druce that they should both send the material they had received to the University herbarium. Druce must have refused, as by September 1912 Bailey was incorporating the plants he had received from Fryer into his British herbarium.[6]

DANDY AND TAYLOR'S STUDIES OF *POTAMOGETON*

In 1937 J. E. Dandy and G. Taylor of the British Museum (Natural History) began to co-operate in a study of the British *Potamogeton* species. Taylor had collected *Potamogeton* specimens during the British Museum Expedition to East Africa (1934–35). Dandy worked through this collection, which contained several British species, when preparing his account of the tropical African *Potamogeton* species (Dandy 1937). Together the two colleagues resolved to produce a monograph of the British species, with particular emphasis on their distribution. With this end in view they published preliminary papers in a series of 'Studies of British Potamogetons', eighteen of which appeared in *The Journal of Botany* between 1938 and 1942. In these papers the British distribution of the critical 'pusilloid' *Potamogeton* species was clearly set out for the first time, and the identity of several hitherto misunderstood species and hybrids was clarified. Taken together, these papers must represent one of the most impressive modern contributions to the taxonomy of the British flora.

Dandy and Taylor's careers diverged after the War, with Taylor leaving the British Museum for Kew in 1956. Thereafter their collaboration became more difficult, and with both men being expected to undertake an increasing burden of administrative work it proved impossible to complete the proposed monograph (Taylor 1977). However, after his retirement Dandy published the account of *Potamogeton* in *Flora Europaea* (Dandy 1980) and an invaluable treatment of the British hybrids (Dandy 1975).

The taxonomy of the genus adopted in this paper is that of Dandy and Taylor. All the taxa published by Fryer at specific rank, or subsequently raised to this rank, are cited by Dandy (1958, 1975) as valid names or synonyms. For infraspecific taxa, and for detailed information on many of the species, it has been necessary to consult Dandy and Taylor's unpublished work. I have used the following sources in preparing this paper:

1) Herbarium specimens in **BM**, **CGE** and **MANCH**.

2) The 'Dandy Index', a card index held in the Botany Department, British Museum (Natural History), which details herbarium specimens examined by Dandy and Taylor or (in later years) by Dandy alone. During the course of their studies Dandy and Taylor determined the specimens in most of the more significant national herbaria. The card index includes details of most of the specimens they examined, although some appear not to be included. It was compiled by Dandy and maintained until his death in 1976.

3) A manuscript monograph "British species of *Potamogeton* L." by Dandy and Taylor. Dandy's annotated copy is held in the Botany Department library, British Museum (Natural History); Sir George Taylor's is in his own possession. This draft monograph is particularly valuable for its bibliography and for the extensive synonomy cited for each species. It was written in the 1940s, and consequently the taxonomic and distributional evidence is superseded by Dandy's (1958, 1975, 1980) later published works, the distribution maps based on specimens determined by Dandy and Taylor (Perring & Walters 1962; Perring & Sell 1968) and the specimens cited in the Dandy Index.

THE *POTAMOGETON* TAXA DESCRIBED BY FRYER

For each of the taxa described by Fryer, I have briefly outlined the reasons which led him to describe it as new, considered the typification and added any notes on the subsequent treatment of the plant which appear relevant.

POTAMOGETON × *BENNETTII* Fryer in *J. Bot., Lond.*, **33**: 1 (1895).

Type: Wood Pond, Grangemouth, Stirling, 24th August 1894, R. Kidston & Col. Stirling. *A. Fryer 3001* (lectotype: **BM**!). Determined as *Potamogeton* × *bennettii* Fryer by J. E. Dandy & G. Taylor, 1937.

The sterile hybrid *Potamogeton* × *bennettii* has been considered in detail by Dandy & Taylor (1939c). Fryer (1895) thought that it was probably *P. crispus* × *obtusifolius*, but Dandy and Taylor provide a convincing justification for regarding it as *P. crispus* × *trichoides*. *P.* × *bennettii* is the correct name for this hybrid between two very dissimilar parents (Dandy 1975). The name commemorates Arthur Bennett (1843–1929), Fryer's friend and fellow student of the genus *Potamogeton*.

Fryer 3001 is identified as the lectotype of *P.* × *bennettii* in the Dandy Index, and the specimen cited above is labelled as the lectotype in **BM**.

P. × *bennettii* is confined to the Forth & Clyde Canal system (Perring & Sell 1968; Dandy 1975). It is not known outside the British Isles. The morphologically similar hybrid *P.* × *lintonii* (q.v.) is more often found in canals than in other habitats, but is much more widespread.

POTAMOGETON × *BILLUPSII* Fryer in *J. Bot., Lond.*, **31**: 353 (1893).

Type: Cultivated root from Parsonware Drove, Benwick, Cambridgeshire, 1892. *A. Fryer 2245* (lectotype: **BM**!).

Fryer based *Potamogeton* × *billupsii* on a single plant which he found in 1892. It grew in shallow water amongst a mass of *P. coloratus* and *P.* × *zizii* at Benwick (Fryer 1893, 1898b). This plant was later destroyed by the deepening of the ditch in which it grew, but Fryer had by then taken it into cultivation. When grown in shallow water it produced abundant flower spikes, which proved to be "absolutely barren". Fryer believed that it was a hybrid between *P. coloratus* and *P.* × *zizii*. (*P.* × *zizii* is itself a hybrid between *P. gramineus* and *P. lucens*. It is the only British *Potamogeton* hybrid which produces well-formed fruit.) He named it after Christopher Robert Billups (1861–1938), his nephew, who assisted him in the study of pondweeds.

The specimen cited as lectotype above was selected by Dandy and Taylor (Dandy Index), and is labelled as such in **BM**. It is the original of one of the plates (tab. 338) that illustrated Fryer's description of *P.* × *billupsii*. Robert Morgan's coloured drawing for the plate is attached to the specimen.

Dandy and Taylor accepted that *P.* × *billupsii* was a hybrid, but regarded the parents as *P. coloratus* and *P. gramineus*. *P.* × *billupsii* is the correct binomial for this hybrid (Dandy 1975).

Fryer's 1892 record of *P.* × *billupsii* from Benwick is still the only substantiated record from eastern England. Fryer himself (1893, 1898b) mentioned a plant which he collected in 1892 at Sutton Meadlands, Cambs., and which he thought was probably *P.* × *billupsii*. I have not been able to trace this specimen, nor can it be identified with any recorded in the Dandy Index. In its absence the record cannot be accepted, especially as Fryer was himself uncertain of its identity. The reports of *P.* × *billupsii* from Burwell, Cambs. (Evans 1911, 1939) and Ramsey St Mary's, Hunts. (*Rep. botl Soc. Exch. Club Br. Isl.*, **2**: 400 (1909), Druce (1926)) are based on specimens later identified as *P. gramineus* by Dandy and Taylor. However *P.* × *billupsii* is known from Benbecula, Outer Hebrides, where it was first collected in 1940 and has been refound on several occasions.

POTAMOGETON CRASSIFOLIUS Fryer in *J. Bot., Lond.*, **28**: 321 (1890).

Type: The Engine Drain, Mepal, Cambridgeshire, 7 July 1890. *A. Fryer 1656* (lectotype: **BM**!). Determined as *Potamogeton* × *fluitans* Roth by J. E. Dandy & G. Taylor, 1938.

Potamogeton crassifolius was described by Fryer (1890c) as a sterile hybrid resembling *P.* × *fluitans*, but whereas *P.* × *fluitans* has the parentage *lucens* × *natans*, Fryer thought that *P. crassifolius* was a hybrid between *zizii* (i.e. *lucens* × *gramineus*) and *natans*. In addition to pointing out the morphological differences between *P. crassifolius* and *P.* × *fluitans*, he supported this suggestion with evidence drawn from the distribution of *P. crassifolius*.

Fryer (1890c) recorded *P. crassifolius* from three Cambridgeshire parishes, Chatteris, Mepal and

Doddington. He discussed two localities in detail: Mepal Engine Drain, in which the type variant of the species grew, and Westmoor, Doddington, where the population differed slightly. Fryer (1898a) later named the Westmoor plant f. *verrutus* (see below). The lectotype should be based on the Engine Drain plant which Fryer regarded as typical. *Fryer 1656*, a widely distributed collection, is designated as the lectotype in Dandy's Index. Although no specimen is actually labelled as a lectotype in **BM**, one sheet is enclosed in a Type Specimen folder, doubtless because it was Dandy's choice of lectotype. It is an entirely appropriate selection and I have now labelled it as the lectotype.

In his final treatment of *P. crassifolius*, Fryer (1898a) regarded it not simply as *P.* × *zizii* × *P. natans* but as *P. coriaceus* × *P. natans*. He thought of *P. coriaceus* as the backcross between *P.* × *zizii* and *P. gramineus*.

The lectotype and the other specimens in **BM** originally labelled by Fryer as *P. crassifolius* have been determined as *P.* × *fluitans* by Dandy and Taylor.

POTAMOGETON CRASSIFOLIUS Fryer f. *VERRUTUS* Fryer, *Potamoget. Brit.*, 9 (1898), ('*verruta*').

Type: Cultivated plant from Westmoor, Doddington, Cambridgeshire, 6 September 1890. *A. Fryer 1735* (lectotype: **BM**!). Determined as *Potamogeton* × *fluitans* Roth by J. E. Dandy & G. Taylor, 1938.

In his original description of *Potamogeton crassifolius*, Fryer (1890c) pointed out that the population at Westmoor, Doddington, differed from the typical plant in leaf characters, being closer to one of the putative parents, *P. natans*. By the time he prepared the description of *P. crassifolius* for his monograph, Fryer (1898a) had studied the Westmoor plant in cultivation for eight years. On the basis of these observations he described the Westmoor plant as f. *verrutus*.

The specimen cited above is noted as lectotype in the Dandy Index and labelled as such in **BM**. It is the original of the lower figure on Plate 5 of the monograph by Fryer & Bennett (1915), which illustrated the description of f. *verrutus*.[7]

In classical latin the adjective *verrutus* (or *verutus*) is used only in a military sense, and means "armed with a javelin". It is rare in botanical latin, and Fryer does not explain its relevance to the Westmoor population of *Potamogeton crassifolius*. He probably intended it to refer to the plant's very long lanceolate or oblanceolate submersed leaves, which are well illustrated in the plate cited above.

POTAMOGETON DRUCEI Fryer, *Potamoget. Brit.*, 31 (1898), *pro hybr.*

Lectotype: Plate 21, fig. 1, in the version of Fryer, *Potamoget. Brit.* (1898), with colour plates.

Potamogeton drucei was named by Fryer (1898b) in honour of G. C. Druce (1850–1932), who discovered the plant in the R. Loddon, Berkshire, in 1893. When he published the description Fryer thought that the plant was probably a hybrid between *P. alpinus* and *P. natans*. His subsequent views, and the opinions of other British and European botanists, are chronicled by Dandy & Taylor (1939a). No consensus about its identity was reached until Dandy & Taylor (1939a) demonstrated that it is identical to *P. nodosus*, a widespread species in Europe and elsewhere.

Dandy and Taylor did not select a lectotype of *P. drucei*. Fryer received material collected by Druce in 1893, but this was "badly dried and wanted roots and lower leaves". The specimens were so inadequate that Fryer regarded them as indistinguishable from *P.* × *fluitans* (Fryer 1898b). He subsequently received better specimens and living plants (which he cultivated). His description of *P. drucei* was based on these. However, the only specimen he cited specifically was Druce's inadequate original collection. The illustration (Plate 21) which accompanied his description was drawn from a fresh specimen collected in the R. Loddon by Druce in September 1898; a young leaf from a cultivated plant was also illustrated.

Four specimens of *P. nodosus* from Fryer's herbarium survive in **BM**, in addition to a packet of fruits collected after the description of *P. drucei* in 1898. Although the lower edge of all four sheets has been burnt, the date of collection is still legible on three. These were gathered by Druce in the R. Loddon in June, July and August 1893. The date of the fourth specimen has been burnt away, but it appears from the surviving portion of the label to be a duplicate of the specimen collected in August. None of these specimens is actually labelled as *P. drucei*, and in view of the dissatisfaction expressed by Fryer with Druce's 1893 specimens, it does not seem advisable to select one of these as a lectotype. Druce did not collect any material between 1894 and 1897. None of the specimens he collected in 1898 and now present in **BM**, **CGE** or **MANCH** were acquired from Fryer's herbarium. None of the 1898 specimens in Druce's herbarium (**OXF**) bears any indication that it was examined by Fryer. The letters which Fryer wrote to Druce about *P. drucei* are preserved with Druce's specimens in **OXF**, and extracts from them have been published (Druce 1920). They show that Fryer's later opinion of *P. drucei* was almost entirely based on the living material which he received from Druce in 1898 and cultivated at Chatteris.[8] In the absence of a satisfactory specimen available for selection as lectotype, I have chosen the excellent illustration, drawn by Robert Morgan, which is cited above.

G. C. Druce became very attached to the pondweed named after him. He was photographed inspecting it in the River Stour (Allen 1986, p. 135) and it was used as a motif in the bookplate presented to him by admiring members of the Botanical Exchange Club (Anon. 1926). Druce (1927) himself did not fail to point out that it was carved in stone in the University Museum, Oxford, where it can still be seen. It is perhaps fortunate that he did not live to see it reduced to a synonym of *P. nodosus*.

POTAMOGETON FALCATUS Fryer in *J. Bot., Lond.*, **27**: 65 (1889).
P. gramineus var. *falcatus* (Fryer) Druce, *List Brit. pl.*, 2nd ed., 116 (1928).
Type: Stocking Fen, Ramsey, Huntingdonshire, 21 July 1888. *A. Fryer 1131* (lectotype: **CGE**!). Determined as *P. gramineus* L. by C. D. Preston, 1986.

Potamogeton falcatus was described by Fryer (1889c) from a single locality, Stocking Fen, Ramsey, Hunts. Fryer described it as a species because he was unable to ascribe it to any of the taxa then recognized. It differed from *P. gramineus* in having amplexicaul leaves, which gave it a close resemblance to *P.* × *nitens* (*P. gramineus* × *perfoliatus*). Fryer was advised by W. H. Beeby to include it as an intraspecific variant of *P.* × *nitens*, and subsequently the similarity was noticed by N. E. Brown (Fryer 1890b) and G. Tiselius (Fryer 1892a). However by 1889 Fryer had realized that *P.* × *nitens* was a sterile hybrid, whereas *P. falcatus* produced fertile fruit.

At one stage Fryer (1892a) contemplated a further note on *P. falcatus*, but this never appeared. We do not know his later views on the nature of the plant. In 1896 he referred to it as an "obscure and doubtful species". The discussion of *P. falcatus* in the posthumously published section of his monograph (Fryer & Evans 1913) is derived from his original paper, but Evans noted that "to the end of his life Fryer was somewhat uncertain as to the specific validity of this form".

In the Dandy Index an unnumbered specimen at **BM** collected by Fryer at Stocking Fen, Ramsey, on 11 July 1888 is selected as lectotype. This was the original of one of the figures that accompanied Fryer's description (t. 286, fig. 1). Unfortunately it is not now present in **BM**, and is not duplicated elsewhere. It is therefore necessary to select a new lectotype, which should be a fruiting specimen collected by Fryer before 1889 and labelled *P. falcatus.* I have chosen the specimen at **CGE** cited above, which closely matches the description in Fryer's protologue. It is from the herbarium of C. C. Babington, and must have been sent by Fryer to Babington before the latter's death in 1895.

The lectotype selected in the Dandy Index had been determined by Dandy and Taylor as *P. gramineus* L., and the lectotype I have now selected to replace it is also referable to this species.

POTAMOGETON × *LINTONII* Fryer in *Rep. Watson bot. Exch. Club*, **1899–1900**: 21 (1900), ('*lintoni*').
Type: Canal, Renishaw, Derbyshire, July 1899. *C. Waterfall* (lectotype: **BM**!). Determined as *P.* × *lintonii* Fryer (type collection) by J. E. Dandy & G. Taylor.

P. × *lintonii* has been discussed by Dandy & Taylor (1939c). They agree with Fryer's opinion that it is a hybrid between *P. crispus* and *P. friesii*, adding evidence drawn from the morphology of the stipular sheaths to the arguments advanced by Fryer. The name is the correct binomial for this hybrid (Dandy 1975). It commemorates the Rev. W. R. Linton (1850–1908), author of the *Flora of Derbyshire*, who came to the same conclusion as Fryer about the hybrid nature of this plant.

Fryer's description of *Potamogeton* × *lintonii* was based on specimens collected by C. Waterfall at Renishaw in July 1899. Despite the fact that the description was published in the annual report of a Botanical Exchange Club, Dandy and Taylor only saw material of this collection in one herbarium, **BM** (*fide* Dandy Index). The single sheet now at **BM** is stamped 'Watson Botanical Exchange Club' and I have designated it as the lectotype. It must be regarded as a lectotype rather than the holotype as Fryer consistently referred to "specimens" (plural) in his protologue. There is a specimen at **SHD** which comes from Waterfall's own herbarium, and which may be an isolectotype. The details on the label differ slightly from those on the specimen at **BM**, as the collectors are given as C. Waterfall and the Rev. W. R. Linton and the date of collection as 8 July 1899.

P. × *lintonii* is the most frequent of the British *Potamogeton* hybrids with a parent in the narrow-leaved Sect. *Graminifolii*. It is particularly associated with canals in midland England (Perring & Sell 1968).

POTAMOGETON × *NITENS* Weber f. *INVOLUTUS* Fryer in *J. Bot., Lond.*, **34**: 1 (1896) ('*involuta*').
P. nitens f. *involutus* Fryer in *Rep. botl Soc. Exch. Club Br. Isl.*, **1**: 461 (1895) nom. nud.
P. nitens var. *involutus* (Fryer) Ascherson & Graebner, *Syn. mitteleur. Fl.*, **1**: 326 (1897).
P. involutus (Fryer) H. & J. Groves in Babington, *Man. Brit. bot.*, 9th ed., 440 (1904).
Type: Blackbush Drain, Whittlesea, Cambridgeshire, 25 June 1895. *A. Fryer 3004* (lectotype: **BM**!). Determined as *Potamogeton* × *nitens* Weber by J. E. Dandy & G. Taylor, 1939.

In September 1894 Fryer (1894) discovered a population of *Potamogeton* × *nitens* in a drain and ditch at Blackbush Drove, Whittlesey, Cambs., which he described as "a very peculiar plant, with an extraordinary development of coriaceous floating leaves". He later (Fryer 1896) named it *P.* × *nitens* f. *involutus*, a variant differing from the usual plant in having involute submersed leaves and in the abundance of its coriaceous floating leaves. Its fruits were abortive but Fryer commented that "they are sufficiently developed to make it seem likely that in exceptional cases they may ripen and reproduce the species by seed".

When he described f. *involutus* Fryer was uncertain of its parentage, thinking that it was a hybrid between *P. perfoliatus* and either *P. gramineus* or *P.* × *zizii* (*P. lucens* × *gramineus*). In 1903 he annotated a specimen of f. *involutus* in C. Bailey's herbarium (**MANCH**!) "This is *P. zizii* × *P. perfoliatus*, therefore cannot be *nitens*. I now name it × *P. involutus*". The plant was formally raised to specific rank in the Groves brothers' edition of Babington's *Manual*, where it was given the same hybrid formula. In 1908 Fryer told E. W. Hunnybun that *P. involutus* was probably a hybrid between *P. perfoliatus* and *P. coriaceus*[9] (the latter he regarded as a fertile hybrid between *P.* × *zizii* and *P. gramineus*). This view is repeated in the posthumously published section of Fryer's monograph (Fryer & Evans 1913).

Fryer stated in his protologue that *P.* × *nitens* f. *involutus* "grows abundantly in Blackbush Drain and some adjacent ditches near Whittlesea, Cambridgeshire". I am not aware of any previous attempt to lectotypify this name. There are many specimens from Fryer's herbarium (**BM**!, **CGE**!, **MANCH**!) collected at Blackbush Drain in 1894 and 1895, all of which were determined as *P.* × *nitens* by Dandy and Taylor. I have selected one as a lectotype and cited it above.

POTAMOGETON POLYGONIFOLIUS Pourr. f. *CANCELLATUS* Fryer, *Potamoget. Brit.*, 21 (1898) ('*cancellata*').
P. polygonifolius var. *cancellatus* (Fryer) H. & J. Groves in Babington, *Man. Brit. bot.*, 9th ed., 437 (1904).
P. oblongus Viv. var. *cancellatus* (Fryer) Druce, *List Brit. pl.*, 2nd ed., 116 (1928).
Type: Burn of Loch Brouster above Bridge of Walls, Shetland, 19 August 1890. *W. H. Beeby 1077* (lectotype: **SLBI**!). Determined as *P. polygonifolius* Pourr. by C. D. Preston and N. F. Stewart, 1986.

In 1890 W. H. Beeby discovered a *Potamogeton* growing plentifully in the burn flowing from Brousta Loch above Bridge of Walls, Walls, Shetland. He reported it as a remarkable plant resembling deep-water states of *P. polygonifolius* but differing in producing only a few floating leaves when growing in shallow water. Because these leaves were thinner and less coriaceous than those normally produced by *P. polygonifolius*, the plant resembled *P. coloratus*. However Beeby thought that it was a hybrid of *P. polygonifolius* and *P. gramineus*, although he admitted that "what it really is must at present be held to be uncertain" (Beeby 1891).

By the time Fryer dealt with this plant in his monograph (Fryer 1898a), he had been able to study it in cultivation at Chatteris. He confirmed that it "remains unaltered when cultivated in stagnant water, under conditions wholly differing from those of its natural station". Despite this opportunity to study the plant, he was also unsure of its identity. After quoting Beeby's account, Fryer said that at first he had "strongly inclined" to regard it as *P. coloratus*. "After further examination, and considering the fact that *P. coloratus* has not been found in the Shetland Isles, I now incline to agree with Mr Bennett in ranking this form under *P. polygonifolius* for the present. In deference to Mr Beeby's opinion as to its being possibly a hybrid, I do not use the term *var.*, but in conformity with my usage in this work prefer to employ the term *forma*, as indicating a possible hybrid origin". He therefore described it as f. *cancellatus*. Fryer regarded an Irish plant collected by R. W. Scully in 1888 in the Long Range, Killarney, Co. Kerry, as very similar, but as he had not been able to cultivate it he based his description solely on the Shetland material.

No lectotype for f. *cancellatus* has yet been proposed. Ideally it should be a Beeby specimen from Fryer's herbarium, either collected in the wild or subsequently cultivated at Chatteris. Unfortunately no such material appears to survive at **BM**, **CGE** or **MANCH**. The lectotype must therefore be selected from the specimens collected by Beeby in 1890, which must be regarded as syntypes or isosyntypes, and the illustrations which accompany Fryer's description. As specimens are to be preferred to illustrations, I have selected the Beeby specimen in **SLBI** as lectotype and cited it above.

POTAMOGETON SALIGNUS Fryer in Hiern, *Victoria Hist. Devon.*, **1**: 129 (1906).
Type: In the Wye, Carey, Herefordshire, 3 June and 6 July 1893. *A. Ley*, *A. Fryer 2674* (lectotype: **BM**!). Determined as *Potamogeton* × *decipiens* Nolte ex Koch by J. E. Dandy & G. Taylor, 1938.

The circumstances surrounding the description of *Potamogeton salignus* have been clearly set out by Dandy & Taylor (1939b), and need not be repeated here. Dandy and Taylor lectotypify this name by one of the specimens in Fryer's herbarium (**BM**) collected at Carey on the Wye in 1893 by the Rev. A. Ley. None of the specimens now at **BM** is formally labelled as a lectotype, but one bears a pencil note in Dandy's handwriting "lectotype P. salignus?". It does not seem possible to decide whether this was the plant originally selected by Dandy and Taylor, or whether the original lectotype was destroyed in the war and Dandy was considering this sheet as a replacement. In any event, Dandy's annotation makes it the most appropriate lectotype of *P. salignus* and I have labelled it accordingly. As Dandy & Taylor (1939b) explain, the Wye plant is taxonomically identical to *P.* × *salicifolius* (*P.* × *decipiens*) and they determined the lectotype as such.

POTAMOGETON UNDULATUS Wolfg. var. *COOPERI* Fryer in *J. Bot., Lond.*, **29**: 289 (1891).
P. × *cooperi* (Fryer) Fryer in *Rep. botl Soc. Exch. Club Br. Isl.*, **1**: 497 (1897).
Type: The Leicester Canal, Loughborough, E. F. Cooper. Collected as fresh material by Cooper and pressed by Fryer on 23 August 1891 as *Fryer 2032* (lectotype: **BM**!). Determined as *Potamogeton* × *cooperi* (Fryer) Fryer by J. E. Dandy & G. Taylor, 1937.

Potamogeton undulatus var. *cooperi* was described by Fryer (1891) as a hybrid between *P. crispus* and *P. perfoliatus*. He ranked it as a variety of *P. undulatus* Wolfg. as he then regarded Wolfgang's plant as a hybrid with the same parentage, although differing from the English plant "in some slight degree". Subsequent investigations by J. Baagöe and C. Raunkiaer showed that *P. undulatus* was in fact the hybrid *P. crispus* × *praelongus*, and on being informed of this Fryer raised his plant to specific rank (Fryer 1897, 1900a).

E. F. Cooper first found *P.* × *cooperi* in the Leicester Canal at Loughborough in 1885. He initially regarded it as a variant of *P. perfoliatus*, but Fryer recognized that it was *P. perfoliatus* × *crispus* when he was shown the material (Cooper 1894). By the time that he described var. *cooperi*, Fryer had received fresh material collected by Cooper at Loughborough and by C. R. Billups in the R. Dee near Chester. He cultivated both plants, and thus proved "their absolute specific identity". A plate based on fresh specimens from Loughborough illustrated the description.

There are numerous specimens collected by Cooper in Fryer's herbarium, including plants cultivated by Fryer. The specimen cited as lectotype above was labelled by Fryer "The type specimen described in Journal of Botany". It is not actually designated as the lectotype in the Dandy Index, but a label identifying it as the "Type Specimen" dates from the period when Dandy and Taylor were studying the genus. It is the obvious choice of lectotype.

E. F. Cooper was not the first botanist to collect the hybrid *P. crispus* × *P. perfoliatus*. Between 1878 and 1884 it was gathered in five vice-counties. In four of these (v.cc. 40, 55, 57, H39) the plants were named *P. perfoliatus* or, more rarely, *P. crispus* and their hybrid nature was not recognized. However, a specimen collected near Wetherby (v.c. 64) by J. Jackson in 1881 was described as *P. perfoliatus* var. *jacksonii* F. A. Lees in *Rep. bot. Rec. Club*, **1880**: 150 (1882). Lees was uncertain of the identity of this plant, but Fryer recognized its similarity to *P. undulatus* var. *cooperi*, regarding it as another variety, *P. undulatus* var. *jacksonii* (F. A. Lees) Fryer in *J. Bot., Lond.*, **29**: 291 (1891). He later recognized that the plants were not distinct even at varietal level, and included both under *P.* × *cooperi* (Fryer 1900a).

Potamogeton × *cooperi* remains the correct name for the hybrid of *P. crispus* and *P. perfoliatus* (Dandy 1975). It is relatively widespread in the British Isles (Perring & Sell 1968).

POTAMOGETON VARIANS Morong ex Fryer in *J. Bot., Lond.*, **25**: 308 (1887).
Type: Witcham Meadlands Drove, Mepal, Cambridgeshire, 1 September 1887. *A. Fryer 457* (lectotype: **BM**!). Determined as *P. gramineus* L. by C. D. Preston, 1986.

During his studies of the Fenland Potamogetons, Fryer came to believe that one plant was identical to an American plant which had been called *P. varians* by the Rev. T. Morong. Morong confirmed this identification, which had initially been suggested by Arthur Bennett. Fryer regarded *P. varians* as a fertile plant closely allied to *P. gramineus*. He (1889a, b) said that it was "the most remarkable *Potamogeton* known to me in its power of resisting extreme drought and heat", and described how it would grow "on the grassy bottoms of ditches as dry as an ordinary meadow".

Morong had never published the name *P. varians*, so it fell to Fryer to validate it. He did this in a paper in which he described the "land-forms" of the Fenland *Potamogeton* species, phenotypes which he had studied in the hot summer of 1887 (Fryer 1887). Only later did he give a detailed description of the plant's submersed as well as its land-form (Fryer 1889b). Both states were illustrated in a plate (tab. 287) which accompanied his next, albeit unrelated, paper (Fryer 1889c).

Fryer's protologue is almost exclusively devoted to a description of the land-form of *P. varians*, with the submersed plant being mentioned only incidentally. A land-form must therefore be selected as lectotype. There are specimens in **BM**, **CGE** and **MANCH** collected by Fryer in 1887 and labelled as "Potamogeton varians Morong. Land-form". One of the specimens at **BM** is annotated by Fryer: "In a perfectly dry ditch, from which the herbage had been cut, growing unshaded and exposed to the blown ashes of a 'burning ground' ". This wording corresponds closely with the passage in the protologue: "I have gathered healthy plants of *P. varians* (on the bottom of a perfectly dry ditch exposed to the full rays of the sun) the leaves of which were covered with dust and ashes blown from an adjacent 'burning-ground', and yet the lower leaves were as thin and translucent as those of *P. plantagineus*." The plants on this sheet closely match Fryer's description of the land-form of *P. varians*. The fact that they were collected at Witcham Meadlands Drove is appropriate, as another specimen from this locality (*Fryer 417*, **CGE**!) bears the note in Fryer's hand "The plant from this locality assented to by Morong, but not quite the original type". I have therefore selected the **BM** specimen as lectotype and the full details are cited above.

Fryer (1890a, 1892b) came to regard *P. varians* as a hybrid between *P. gramineus* and *P.* × *zizii*. It is now treated as a synonym of *P. gramineus*. Both the lectotype and also the many specimens of submersed plants subsequently collected by Fryer are referable to this species. The American plant to which Morong originally applied the name *P. varians* is not in fact identical to Fryer's Fenland plant, being a hybrid between *P. gramineus* and the closely related American species *P. illinoensis* Morong (Ogden 1943).

NOMINA NUDA

Potamogeton coriaceus var. *major* Fryer in *J. Bot., Lond.*, **28**: 321 (1890) nom. nud.
Potamogeton falcatus var. *major* Fryer in *J. Bot., Lond.*, **32**: 379 (1894) nom. nud.

Each of these names only appears once in Fryer's publications. The specimens labelled *P. coriaceus* var. *major* and *P. falcatus* var. *major* in his herbarium are *P.* × *zizii* and *P. gramineus* respectively. On a herbarium specimen of *P. coriaceus* var. *major* (**MANCH**!) Fryer commented "This form is . . . constantly distinct from the type. Fresh specimens have the facies of *P. crassifolius*". The variety of *P. coriaceus* was taken up by Ascherson and Graebner in the combination *P.* × *zizii* var. *coriaceus* subvar. *major* Fryer ex Ascherson & Graebner in Engler, *Pflanzenr.* IV, 11 (Heft **31**): 83 (1907).

DISCUSSION

In investigating the Fenland Potamogetons, Fryer was particularly concerned with the plants that he included in the '*P. lucens* group', i.e. *P. gramineus*, *P. lucens* and their hybrids. He described several taxa in this group, usually after prolonged field observation and cultivation in his garden. He also applied the names of taxa described by others, such as *P. graminifolius* H. & J. Groves and *P. coriaceus* (Mert. & Koch) A. Benn., to segregates of the *P. lucens* group in Fenland. In doing so he consciously adopted a narrow species concept. Almost all the taxa that he described in this group have now been reduced to synonyms of more widespread and variable species or hybrids. It is perhaps not surprising that it has proved impractical to adopt his very narrow species concept at a national or international level.

The names proposed by Fryer which are still in use are those for the hybrids *P.* × *bennettii*, *P.* × *billupsii*, *P.* × *cooperi* and *P.* × *lintonii*. Only *P.* × *billupsii* was described from Fenland. The other three were based on material sent to him from elsewhere, and do not belong to the *P. lucens* group.

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NOTES

1 In their edition of Babington's *Manual*, the Groves brothers state under *P. flabellatus* Bab. that "a slender maritime form with setaceous l[eaves] is var. *scoparius* (Fryer)". Fryer (1888) had discussed *P. scoparius* [Wallr.] in a paper in which he concluded that it was probably a "mere state" of *P. flabellatus*. *P. scoparius* of Wallroth is probably the plant the Groves had in mind, but as they (contrary to their practice elsewhere in the account of *Potamogeton*) do not cite Wallroth as the authority, var. *scoparius* must be treated as a newly described variety. The most appropriate citation appears to be *P. flabellatus* Bab. var. *scoparius* Fryer ex H. & J. Groves in Babington, *Man. Brit. bot.*, 9th ed., 443 (1904). I do not, therefore, treat it as a taxon described by Fryer.

2 A. Fryer to J. Britten, 13 December 1889. Autograph collection, Botany Department, British Museum (Natural History). I have expanded Fryer's contractions. Words underlined twice by Fryer are reproduced in bold type.

3 C. Bailey to G. C. Druce, 24 May 1912. Druce papers, Department of Plant Sciences, University of Oxford, box 29.

4 Miss R. Fryer to G. C. Druce, 14 September 1913. Druce papers, box 15.

5 Miss R. Fryer to G. C. Druce, 22 September 1913. Druce papers, box 15.

6 C. Bailey to G. C. Druce, 24 May 1912, 15 September 1912. Druce papers, box 29.

7 The dates of collection given by Fryer (1898a, p. 11) for the plants illustrated on plate 5 should be transposed. The cultivated plant was collected in September 1890; the wild plant in August 1892.

8 A. Fryer to G. C. Druce, 1 September 1898, 3 September 1898, 14 September 1898.

9 A. Fryer to E. W. Hunnybun, 11 August 1908. Hunnybun letters, Herbarium, Botany School, University of Cambridge.

10 C. Bailey to G. C. Druce, 30 December 1912. Druce papers, box 29.

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APPENDIX

When C. Bailey received Fryer's herbarium in 1912 he listed the number of specimens of *Potamogeton* and related genera that it contained.[10] He said that "the figures must be regarded as merely approximate. I had not the time to make a more detailed list. . . ." and "The 4 sheets [*sic*; presumably 'species' was intended] marked 0 are doubtless in the herbarium, but I did not come across them". Nevertheless the list not only indicates the size of Fryer's herbarium but gives some idea of the taxa of particular interest to him. I have arranged the species in systematic order (following Dandy 1958, 1980) with the number of specimens and added the current name in square brackets where appropriate.

Potamogeton

Subgen. *Potamogeton* sect. *Potamogeton*

natans		182
polygonifolius		85
coloratus		183
× *billupsii*		58
**drucei*	[*nodosus*]	0
lucens		216
× *fluitans*		145
crassifolius	[× *fluitans*]	311
decipiens	[× *salicifolius*]	220
salignus	[× *salicifolius*]	0
falcatus	[*gramineus*]	144
fluctuans	[*gramineus*]	27
graminifolius	[*gramineus*]	213
heterophyllus	[*gramineus*]	406
varians	[*gramineus*]	439
†*heterophyllus* × *zizii*		25
kirkii	[× *sparganifolius*]	7
× *zizii*		1047
angustifolius	[× *zizii*]	19
coriaceus	[× *zizii*]	258
× *nitens*		135
involutus	[× *nitens*]	145
alpinus		126
× *griffithii*		8
praelongus		16
perfoliatus		128

Subgen. *Potamogeton* sect. *Graminifolii*		
friesii		65
rutilus		0
obtusifolius		61
sturrockii	[*obtusifolius*]	0
pusillus	[*berchtoldii*]	80
× *lanceolatus*		10
trichoides		42
zosteraefolius	[*compressus*]	36
acutifolius		12
Subgen. *Potamogeton* sect. *Batrachoseris*		
crispus		78
× *cooperi*		232
× *bennettii*		24
Subgen. *Coleogeton*		
filiformis		32
pectinatus		54
flabellatus	[*pectinatus*]	86
scoparius	[*pectinatus*]	48
Groenlandia		
densa		23
Ruppia and *Najas*		24
	TOTAL	5450

*Bailey presumably missed the specimens of *P. drucei* as they are not labelled as such.
†Some sheets labelled '*heterophyllus* × *zizii*' by Fryer are referable to *P. gramineus*, others to *P.* × *zizii*.

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Dactylorhiza lapponica (Laest. ex Hartman) Soó in Scotland

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ABSTRACT

Observations on tetraploid marsh-orchid populations in Scotland have revealed the presence of *Dactylorhiza lapponica* (Laest. ex Hartman) Soó, new to the British Isles. A description of this species is given and its distribution and habitat in Scotland are discussed.

INTRODUCTION

In 1967, a population of marsh-orchids was discovered by one of the authors (A.G.K.) in Knapdale, Kintyre, v.c. 101. After considerable hesitation these plants were identified as *Dactylorhiza traunsteineri* (Sauter) Soó (Cunningham & Kenneth 1979) and until 1983 this remained as the only confirmed Scottish record of this species. However, following examination of photographs of these Knapdale plants by another of the authors (D.J.T.), it was realized that they did not closely match any known variant of *D. traunsteineri* from British localities and, after discussion with R. H. Roberts, they were transferred to *D. majalis* (Reichb. f.) Hunt & Summerh. subsp. *occidentalis* (Pugsley) Sell (Tennant & Kenneth 1983), although at the same time it was realized that they possessed many features which were atypical of even this taxon. The possibility that the Knapdale dactylorchids might be referable to a Continental species or subspecies not hitherto recognized in the British Isles had been considered, but none of the descriptions of potential taxa available at that time seemed to match those of the Scottish plants. However, as a consequence of extended field-work which is described below, the authors now suggest that the Knapdale plants, and similar dactylorchids found in other localities in western Scotland and in the Outer Hebrides, should in fact be referred to *D. lapponica* (Laest. ex Hartman) Soó.

During the same field-work, *D. traunsteineri* was, however, confirmed in the following localities, in addition to those in W. Ross, v.c. 105 (Lowe *et al.* 1986): Mid Ebudes, v.c. 103, Tiree, GR 17/0.4, found by J. Cadbury in 1983 and recognized by D.J.T. from photographs; Kintyre, v.c. 101, Knapdale, GR 16/7–8.7–8, four localities found by A.G.K. between 1983 and 1986; Westerness, v.c. 97, Ardnamurchan, GR 17/6.6, found by L. M. Watson in 1983. The identities of the Knapdale and Ardnamurchan plants have been confirmed by R. H. Roberts. No specimens were found on North Uist, North Harris or Raasay, despite published reports (Campbell 1937; Heslop-Harrison *et al.* 1941; Heslop-Harrison & Morton 1951).

FIELD STUDIES

Between 1984 and 1986 field-work was undertaken on marsh-orchids in northern and western Scotland. Localities were examined in Westerness, v.c. 97, Kintyre, v.c. 101, N. Ebudes, v.c. 104, W. Ross, v.c. 105, and the Outer Hebrides, v.c. 110. In the Outer Hebrides the islands of North Harris, South Harris, North Uist, Benbecula and South Uist were visited, and in N. Ebudes, the islands of Skye and Raasay.

At eight localities in western Scotland rather small populations of dactylorchids were found which were very similar to those of a larger population of Knapdale plants which we described in an earlier paper (Tennant & Kenneth 1983). It therefore appeared that this taxon was much more widespread in this part of Scotland than had been realized and was also more variable than described in the 1983 paper. Additionally it was noted that these plants seemed to be confined to a very distinctive habitat in base-rich hill flushes at relatively low altitudes. Dactylorchids which appeared to correspond to those of the original Knapdale population were seen in the following localities:

Kintyre, v.c. 101, Knapdale, GR 16/7–8.7–8: Five separate sites, including the original location; Sites 1–5, all found by A. G. K. between 1967 and 1986.

Westerness, v.c. 97, Ardnamurchan, GR 17/6.6: Site 6, found by L. M. Watson in 1983.

Outer Hebrides, v.c. 110, South Harris, GR 18/0.9: Sites 7–8, found by the authors and by M.R.L. respectively during 1985 field-work at locations cited by J. W. Heslop Harrison for *D. majalis* subsp. *occidentalis*.

A further location was recognized from photographic evidence at **CGE**, being a site found in 1970 by P. D. Sell, viz:

Westerness, v.c. 97, Morven, GR 17/6.5: Site 9.

TABLE 1. COMPARISON OF *D. LAPPONICA* FROM SCANDINAVIA AND CENTRAL EUROPEAN ALPS WITH POPULATIONS FROM SCOTLAND

Figures quoted are ranges of mean values.

Character	Scotland[a]	Scandinavia/European Alps[b]
Height (cm)	7·0–21·0	17·67–20·6
Stem diameter at base of spike (mm)	2·4–3·2	2.21–2·66
Number expanded sheathing leaves	2·3–3·0	–
Number non-sheathing leaves	0·8–1·7	–
Total number leaves	3·3–4·3	3·04–3·52
Length longest leaf (cm)	5·0–8·9	4·75–6·8
Width longest leaf (cm)	1·1–1·5	0·86–1·41
Intensity leaf markings on upper surface	Heavy	Heavy
Dimensions lower floral bracts (mm)[c]	13–19 × 3·4–4·1	13·2–16·5 × 3·51–4·08
Length of inflorescence (cm)	3·0–4·6	3·7–4·92
Number of flowers	8·9–12·8	8·73–13·43
Distribution of flowers in inflorescence	Lax, rather secund	Lax, rather secund
Labellum length to apex of central lobe (mm)	6·3–7·8[d]	5·67–6·73
Labellum maximum width (mm)	(6·4) 7·3–9.4[d]	7·69–9·44
Labellum degree of reflexion	Flat to semi-reflexed	Flat to somewhat reflexed
Position of lateral sepals	Very erect to sub-erect	Very erect to sub-erect
Spur length (mm)	7·5–9·2[d]	7·82–9·57
Spur maximum width flattened (mm)	2·6–3·4[d]	–
Ovary length (mm)	–	8·87–10·88
Number of plants in sample mean	4–14	21–123

[a]Measurements carried out by the authors on populations at Sites 1–7. The small number of plants in the sample reflects the size of some of the populations.

[b]Measurements published by Reinhard (1985).

[c]Measurements of lowest bract (Scotland) and four lower bracts (Scandinavia/European Alps).

[d]Number of floral parts measured in sample ranged from 10–45.

Measurements were carried out on all of these populations except Site 9, and the results are given in Table 1. For simplicity the above locations are referred to later in this paper only by their Site number.

The dactylorchids studied at Sites 1 to 8 in western Scotland conformed to the following description: Tuber small, slender, deeply cleft into two. Height 6–18 (–24) cm. Stem rather slender to medium diameter and only slightly hollow, upper part often suffused purplish with anthocyanin. Expanded sheathing-leaves 2–3 with 0–2 non-sheathing leaves; lowest expanded leaf oblong-oblanceolate, apex obtuse or sub-acute, 3·0–6·0 cm long × 0·8–1·5 (–1·8) cm wide; second lowest narrowly oblong-lanceolate to narrowly elliptical, apex acute or sub-acute, 4·0–8·0 (–10·5) cm long × 0·8–1·7 cm wide, spreading or semi-spreading, occasionally slightly undulate or recurved towards the apex; non-sheathing leaf erect; expanded leaves pale, dull or medium green, more or less uniformly and often heavily covered on upper surface with large dark violet-brown dots, bars, rings or blotches, occasionally heavily marbled, frequently tinged on the margin with the same colour, rarely unmarked; lower surface unmarked, or non-sheathing leaf sometimes with a few small flecks or blotches on the under-side. Inflorescence 2·5–5·5 cm long, usually lax and secund: flowers few, 3–12, occasionally up to 18. Floral bracts sometimes large, the lower to 25 × 5 mm, greenish, often tinged purple on the margin and invariably spotted on either or both surfaces, sometimes stained purple which more or less obscures the spots. Peripheral bract-cells 80 to 135 µm (mean length), variable in shape and size, rounded to markedly angular. Flowers usually magenta-purple or magenta-red, rarely pale, with deeper markings. Lateral sepals very erect, occasionally sub-erect, invariably marked with darker rings, elongated spots and dots. Labellum flat or its lateral lobes somewhat reflexed, rhombic to sub-deltoid, with or without sinuses, usually with a broad-based central lobe often projecting well beyond the lateral lobes, heavily marked, usually with very intense dark violet-purple or dark crimson lines, rings and dots, occasionally merging in the central part to form a dark patch; spur robust, in flattened state 6·5 – 10·5 × 2·2 – 4·0 mm, more or less cylindrical and straight, sometimes curved and slightly conical. Ovary c. 9 – 13 mm. The flowering period in western Scotland varies appreciably with seasonal climatic variation, commencing flowering from late May to mid- June and often extending into July.

A detailed examination of the length and shape of the peripheral cells of the floral bracts of the dactylorchids from Sites 1 to 7 was undertaken by R. H. Roberts, and the results summarized above clearly show that they correspond to those of tetraploid taxa.

IDENTIFICATION

Correspondence with Scandinavian specialists indicated that the Scottish dactylorchids from Sites 1–9 were very close to the Scandinavian *D. pseudocordigera* (Neuman) Soó (C. I. Sahlin and F. Björkbäck, pers. comm.) and *D. lapponica* (F. Wischmann pers. comm.) although none of these correspondents was prepared to make a positive determination. Fortunately, an extensive biometric study of Scandinavian and Alpine dactylorchids was recently published by H. R. Reinhard of Zürich (Reinhard 1985). Part of this study concluded that *D. pseudocordigera*, from central Scandinavia, and *D. lapponica*, from northern Scandinavia and Lapland, should be treated as a single, undivided species under the name *D. lapponica*; this view is also shared by the Norwegian specialist, F. Wischmann of Oslo (pers. comm. 1986). Earlier, Vermeulen (1947) and Landwehr (1977) had expressed a similar opinion, although both retained *pseudocordigera* and *lapponica* as subspecies of *D. lapponica*. Acceptance of this concept of a single species helped to crystallize our own thoughts on the status of the Scottish dactylorchids. In particular, Reinhard's biometric data for *D. lapponica*, based on 51 characters of 257 individual plants from 31 sites in Scandinavia and the Alps, enabled a comparison with the Scottish plants (Table 1). Following an examination of our biometric data and numerous photographs, Reinhard (pers. comm.) stated that without hesitation he could say that some of the dactylorchids from western Scotland were referable to *D. lapponica*, matching well some of the Scandinavian plants of that species examined during his own field-studies, and in a second communication he stated that a copy of our herbarium material (**E**), showing specimens collected from one of the populations in Knapdale (Site 2), matched the lectotype of *D. lapponica* very closely and were without doubt referable to that species.

R. H. Roberts has also made the following comments on the Scottish dactylorchids. "The shapes of the labella collected at sites 1, 2 and 6 are surprisingly like many of those of *D. lapponica* shown by Reinhard (1985) and Kalteissen & Reinhard (1986) and seem such a good match for the latter that they certainly do a lot to convince me. Some of the Scottish dactylorchids are so similar to the *D. lapponica* illustrated and described by Reinhard that one feels compelled to say that they belong to this entity, and hence I feel happy to agree with Reinhard's view. Additionally, some of the herbarium specimens of Scandinavian *D. lapponica* at Kew match the specimens (**E**) collected at sites 1 and 3 in Scotland well."

NOMENCLATURE

DACTYLORHIZA LAPPONICA (Laest. ex Hartman) Soó, *Nom. nov. gen.* Dactylorhiza 5 (1962). *Orchis lapponica* Laest., nomen. *Orchis angustifolia* Krocker var. *lapponica* Laest. ex Hartman, *Handb. Skand. fl.*, 4th ed., 281 (1843). *Orchis traunsteineri* Sauter var. *lapponica* (Laest. ex Hartman) Hartman, *Handb. Skand. fl.*, 5th ed., 225 (1849). *Orchis lapponica* (Laest. ex Hartman) Reichb. f., *Icones fl. germ. helv.*, **13/14**: plate 53 (ccccv of the whole enumeration) (1850). *Orchis latifolia* L. var. *lapponica* (Laest. ex Hartman) Reichb. f., *Icones fl. germ. helv.*, **13/14**: 58 (1851). *Dactylorchis lapponica* (Laest. ex Hartman) Vermeulen, *Stud. Dactyl.* 155 (1947). *Dactylorhiza cruenta* O. F. Mueller subsp. *lapponica* (Laest. ex Hartman) E. Nelson, *Monogr. Ikon. Orch. Gatt.* Dactyl. 72 (1976). *Dactylorhiza traunsteineri* (Sauter) Soó subsp. *lapponica* (Laest. ex Hartman) Soó, in *Bot. J. Linn. Soc.*, **76**: 367 (1978). *Dactylorhiza majalis* (Reichb. f.) P. F. Hunt & Summerh. subsp. *lapponica* (Laest. ex Hartman) Sündermann, *Europ. medit. Orch.* 45 (1975). TYPE: Karesuando, Tornea, Swedish Lapland, 1840, *Laestadius* (lectotype: **UPS**, chosen by Reinhard (1985) who also illustrated it in Plate 52 on p. 415 of his work). Vermeulen's (1947) choice of a Laestadius specimen collected in 1846 must be overuled because it postdates the protologue by three years.

Orchis pseudocordigera Neuman in *Bot. Notiser*, **1909**: 236 (1909). *Dactylorchis lapponica* (Laest. ex Hartman) subsp. *pseudocordigera* (Neuman) Vermeulen, *Stud. Dactyl.* 155 (1947). *Dactylorhiza pseudocordigera* (Neuman) Soó, *Nom. nov. gen.* Dactylorhiza 4 (1962). TYPE: Norvegia Dovre in paludosis juxta rivulum inter Tofte et Harbacken et in Kvitdalen, *Neuman*, specimen no. 1 (holotype: **O**).

The specific epithet *lapponica* has priority over the rival *pseudocordigera* because its publication as a new combination at species level was effected by Reichenbach in 1850 in the volume of illustrations to the text (which appeared a year later in 1851) of his *Icones*, even though in the text the name *Orchis lapponica* appears in synonymy under *Orchis latifolia*.

HABITAT

The Scottish populations of *D. lapponica*, with which the dactylorchids from Sites 1–9 were now united, were found in hill-flush communities at altitudes of approximately 150–300 m in Knapdale, Morvern and Ardnamurchan, but descended to below 30 m at a single locality in South Harris. *Schoenus nigricans* and *Molinia caerulea* were invariably co-dominant at these locations and at one South Harris site these were co-dominant together with *Carex panicea*. The list of associated species present in all the sites studied showed that they were very similar to the habitats described in Scotland for *D. traunsteineri* (Lowe *et al.* 1986) and also for *D. incarnata* (L.) Soó subsp. *cruenta* (O. F. Mueller) Sell (Kenneth & Tennant 1984, 1987) and therefore appear to be also referable to the *Pinguiculo-Caricetum* Jones syntaxon described by Wheeler (1980).

D. lapponica, however, appears to show a greater tolerance towards a slightly more acidic habitat, which is subject to a lower degree of flushing, when compared with *D. traunsteineri*, as a small percentage of plants of the former often stray into the adjacent wet heath community, whereas this has not been observed in the case of *D. traunsteineri*.

The recent discoveries of *D. lapponica* and *D. traunsteineri* in western Scotland discussed in this paper, and earlier of *D. incarnata* subsp. *cruenta* (Kenneth & Tennant 1984, 1987) in north-western Scotland, present a marsh-orchid flora with close similarities to that found in Scandinavia and the central European Alps.

CONSERVATION

Most of the sites for these taxa presently known in Scotland contain only a very small number of plants and possibly represent a relic flora remaining after late glacial times. The sites are all especially vulnerable to destruction either by afforestation or by land drainage. Since the discovery of the first Knapdale site for *D. lapponica* in 1967 one of these has recently been damaged in this manner, and further sites are currently under threat from afforestation. One of us (A.G.K.) has been actively involved, with the co-operation of the land-owners, in conservation measures for some of the Knapdale sites in 1986 in the hope that further damage can be prevented. An adequate number of specimens and many photographs were earlier placed in **E**, with copies also at **CGE**, in the hope that this will prevent the need for the collecting of further plants from these sites. It is hoped that additional localities will be recognized in the western Highlands and Islands of Scotland for these taxa now that they have become more clearly defined.

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The occurrence of *Dactylorhiza traunsteineri* (Sauter) Soó in Britain and Ireland

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ABSTRACT

A recent study of morphological variation in *Dactylorhiza* has indicated that *Dactylorhiza traunsteineri* (Sauter) Soó does not occur in Britain or Ireland. Further sampling of some morphological characters in a putative population of this species on Anglesey has been carried out in an attempt to clarify the matter, and a comparison of data from this population with data derived from Alpine plants suggests that *D. traunsteineri* does occur in these islands.

INTRODUCTION

The marsh-orchid with which British and Irish botanists have become familiar over the last 30 years as *Dactylorhiza traunsteineri* (Sauter) Soó was first found in Ireland by H. W. Pugsley. He recognized it as a new plant from herbarium specimens in the National Herbarium (**DBN**) and from living material sent to him later from two localities in Co. Wicklow. Although he noticed the close similarity of the plant to *Orchis traunsteineri* Sauter ex Reichenb. (*D. traunsteineri*), which he had seen in southern Bavaria in 1934, he decided that it was not identical with that species, but, like another marsh-orchid, *O. majalis* Reichb. var. *occidentalis* Pugsley (*D. majalis* (Reichb.) Hunt & Summerhayes subsp. *occidentalis* (Pugsley) P. D. Sell) which had recently been found in Ireland (Pugsley 1935), was yet another entity allied to *D. majalis.* He consequently named it *O. majalis* subsp. *traunsteinerioides* (Pugsley 1936), but after seeing the plant in the field decided that it was not after all closely allied to *D. majalis* and ultimately raised it to the rank of species.

Heslop-Harrison (1953) made a critical study of this plant and as a result assigned it to *O. traunsteineri*, his only reservation being that a biometric study of Alpine plants might eventually enable the British and Irish variant to be segregated as a subspecies.

Bateman & Denholm (1983) have recently come to a different conclusion. They point out that a comparison of biometric data from British and Irish populations of *D. traunsteineri*, collected by themselves and others (Heslop-Harrison 1953; Lacey & Roberts 1958; Roberts & Gilbert 1963; Roberts 1966), with the descriptions of Alpine plants by Vermeulen (1949) and Nelson (1976) reveals several discrepancies. "True Alpine *D. traunsteineri* is reported to have narrower leaves (<1 cm wide), longer, more lax inflorescences, smaller labella with poorly-developed sinuses, shorter central lobes, and smaller spurs. They also flower later." (Bateman & Denholm 1983). From this they have concluded that the British and Irish plants have been wrongly assigned to *D. traunsteineri* and have reduced them to the rank of subspecies, as *D. majalis* subsp. *traunsteinerioides*.

Bateman & Denholm's data for *D. traunsteineri* were taken from three populations, one in Co. Kildare, Ireland (Pollardstown Fen) and the other two in Anglesey (Cors Erddreiniog and Rhos-y-gad). Biometric data for some morphological characters were already available from the Anglesey populations and it was therefore possible to compare the two sets of values. When this was done large discrepancies were found between them, particularly in the data from the Rhos-y-gad population, where the means for labellum length (7·9 versus 8·91 mm), labellum width (10·2 versus 12·1 mm) and spur width (3·5 versus 4·0 mm) are found to be so widely at variance as to raise doubts about the reliability of the procedures used in Bateman & Denholm's study.

In view of these widely different results, the Rhos-y-gad population was sampled again for some of the morphological characters in 1984 and a number of the observations were repeated two years later in 1986.

MATERIALS AND METHODS

Morphological characters were recorded in 1984 from a randomly selected sample of flowering plants. Counts of the total number of leaves, number of non-sheathing leaves, number of flowers in the inflorescence and measurements of the width of the second leaf from the base of the stem and the length of the inflorescence were made in the field. A single flower, taken from halfway along the spike, was removed from each plant, and labella and spurs from the sample were mounted separately on card. The width of the labellum was measured at its widest part, together with its length from the spur opening to the tip of the central lobe. Spur dimensions were taken from the flattened, mounted specimens, spur width being measured at the entrance, and spur length from the entrance to the apex.

Counts of the total number of leaves, number of non-sheathing leaves and data for labellum and spur dimensions were repeated in 1986. In addition, the length of the central lobe of the labellum was measured.

RESULTS

Sample means for labellum and spur dimensions are given in Table 1, in which the data of Bateman & Denholm (1983) for these characters are included for comparison. They are also compared graphically in Figs 1a and 1b, from which it can be seen that while the three sets of data obtained by the present writer show good agreement for all four characters, those of Bateman & Denholm (1983) only agree with them for the character of spur length; their means for labellum length, labellum width and spur width differ from them by large and statistically significant amounts.

TABLE 1. SAMPLE MEANS AND STANDARD DEVIATIONS FOR LABELLUM AND SPUR DIMENSIONS FROM THE RHOS-Y-GAD POPULATION OF *D. TRAUNSTEINERI*, TAKEN DURING FOUR SEPARATE SEASONS

		Labellum length (mm)		Labellum width (mm)		Spur length (mm)		Spur width (mm)	
Sample	n	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R.H.R., 1963	40	7·9	0·89	10·2	1·14	8·3	1·27	3·5	0·63
R.H.R., 1984	34	8·1	0·79	9·9	1·31	8·5	1·02	3·4	0·42
R.H.R., 1986	30	8·2	0·84	10·5	1·29	8·9	0·90	3·4	0·43
1983[1]	10	8·9	0·78	12·1	1·95	9·0	1·39	4·0	0·82

[1]Data of Bateman & Denholm (1983).

Similarly their mean value of 1·0 for the number of non-sheathing leaves differs from the mean of 0·6 from a sample of 50 in 1963, while means of 0·7 and 0·66 were obtained by the writer from samples of 35 and 30 in 1984 and 1986 respectively. Thus, while the present writer's values differ at most by only 16·6%, Bateman & Denholm's estimate differs from the largest of them by 42·9%.

DISCUSSION

Repeated sampling of the Rhos-y-gad population during different flowering seasons has shown that the very large mean values for labellum dimensions and spur width obtained by Bateman & Denholm are not readily repeatable. The possibility was considered that the small size of their sample may account for the poor estimates of population means. However, an independent biometric study of the Rhos-y-gad population of *D. traunsteineri* by Jenkinson (1986) is also based

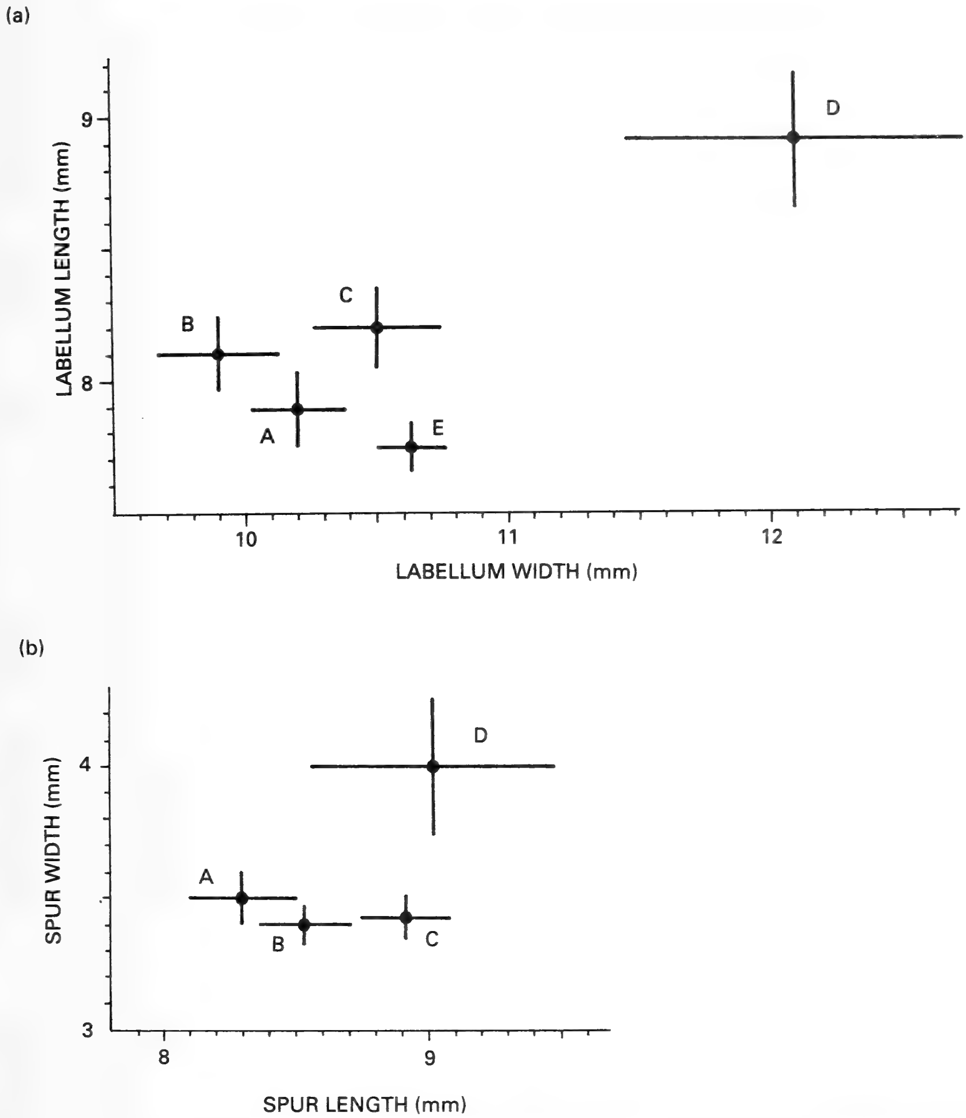

FIGURE 1. (a) Scatter diagram of sample means of labellum dimensions. Bars represent one standard error on either side of the mean. A, B & C, data of R.H.R.; D, data of Bateman & Denholm (1983); E, data of Reinhard (1985). (b) Scatter diagram of sample means of spur dimensions. Legend as in (a).

on a sample of ten flowering plants and his mean values for labellum length (8·0 mm) and labellum width (10·15 mm) show very good agreement with those of the present writer. The other possibility is that Bateman & Denholm have included in their sample hybrids of *D. traunsteineri* with either *D. fuchsii* (Druce) Soó or *D. maculata* (L.) Soó, both of which occur in the same locality. While this could possibly account for the large labellum dimensions, one would expect the mean value for spur width to be smaller (not larger) than the mean from pure *D. traunsteineri*, and this possibility must also be ruled out.

Whatever the explanation for them may be, their large values for floral dimensions may have partly persuaded these authors that the British and Irish plants are not identical with Alpine *D. traunsteineri*, a view which was reinforced by placing too much reliance on descriptions (by Vermeulen and Soó) that were not based on biometric data. However, as the result of a recent study by Reinhard (1985), data from Alpine populations of this species are now available and a comparison of the mean values for some of the morphological characters with those from Anglesey plants (Table 2) shows that most of the supposed discrepancies cited by Bateman & Denholm do not exist. Most of the small differences between data means are not statistically significant. The only characters for which comparisons cannot be made are depth of sinuses, for which Reinhard gives no data, and spur width, for which he gives the diameter of the unpressed spur (mean = 2·59 mm).

TABLE 2. A COMPARISON OF DATA ON *D. TRAUNSTEINERI* FROM ANGLESEY AND ALPINE LOCALITIES

	Rhos-y-gad (n=30)[2]			Alpine localities (n=75)[3]		
	Mean	S.D.	S.E.	Mean	S.D.	S.E.
No. of leaves	3·82	0·53	0·09	3·99	0·63	0·07
Leaf width (cm)[4]	1·00	0·21	0·04	1·00	0·23	0·03
Inflorescence length (cm)	4·51	0·84	0·16	4·73	1·13	0·13
No. of flowers per inflorescence	9·40	3·62	0·67	8·43	2·34	0·27
Labellum width (mm)	10·50	1·29	0·24	10·63	1·12	0·13
Labellum length (mm)	8·20	0·84	0·16	7·74	0·76	0·09
Length of labellum mid-lobe (mm)	2·25	0·62	0·12	2·38	0·67	0·08
Spur length (mm)	8·92	0·90	0·17	10·90	1·24	0·14

[2]Data of R.H.R.
[3]Data of Reinhard (1985).
[4]Taken from the second leaf from the base of the stem.

It is therefore clear that the British populations of *D. traunsteineri* show a remarkable similarity to Alpine ones, and that Heslop-Harrison (1953) was correct in assigning them to this species. Furthermore, the almost exact correspondence between the Anglesey population and the Alpine plants provides additional support for the view already expressed (Roberts 1966) that the Rhos-y-gad plants are not influenced to any appreciable extent, if at all, by introgression with *D. majalis* subsp. *purpurella* (T. & T. A. Steph.) D. Moresby Moore & Soó. It clearly does not support Bateman & Denholm's belief that gene-flow between these taxa "is at most only partially restricted."

ACKNOWLEDGMENTS

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Cochlearia pyrenaica DC., a species new to Scotland

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ABSTRACT

Cochlearia pyrenaica DC. (Cruciferae), with a chromosome number n = 6 bivalents and 0–2B, has been collected on the Isle of Skye, v.c. 104, N. Ebudes. This is the first record of the species from Scotland.

INTRODUCTION

Hultén (1970) stated that *Cochlearia officinalis* is "a very complicated complex treated differently by practically all students of the group". The difficulties are especially due to two factors: (a) considerable cytological evolution has taken place without corresponding morphological evolution (Saunté 1955; Gill 1965, 1971a, b, 1973, 1976; Gill *et al.* 1978), and (b) much of the variation that has been given taxonomic weight is undoubtedly of environmental origin, as the complex is very plastic in its reaction to the environment (Elkington 1984).

Due especially to the extensive studies by Gill the genus is fairly well understood and mapped in the British Isles. In Great Britain, the mainly southern and Central European species, *C. pyrenaica* DC., has been recorded only from England (v.cc. 57, 59, 64, 65, 66, 69) according to Gill *et al.* (1978).

In connection with field studies in Great Britain in July and August 1984, living material of *Cochlearia* was brought to the University of Oslo and examined morphologically and cytologically in order to compare British and northern Scandinavian taxa.

MATERIALS AND METHODS

A few living plants of what was supposed to be an inland ecotype of *Cochlearia officinalis* L. were collected at the following locality:

Scotland, v.c. 104, N. Ebudes, Isle of Skye, Beinn Edra, above Loch Corcasgil, 450 m, GR 18/452.634, 30th July 1984. (Voucher specimen *I. Nordal 1367*, **O**.)

The plants had unripe seeds that later matured in a greenhouse at the University of Oslo. The seeds were harvested and kept cool for some months. They were then sown and grown under similar conditions in a phytotron chamber at 16°C day temperature and 8°C night temperature with 16 hours light and 8 hours darkness. The plants produced leaf rosettes and three months after sowing five of the plants were moved to a completely dark chamber at 0°C for three months to simulate winter conditions. Then they were returned to the original growth conditions to stimulate flowering.

Meiotic preparations were made after fixation of young flower buds in Carnoy's fluid. They were kept at −20°C for about 24 hours, and then squashed in aceto-orcein. The preparations were made permanent in euparal.

RESULTS

ECOLOGY OF THE SITE

The plants were collected in small crevices on a fairly steep, flushed rock. Species dominating in

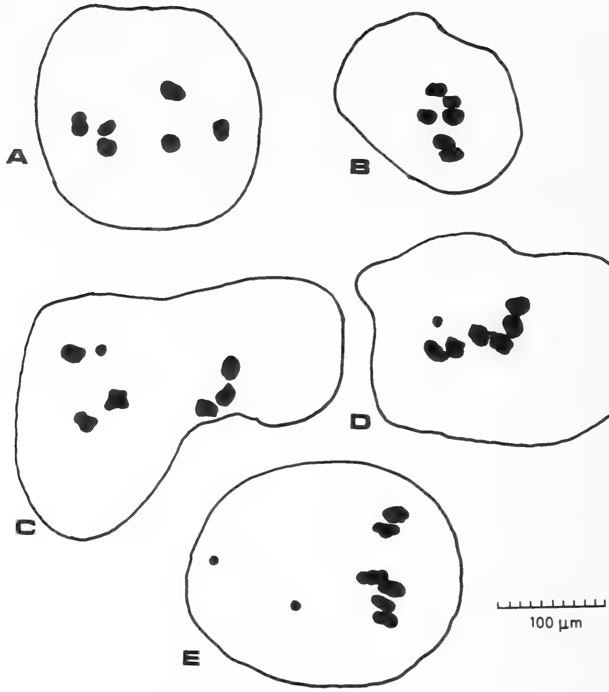

FIGURE 1. Meiotic configurations in pollen mother cells of three different specimens of *Cochlearia pyrenaica* DC. from Scotland. A, B. Metaphase I with 6 bivalents and 0 B-chromosomes. C, D. Metaphase I with n = 6 bivalents and 1 B-chromosome. E. Metaphase I with 6 bivalents and 2 B-chromosomes.

the habitat together with *Cochlearia* were: *Oxyria digyna* (L.) Hill, *Rumex acetosa* L., *Sedum rosea* (L.) Scop., *Chrysosplenium oppositifolium* L., *Saxifraga hypnoides* L., *S. stellaris* L., *Geum rivale* L., *Angelica sylvestris* L., *Luzula sylvatica* (Hudson) Gaudin, *Anthoxanthum odoratum* L., *Deschampsia cespitosa* (L.) Beauv., *Festuca rubra* L., and several bryophyte species.

MORPHOLOGY

The cultivated first-year plants branched very early and formed several rosettes joined by more or less supra-terrestrial rhizomes. The rosette leaves were long-petiolate and reniform with a cordate base, glossy and rather dark green in colour. The lower cauline leaves were short-stalked and truncate, whilst the mid- and upper-leaves were sessile and coarsely toothed with more or less amplexicaul bases. The flowering stems were much branched and up to 40 cm tall. The white flowers had petals about 4 mm long and 1·5 mm wide. The siliculae were elliptical, tapering at both ends, 6–7 × 3–4 mm and contained, on average, eight seeds.

CYTOLOGY

Of the five plants analyzed cytologically, one showed six bivalents with two B-chromosomes, two showed six bivalents with one B-chromosome and two showed six bivalents without B-chromosomes (Fig. 1). The meioses of all plants were regular. Only in a few cases were bridges and fragments observed in anaphase I, indicating inversions.

DISCUSSION

Taxa belonging to the *Cochlearia officinalis* group cannot be identified with certainty without knowing their chromosome number. The chromosome number 2n = 12 is, in Britain, only found in *C. pyrenaica* (Gill *et al.* 1978). The morphological features of the plants examined here correspond

FIGURE 2. Localities of cytologically examined *C. pyrenaica* from Great Britain. Triangles, after Gill *et al.* (1978); circle, the population studied here.

closely with those of this species. The plants from this study were compared with living plant material of *C. pyrenaica* from Yorkshire (Malham Tarn Field Centre, coll. J. J. B. Gill). Representatives of the two populations looked very similar except for the lighter colour of the leaves of the latter. The identification of the Scottish material thus seemed to be unequivocal.

The distribution of *C. pyrenaica* in Great Britain is given in Fig. 2.

Only one representative of a 2n=12 cytotype of *Cochlearia* has earlier been recorded north of the population studied here, and that is from south-eastern Iceland (Gill 1971a). Although Gill did not specifically name his 2n=12 plant *C. pyrenaica*, he did state that it was morphologically distinct from the common Icelandic taxon *C. groenlandica* with 2n=14. He only had the opportunity to study the first year's rosettes, and that description is compatible with its being *C. pyrenaica.*

C. pyrenaica in Europe has long been recognized as a plant of base-rich habitats (Hegi 1919; Hiemans 1971; Gill *et al.* 1978). The base-status of the habitat of the Scottish population has not been determined, but the species composition would indicate medium eutrophic conditions.

According to Gill (1973) and Gill *et al.* (1978), *C. pyrenaica* is supposed to be the diploid ancestor of the autotetraploid *C. officinalis.* The diploid parent of any autotetraploid will often compete with its tetraploid offspring. *C. pyrenaica* probably survived the last glaciation in southern England (Gill *et al.* 1978). It might have followed the ice withdrawal towards the north, but has now been largely replaced by the more successful tetraploid. In this light the Scottish population may be interpreted as a relict population from periods of early deglaciation of the area.

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I am very grateful to Professor J. J. B. Gill who, during my field work in Britain, shared his wide experience and knowledge of this tricky, but fascinating, genus with me. He also provided me with living material of several of the British taxa. I would also like to thank Mrs Eva Bovim, who has given skilled technical assistance.

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Male predominant sex ratios in Holly (*Ilex aquifolium* L., Aquifoliaceae) and Roseroot (*Rhodiola rosea* L., Crassulaceae)

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ABSTRACT

Sex ratios are reported in seven populations of Holly, *Ilex aquifolium* L., four of which are semi-natural, and three of which are probably planted. All populations have an excess of males, although in no semi-natural population is the excess significant, and it is not quite significant at the 5% level for the semi-natural populations taken together. The fruit-set of Holly is shown to fall from 95% to 35% at distances to the nearest male of 40 to 100 m. A large population of Roseroot, *Rhodiola rosea* L., from sea-cliffs in north-west Scotland has a highly significant excess of males, and may be subandroecious with limited female function in some males. Problems associated with the assessment of sex ratios in these species are discussed.

INTRODUCTION

In their very useful review of dioecy in the flora of the British Isles, Kay & Stevens (1986) report no departure from a 1:1 ratio of males to females in populations of Holly (*Ilex aquifolium* L.) in the hedgerows of Brecon, Wales (65 plants), or of trees in the New Forest, England (485 plants) (Peterken & Lloyd 1967). These appear to be the only investigations into the sex ratio of Holly that have been reported. For the Roseroot, *Rhodiola rosea* L., no sex ratio count seems to have been published. In this paper, male predominant ratios are reported for the first time in both species, and problems associated with the assessment of sex ratios are discussed for both. Some preliminary data of the fruit set of Holly at various distances from males are also reported.

HOLLY

The European Holly, *Ilex aquifolium*, is probably always dioecious, although there are some confusing reports in the literature. Some of these may refer to the monoecious hermaphrodite *I.* × *altaclerensis* 'Pyramidalis', a popular hybrid cultivar, which may develop a greater proportion of female flowers with age. This may account for reports of sex change in Peterken & Lloyd (1967) and Hyde (1961), although these reports may also refer to the report in Hegi (1924–27) of a large Holly tree near Cologne which had completely changed sex between 1910 and 1916. The identity of the latter is unknown. Certainly, I failed to find a single set fruit on more than 500 male trees of *I. aquifolium* that I examined in 1986. Proving that females have no male function is more difficult, for female flowers produce quite well-formed, but empty anthers. However, no fruit had set on a few totally isolated females I examined in 1986. Ward (1905:288) states that female flowers in *I. aquifolium* are sometimes male fertile, but there is no subsequent report of this type. If this were the case, populations of Holly would be androdioecious (males and hermaphrodites), or subgynoecious (males and variably male females), which are both very rare conditions, if indeed they occur at all (Richards 1986).

There are three major problems associated with the determination of sex ratios in Holly. Firstly, many populations in hedgerows, estates, farms, garden boundaries, etc. may be planted, at least originally, and vegetatively propagated material may have been used to establish these. Therefore, it is necessary to examine populations from natural or semi-natural communities which are unlikely to have been established artificially.

Secondly, Holly responds to coppicing or heavy pruning by producing new stems from the base, and plants in hedges, wood edges, etc. frequently possess a number of boles. When plants occur densely, it can be very difficult to differentiate between neighbouring clones of the same sex. As males may be vegetatively more vigorous (although there is no evidence of this), it is possible that the number of male individuals is overestimated.

Thirdly, Holly often flowers poorly. Trees do not flower when small or young. In a sample of 220 trees examined in the grounds of Queen Elizabeth High School, Hexham, Northumberland (GR 35/925.640) in June 1986, no trees flowered that were less than 3 m high or had a bole girth at 1 m of less than 40 cm. Trees flower poorly or not at all in shade. In the same sample, only 42% of trees higher than 3 m were flowering, and these were mostly trees in good light. Most apparently natural populations of Holly occur as a shrub layer beneath a mature woodland canopy, and poor flowering considerably hampers the estimation of sex ratios in natural populations. Of 40 trees which I examined in the natural Caledonian forest of the Beinn Eighe National Nature Reserve in W. Ross (v.c. 105) in August 1986, none had apparently flowered.

One cannot assume that non-fruiting plants are male; many will not have flowered. It follows that estimates of sex ratio must be made when trees are in flower, usually in June. Both the earlier reports of sex ratio in this species were made with respect to fruiting/non-fruiting plants, and must be considered suspect. It is difficult to know whether a high proportion of non-flowering adult trees biases the estimate. It is not known whether males and females first flower at the same age, flower equally regularly, and respond in the same way to shade with respect to flowering. Many tree species tend to flower younger when male (Richards 1986); this tends to bias sex ratio counts in favour of males. However, when fruiting/non-fruiting is used to estimate sex ratios in trees of all ages, the number of females will be seriously underestimated, and this may be the case in earlier sex ratio reports for Holly.

Holly flowers are often only produced high on a tree, but trees in flower are easily sexed, especially using binoculars. Darwin (1877) and others have stressed the similarity of male and female Holly flowers, and this may deceive pollen-gathering bees into visiting female flowers (although flowers of both sexes have plentiful nectar). However, the conspicuous green ovaries of female flowers ensure that sex determination is readily achieved.

During 1986, sex ratios of seven populations were recorded (Table 1). In all of these, more males than females were in flower. In three populations, trees had evidently been planted in parks or estates; for two of these there was a significant excess of males. In none of the other populations taken singly, was the excess of males significant, but the samples were small. If these four semi-natural populations are taken together, the excess of males just fails to be significant at $p = 0{\cdot}05$. For all populations taken together there is a highly significant excess of males. As a substantial (but unrecorded) proportion of trees in all populations were not in flower, it is possible that actual sex ratios in natural populations do not differ from 1:1, if females flower less well, or at a greater age or size than males.

There are several possible explanations for the discovery of apparently male predominant populations of Holly in Northumberland and northern Scotland.

1. Male predominance in planted populations results from an excess of propagated males.
2. Male plants flower more frequently than females.
3. Unlike populations to the south, in the New Forest and Brecon, Wales, populations of Holly in the north of Britain are male-predominant; it is possible that a cline for increasing male predominance northwards occurs.

It seems unlikely that Man would have knowingly selected for males when propagating, as the attractive berries of females can be a motive for planting. It is however possible that vegetative propagation of males is more successful, although I know of no such evidence. If males do flower more frequently than females, it must be presumed that a proportion of the non-fruiting plants, assumed to be males, in the New Forest and Brecon reports, were in fact non-flowering females. If this is the case, it may be that southern populations are in fact *female*-predominant, although recorded (in fruit) at 1:1. There is no further evidence that Holly becomes increasingly male northwards. However, if males and females experience different reproductive loads which influence survival and longevity, as is the case in many trees (summarized in Richards (1986: 327–328)) it might be that superior survival of males is enhanced in less optimal northern climates.

Fruit set was examined on five trees in Leazes and Exhibition Parks in Newcastle upon Tyne, at

TABLE 1. NUMBERS OF FLOWERING INDIVIDUALS OF HOLLY IN SEVEN POPULATIONS
N.S. = not significant; *** = $p < 0{\cdot}001$

Site	Habitat and nature of population	Number of males	Number of females	% males	χ^2	
Pasture House, Dipton Mill, Northumberland, GR 35/939.592	Overgrown road hedge with mature trees, probably relict woodland	14	8	63·6	1·64	N.S.
Hexham Golf course, Northumberland, GR 35/916.653	Edge of steep woodland on river terrace, modified ancient woodland	29	26	52·7	0·16	N.S.
Queen Elizabeth High School, Hexham, Northumberland, GR 35/925.640	Old unmanaged estate garden, most Hollies self-sown	32	25	56·1	0·86	N.S.
Flowerdale, Gairloch, W. Ross, GR 18/814.753	Overgrown road hedge with mature trees, self-sowing but some possibly planted	13	6	68·4	2·58	N.S.
Leazes Park, Newcastle upon Tyne, GR 45/244.648	Urban park, most trees probably planted	41	10	80·3	18·8	***
Exhibition Park, Newcastle upon Tyne, GR 45/247.657	Urban park, all trees planted	7	6	53·8	0·08	N.S.
Close House, Wylam, Northumberland, GR 45/128.659	Drive to large estate, probably planted hedge	21	2	91·3	15·6	***
Top four natural or semi-natural populations together		88	65	57·5	3·46	p=0·06
All seven populations together		157	83	65·4	22·8	***

various distances from the nearest male (in all cases other males were much more distant) (Table 2). Many trees of other species were present in these localities, so that when the female was separated from the male by 40, 100 and 200 m, it was not possible to see the male from the female tree. Fruit set was good when males were up to 40 m distant from females, but became poor at 100 and 200 m distance. In Oregon, Roberts (reported in Ticknor 1986) found 80% and 63% fruit set at 90 m in successive years, but at 280 m from the nearest male, fruit set was only 25% and 5% in those years. These results suggest that not more than 50 m should separate males from females for a high percentage of fruit set to result.

TABLE 2. FRUIT SET ON FIVE HOLLY TREES WITH DISTANCES TO NEAREST MALE

Distance to male (m)	No. of female flowers sampled	No. of fruits set	% fruit set
2–4	46	44	95·6
5–8	12	11	91·6
40	122	116	95·1
100	200	71	35·5
200	82	5	6·1

ROSEROOT

Rhodiola rosea, Roseroot, is a widespread arctic-alpine species found on wet, usually north-facing and usually basic cliffs. In the British Isles it occurs in the mountains of Wales, northern England, Ireland and Scotland, usually in small, isolated and relatively inaccessible colonies. These are rarely large enough for meaningful sex ratio estimates to be made. However, Roseroot also occurs on sea-cliffs, and in north-western Scotland these colonies may be much larger. Kay & Stevens (1986) quote Knuth (1908) to the effect that European populations are usually dioecious, but that hermaphrodite plants occur in the Alps, and trioecious populations in Greenland (male, female and hermaphrodites coexisting). In the sea-cliff population reported here (Rubha Reidh, W. Ross, v.c. 105), most females set many fruits, but in a proportion, estimated at about 20% of females, only 1–2 fruits were set per inflorescence. As the population was in fruit, and partially inaccessible, I am not certain of the cause of this. However, all females had males in close proximity, and plants with intermediate types of fruit set rarely occurred. I suspect that the plants with poor fruit set were primarily male with a few female flowers. All plants with any fruits were scored as female, so the number of genetical males may have been underestimated. If these poorly fruiting plants were partially hermaphrodite, this population can be classed as subandroecious, with females, and slightly and variably female males. This condition is not uncommon and may represent an intermediate stage between monofactorial unstable gynodioecy and full dioecy (Richards 1986).

Roseroot is otherwise extremely easy to sex, for females produce large fruits, and conspicuous fruiting stems often persist from earlier years (living and male stems are annual). Remains of flowers on male plants persist all summer. A proportion of young, or highly shaded individuals do not flower. At Rubha Reidh (GR 18/739.916), perhaps 15% of individuals were not flowering. In this locality a very large population grows at high density, and clones extend for two or three metres and intermix with several other clones. A conservative scoring policy was adopted, and contiguous growths of the same sex were considered to belong to the same clone. This could bias the estimate of sex ratio if one sex (probably the male) grew more vigorously than the other. There was no clear evidence of differential growth between the sexes, but intensive investigations were not made.

At Rubha Reidh, 156 males and 100 females were recorded ($\chi^2 = 2{\cdot}25$, $p < 0{\cdot}001$). If all non-flowering plants were female, which seems very unlikely, the excess of males would persist, but would cease to be significant. However, possible biases from plants recorded as females which may have been genetically male, and from superior clone size in males leading to the under-recording of males, which have both been discussed, both lead to the underestimation of males. It is difficult to escape from the conclusion that this population has a real excess of males.

Dioecious populations that are male predominant, and those that are female predominant have both been recorded in the literature (Richards 1986). It has been suggested that female predominant ratios commonly result from competition between X and Y chromosome linkage groups, between pollen grains on the stigma, or between zygotes as seeds, seedlings or adults. Such competition will be density-dependent, and will be maximized in plants with a short generation time and rapid population cycling. Male predominant ratios will result from different reproductive loads between the sexes. Males will generally suffer lighter loads than females, and it is common to find in long-lived perennials, especially woody plants, that males flower when younger, flower more prolifically, live longer, and show better vegetative growth than females. Lloyd (1974) doubts whether disparate sex ratios can in themselves ever be adaptive, but rather are the by-product of sexual selection for individual gender fitnesses.

It is possible that male-predominant ratios in both Holly and Roseroot, which are both long-lived perennials, are a product of differential reproductive loads and longevities between the sexes. As yet there is no firm evidence for this.

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The past and present distribution of *Stachys germanica* L. in Britain

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ABSTRACT

Stachys germanica L. (Downy Woundwort) is confined to Oxon, v.c. 23, although it was probably native or well-established in N. Hants., v.c. 12; W. Kent, v.c. 16; Northants., v.c. 32, and S. Lincs., v.c. 53, in the 19th century. A field and literature survey of the Oxfordshire sites was undertaken in 1984 and 1985. The eleven known post-1950 sites are scrubby wood edges, hedges, uncultivated banks and verges, quarries and fallow fields on oolitic limestone soils. All the known populations are small and vary from 1–100+ plants. Flowering is erratic and long-term seed dormancy is followed by a few years of flowering and seed production, usually after wood cutting. The majority of sites are in old hedges in association with ancient routeways, although two populations occur in semi-natural habitats. *S. germanica* is probably a native species, well-adapted to traditional forms of forestry and agricultural practice on the Oxfordshire oolite, but is vulnerable to modern changes, including the removal or neglect of old hedgerows and copses.

INTRODUCTION

Stachys germanica L. is a robust and attractive labiate, readily distinguished from other native British members of the genus by the long, silky hairs which cover the stem, leaves and calices. The garden escape, *S. byzantina* C. Koch (=*S. lanata* Jacq.) (Lamb's ear), is often mistaken for the native plant but differs markedly in a number of characters, notably general habit, leaf shape and lanate-tomentose hair covering. The ecology, phenology and population dynamics of *S. germanica* are discussed by Dunn (1987).

S. germanica is a widespread species of dry calcareous pastures, roadsides and hedgebanks in central and southern Europe (Ball 1972). It is rare in northern Europe, especially in Britain where it reaches the northern limit of its range. Perring & Walters (1962) indicate records of *S. germanica* in eight 10-km squares for pre-1930 records, two post-1930 records and ten 'introductions' in England and Wales. Perring & Farrell (1977) report that "this attractive perennial species of calcareous pastures and roadside verges is now believed to be extinct except in five localities in Oxfordshire." In 1981, when *S. germanica* was added to Schedule 8 of the Wildlife and Countryside Act as a species in need of legislative protection, the known wild population was extremely small and in apparent danger (N.C.C. unpublished data). Subsequent searches suggest that the real position is slightly more favourable. In 1984 and 1985, *S. germanica* was found in flower in four of the eleven known post-1950 sites in Oxfordshire, but several of the other sites had become overgrown by dense scrub. The majority of sites are along the transition between scrubby, deciduous woodlands or hedgerows and uncultivated calcareous grassland. *S. germanica* can also grow in open limestone grassland where this is tall and sheltered, and it also colonized crop fields in the past. The plant is a poor competitor, requiring light and open conditions for germination and the first-year rosette phase of its life-cycle, and hence benefits from periodic woodland clearance by coppicing, scrub removal or hedge thinning. Its sudden appearances after a long absence suggest that the plant has a strategy of long-term seed dormancy, flowering and setting seed only in suitable conditions. The seeds are relatively large and heavy (one observer likened dehiscence to "coals falling from a scuttle"), and the main seed bank probably lies close to the parent population. Most of the extant populations are extremely local with a characteristic clumped form. Records suggest that it may persist at suitable sites for well over a century. As a plant of transitional, open habitats the phytosociological affinities of *S. germanica* are difficult to define. Most of the sites lie in the close vicinity of tall, moderately species-rich grassland dominated by *Bromus erectus* and *Brachypodium pinnatum*, but at only two sites does the plant grow among closed grassy turf. More typically it grows on sheltered patches of bare soil, accompanied by other robust colonizers, notably *Clematis vitalba*, *Alliaria petiolata*, *Verbascum thapsus*, various thistles and umbellifers and regenerating scrub or hedgerow sprouts. In its hedgerow locations, *S. germanica* is sometimes accompanied by local species, notably *Astragalus glycyphyllos*, *Cirsium eriophorum* and *Nepeta cataria*, while *Salvia pratensis* occurs in similar situations nearby. These hedges are, without exception, rich in woody constituents including a high proportion of *Acer campestre* and *Corylus avellana*, indicative of ancient date and probable woodland origin (Pollard *et al.* 1974). The nature of the Oxford habitats of *S. germanica*, coupled with the known facts of its reproductive pattern, geographical distribution and very low frequency of naturalization, suggest strongly that, contrary to the opinion held by some 19th century authorities, *S. germanica* is a native species (Webb 1985). It was probably an original inhabitant of wood edges and glades, a circumboscal species (Rackham 1980) which became adapted to coppice and hedgerow management regimes on suitably dry, calcareous soils and colonized open ground in quarries and arable fields.

NON-OXFORDSHIRE RECORDS

There are reliable records of *Stachys germanica* from at least ten vice-counties, and unauthenticated references in county floras to several others, some of which are probable or certain errors. Table 1 refers to those records which the author has traced. Some of the casual records not backed by an authenticated specimen are probably *S. byzantina* but *S. germanica* does occur, very occasionally, as an introduced casual, probably imported from Europe. In N. Hants., W. Kent, Northants. and S. Lincs. it evidently once occurred in similar situations to its Oxford localities and is probably an extinct native in those vice-counties. It may also have been native at one time in Beds., S. Hants. and E. Kent. All the recorded sites, with the exception of Luton, Beds., lie on chalk or oolite soils. In the case of the W. Kent record, the plant occurred at the edge of an ancient wood; in S. Lincs. it occurred in an area known to have been well-wooded in the early Middle Ages (Gibbons 1975). All the populations were small, except for those in an oolite quarry (or quarries) in Northants., and roadside hedges and verges around Colsterworth, S. Lincs., where it was respectively described as "plentiful" and "a common weed". The loss of the species was attributed to ploughing in the case of N. Hants. and W. Kent, and to the infilling of the quarry in Northants. Taken together, the records indicate that the plant was widespread but very rare by the time naturalists were first compiling county lists. Its wide distribution suggests that it may once have been considerably more common when semi-natural woodland and calcareous grassland were more extensive and the climate milder than at present.

OXFORDSHIRE SITES

Stachys germanica was first recorded in Britain "in the field joyning Witney Parke", Oxfordshire, in 1632 (Druce 1886). The discoverer was Leonard Buckner, a London apothecary, and his record was published in Johnson's revision of Gerard's *Herbal* the following year. A specimen from Witney Park, dated c. 1730, survives in the Dillenius herbarium (**OXF**). Although no further localities are recorded for another century, Jacob Bobart, who was responsible for the entry of this species in the 1699 edition of Morison's *Plantarum Historia Universalis Oxoniensis*, states that the plant occurred on hills, rough stony ground and fallow land in Oxfordshire, presumably in more than one place ("*Locis variis montosis et saxosis asperis et arvis restilibus, agri Oxoniensis*"). In about 1735, John Blackstone found *S. germanica* growing plentifully "by the lane leading from Wychwood Forest to Charlbury" and in some of the coppices of the forest itself (Druce 1910). On 20th October 1767, Gilbert White, then visiting his friend John Mulso, Rector of Witney, describes an expedition to see "the base horehound, the *Stachys Fuchsii* of Ray, which, that Gent. says, grows near Witney park." White found "but one plant under the wall but further on near the turnpike that leads to Burford, in an hedge opposite to Minster Lovel, it grows most plentifully. It was still blowing & abounded with seed; a good parcel of which I brought away with me to sow in

TABLE 1. *STACHYS GERMANICA*: RECORDS IN VICE-COUNTIES OTHER THAN OXON

Vice-county	Location	Habitat	Source	Probable status	Year
1, W. Cornwall	Landaviddy	Field	Davey (1909)	Error (Margetts & David 1981)	1848
	Trewin	Field	Davey (1909)	Error (Margetts & David 1981)	undated
10, Wight.	Steephill, Isle of Wight	Chalk-pit	Rayner (1929)	Unknown	1909
12, N. Hants.	Itchen Abbas	Road verge and uncultivated field	*W. Spicer*, **BM**, Townsend (1883)	Native	1850, 1872
	?Itchen Abbas		*Sowerby*, **BM**		1859
15, E. Kent	Earthist	Bank	Hanbury & Marshall (1899)	Unknown	1829
16, W. Kent	Darenth Wood	Wood edge and uncultivated field	*J. T. Boswell Syme*, **BM**	Native	1857
	Sevenoaks	Railway station	Hanbury & Marshall (1899)	Casual or error	undated
30, Beds.	Clapham Hill	?Chalk grassland	Dony (1953)	Unknown	1801
	Near Luton	?	C. Abbot in Dony (1953)	Casual or error	c. 1798
32, Northants.	Fineshade	Limestone quarry	*W. Lewin*, **OXF**	Native	1870
33, E. Gloucs.	Redbrook	?	Riddelsdell *et al.* (1948)	Casual	1874
	Oakridge	?	Riddelsdell *et al.* (1948)	Casual or error	undated
34, W. Gloucs.	Kingswood	Fowl-run	Sandwith (1932)	Casual	1917
	Baptist Mills	?	Riddelsdell *et al.* (1948)	Casual	1930
	Poole Keynes	?	Riddelsdell *et al.* (1948)	Casual or error	undated
50, Denbigh	Eyarth Woods	Woodland	Dallman (1911)	Probable error (for *Stachys alpina*)	1908
53, S. Lincs.	Easton	?	R. Richardson in Gibbons (1975)	Native	1727
	Colsterworth	Road verges, hedges and fields	Turner & Dillwyn in Woodruffe-Peacock (1896)	Native	1794–96
			J. Davies in Gibbons (1975)		1805
	Stoke Rochford	?	Gibbons (1975), **K**	Native	1800
	Thurlby	Road verge	J. Dodsworth in Woodruffe-Peacock (1896)	Native	1840
54, N. Lincs.	Grimsby	Dock yard	*A. Smith*, **LINC**	Casual	1903
62, S.E. York	Whitby	?	*C. Bailey*, **BM**	Error (for *Stachys byzantina*)	1867

the dry banks round the village of Selborne" (White 1986). The introduction was evidently successful for, six years later, White observed that he never saw the bee, *Apis manicata* (=*Anthidium manicatum*) until *Stachys germanica* flowered, "on which it feeds all day: tho' doubtless it had other plants to feed on before I introduced that *Stachys*." Sibthorp (1794) listed it from cornfields and along waysides in the vicinity of Witney, Stonesfield and Woodstock in the west of the county. A contemporary botanist, Samuel Goodenough, found the plant in plenty in cornfields around Brize Norton in about 1800 (Druce 1927). The impression given by these early records is that *S. germanica* was more common in Oxfordshire than today and occurred in a variety of habitats, although it always seems to have been confined to the oolite and related formations.

Although records of *S. germanica* are frequently too imprecise to assign to known localities, I estimate that the plant has been found in about 30 sites over an area of approximately 150 km^2 since its discovery, and at eleven since 1950. Fig. 1 illustrates the past and present distribution of the species in 2-km tetrads. The records of *S. germanica* lie within an area of distinctive landscape

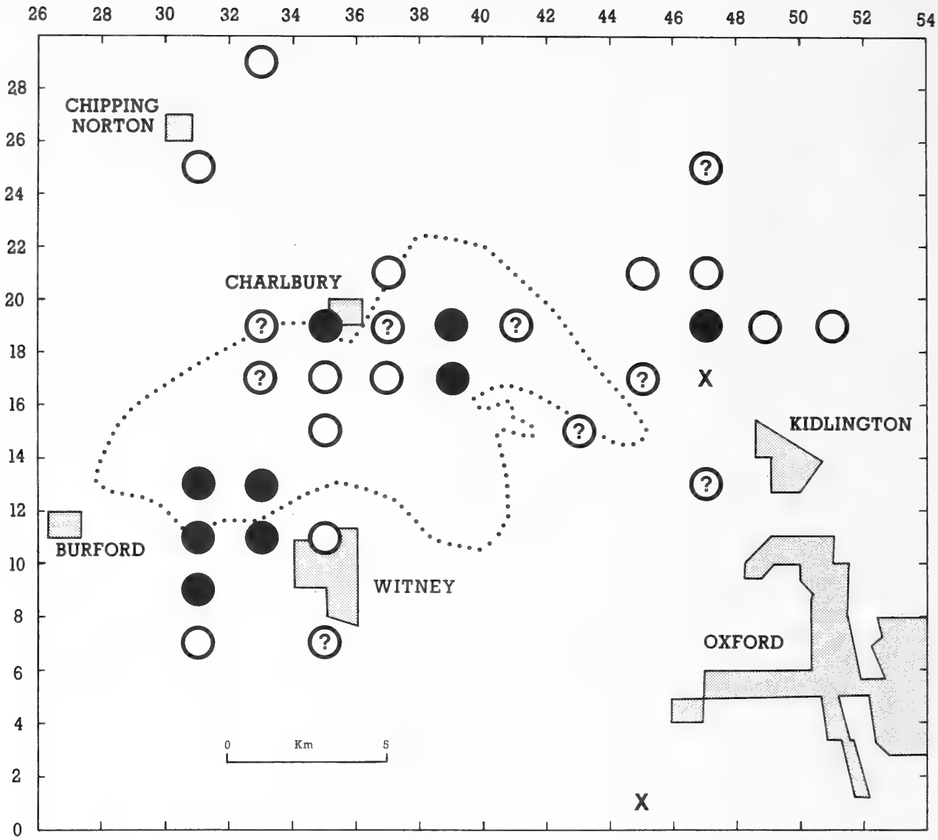

FIGURE 1. Past and present distribution of *Stachys germanica* in Oxfordshire. ● post-1950; ○ pre-1950; ⓘ locality uncertain; X introduction; .... boundary of the Wychwood Forest at the time of the Domesday Book.

and social history, with a long continuity of managed deciduous woodland and calcareous grassland. This part of Oxfordshire is known to have been under fairly intensive cultivation in Roman times (Emery 1974), and from a very early period was scored by an intricate network of narrow lanes, "like veins on a leaf", many of which survive in their original, unmetalled condition as 'green lanes' – strips of old limestone grassland commonly bounded by hedges. Even those lanes which have since been widened and metalled often retain their original banks and verges. Elsewhere, old grassland survives mainly as small, steep banks flanking the 'bottom land' of streams and dry valleys. As a consequence of physical and historical factors, therefore, there has developed in this area an unusually high density of 'edge' habitats with the necessary combination of old woodland and grassland making an abundance of potential habitats for *S. germanica*. The frequency of old lanes and banks appears to be an important factor governing the distribution of this plant.

The physical and historical nature of the 20th century localities of *S. germanica* are outlined below, together with the recorded occurrences of the species. The precise locations of most of the sites must be kept confidential for conservation reasons.

HEDGEROW AND ROAD VERGE SITES

STURDY'S CASTLE

The broad, road verges in the vicinity of Sturdy's Castle public house have been known as a *Stachys germanica* site for nearly two centuries. The plant grew on the level verges of the A423, close to a thicket derived from an old hedge, and usually flowered after the latter had been cut back. It was first recorded as "abundant" near Sturdy's Castle by William Baxter early in the 19th century (Druce 1927) and was rediscovered there by Druce (**OXF**) in 1903. A party who went to look for it in 1906 found the verge "unusually bare" following roadside works and no plants were in evidence (Druce 1907). The species was found again in 1931 (**OXF**), however, and again in 1962, following the cutting back of the encroaching thicket. In the latter year, 20 small plants were found on the disturbed ground by the hedge and, in the following year, 19 plants and three non-flowering rosettes appeared (**OXF**, **RNG**). A few more plants were found in successive years until about 1969. No plants were seen here in 1984 or 1985, by which time the hedge had once again become overgrown, but it may reappear once again when the hedge is cut back, although the verge flora is evidently less rich now than at the beginning of the century.

A second verge locality lies by the side of a lane about 2 km from the above. It was first found here by W. Wilson Saunders in 1840 (**OXF**) and was rediscovered in 1921 (**BM**). The plant reappeared in 1962 (**OXF**) close to the adjoining hedge, when 26 plants were counted on ground whose surface had been scraped about two years previously. A further four or five plants appeared the following year but were cut down before they could set seed. So far as is known, none have been seen since, although the habitat remains suitable.

SITE A

Site A is a green lane, whose population of *Stachys germanica* is described in detail by Dunn (1987). The lane has a rich, tall, limestone grassland, verge flora and a very old boundary hedge, probably of woodland origin (see below). 62 plants were discovered here in 1984, on bare ground exposed after the hedge was severely cut back, probably for the first time in 35–40 years. The plant has reappeared annually, although in 1986 the stems were picked before it could set seed.

SITE B

An old lane near Worsham has been known as a locality for *S. germanica* for at least 50 years. A single plant appeared here in 1972 by the then overgrown boundary hedge. Another appeared in 1974, following a fire which had burned down that particular section of the hedge. In 1985, 25 plants bearing 43 vigorous flowering stems appeared out of a tangle of tall vegetation and regenerating hedgerow sprouts, on ground which had clearly been disturbed, perhaps again by fire, a few years previously. None were found in 1986, when the vegetation had perhaps become too dense to allow germination.

AKEMAN STREET

S. germanica has been found in at least three places along the route of this Roman road during the present century. One site was an old hedge bordering a shaded ditch near Stonesfield where more than one plant was observed in 1949 (**RNG**), and a single individual found in the ditch in 1955 (H. Bowen, pers. comm. 1985). Another single plant was found by a hedge 7 km further west in 1980. A third site along Akeman Street in the vicinity of Minster Lovell was recorded by Druce (1927).

CRAWLEY GREEN LANE

A single, stunted plant of *S. germanica* was found in 1979 in the centre of a green lane bordered on both sides by hedges. This lane is used as a farm track and the plant occurred on ground recently disturbed by cattle (J. M. Campbell in litt.), by whose agency it may have been introduced.

DORNFORD GREEN LANE

S. germanica was discovered along the course of this ancient track by W. D. Mavor in 1820 (Druce 1927). It was refound by Druce in the late 19th century and by W. B. Turrill and A. B. Jackson in 1909 (**OXF**, **BM**) and S. H. Bickham in 1912 (**BM**). The lack of recent records may be partly due to the overgrown boundary hedges, which are presently so dense as to threaten to block the lane in places.

WOODLAND, GRASSLAND AND QUARRY SITES

SITE C

One of the largest populations of *Stachys germanica* occurs by the edge of an ancient copse and in a neighbouring crop field in the vicinity of Minster Lovell. The edges of the copse are scalloped with small glades for game management purposes, from which scrub is periodically cut. A narrow strip of old grassland separates the wood from a small field, used in recent years to grow game crops of buckwheat and canary grass, and sometimes deliberately left fallow allowing colonization by biennial and perennial 'weeds'. The site was evidently known to Druce (1927). 25 plants of *Stachys germanica* were discovered flowering along the grassy field border by Palmer (1967). He found a further twelve plants in 1971 but none in the two subsequent years. The plant also appears at irregular intervals in glades along the edge of the copse, usually after scrub clearance. In one such glade, about 100 plants appeared on the bare ground in 1984 but only a single plant in 1985 (Palmer, pers. comm. 1985). *S. germanica* has also appeared almost annually in recent years on the strip of grassland and among the game crop. Estimates of its numbers have varied from one to three plants in 1980, 1984 and 1985, to 20–50 in 1982–83. The flowering of *Stachys germanica* at this site seems to depend on the periodic clearance of wood-edge glades, a form of management resembling coppice, and the continued maintenance of fields of game crops which are not ploughed every year. This is presently the only site in which *S. germanica* grows as a crop 'weed' as it did in the 18th century.

SITE D

Site D lies about 1 km west of site C on a west-facing bank of tall limestone grassland dominated by *Bromus erectus* and partially invaded by hawthorn scrub. 23 plants of *S. germanica* were found in 1984 and a further nine in 1985, scattered along a section of the bank. The landowner has known of the plant for about 20 years and flowering seems to be unusually regular.

STONESFIELD QUARRY

Druce (1910) reported that *S. germanica* had occurred in oolite quarries in the neighbourhood of Taynton, Burford, Minster Lovell and Charlbury, but omitted reference to the first two parishes in his later county flora (Druce 1927). The only quarry site known in recent years is a shallow, disused, slate quarry near Stonesfield, which was evidently also known to Druce. A few plants, mostly single specimens with a maximum of four in 1978, have appeared on the bare, stony ground of the quarry, but the site had become overgrown by 1985 when none were found. Seedlings of *S. germanica* from another site were planted here in 1964, and the more recent records are therefore of unknown provenance.

OTHER OXFORDSHIRE SITES

Stachys germanica has been recorded from several other sites for which no habitat details or population data exist. The neighbourhood of Charlbury was once a well-known locality; most herbarium specimens seem to have been collected from the roadside banks and hedges running westwards from the village railway station along the northern fringe of Wychwood. The plant was first found hereabouts in c. 1735 (Druce 1910) but most sheets examined date from 1870–1935 (**OXF**, **BM**). Druce (1927) also refers to sites to the immediate north and south of the village. The neighbourhood of Witney was another favoured area; herbarium sheets labelled "near Witney" begin in 1766 (herb. Sir Joseph Banks, **BM**) and the last dated sheet is 1893 (**OXF**). A single plant was found by a hedge west of the town in 1972, but none appeared the following year (B.R.C.). Sibthorp (1794) discovered the plant along the main Oxford road between Woodstock and Enstone, although the site or sites may have been lost when the old road was straightened and improved in 1800. Finally a number of other records exist outside the main recorded range of *S. germanica*. Those backed with an authentic specimen are Kirtlington Park (*Whiteheaves*, 1858, **OXF**; *Druce*, 1901, **OXF**); Faringdon (undated, **OXF**) and Hanborough (*Druce*, 1888, **OXF**), while Druce (1927) also admitted Chipping Norton (1805), Sarsgrove (undated), Steeple Aston (undated), and Begbrook (undated). Seedlings from Sturdy's Castle were planted out at a railway cutting through the oolite at Hensington and in a field near Wytham Wood, Oxford in the 1960s (C. J. Cadbury in litt.).

HISTORICAL FACTORS

The majority of sites of *Stachys germanica* in Oxfordshire are on the verges of green lanes and roads, usually associated with a hedge. A historical analysis of the recent sites suggests that it survives mainly in sites which show very long continuity of management and that the present-day routeways and hedges are of ancient origin. The larger old lanes were employed as drove roads for cattle and sheep until recently, and are characterized by tall hedges and very broad grass verges, often of uncultivated limestone grassland. At one time they would have carried a considerable traffic, both from local manors, whose commons often lay some distance away, and, in the case of the broadest lanes, as main routes. The green lane at Site A, for example, is known to have been used for conveying salt in the Middle Ages (Houghton 1929), and there is evidence that it was in use as early as the 8th century (J. Bond pers. comm.). The A423 at Sturdy's Castle was formerly a broad drove road which is mentioned in 11th century charters (Hooke 1981). The *S. germanica* site borders a deep, parallel earthwork and is close to the intersection of Akeman Street, a Roman road. Dornford Lane is another broad track, presently little used, which dates from no later than the 10th century and once linked the Norman Kings' hunting lodge at Woodstock with an outlying manor on the royal demesne (Hoskins 1955). All the other lanes containing *S. germanica* have been identified on 18th century county maps, which clearly show their boundary hedges, and there is every reason to assume they are of at least medieval origin.

Corroborative evidence of ancient date is provided by the hedges in which *S. germanica* has occurred. Table 2 presents data collected from six hedges in which the species has occurred at least once since 1950. There is a strong possibility, both on biological and historical grounds, that some or all of these hedges were formed from woodland constituents. Three lie within the reconstructed Domesday boundary of the Royal Forest of Wychwood (Schumer 1984) and all lie within what was then a well-wooded area. The hedgerow constituents reveal these hedges to be of medieval or even

TABLE 2. PHYSICAL AND BOTANICAL CHARACTERISTICS OF HEDGEROWS CONTAINING *STACHYS GERMANICA*

The hedges marked with an asterisk occur within the Domesday Book boundary of Wychwood royal forest, as defined by Schumer (1984).

Hedges	Length examined (metres)	Associated earthworks	Number of hedgerow species	Dominant hedgerow species	Notable features
Sturdy's Castle	200	Sunken lane with steep banks	9	Mixed but *Prunus spinosa*, *Acer campestre*, *Crataegus* prominent	
Site B	150	Faint bank and ditch	14	*Acer campestre*, *Prunus spinosa*	
Site A*	200	Faint ditch	17	*Acer campestre*, *Corylus avellana*	*Sorbus torminalis* in hedgerow. Parish boundary
Stonesfield*	100	Prominent bank and ditch	11	*Acer campestre*, *Corylus avellana*, *Sambucus nigra*	Ancient stools of *Acer campestre* and *Ilex aquifolium*. Parish boundary
Akeman Street*	50	Cut into natural bank	7	Mixed (no *Acer*)	
Crawley Green Lane	100	Cut into natural bank	6	*Acer campestre*, *Corylus avellana*, *Prunus spinosa*	
Dornford Lane		Not examined	not counted	*Acer campestre*	

earlier date. The abundance of *Acer campestre*, both as a hedgerow constituent and as a standard tree, and of *Corylus avellana*, suggests woodland origin, as does the presence of *Sorbus torminalis* in one hedge, whose suckers accompany one of the largest clumps of *S. germanica*. The Wychwood area has a well-documented history of land reclamation from woodland or assarting, especially in the 13th century, by which neighbouring fields retained strips of original woodland both as an enclosure and as a source of firewood (Schumer 1984; Stede undated). The evident association of *S. germanica* with these ancient landscape features is strong evidence that the plant is a true native despite the apparently man-made origin of most of its sites.

SURVIVAL FACTORS

The historical distribution of *Stachys germanica* has no parallel in the British flora although it is approached by another large labiate, *Salvia pratensis*, which is very locally abundant in tall calcareous grassland on tracksides, verges and banks on the same part of the Oxfordshire oolite. *Cynoglossum germanicum*, which once shared the coppices of Wychwood with *S. germanica*, also shares its predilection for ancient trackways: the largest Oxfordshire colony of *C. germanicum* lies on the wooded bank of a pre-Saxon lane known as the Ruggeway (Emery 1974). Finally, the closely related *Stachys alpina* is also found mainly by hedges and in open woodland on oolitic soils in Gloucestershire and on limestone in Denbigh. The best known colony is by an ancient hedge with twelve constituent woody species within a 100 m length, and closely resembles some of the Oxfordshire sites of *S. germanica*.

Why does *Stachys germanica* survive on the Oxfordshire oolite but, so far as we know, nowhere else in Britain? Possibly the plant was always rare and was eliminated elsewhere in the country by a series of chance events. However a possible explanation of its survival can be deduced from the circumstantial evidence of the land-use record of western Oxfordshire. Two particular local circumstances probably favoured the survival of *Stachys germanica*:

i) The presence of a large, ancient forest on predominantly calcareous soils, which was long managed as coppice-with-standards woodland (Stede undated; Petchey 1977).

ii) The survival of semi-natural habitats, notably ancient and medieval tracks and hedges, in a landscape which has changed relatively little since the Middle Ages (Emery 1974).

Stachys germanica appears to be a plant of woodland edges and clearings, which is well-adapted to a coppicing regime, when suitable conditions of light and open ground become available periodically. Although very few Oxfordshire woods are coppiced today, scrub clearance, a regular form of game management in some copses on the oolite, and the periodic cutting back of broad hedges provide similar ecological conditions. The former, local, two-field crop rotation, in which half the land was left fallow in any one year, also allowed biennials such as *S. germanica* to spread into crop fields from the boundary hedge or copse. A further niche for *S. germanica* was provided by the small quarries of Cotswold stone and slate which nearly every parish in the area once possessed.

In S. Lincs., and perhaps also in Northants., N. Hants. and W. Kent, habitat reduction and changes to traditional farming practices may have eliminated *S. germanica*. Happily, the area in which it occurs in Oxfordshire is one of large estates, in which game interests ensure that some deciduous woods, hedgerows, grassy banks and even fallow fields are conserved and that the use of environmentally harmful farming practices such as stubble-burning and the spraying of headlands is limited. The result is a landscape which, although far less suitable for *S. germanica* than its medieval predecessor, is still one in which sufficient old woodland/grassland edge habitats occurs for the plant to survive at the edge of its range. This does not in itself explain why the species has survived *only* in Oxfordshire, but this circumstance itself suggests that conditions here are more favourable to the plant than in other vice-counties.

CONSERVATION

There is no evidence to suppose that *Stachys germanica* has greatly declined during the present century. It has been found in at least eleven sites since 1950. Druce, who had a closer acquaintance with the Oxford flora than most living botanists, evidently succeeded in finding it in only nine sites over 40 years (Druce 1886, 1927). On the other hand, the population of flowering plants at some sites is very small in any given year, often single plants only, although the store of dormant seed buried in the soil may be much higher. Most discoveries of *S. germanica* have been made by chance and its true status is probably underestimated, although it is undoubtedly rare and local. Several recent trends may be contributing towards a long-term decline however. *S. germanica* is a southern European species at the edge of its range here and there is some evidence that long winters and cool summers weaken British populations and restrict seed production (Dunn 1987). The plant also requires the regular cutting of coppice, scrub and hedges in order to flower and set seed. In Wychwood, where regular coppicing had all but ceased by the late 18th century, it seems to have disappeared, along with other light-demanding old woodland species such as *Cynoglossum germanicum*, *Gagea lutea* and *Convallaria majalis* (Druce 1910). Many hedges in *S. germanica* localities are presently neglected and their grassland verges overgrown, a consequence of increased maintenance costs and the decline of dairying in favour of cereal crops. In 1975, local authorities began to cut back on roadside mowing and scrub cutting operations to save money. As a result, former roadside sites such as Sturdy's Castle are now thickly overgrown. The hedges of those green lanes which were used as drove roads must once have been kept in check by the browsing of cattle, while the hooves of domestic animals and the wheels of carts may have helped to transport the large, heavy seeds of *S. germanica* to other suitable sites. Many lanes are used less intensively today and the plant's ability to colonize new sites is correspondingly reduced. Suitable sites for *S. germanica* are also being lost by habitat removal; there are fewer banks of unspoiled limestone grassland than formerly and many have suffered eutrophication, especially by slurry spreading, or have become overgrown with scrub. Finally, recent events have shown that this attractive plant must be considered a target for unscrupulous collectors and gardeners. Conservation efforts have been inhibited by lack of knowledge, although intensive observation over three years at one site has indicated a form of management under which the species thrives (Dunn 1987). One site with a relatively large population of *S. germanica* is being notified as a Site of Special Scientific Interest (S.S.S.I.) with the co-operation of the landowners, and a very small population occurs on an existing S.S.S.I. With Government grants and voluntary management agreements available to landowners, it is likely that at least some *S. germanica* sites will continue to receive appropriate management and that the conservation outlook for the species is reasonably satisfactory.

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Three species of clubmoss (Lycopodiaceae) at a lowland station in Shropshire

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ABSTRACT

The clubmosses *Huperzia selago* (L.) Bernh. ex Schrank & Mart., *Lycopodium clavatum* L., and *Diphasiastrum alpinum* (L.) Holub have recently been discovered on acidic clay spoil from the Carboniferous Lower Coal Measures at Stoneyhill, Telford, Shropshire, v.c. 40. *H. selago* and *L. clavatum* occur elsewhere in Shropshire but *D. alpinum* has not been reported in the county since 1726. Stoneyhill was open-cast for coal and clay and abandoned in the mid 1960s. Colonization by plants has occurred, with the clubmosses behaving as colonists in moss and lichen dominated communities. The possible origins of these three species in close association at a lowland site are discussed.

INTRODUCTION AND OBSERVATIONS

Clubmosses (Lycopodiaceae) are found on heaths, moorlands and montane grasslands, and are usually associated with upland areas. The discovery in 1983/84 of *Huperzia selago*, (L.) Bernh. ex Schrank & Mart., *Lycopodium clavatum* L., and *Diphasiastrum alpinum* (L.) Holub at a lowland site at Stoneyhill, Telford, Shropshire, v.c. 40, is thus of great interest.

Stoneyhill (GR 33/666.061) lies to the west of Telford at around 170 m above sea level and has a history of mining. The underlying Carboniferous Lower Coal Measures strata are composed of thin bands of coal underlaid by fireclays with workable coals in the upper layers. There are also subordinate ironstones embedded in mudstones mixed with the clay strata. Coal was extracted from drift mines in the 1930s; subsequently the site was open-cast for both clay and coal from the mid 1950s until the site was abandoned in the mid 1960s. There has been no restoration of the site and natural regeneration has taken place on the spoil heaps.

Much of the site is bare ground (pH 4.5–5) with a thin mat of algae comprising a typical wet acid flora, mainly *Zygogonium* sp. (presumably *Z. ericetorum*) with a small amount of *Hormidium* sp., *Mesotaenium* sp., and *Glindrocystis* sp. There is a good diversity of mosses (*Campylopus introflexus*, *Ceratodon purpureus*, *Dicranella heteromalla*, *Pohlia nutans*, *Polytrichum commune*, *P. formosum*) in association with lichens (*Cladonia floerkeana*, *C. furcata*, *C. impexa*, *C. squamosa*). *Agrostis capillaris* and *Hieracium* sp. are scattered over the site with *Holcus lanatus*, *Deschampsia flexuosa*, *Hypochaeris radicata* and *Calluna vulgaris*; *Ulex europaeus*, *Cytisus scoparius* and *Betula pendula* are present in localized areas.

Huperzia selago was discovered in late 1983 as two plants, one of which was apparently dead, on the northern side of a low bank of clay containing small pieces of coal up to 3 cm in size. Associated species included *Agrostis capillaris*, *Hypochaeris radicata* and *Holcus lanatus*, as well as mosses and

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lichens. The plants were uprooted by unknown persons in June 1984 and they were donated to the British Museum (Natural History) (**BM**), as transplantation was considered inadvisable (A. C. Jermy, pers. comm.).

L. clavatum and *D. alpinum* are both found on a north-west-facing (approximately 320°) low ridge of clay (pH 4.5) with ironstone nodules up to 10 cm in size. *D. alpinum* is present as at least 20 plants scattered over the southern end of the ridge, both on the slope and on the flat top. Smaller, younger plants outnumber larger, older plants. Some of the smaller plants have definitely developed from rhizomes; others are up to 1 m from the nearest larger clump and no rhizomes were observed. Several new plants, which are lighter green in colour than the older plants, were found in July 1986. At the foot of the slope, four clumps of *L. clavatum* are present, two of which intermingle with *D. alpinum* over an area of approximately 60 × 30 cm. The moss *Rhacomitrium lanuginosum*, more commonly associated with upland areas, is also present. Associated plants include *Agrostis capillaris*, *Holcus lanatus*, *Hypochaeris radicata*, *Lotus corniculatus*, *Leontodon autumnalis* and *Hieracium* sp. with the mosses *Campylopus introflexus*, *Ceratodon purpureus*, *Pohlia nutans* and *Cladonia* lichens.

A second bank of similar pH and soils, but much damper, has three patches of *L. clavatum* at the bottom of its northern face (aspect approximately 360°). One patch is extensive, covering approximately 75 × 90 cm, and sporing profusely in summer and autumn. At the northern end of the site, some 300–400 m from the above banks, a small number of plants of *D. alpinum* and one plant of *L. clavatum* were found growing on open ground but these were destroyed during site reclamation. The associated vegetation and pHs were similar to those described above.

TRANSLOCATION EXPERIMENTS

Attempts were made to move those plants which were to be affected by a derelict-land reclamation scheme. Three clumps of *D. alpinum* together with algal mat, mosses and lichens were moved as a turf approx 30 × 30 cm and 10–15 cm deep. They were planted on the top of the main ridge close to an existing patch of *D. alpinum*. One clump of *L. clavatum* was also moved to the foot of a ridge close to existing *L. clavatum* plants. The plants had to be moved during the dry summer of 1984 and, in spite of being regularly watered with water from an adjacent pool, only one of the plants, a clump of *D. alpinum*, survived.

One clump of *D. alpinum* and one of *L. clavatum* were also moved to Hartlebury Common Local Nature Reserve, Worcestershire. *L. clavatum* was found at this site up to the 1920s/1930s and *D. alpinum* was last recorded from the site in 1836. Unfortunately, the translocated *D. alpinum* was dug up by a dog or a rabbit. However, *L. clavatum* survives on a slope down to a small bog, growing on acid soil (D. Scott, pers. comm. 1986).

DISCUSSION

Nationally, the distribution of these three clubmosses reflects their association with the more mountainous areas of the north and west. Of the three, the distribution of *D. alpinum* is the most restricted, being found in northern and central Wales, the Lake District, the north of England, and Scotland (Jermy *et al.* 1978). Stoneyhill lies on the line between known *D. alpinum* sites in South Wales and Derbyshire which forms the south-eastern limit of its present distribution in Great Britain. Sinker *et al.* (1985) have described the present distribution of these three species in Shropshire. *H. selago* was formerly found on the ridges of the Stiperstones and the Long Mynd, the Stretton Hills, and Brown Clee in the Clee Hills; it is now recorded only from Titterstone Clee. *L. clavatum* is found on the Ercall Hill and the Stiperstones. *D. alpinum* was last recorded on the Stipperstones in 1726 and its discovery at Stoneyhill is thus particularly interesting.

The presence of an old specimen collected from a lowland site at Hartlebury Common, Worcestershire (in herb. Babington, **CGE**), determined by A. C. Jermy as *D.* × *issleri* (Rouy) Holub, stimulated Jermy and I. C. Trueman (pers. comm.) to consider the possibility of the Stoneyhill plants being this partially fertile hybrid (*D. alpinum* × *D. complanatum* (L.) Holub). After much study of the plants *in situ*, they agreed that they represented *D. alpinum*.

The Stoneyhill habitat shows similarities to montane grassland communities, notably the acid soils, low vegetation cover, and the exposed nature of the site. Colonization of the acid clay spoils at Stoneyhill has occurred since the open-cast site was abandoned in the mid-1960s. The clubmosses are part of the early successional stages together with mosses and lichens; the associated algal mat can be observed to form a crust in dry weather and may assist in retaining moisture. It is of particular relevance to note that these three species of clubmoss were formerly recorded from the moorlands and heaths of Derbyshire. Now only *L. clavatum* may be found in these habitats, whilst all three species are found in quarries and on tip-heaps of acid refractory sands on the Carboniferous limestone plateau, where they behave as occasional colonists of newly available and suitably moist and acid habitats (Clapham 1969). The presence of unusual plants on industrial sites which have been colonized by natural vegetation has been noted elsewhere (e.g. Greenwood & Gemmell 1978; Teagle 1978). The main area of interest at Stoneyhill has been retained as a nature reserve as part of a derelict-land reclamation scheme due to cooperation between Shropshire County Council and the Shropshire Trust for Nature Conservation.

The discovery of these three clubmosses in a very localized area raises questions as to how they may have arrived. The obvious explanation is that spores of *H. selago* or *L. clavatum* were carried either on the prevailing westerly winds, or possibly by birds (I. C. Trueman, pers. comm.) from the Ercall (4 km north-west of Stoneyhill), the Stiperstones (c. 30 km to the west) or the Clee Hills (c. 30 km to the south). Spores of *D. alpinum* would have had to have been carried from north-western Wales, some 100 km away. A second theory is that these species have been present in the Telford area for many years and have migrated from one suitable site to another as pitmounds were created during the exploitation of the East Shropshire Coalfields. Earlier botanists who found these three species elsewhere in the County might well have overlooked their presence in the apparently unlikely conditions of the abandoned coal and clay tips which have been present in the Telford area for at least 250 years. It is noteworthy that the distribution of clubmosses at Stoneyhill suggests that there is much variation in the spoil, which is to be expected at an old open-cast site on Coal Measures strata. The possibility that other suitable sites in the Telford area might have clubmosses is being explored.

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Supplementary list of wool-alien grasses recorded from Blackmoor, North Hants., 1959–1976

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ABSTRACT

A list of grasses found as wool-aliens over the period 1959–1976 on a fruit farm at Blackmoor, N. Hants, v.c. 12, is given. This list is supplementary to an interim list published in 1974, making a final total of over 360 species. Some taxonomic notes and comments on the species are included.

INTRODUCTION

An enormous variety of wool-alien plants were collected from the fruit farm at Blackmoor, N. Hants., v.c. 12, and neighbouring railway sidings at Bordon (closed before 1971), from at least 1959 up to 1976, by which time the use of wool-shoddy had been discontinued.

This paper provides a supplementary list of these grass species, in the same format as a previously published interim list from Blackmoor (Ryves 1974). As a result, 128 new species have been added to the previous total of 234 grasses in the interim list, making a grand total of over 360 species, representing some 4% of the world's grasses. These all occurred in an area of about two and a half square kilometres, and yet almost none of them persisted for more than one or two years. Many, but by no means all, have occurred as wool-aliens in other localities in Britain and abroad, and apparently form a component of a quasi-constant wool-alien flora. It should be noted that a few of the grasses listed are common native species or casuals, so might not have originated from wool-shoddy.

Most specimens were expertly determined by the late Dr C. E. Hubbard (CEH) of the Royal Botanic Gardens, Kew. Taxonomic comments and notes on some of the species listed are given.

THE EARLY YEARS (1959–1970)

The three principal botanical collectors at Blackmoor during these years were:

(i) J. E. Lousley (JEL), whose herbarium is now at Reading University (**RNG**), with duplicates at **K**, **BM**, etc.
(ii) Miss M. McCallum Webster (MMcCW), whose collections are mainly at **E**, with some material at **K**, **BM**, etc.
(iii) Lady Anne Brewis (ABMB), who sent specimens to **CGE**.

It has been possible to examine only the collections of grasses at **K** and **RNG**, but fortunately comprehensive lists of grass specimens were obtained from all these three botanists (pers. comm. to myself or to E. J. Clement). In general the botanical names in use at the time of identification are quoted in this final list. Some of the identifications in the early years are doubtful (as noted in the present list) and the whereabouts of some specimens is unknown. A few records from Bordon railway sidings made during these years have also been included.

THE YEARS 1973–1976

The summer of 1973 was exceptionally hot and dry, and the wool-alien grasses were unusually well developed and mature for this country. For instance, *Pennisetum clandestinum* (Kikuyu Grass) actually flowered in the field, and one individual of *Digitaria ternata* formed a clump 1 m across. The preceding mild winter had enabled several species to survive from the previous year, including *Amphibromus neesii*, *Cynodon incompletus*, *Paspalum dilatatum* and *Stipa neesiana*, and the abundance and widespread distribution of *Eragrostis cilianensis* later on in the season suggested that some plants from the previous year had set viable seed. This grass is a common weed in Hungary, for example, where there are very long, hot summers and short, bitterly cold winters, and there seems to be no reason why it should not persist in southern England.

Many of the grasses which occurred in the years 1969–1972 also appeared in 1973, but no attempt is made to list them all separately. Some noteworthy records included *Aristida congesta*, *Eragrostis atrovirens*, *E. glandulosipedata*, *E. lacunaria*, *E. obtusa*, *E. procumbens*, *E. virescens*, *Digitaria diffusa*, *D. divaricatissima*, *D. tenuissima*, *D. ternata*, *Leptoloma cognatum*, *Panicum buncei*, *P. mitchelii*, *P. queenslandicum*, *P. subxerophyllum* and *Thyridolepis xerophila*, which were previously seen on very few occasions.

After 1974 the use of wool-shoddy was discontinued at Blackmoor, and there was consequently a dramatic decrease in the number of alien grasses recorded. In that year, however, single plants of *Gastridium phleoides* and *Eragrostis macilenta* were seen. Several more rarities were noted in 1975 and 1976, but since then no new grasses have been found at Blackmoor.

Many specimens dating from the later years are to be found in private herbarium collections, notably **herb. E. J. Clement** and **herb. T. B. Ryves** and the herbaria of some of the botanists acknowledged in the interim list (Ryves 1974).

SYSTEMATIC LIST

The format, signs and abbreviations of the interim list (Ryves 1974) apply, viz:

Initials refer to botanists named in the Introduction.

! Specimen in **herb. T. B. Ryves**

* Listed by Lousley (1961)

? Identification doubtful, often due to immature material or suspect locality

[ ] Author's comments

Genera that were not included in the interim list are described in *Flora Europaea* (Tutin 1980); non-European genera are given a short description.

Several unnamed specimens may well represent species new to science (e.g. in *Stipa*, *Diplachne* and *Leptochloa*). A number of other specimens (e.g. in *Danthonia*, *Eragrostis*, *Panicum*, *Aristida*, *Stipa* and *Cynodon*) are widely scattered in various collections (e.g. **K**, **RNG**, **herb. T. B. Ryves**, etc.) and remain undetermined due to the inadequate material.

TRIBE *BROMEAE*

BROMUS L.

* *B. alopecurus* Poiret: Mediterranean. 1962 MMcCW (**K**, **E**, **RNG**).

* *B. arenarius* Labill.[1]: Australia, introduced U.S.A. 1960, 1961, 1965 MMcCW, ABMB (**K**, **RNG**), det. CEH [? *B. pectinatus* Thunb. from S. Africa].

B. arvensis L.: S. Europe, widespread. 1961 MMcCW, JEL (**K**, **E**, **RNG**), det. CEH.

B. commutatus Schrad.: Europe, N. Africa and W. Asia, widespread. 1973!

* *B. rigidus* Roth: Mediterranean, widespread. 1972 TBR, det. CEH.

* *B. scoparius* L.: Mediterranean. 1960 MMcCW (**K**), det. A. Melderis.

* *B. sterilis* L.: Europe and S.W. Asia, widespread. 1973!

* *B. tectorum* L.: Europe, widely introduced elsewhere (e.g. U.S.A.) 1961. ABMB.

TRIBE *TRITICEAE* (*HORDEAE*)

AEGILOPS L.

A. triuncialis L.: Mediterranean and Asia, introduced U.S.A. 1970 TBR (**K**), det. CEH.

[1]*Bromus japonicus* should probably be deleted from the interim list (Ryves 1974), as most of the specimens are referable to *B. arenarius* (or *B. pectinatus*), which may however be identical with *B. japonicus* var. *velutinus* Aschers. & Graebn. and *B. patulus* Mert. & Koch var. *pectinatus* (Thunb.) Stapf, described by Chippindall (1955) from S. Africa. "The whole complex requires study by a monographer" (C. E. Hubbard in litt. to E. J. Clement).

AGROPYRON Gaertn. (*ELYMUS* L.)

A. smithii Rydb.: N. America. 1973 G. Hanson!

ELYMUS L.

E. canadensis L.: N. America. JEL (**RNG**) [incorrectly determined as *Taeniatherum caput-medusae* (L.) Nevski], 1972!, det. CEH [Listed as *Elymus* sp. in Ryves (1974)].

HORDEUM L.

H. brachyantherum Nevski: N. America. 1966 MMcCW.

* *H. compressum* Griseb.: S. America. 1966 MMcCW.

* *H. distichon* L. (Two-rowed Barley): Europe, cultivated. Frequent, MMcCW.

* *H. marinum* Huds.: Coasts of W. Europe and Mediterranean, widespread. 1973!

* *H. murinum* L. (Wall Barley): Europe and S.W. Asia. 1966 MMcCW, 1973!

* *H. muticum* Presl.: S. America. 1964 MMcCW (**E**, **RNG**), det. JEL, A. Melderis.

H. procerum Nevski: S. America. 1970, 1971! (**K**, **E**), det. CEH.

H. pusillum Nutt. America (Ryves 1974) [? *H. euclaston* Steud. from S. America].

H. stenostachys Godr.: S. America. 1966 ABMB.

* *H. violaceum* Boiss.: W. Asia. c. 1959 MMcCW, det. CEH.

TRITICUM L.

T. aestivum L. (Wheat): Europe, cultivated cereal. 1961 MMcCW.

TRIBE *FESTUCEAE*

APERA Adanson.

* *A. intermedia* Hack.: Asia Minor. 1961 J. Hodgson (**RNG**), det. CEH.

BRIZA L.

B. humilis Bieb.: S.E. Europe and Asia Minor. 1961 MMcCW, JEL (**K**, **E**, **RNG**), det. CEH.

B. minor L.: Europe and Asia, widely naturalized in warm countries. 1961 MMcCW (**E**), det. CEH.

LOLIUM L.

* *L. loliaceum* (Bory & Chaub.) Hand.-Mazz.: Mediterranean, widely introduced. 1961 MMcCW 1970!, det. CEH.

L. multiflorum Lam. × *L. rigidum* Gaud.: 1960 ABMB (**RNG**), det. E. E. Terrell.

L. temulentum L. × *L. subulatum* Vis.: 1960 MMcCW, det. CEH.

POA L.

P. costiniana Vickery: Australia. 1975! (**K**), det. CEH.

P. labillardieri Steud.: Australia. 1961 JEL, 1971 TBR (**RNG**), det. CEH.

P. ?ligularis Nees: S. America. 1971!

P. nemoralis L.: N. temperate zone. 1973!, det. CEH.

P. poiformis (Labill.) Druce: Australia. 1964 MMcCW (**K**, **E**, **BM**).

VULPIA C. C. Gmel.

* *V. geniculata* (L.) Lenk.: W. Mediterranean. 1962 MMcCW.

V. ?membranacea (L.) Dum.[2]: Mediterranean and W. Europe, introduced Australia, 1970!, det. CEH [variant of *V. myuros* (L.) Gmel., det. C. A. Stace].

V. ?octoflora (Wilt.) Rydb.: U.S.A. and S. America. 1970!, det. CEH. [Determination doubtful according to C. A. Stace].

V. broteri Boiss. & Reut.: S.E. Europe. JEL (**RNG**), det. C. A. Stace.

TRIBE *MELICEAE*

MELICA L.

M. violacea Cav.: S. America. 1966 JEL (**K**, **RNG**).

TRIBE *GLYCERIEAE*

GLYCERIA R. Br.

G. declinata Breb.: Europe, introduced elsewhere. 1974!, det. CEH.

G. fluitans (L.) R.Br.: Europe and N.E. America. 1973! ABMB, det. CEH.

[2]*Vulpia ambigua* (Le Gall) More (Ryves 1974) and *V. membranacea* were determined on the basis of the relative lengths of the glumes and lemmas. C. A. Stace (in litt.), who is currently revising the genus, considers that the specimens are extreme variants of *V. myuros*.

TRIBE *AVENEAE*

AIRA L.

* *A. caryophyllea* L.: Europe. 1969 MMcCW (**E**).

* *A. elegans* Willd.: S. Europe. 1966 ABMB (**RNG**).

AVENA L.

A. ludoviciana Dur.: S. Europe. 1961, 1962 MMcCW (**K, E**), det. CEH and N.L. Bor.

* *A. sterilis* L. (Animated Oat): Mediterranean to Afghanistan. 1970!, det. CEH.

KOELERIA Pers.

* *K. phleoides* (Vill.) Pers. (*Lophochloa phleoides* (Vill.) Rchb.): 1961 MMcCW (**K, E**), det. CEH.

TRISETUM Pers.

T. ?spicatum (L.) Richt.: north temperate zone and mountains. 1964 MMcCW, det. J. K. O'Byrne [specimen in **K** is from Galashiels].

TRIBE *PHALARIDEAE*

PHALARIS L.

P. canariensis L. (Canary Grass): S. Europe, cultivated and widely introduced elsewhere. 1961 MMcCW.

TRIBE *AGROSTIDEAE*

AGROSTIS L.

* *A. aemula* R. Br.: Australia. 1970!, det. CEH.

A. castellana Boiss. & Reuter: Mediterranean, widespread. 1973!, det. CEH.

A. preissii (Nees) Vickery: Australia. 1966 J. L. Mason (**K**).

A. scabra Willd.: N. America and N.E. Asia, widespread. 1967–1975 MMcCW, JEL! (**E, RNG**). [Established on railway at Bordon].

* *A. semiverticillata* (Forskål) C. Christ.: Mediterranean and N.E. Africa, widespread. 1973 MMcCW, ABMB! (**E**).

A. stolonifera L. × *A. tenuis* Sibth.: 1972 TBR, det. CEH.

GASTRIDIUM Beauv.

* *G. phleoides* (Nees & Mey.) C. E. Hubbard: Mediterranean, introduced into warm temperate regions. 1960, 1964 MMcCW, 1974! (**K, E, RNG**), det. CEH.

[*G. ventricosum* (Gouan) Schinz & Thell. was recorded in error].

PHLEUM L.

P. bertolonii DC.: Europe. 1964, 1966 MMcCW.

* *P. pratense* L.: Europe and Asia, widely introduced. Frequent!

TRIBE *STIPEAE*

ECHINOPOGON Beauv. 7 species, Australia and New Zealand. Spikelets 1-flowered in a dense, bristly, spike-like panicle; lemmas 2-lobed, long awned, bearded at the base.

E. ovatus (Forst. f.) Beauv.: Australia and New Zealand. 1966 MMcCW (**K, E, RNG**), det. JEL.

ORYZOPSIS Michx. 50 species, N. temperate and sub-tropical zones. Spikelets 1-flowered; lemmas becoming hard and terete, with a short, deciduous awn.

* *O. miliacea* (L.) Aschers. & Schweinf.: S. Europe, widespread. 1964 MMcCW, 1966 JEL (**E, BM, RNG**).

STIPA L.

S. aristiglumis F.v.M.: Australia. 1971–1974! (**K, E, RNG**), det. CEH.

S. blackii C. E. Hubbard: Australia. 1972 TBR (**K**), det. CEH.

S. brachychaetoides Speg.: S. America. 1970–1975! MMcCW (**K, E, RNG**) [incorrectly determined as *S. brachychaeta* Godron in **RNG**], det. CEH.

S. capensis Thunb.: Mediterranean, widely introduced. 1965 JEL (**RNG**).

* *S. hyalina* Nees.: S. America. 1964, 1972 JEL! (**K, RNG**), det. CEH.

S. juergensii Hack.: S. America. 1973! (**K**) det. CEH.

S. nitida Summerh. & C. E. Hubbard: Australia. 1973! (**K**), det. CEH.

S. ?richardsonii Link.: N. America. 1964 JEL (**RNG**).

S. ?scabra Lindl.: Australia. JEL [specimen not found at **RNG**].

S. tenuis Phil.: S. America. TBR 1972 (**K**), det. CEH.

TRIBE *DANTHONIEAE*

DANTHONIA Lam. & DC.

D. ?caespitosa Gaud.: Australia. 1972 JEL (**RNG**).

D. montevidensis Hack. & Arach.: S. America. 1973!, det. CEH.

* *D. penicillata* (Labill.) Beauv.: Australia. 1964 JEL, MMcCW (**E**, **RNG**), det. CEH [very close to *D. racemosa* R. Br.].

D. ?pilosa R. Br.: Australia. 1960 MMcCW (**K**).

* *D. racemosa* R. Br. var. *obtusata* F.v.M.: Australia. Frequent! (**K**), det. CEH.

D. thomsonii Buchanan: Australia. 1965 MMcCW (**K**, **E**), det. CEH.

TRIBE *ARISTIDEAE*

ARISTIDA L.

A. benthamii Henr.: Australia. JEL (**RNG**).

A. congesta Roem. & Schultes: S. Africa. 1964, 1972, 1973! JEL, MMcCW (**K**, **RNG**), det. CEH. [previously recorded as *A. elytroporoides* Chiov., det. N.L. Bor].

A. contorta F.v.M.: Australia. 1964 MMcCW, JEL (**E**, **RNG**), det. CEH [previously recorded as *A. arenaria* Gaud., det. N.L. Bor].

A. ramosa R. Br.: Australia. 1972! (**K**, **E**), det. CEH.

TRIBE *PAPPOPHOREAE*

ENNEAPOGON Desv. ex Beauv.

E. avenaceus (Lindl.) C. E. Hubbard: Australia. 1964 JEL (**RNG**).

E. brachystachyus (Jaub. & Spach) Stapf: Africa. 1972, 1973! JEL, MMcCW (**K**, **E**, **RNG**), det. CEH [*E. desvauxii* Beauv. from America].

SCHMIDTIA Steud. 2 species, Africa. Leaves broad, usually glandular-hairy; panicle contracted, greyish; lemmas hairy, 6-lobed and 5-awned.

* *S. kalahariensis* Stent.: Africa. 1973! MMcCW (**K**, **E**, **RNG**), det. CEH.

TRIBE *ERAGROSTIDEAE*

DIPLACHNE Beauv.

Diplachne sp.: S. Africa. c. 1973 TBR. [Stoloniferous; perhaps a new species according to CEH].

ELEUSINE Gaertn.

E. tristachya (Lam.) Lam.: S. America, widely introduced. [Ryves (1974) gave Tropical Africa as its area of origin].

ERAGROSTIS N. M. Wolf.

E. atherstonei Stapf: E. & S. Africa. 1964 JEL (**RNG**), det. CEH.

* *E. barrelieri* Daveau: Mediterranean, W. Asia and N. Sudan, widespread. 1973! MMcCW (**K**, **E**, **RNG**), det. CEH.

E. bicolor Nees: S. Africa. 1964 MMcCW (**E**), det. J. K. O'Byrne.

E. caesia Stapf: S. Africa. 1964 MMcCW (**E**), det. CEH, S. T. Blake.

E. elongata (Willd.) Jacq.: Australia. 1964 JEL (**RNG**).

E. heteromera Stapf: S. Africa and southern Tropical Africa. 1973, 1976!, det. CEH.

E. kennedyae F. Turner: Australia. 1973! MMcCW (**K**), det. CEH.

E. leptocarpa Benth.: Australia. 1970! (**K**), det. CEH.

E. microcarpa Vickery: Australia. 1964 MMcCW (**E**), det. S. T. Blake.

E. pergracilis S. T. Blake: Australia. 1964 MMcCW (**K**), det. M. Lazarides [near *E. dielsii* Pilg.].

E. pleniculmis Nees: S. Africa. 1971! (**K**), det. CEH.

E. rotifer Rendle: S. & S.W. Africa. 1973 TBR (**K**), det. CEH.

E. schweinfurthii Chiov.: Africa. [*E. articulata* (Schrank) Nees. from S. America 1964 JEL (**RNG**), and *E. racemosa* (Thunb.) Steud. from Africa (Ryves 1974) should probably be included in this species].

E. subulata Nees (*E. curvula* (Schrad.) Nees var. *conferta* Stapf): S. Africa. 1973 ABMB, TBR (**K**), det. CEH.

LEPTOCHLOA Beauv.

* *L. peacockii* (Maiden & Betch.) Domin: Australia. 1959, 1964, 1971! MMcCW (**K**, **E**), det. CEH.

* *L. squarrosa* Pilg.: E. Africa. 1959, 1964 JEL (**RNG**).
L. sp.: 1964 *MMcCW 9372* (**E**).
TRIDENS Roem. & Schultes
T. brasiliensis Nees ex Steud.: S. America. 1973! MMcCW (**K**, **E**), det. CEH.

TRIBE *SPOROBOLEAE*
SPOROBOLUS R. Br.
S. asper (Michx.) Kunth: N. America. 1973! (**K**), det. CEH.
S. creber de Nardi: Australia. 1974! (**K**), det. CEH. [?*S. elongatus* R. Br.].
S. cryptandrus (Torr.) A. Gray: N. America. 1972, 1973, 1975! (**K**), det. CEH [?*S. subinclusus* from S. America].
S. indicus (L.) R. Br.: N. & S. America. 1971, 1972! (**K**), det. CEH.
S. ?engleri Pilg.: S.W. Africa. 1964 JEL (**RNG**).

TRIBE *CHLORIDEAE*
CHLORIS Sw.
* *C. pycnothrix* Trin.: Africa. 1959, 1971! MMcCW (**K**, **RNG**), det. CEH.
CYNODON L.
C. aethiopica Clayton & Harlen: Africa. 1971! (**K**), det. CEH.
* *C. hirsutus* Stent.: S. Africa. 1965, 1966 H. J. M. Bowen (**RNG**) [perhaps a variant of *C. incompletus* Nees].
C. transvaaliensis Burt-Davy: S. Africa. 1975!, det. CEH.
MUNROA Torr. 3 species, N. & S. America. Procumbent, much-branched annuals; spikelets 2–3 in reduced spikes, enclosed in broad sheaths of short leaves.
M. squarrosa (Nutt.) Torr. (False Buffalo-grass): America. 1973! (**K**, **E**), det. CEH.

TRIBE *PANICEAE*
BRACHIARIA Griseb.
B. gilesii (Benth.) Chase: Australia. 1973! (**K**, **E**), det. CEH.
DIGITARIA Heist. ex Fabr.
D. hubbardii Henr.: Queensland. 1973! (**K**, **E**, **RNG**), det. CEH.
D. parviflora (R. Br.) Hughes: Australia. 1973 (**K**, **RNG**), det. CEH [?*D. tenuissima*].
D. ?zeyheri (Nees) Henr.: S. Africa. 1966 MMcCW (**E**, **BM**), det. CEH. [Probably the Australian *D. ammorphila* (F.v.M.) Hughes].
ERIOCHLOA Kunth.
E. fatmensis (Hochst. & Steud.) Clayton (*E. nubica* (Steud.) Hack. & Stapf ex Thell.): Tropical and South Africa. 1975 TBR, JEL (**K**, **RNG**), det. CEH. [The **RNG** specimen has been wrongly determined as *E. pseudoacrotricha* (Stapf) C. E. Hubbard].
* *E. gracilis* (Fourn.) Hitchc.: N. America. 1972 TBR, det. CEH.
PANICUM L.
* *P. capillare* L.: N. America, widely naturalized. 1965.
P. coloratum L.: S. & S.W. Africa. 1972, 1975! (**K**, **E**), det. CEH.
P. dichotomiflorum Michx.: N. America. 1973 TBR (**K**), det. CEH.
P. gilvum Launert: S.W. Africa. 1973–1976! JEL, MMcCW (**K**, **E**, **RNG**), det. CEH.
* *P. laevifolium* Hack.: S. Africa. 1960, 1964, 1973, 1974! MMcCW (**K**, **RNG**), det. CEH.
P. milioides Nees: S. America. 1973 TBR (**K**), det. CEH.
P. prolutum F.v.M. (Coolah Grass): 1973! (**K**), det. CEH.
PASPALUM L.
P. distichon L.: Tropics. 1966 ABMB.
PENNISETUM (L.) Rich.
P. alopecuroides (L.) Spreng.: Asia and Australia, widely cultivated for ornament. 1973! (**K**), det. CEH.
P. sphacelatum (Nees) Durand & Schinz: Africa. 1972, 1973! JEL, MMcCW (**K**, **E**), det. CEH. [Replaces *P. glabrum* Steud., listed in Ryves (1974) on the basis of a specimen lacking a rootstock].

SETARIA Beauv.

S. adherens (Forsk.) Chiov. (*S. verticillata* (L.) Beauv. subsp. *adherens* Forsk.): Africa, warm regions. Probably frequent (**K**), det. CEH.

S. italica (L.) Beauv.: S. Europe, cultivated. 1960 MMcCW. (Bordon railway sidings).

TRICHOLAENA Schrad. 2 species, S. Africa. Tufted perennials, with large, open panicles; spikelets 2-flowered, without awns.

T. monachne (Trin.) Stapf. & C. E. Hubbard: S. Africa. 1964 JEL (**RNG**).

TRIBE *ANDROPOGONEAE*

BOTHRIOCHLOA Kuntze

* *B. ?insculpta* (Hochst.) A. Camus: Africa. 1959 JEL, MMcCW (**RNG**). [Probably an Australian *Bothriochloa*.]

DICANTHIUM Willem

* *D. sericeum* (R. Br.) A. Camus: Australia. 1959, 1964 JEL, MMcCW (**E**, **RNG**), det. CEH.

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Local Floras – a progress report

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ABSTRACT

Information on the latest substantial Flora or checklist, together with details of current work in progress, are given for each vice-county in the British Isles. Priorities for further work are identified.

INTRODUCTION

Since 1950 a great deal has been accomplished in recording the distribution of the British flora. At national level the results of the B.S.B.I.'s Distribution Maps scheme were published in Perring & Walters (1976) and Perring & Sell (1968). There has also been published a succession of checklists and local Floras, many of them taking the Watsonian vice-county as their area of study. At best, these can give considerably more information than is possible within the national *Atlas* format. A recent development has been to combine an *Atlas* format and appropriate supporting text in some local Floras, e.g. for Sussex (Hall 1980) and Kent (Philp 1982).

An earlier paper (Perring 1964) noted some purposes of local Floras and gave advice on points to be considered in their compilation. Perring (1971) listed existing or proposed Floras and noted the location of voucher specimens. The object of the present paper is to update the information previously given on recorders, to list the latest substantial Flora or checklist for each county, to note work in progress which could lead to publication of new or revised Floras and checklists, and to identify the priorities for further work. As well as the summary by vice-county of the existing state of progress (Appendix 1), the paper includes an updated table of priorities (Appendix 2).

The current position for England is that a more or less comprehensive account of the flora has been produced for nearly every county, and that in many cases a modern Flora is available. In Wales the position is not quite so good, but few counties lack a Flora or active work towards producing one. Scotland and Ireland, which have large areas of remote territory and fewer botanists, are less well provided for, and there are still counties for which even a simple checklist is not readily available. The priorities for further work must therefore be to fill in gaps by:

– producing checklists where none exists;
– following these up with more detailed county or local Floras;
– updating previous Floras.

The data for an initial checklist can be compiled by consulting the works listed by Simpson (1960), who included a substantial section indexed by vice-county. There are also the various *Atlas* publications (Perring & Walters 1963; Perring & Sell 1968; Jermy 1978) which indicate distributions on a 10-km square basis throughout the British Isles, but with a varying degree of completeness. For Wales, the vice-comital and 10-km square distribution of each species can be obtained from Ellis (1983). Ireland was completely covered on a vice-county basis by Scannell & Synnott (1987). No such summary of distributions is yet available for Scotland. Later records are to be found in *Watsonia*, *B.S.B.I. News* (adventive species), *Irish Naturalists' Journal, Bulletin of the Irish Biogeographical Society* and *Nature in Wales*.

National databases which contain recent records, as well as older ones culled from earlier publications and herbarium specimens, may also be consulted:

– Biological Records Centre, Monks Wood Experimental Station, Abbots Ripton, Huntingdon, PE17 2LS;
– National Museum of Wales, Botany Department, Cardiff, CF1 3NP;

– Irish Biological Records Centre, An Foras Forbatha, Waterloo Road, Dublin.

Other useful sources of data for local Flora writers are the *Dictionary of British and Irish botanists and horticulturalists* (Desmond 1977) and *British and Irish herbaria* (Kent & Allen 1984).

Hints on how to approach the production of any Flora more elaborate than a checklist are given in Wanstall (1963), but it is worth re-emphasizing certain facts. A local Flora is a work of reference on the distribution of plants in a limited area and it preferably indicates reasons for the observed distribution. Changes in the flora over time may be of interest and examples of typical habitats, together with information on rainfall, geology and other geographical factors affecting distribution may all be worth including. Some history of botanical work and of collectors in the area can add a useful element of local colour. What can be included will depend on the number of copies that are expected to be sold – and at what price – and this in turn will usually be a function of the size and wealth of the local population and holiday visitors. Within the limitations of a given size, the saleability of a Flora will vary depending on how attractively the information in it is presented and whether or not it includes any uniquely valuable data. Illustrations are an additional attraction but may be prohibitively expensive for most local Floras.

More thinly populated areas, remote from cities, may not justify an elaborate Flora, and good examples of appropriate floristic treatments are those for Skye (Murray & Birks 1980) and Pembrokeshire (Davis 1970). However, there are some notable exceptions to this conclusion, where the botanical interest of the area, the drive of the author and the resources available to him or her have combined to make possible a more comprehensive publication. Recent examples of such fuller treatment include the Floras of Mull (Jermy & Crabbe 1978), Connemara and the Burren (Webb & Scannell 1983) and Moray, Nairn and East Inverness (McCallum Webster 1978).

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APPENDIX 1. VICE-COUNTY FLORAS

The list of county Floras which follows indicates the main publications for each county, but does not show whether these are still in print. This information is available from Mrs M. Perring, 24 Glapthorn Road, Oundle, Peterborough, PE8 4JQ, who publishes a regular stocklist.

V.C.	Worker/Recorder	Flora/current work
England and Channel Islands		
S, (JERSEY)	Mrs F. Le Sueur	*Flora of Jersey* (F. Le Sueur 1985).
S, (GUERNSEY AND OTHER CHANNEL ISLANDS)	D. McClintock	*The wild flowers of Guernsey* (D. McClintock 1975).
1b, SCILLY	Mrs R. E. Parslow	*The flora of the Isles of Scilly* (J. E. Lousley 1971).
1, W. CORNWALL	K. Spurgin	*A review of the Cornish flora 1980* (L. J. Margetts & R. W. David 1981).
2, E. CORNWALL	Miss R. J. Murphy	
3, S. DEVON	Miss M. A. Turner	*Flora of Devon* (W. Keble Martin & G. T. Fraser 1939); *Atlas of the Devon flora* (R. B. Ivimey-Cook 1985).
4, N. DEVON	W. H. Tucker	
5, S. SOMERSET	Capt. R. G. B. Roe	*The flora of Somerset* (R. G. B. Roe 1981); a Flora of Avon project is being co-ordinated at Bristol Museum.
6, N. SOMERSET		
7, N. WILTS.	D. E. Green	*The flora of Wiltshire* (J. D. Grose 1957); *Supplement* (L. F. Stearn 1975); N. Mocatta, D. Green and others are collecting data for a new Flora on a tetrad basis.
8, S. WILTS.	Miss A. M. Hutchinson	
9, DORSET	Dr H. J. M. Bowen	*A geographical handbook of the Dorset flora* (R. Good 1948); *A concise Flora of Dorset* (R. Good 1984).
10, WIGHT	B. Shepard	*Flora of the Isle of Wight* (J. Bevis, R. Kettell & B. Shepard 1978).
11, S. HANTS.	R. P. Bowman	*Flora of Hampshire*, 2nd ed. (F. Townsend 1904); Supplement (J. F. Rayner 1929); Lady A. Brewis is co-ordinating work of the Hampshire Flora Committee on a new Flora.
12, N. HANTS.	Lady A. Brewis	
13, W. SUSSEX	Mrs M. Briggs	*Sussex plant Atlas* (P. C. Hall 1980).
14, E. SUSSEX	Mrs L. B. Burt	
15, E. KENT	E. G. Philp	*Atlas of the Kent flora* (E. G. Philp 1982).
16, W. KENT	E. G. Philp	
17, SURREY	Mrs J. E. Smith	*Flora of Surrey* (J. E. Lousley 1976); *Flora of Surrey: Supplement and checklist* (A. C. Leslie 1987).
18, S. ESSEX	Dr K. J. Adams	*Flora of Essex* (S. T. Jermyn 1974).
19, N. ESSEX	Dr K. J. Adams	
20, HERTS.	T. J. James & B. Sawford	*Flora of Hertfordshire* (J. G. Dony 1967).
21, MIDDLESEX	D. H. Kent	*The historical Flora of Middlesex* (D. H. Kent 1975); *Flora of the London area* (R. M. Burton 1983).
22, BERKS.	Dr H. J. M. Bowen	*The flora of Berkshire* (H. J. M. Bowen 1968).
23, OXON	H. J. Killick	*The flora of Oxfordshire* (G. C. Druce, 2nd ed. 1927); Dr S. R. Woodell and others are preparing a new Flora.
24, BUCKS.	R. Maycock	*Flora of Buckinghamshire* (G. C. Druce 1926); work on a new Flora is near completion.
25, E. SUFFOLK	F. W. Simpson &	*Simpson's Flora of Suffolk* (F. W. Simpson 1982); *An ecological Flora of Breckland* (P. J. O. Trist 1979).
26, W. SUFFOLK	Mrs E. M. Hyde	
27, E. NORFOLK	A. Bull	*Flora of Norfolk* (C. P. Petch & E. L. Swann 1968); *Supplement* (E. L. Swann 1975).
28, W. NORFOLK	Dr C. P. Petch	
29, CAMBS.	Mrs G. Crompton	*A Flora of Cambridgeshire* (F. H. Perring *et al.* 1964); *A checklist of the flora of Cambridgeshire* (G. Crompton & H. L. K. Whitehouse 1984); a new Flora is being prepared by G. Crompton, P. H. Oswald, C. D. Preston & H. L. K. Whitehouse.

Appendix 1 continued

V.C.	Worker/Recorder	Flora/current work
30, BEDS.	C. R. Boon	*Flora of Bedfordshire* (J. G. Dony 1953); *Bedfordshire plant Atlas* (J. G. Dony 1976).
31, HUNTS.	Dr T. C. E. Wells	(Checklist) *Flora of Huntingdonshire* (J. L. Gilbert 1965); T. C. E. Wells intends to publish a Flora, and maps have already been prepared.
32, NORTHANTS.	Mrs G. M. Gent	*The flora of Northamptonshire* (G. C. Druce 1930); *Checklist of the vascular plants of Northamptonshire and the Soke of Peterborough* (S. L. M. Karley 1983); Kettering Natural History Society and others are collecting data for a new Flora.
33, E. GLOUCS.	Mrs S. C. Holland	*Flora of Gloucestershire* (H. J. Riddelsdell *et al.* 1948); Supplement (S. C. Holland, H. M. Caddick & D. S. Dudley-Smith 1986); a Flora of Avon project is being co-ordinated at Bristol Museum.
34, W. GLOUCS. (W. of Severn)	Mrs S. C. Holland	
W. GLOUCS. (E. of Severn)	Prof. A. J. Willis	
36, HEREFS.	Mrs S. E. Thomson	*Flora of Hereford* (W. H. Purchas & A. Ley 1889); (Checklist) *Plants of Herefordshire* (L. E. Whitehead 1976).
37, WORCS.	J. J. Day	*The botany of Worcestershire* (J. Amphlett & C. Rea 1909); the previous recorder maintained a list of records that could serve as a basis for an up-to-date checklist.
38, WARKS.	Mrs P. Copson	*A computer-mapped Flora of Warwickshire* (D. A. Cadbury *et al.* 1971).
39, STAFFS.	B. R. Fowler	*Flora of Staffordshire* (E. C. Edees 1972).
40, SALOP	I. C. Trueman	*Ecological Flora of the Shropshire region* (C. A. Sinker *et al.* 1985).
53, S. LINCS.	Mrs I. Weston	*Flora of Lincolnshire* (E. J. Gibbons 1975).
54, N. LINCS.		
55, LEICS.	Rev. A. L. Primavesi	*Flora of Leicestershire and Rutland* (A. R. Horwood & C. W. F. Noel 1933); work on a new Flora is near completion.
55b, RUTLAND	K. G. Messenger	*Flora of Rutland* (K. G. Messenger 1971).
56, NOTTS.	Mrs K. Jefferies & G. P. Walley	*A Flora of Nottinghamshire* (R. C. L. Howitt & B. Howitt 1963).
57, DERBYS.	Mrs A. Lee	*Flora of Derbyshire* (A. R. Clapham 1969); Supplements (K. M. Hollick & S. Patrick 1974, 1980).
58, CHESHIRE	A. Newton	*Flora of Cheshire* (A. Newton 1971).
59, S. LANCS.	Miss V. Gordon	*Travis' Flora of South Lancashire* (J. P. Savidge *et al.* 1963).
60, W. LANCS.	E. F. Greenwood	*Flora of West Lancashire* (J. A. Wheldon & A. Wilson 1907); *Flora of Liverpool district*, 2nd ed. (C. T. Green 1933); (Checklist) *The flowering plants and ferns of north Lancashire* (L. A. & P. D. Livermore 1987); E. F. Greenwood is collecting data for a new Flora.
61, S.E. YORKS.	Miss F. E. Crackles	*Flora of the East Riding* (J. F. Robinson 1902); Supplement (C. A. Cheetham & W. A. Sledge 1942); F. E. Crackles has been collecting data for a new Flora.
62, N.E. YORKS.	T. F. Medd	*Flora of North Yorkshire* (J. G. Baker 1863); Mrs P. Sykes is preparing a Flora of the North York Moors National Park.
65, N.W. YORKS.	T. F. Medd	
63, S.W. YORKS.	Dr J. Hodgson	*Flora of West Yorkshire* (F. A. Lees 1888); D. R. Grant and T. Schofield have been collecting data for a checklist; Sorby Naturalists hope shortly to publish a
64, MID-W. YORKS.	Mrs P. Abbott	

Appendix 1 continued

V.C.	Worker/Recorder	Flora/current work
		Flora of the Sheffield area; the Cleveland Society intend to produce a checklist for Cleveland.
66, CO. DURHAM	Rev. G. G. Graham	*The flora and vegetation of County Durham* (G. G. Graham 1987).
67, S. NORTHUMB.	Prof. G. A. Swan	*A new Flora of Northumberland and Durham* (J. G. Baker & G. R. Tate 1868); G. A. Swan has been collecting data towards a new Flora, on a 5 × 5 km basis, for many years.
68, CHEVIOT	Prof. G. A. Swan	
69, WESTMORLAND	Dr G. Halliday	*The flora of Westmorland* (A. Wilson 1938); (Checklist) *Flowering plants and ferns of Cumbria* (G. Halliday 1978); work is well advanced under G. Halliday towards a new Flora of Cumbria to be published 1988/89.
69b, FURNESS	Dr G. Halliday	
70, CUMBERLAND	Dr D. A. Ratcliffe	*Flora of Cumberland* (W. Hodgson 1898); see also under v.c. 69/69b; current work: see under v.c. 69/69b.
71, MAN	Dr L. S. Garrad	*Flora of the Isle of Man* (D. E. Allen 1986).
Wales		
35, MONS.	T. G. Evans	*The flora of Monmouthshire* (A. E. Wade 1970).
41, GLAM. (West)	Dr Q. O. N. Kay	*The flora of Glamorgan* (A. H. Trow 1911); a new Flora has been prepared and will be published 1987/8.
GLAM. (South)	J. P. Curtis	
42, BRECS.	M. Porter	None published; M. Porter is co-ordinating work to produce a Flora.
43, RADS.	Miss A. C. Powell	None published; R. Woods has been collecting records and hopes to produce a checklist.
44, CARMS.	R. D. Pryce	(Checklist) *A list of the flowering plants and ferns of Carmarthenshire* (R. F. May 1967); R. D. Pryce has begun work towards a new Flora.
45, PEMBS.	S. B. Evans	*Plants of Pembrokeshire* (T. A. W. Davis 1970); S. B. Evans is continuing work begun by T. A. W. Davis on a new Flora.
46, CARDS.	A. O. Chater	*The flowering plants and ferns of Cardiganshire* (J. H. Salter 1933); Supplement (J. H. Salter 1952); A. O. Chater is collecting data for a new Flora.
47, MONTS.	Mrs M. Wainwright	Ms Flora by Webb in National Museum of Wales; (Checklist) *Plants of Montgomeryshire* (J. Macnair 1977); work has begun on collecting data for a new Flora.
48, MERIONETH	P. M. Benoit	*A contribution to the flora of Merioneth* (P. M. Benoit & M. Richards 1963).
49, CAERNS.	M. Morris	*Flora of Anglesey and Caernarvonshire* (J. E. Griffith 1895); A. P. Conolly is preparing a Flora of the Lleyn peninsula.
50, DENBS.	Mrs J. A. Green	None published; R. K. Brummitt has been compiling records with a view to preparing a checklist.
51, FLINTS.	G. Wynne	None published; G. Wynne is well advanced with work on a Flora to be published 1987/88.
52, ANGLESEY	R. H. Roberts	*Flowering plants and ferns of Anglesey* (R. H. Roberts 1982).
Scotland		
72, DUMFRIESS.	Mrs M. E. R. Martin	*Flora of Dumfriesshire, including part of the Stewartry of Kirkcudbright* (G. F. Scott-Elliot 1896); *Checklist of the flowering plants, ferns and fern-allies of the vice-counties of Dumfries, Kirkcudbright and Wigtown* (H. Milne-Redhead 1972); (Checklist) *Wild plants of Dumfriesshire (v.-c. 72, Dumfries)*

Appendix 1 continued

V.C.	Worker/Recorder	Flora/current work
		(M. E. R. Martin, *Trans. J. Proc. Dumfriess. Galloway nat. Hist. antiq. Soc.*, 3rd ser., **60**: 21–42, 1985).
73, KIRKCUDBRIGHTS.	Mrs O. M. Stewart	Floras: see under v.c. 72; O. M. Stewart has been collecting data for some years with a view to producing an expanded checklist.
74, WIGTOWNS.	Dr A. J. Silverside	Floras: see under v.c. 72; A. J. Silverside is collecting data for a Flora.
75, AYRS.	A. McG. Stirling	*The botany of Ayrshire* (J. Smith 1896); see also under v.c. 76.
76, RENFREWS.	Miss E. R. T. Conacher	*The flora of the Clyde area* (J. R. Lee 1933) covers all of v.cc. 75, 76 & 77, and parts of v.cc. 86, 99 & 100; Supplement (J. R. Lee 1953); B. W. Ribbons, with E. R. T. Conacher and Miss Calver, has been collecting data for over 20 years and hopes to produce a checklist.
77, LANARKS.	Dr P. Macpherson	Floras: see under v.c. 76; work is in progress towards a Flora of the Glasgow area.
78, PEEBLESS.	D. J. McCosh	A short account, with species list, by F. R. S. Balfour in *History of Peeblesshire* (J. W. Buchan 1925); D. J. McCosh is well advanced on a brief account of the flora to be published in 1988/9.
79, SELKIRKS.	Dr R. W. M. Corner	(Checklist) *Flowering plants and ferns of Selkirkshire and Roxburghshire* (R. W. M. Corner 1985).
80, ROXBURGHS.	Dr R. W. M. Corner	Floras: see under v.cc. 79 and 81.
81, BERWICKS.	M. E. Braithwaite	*Flora of Berwick-upon-Tweed* (G. Johnson 1829/31); *Natural History of the eastern Borders* (G. Johnson 1853) covers v.cc. 80 & 81 in part; full records of some 20 species are to be published by the Berwickshire Naturalists; M. E. Braithwaite is co-ordinating further fieldwork on locally scarce species.
82, E. LOTHIAN	Miss E. H. Jackson	*Field Club Flora of the Lothians*, 2nd ed. (I. H.
83, MIDLOTHIAN	D. R. McKean	Martin 1935); The Botanical Society of Edinburgh
84, W. LOTHIAN	Miss J. Muscott	has begun fieldwork on a new Flora.
85, FIFE	G. H. Ballantyne	*List of flowering plants and ferns from Fife and Kinross* (W. Young 1936); (Checklist) *Wild flowers of Kinross*, 2nd ed. (G. H. Ballantyne 1985); G. H. Ballantyne is collecting data for a new Flora of Fife.
86, STIRLINGS.	D. Bayne	Floras: see under v.c. 76.
87, W. PERTH	N. F. Stewart & Miss H. E. Stace	*Flora of Perthshire* (F. Buchanan White 1898); the recorders have recently begun to gather information
88, MID PERTH	Dr R. E. Thomas	towards a new account of the Flora of Perthshire.
89, E. PERTH	Dr R. A. H. Smith	
90, ANGUS	A. B. Ritchie	*Flora of Angus* (R. Ingram & H. J. Noltie 1981).
91, KINCARDINES.	Mr & Mrs E. Birse	*The botanist's guide to the counties of Aberdeen, Banff and Kincardine* (G. Dickie 1860); A. H. Somerville has been collecting data for a checklist.
92, S. ABERDEEN	P. Marren & Mrs U. Urquhart	Flora: see under v.c. 91.
93, N. ABERDEEN	Dr D. Welch	*Flora of Buchan* (J. W. H. Trail 1904); D. Welch is collecting data for a modest Flora.
94, BANFFS.	J. Edelsten	Flora: see under v.c. 91; the late Miss M. McCallum Webster had begun to gather data for a checklist.
95, MORAY	Dr N. M. Pritchard	Flora: see under v.c. 96.
96, EASTERNESS	Mrs M. Barron	*Flora of Moray, Nairn and East Inverness* (M.
96b, NAIRNS.		McCallum Webster 1978).
97, WESTERNESS	A. A. Slack	*A map Flora of mainland Inverness-shire* (G. Hadley, ed. 1985).

Appendix 1 continued

V.C.	Worker/Recorder	Flora/current work
98, MAIN ARGYLL	B. H. Thompson	None published; Prof. K. N. G. Macleay had collected data for 30 years with the intention of producing a Flora, but the project is currently at a standstill. The former recorder maintained, and has passed on, a card index which could be the basis of a checklist.
99, DUMBARTON	Miss A. Rutherford	Floras: see under v.c. 76; A. M. Stirling has been collecting data, and hopes to produce a checklist in 1988/89.
100, CLYDE IS.	A. R. Church	Floras: see under v.c. 76; (Checklist) *Arran's flora* (T. Church 1987); A. M. Somerville is preparing an account of the coastal plants of Arran.
101, KINTYRE	A. G. Kenneth	*Flora of Kintyre* (M. H. Cunningham & A. G. Kenneth 1979).
102, S. EBUDES	Dr E. Bignall	No comprehensive account, but some local Floras: *Flora of Islay and Jura* (J. K. Morton 1959); *Flora of Colonsay* (M. McNeill 1910); *Flora of Easdale and the Garvellachs* (C. W. Muirhead 1962); checklist in *Flora and vegetation of the Inner Hebrides* (A. Currie & C. W. Murray 1983).
103, MID EBUDES	Mrs J. W. Clark	*Island of Mull and adjoining small islands* (A. C. Jermy & J. A. Crabbe 1978); *Flora of the Isles of Coll, Tiree and Gunna* (J. W. Heslop-Harrison 1941).
104, N. EBUDES	Mrs C. W. Murray	*The botanist in Skye*, 2nd ed. (C. W. Murray & H. J. B. Birks 1980); *Checklist of the plants of Rhum* (W. J. Eggeling 1965).
105, W. ROSS	Prof. D. M. Henderson	*Flora of West Ross* (G. C. Druce 1929); D. M. Henderson has been collecting data for a checklist.
106, E. ROSS	P. S. Lusby	*Flora of East Ross-shire* (U. K. Duncan 1980).
107, E. SUTHERLAND	J. K. Butler	*John Anthony's Flora of Sutherland* (J. B. Kenworthy 1976).
108, W. SUTHERLAND	Dr J. Rodgers	
109, CAITHNESS	Vacant	*Flora of Caithness* – (Checklist) *Wildflowers of Caithness* (E. R. Bullard *et al.* 1977).
110, OUTER HEBRIDES	A. Currie	*Vegetation of the Outer Hebrides* (A. Currie in *Proc. R. Soc. Edinb. B*, **77**, 1979) and various other limited accounts; The British Museum (Natural History) intends to collate existing published information and combine this with herbarium records and some fieldwork into a single account.
111, ORKNEY	Miss E. R. Bullard	*Flora Orcadensis* (and *Addenda*) (M. Spence 1914); (Checklist) E. R. Bullard in *The Natural History of Orkney* (R. J. Berry 1985).
112, SHETLAND	W. Scott	*The flowering plants and ferns of the Shetland Isles* (R. C. Palmer & W. Scott 1988).
Ireland		
H1, S. KERRY	Dr C. Mhic Daeid	*Flora of County Kerry* (R. W. Scully 1916); P. Wyse Jackson is gathering information for a supplement, and hopes eventually to produce a new Flora.
H2, N. KERRY	Dr P. Wyse Jackson	
H3, W. CORK	Miss M. J. P. Scannell	*The flowering plants and ferns of the County Cork.* (T. Allin 1883); since 1950, contributions to the knowledge of the flora have been published in *Irish Naturalists Journal*, *Bulletin of the Irish biogeographical Society* and *Watsonia.*
H4, MID CORK	& T. O'Mahony	
H5, E. CORK		
H6, CO. WATERFORD	Dr I. K. Ferguson	I. K. Ferguson has been collecting data on cards as the basis of a proposed checklist.
H7, S. TIPPERARY	Miss E. Ni Lamhna	None published.

Appendix 1 continued

V.C.	Worker/Recorder	Flora/current work
H8, CO. LIMERICK	Mrs S. Reynolds	None published.
H9, CO. CLARE	P. Jackson	Northern part covered by *Flora of Connemara and the Burren* (D. A. Webb & M. J. P. Scannell 1983).
H10, N. TIPPERARY	G. Sharkey & J. Shackleton	None published.
H11, CO. KILKENNY	R. N. Goodwillie	None published; R. N. Goodwillie has begun to collect data towards a checklist.
H12, CO. WEXFORD	P. Carvill	None published; P. Carvill is collecting data for a Flora.
H13, CO. CARLOW	Miss E. Nic Lughada	*The flora of County Carlow* (E. M. Booth 1979).
H14, LAOIS	Dr P. J. Foss	None published.
H15, S.E. GALWAY	Dr M. Sheehy-Skeffington	Partly covered by *Flora of Connemara and the Burren*: see v.c. H16.
H16, W. GALWAY	Dr E. N. Kirby & Dr C. Roden	*Flora of Connemara and the Burren* (D. A. Webb & M. J. P. Scannell 1983).
H17, N.E. GALWAY	Dr M. Sheehy-Skeffington	Partly covered by *Flora of Connemara and the Burren*: see v.c. H16.
H18, OFFALY	Dr J. G. D. Lamb	None published.
H19, CO. KILDARE	D. A. Doogue	D. A. Doogue is gathering data for a checklist to be published 1989/90.
H20, CO. WICKLOW	Dr T. G. F. Curtis	*Flora of County Wicklow* (J. P. Brunker 1951); T. G. F. Curtis is collecting data with a view to updating Brunker's Flora.
H21, CO. DUBLIN	Dr H. Hudson	*Flora of the County Dublin* (N. Colgan 1904); *A supplement to Colgan's Flora of the County Dublin* (Dublin Naturalists' Field Club 1961); *The flora of Inner Dublin* (P. Wyse Jackson & M. Sheehy-Skeffington 1984); H. Hudson is overseeing production of a new Flora by the Dublin Naturalists' Field Club to be published 1989/90.
H22, MEATH	C. Breen	None published.
H23, WESTMEATH	C. Breen	None published; C. Breen, M. J. P Scannell and T. G. F. Curtis are collecting data for a Flora.
H24, CO. LONGFORD	Vacant	None published.
H25, CO. ROSCOMMON	J. Earley	None published.
H26, E. MAYO	D. M. Synnott	*An outline of the flora of Mayo* (D. M. Synnott,
H27, W. MAYO	D. M. Synnott	*Glasra*, **9**: 13–117, 1986).
H28, CO. SLIGO	Dr J. A. N. Parnell	None published; J. A. N. Parnell has begun to collect data for a checklist.
H29, CO. LEITRIM	Dr D. L. Kelly & H. N. McGough	D. L. Kelly has begun to collect data for a checklist.
H30, CO. CAVAN	P. Reilly	None published.
H31, CO. LOUTH	D. M. Synnott	(Checklist) *Wildflowers of Co. Louth* (D. Synnott 1970); D. M. Synnott is collecting data for a Flora.
H32, CO. MONAGHAN	D. M. Synnott	None published.
H33, FERMANAGH	Dr R. S. Forbes	Ms. account by R. D. Meikle *et al.*, c. 1960; the recorders for vcc. 33, 36 and 37 have combined with R. S. Faulkner to collect information for a Flora of the three vice-counties.
H34, E. DONEGAL	Dr T. G. F. Curtis	*The flora of Donegal* (H. C. Hart 1898).
H35, W. DONEGAL	Dr T. G. F. Curtis	
H36, TYRONE	Miss D. S. Lambert	Ms. at Queen's University, Belfast; current work: see under v.c. 33.
H37, CO. ARMAGH	Miss N. Dawson	A preliminary report on the survey of the Co. Armagh Flora, 1965–67; current work: see under v.c. 33.

Appendix 1 continued

V.C.	Worker/Recorder	Flora/current work
H38, CO. DOWN H39, CO. ANTRIM H40, CO. LONDONDERRY	P. Hackney S. Beesley Miss D. S. Lambert	*Flora of the north-east of Ireland*, 2nd ed. (R. Ll. Praeger & W. R. Megaw 1938); the Belfast Naturalists' Field Club is collecting records towards a 3rd edition.

APPENDIX 2

PRIORITIES FOR WORK ON LOCAL (COUNTY) FLORAS

Vice-counties have been placed into five arbitrary categories as follows:
1. No flora has ever been published.
2. The flora is incomplete, lacks localities/some species or was published before 1850.
3. The last flora or supplement was published between 1850 and 1899.
4. The last flora or supplement was published between 1900 and 1949.
5. The last flora or supplement was published after 1950.

Counties where active work is in progress towards a new flora or checklist are shown in bold type; * denotes a checklist; ** denotes a modest flora.

1. **42**, 43, **50**, **51**, 98; H6, 7, 8, 10, **11**, **12**, 14, 18, 19, 22, **23**, 24, 25, **28**, **29**, 30, 32, **33**, **36**
2. 75, **76**, 77, **78**, 81, 86**, 91**, 92**, 94**, **99**; H25, **28**, **29**, **37**
3. 49, 62, 63–65, **67**, **68**, **87–89**, **110**; H3–5, 34, 35
4. **11**, **12**, **23**, **24**, **33**, 37, **41**, 50*, **51***, **55**, **60**, **61**, **69**, **82–4**, 93, 102, 105; **H1**, **2**, 9, 15, 17, **38–40**
5. S (Jersey), S (Guernsey), 1b, 1–10, 13–22, 25–30, 31*, **32***, 34, 35, 36*, 38, 39, 40, **44***, **45****, **46**, **47***, 48**, 52–4, 55b, 56–9, 66, **69–70***, 71*, 72*, **73***, **74***, 79*, 80*, **85**, 90, 95–7, 100*, 101, 103, 104**, 106–8, 109*, 111*, 112; H13, 16, **20**, 21, 26**, 27**, **31***

Short Notes

CARDAMINE IMPATIENS L.: A NATIVE SCOTTISH LOCALITY

During a visit in January 1986 to a remote deciduous woodland by the Slitrig Water to the south of Hawick in Roxburghs., v.c. 80, I saw a number of green rosettes which were unfamiliar to me. They appeared to belong to a crucifer but the leaflets were too divided for *Cardamine hirsuta* L. or *C. flexuosa* With. The illustrated Floras I possessed did not feature the basal rosettes of *C. impatiens* L. However Ellis & Jones (1969) provided the answer with excellent illustrations of the basal leaves of all three species and there was little doubt that the rosettes were those of *C. impatiens*. Their identity was confirmed when the wood was revisited in June with J. Grant Roger when *C. impatiens* was in flower.

This old woodland lies on the steep south-facing side of a valley at an altitude of 215–230 m and covers an area of about 3 ha. The soil is derived from the underlying and mainly basic Silurian rock which outcrops in places and which has been quarried on a small scale many years ago to form small areas of scree. *Cardamine impatiens* is found exclusively on and around these screes, there being several hundreds of plants. *Fraxinus* and *Ulmus* predominate with several of the latter suffering from Dutch Elm disease. *Quercus*, *Betula* and *Corylus* are less common with *Crataegus*, *Prunus spinosa*, *Salix caprea* and *Sorbus aucuparia* also occurring. *Lobaria pulmonaria*, a very local foliose lichen, occurs on *Fraxinus* and *Ulmus*. It is a species indicative of old forest continuity and demonstrates the ancient origins of this woodland. Cattle and sheep have free access and the effects of grazing and trampling are much in evidence with bare soil exposed and several of the *Cardamine* plants uprooted or heavily browsed. *Pteridium aquilinum* is common at the edges of the wood with *Dryopteris filix-mas* conspicuous where there is more shade. *Brachypodium sylvaticum* and *Mercurialis perennis* are locally dominant and there is an extensive and impressive colony of *Origanum vulgare*. Other woodland species present are *Agropyron caninum*, *Circaea lutetiana*, *Epilobium montanum*, *Geranium robertianum*, *Geum urbanum*, *Hypericum hirsutum*, *Moehringia trinerva*, *Myosotis sylvatica*, *Potentilla sterilis*, *Primula vulgaris*, *Ranunculus ficaria*, *Stellaria holostea*, *Stachys sylvatica*, *Teucrium scorodonia*, *Veronica chamaedrys*, *Vicia sepium* and *Viola riviniana*. *Hyacinthoides non-scripta* is absent. It is of interest that a further seven plants of *C. impatiens* were seen rooted in the mossy base of an old *Ulmus* tree in woodland 1·5 km to the north in the same valley. Other local rarities nearby included *Euonymus europaeus*, *Vicia sylvatica* and *Viola hirta* growing on a steep scar above the river. Tansley (1939) quoted E. Price Evans' description of an upland wood of *Fraxinus* on basic igneous rock in Merioneth, Wales, in which *C. impatiens* occurs. There are many similarities between this and the Roxburghshire woodland with two-thirds of the flowering plants common to both. Not surprisingly the western element of the flora is lacking from the latter.

The status of *C. impatiens* in Scotland is confusing. The uncertainty of some of the old records and its occurrence as a casual are responsible for this. The single post- 1930 record for Scotland is from Angus, v.c. 90 (Perring & Walters 1976), where according to Ingram & Noltie (1981) it is doubtfully native. The only pre-1930 record lies in Dumfriesshire, v.c. 72 (Perring & Walters 1976), and it is relevant that Druce (1932) stated that it is "absent from Scotland save Dumfries". He also comments that *C. flexuosa* is often mistaken for it. He presumably took his source as Scott-Elliot (1896) but it is doubtful whether the plants were correctly named and there are no specimens in **E**. I have been unsuccessful in refinding this species in two of the named localities in v.c. 72 and Mrs M. Martin (pers. comm.) has seen neither past nor present material. Hooker (1821) gave "rocks on the banks of the river above the falls of Clyde" on Hopkirk's authority and quoted Lightfoot for "foot of mountains and in shady places but rare". Hooker & Arnott (1855) gave "near the falls of Clyde and banks of Doune, Scotland". Babington (1881) put a query against Scotland and Watson (1883) put a query against Ayrs., v.c. 75, as the sole Scottish vice-county. Hooker (1884) omitted Scotland as did Bentham & Hooker (1924). Clapham (1962) gave Angus as the only Scottish vice county. There are, however, specimens in **E** from Mouse Water in Lanarks., v.c. 77, dated 1883 and from Lanark in 1901 collected by Craig-Christie. It is not known whether the former collection was from an old woodland site but this species has not been seen in v.c. 77 since then (P. Macpherson pers. comm.). Its occurrence in Scotland as a casual is further supported by specimens in **E** from Edinburgh in 1841 and from Methven in Perthshire in 1965. There is also a specimen from Roxburghshire (Ormiston near Kelso) collected in 1876 in **BM**. There is no Scottish material in **K** and I have been unable to examine other herbaria.

It is relevant that *C. impatiens* has recently been discovered in a base-rich wood in Ireland where its native status has now been put beyond doubt (Breen, Curtis & Scannell 1984). This Roxburghshire discovery has now made its native status in Scotland secure. I would hope that this woodland could be given sound protection and its conservation carefully assessed.

ACKNOWLEDGMENTS

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PILULARIA GLOBULIFERA L. RECORDED AT HATFIELD CHASE, N. LINCOLNSHIRE

During extensive surveys of the drainage channels of the Hatfield Chase district, N. Lincs., v.c. 54, in the summer of 1986, a new site was discovered for *Pilularia globulifera* L. This short note describes the characteristics of the site in which this species was found.

Pilularia globulifera (Pillwort or Peppergrass), has a sporadic distribution in the British Isles but in recent times the plant has become rare in Europe and is regarded as an endangered species (Perring & Farrell 1977; Jermy *et al*. 1978). *P. globulifera* has been recorded from three sites in N. Lincs. (Gibbons 1975) and is now extinct at two of these sites, one loss at least being due to drainage (Gibbons & Weston 1985). The species has not been recorded from Notts., v.c. 56 (Howitt & Howitt 1963) although there is at least one record for W. Yorkshire (Lees 1888).

In Europe *P. globulifera* is limited in its distribution primarily to countries bordering the Atlantic; it occurs north to the Hebrides, Moray and southern Fennoscandia; to the east it is very rare in northern and western parts of the Soviet Union, northern Poland and the Odra River Basin in Poland, and isolated parts of southern Bohemia (Czechoslovakia). The species is found in the south to Portugal and mid-Italy but is absent from the Alps (Casper & Krausch 1980).

The drainage channel on Hatfield Chase in which the species occurred, the North Idle Drain, was 6 m wide at the water surface and approximately 12 m wide at the bank top. The soil type was a mixture of glaciofluvial drift, deep permeable sand and coarse loamy soils. The water had a maximum depth of 0·75 m, pH 6·3 and 3·8 mhos conductivity. The banks had a complete cover of herbs, grass and some *Rosa* and *Rubus* shrubs. The water surface was completely overgrown by aquatic plants with two dominant species: *Eleogiton fluitans* (L.) Link. and *P. globulifera*. Table 1 summarizes the species composition of three relevés taken from this drain which are representative of the *Pilularietum globuliferae* (Shimwell 1971).

TABLE 1. SPECIES COMPOSITION OF THREE RELEVÉS FROM NORTH IDLE DRAIN TAKEN ON 12TH AUGUST 1986

	Relevé Number[a]		
	1	2	3
Plot area (m^2)	5	2	4
Total cover (%)	100	100	100
Water depth (cm)	30	20	25
Number of species	10	8	9
Pilularia globulifera	3	3	4
Eleogiton fluitans	4	3	4
Agrostis stolonifera	2	1	1
Juncus bulbosus	2	1	2
Juncus articulatus	2	1	1
Equisetum fluviatile	+	1	+
Glyceria fluitans	1	·	1
Typha latifolia	+	+	·
Callitriche stagnalis	1	·	1
Alisma plantago-aquatica	·	+	+
Sparganium erectum	+	·	·

[a]Cover-abundance using Braun-Blanquet scale.

The North Idle Drain receives an annual herbicide treatment. In 1986 this was an application of 1–2 $mg.l^{-1}$ dichlobenil applied as a granule (Casoron GSR) whereas in 1985 terbutryne (0·05–0·10 $mg.l^{-1}$) was used. Both treatments were in the spring. The drain was hand scythed and hand dragged in the autumn.

The chromosome number of the plants collected was 2n=26 (Krahulcova pers. comm.). Herbarium specimens of this collection have been deposited in **UTLH** and the National Museum in Prague, **PR**.

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GENTIANELLA CILIATA (L.) BORKH. IN BUCKINGHAMSHIRE

During the summer of 1982, P. Phillipson discovered a gentian in chalk grassland near Wendover, v.c. 24. This was provisionally identified by G. Atkins as *Gentianella ciliata* (L.) Borkh., and this identification was confirmed by R. Pankhurst at the British Museum (Natural History).

The plants form a flourishing colony covering an area of approximately 10 × 15 m, in a closed community of short turf on a very thin humus over Lower Chalk. In 1982, a maximum of 50 flowering plants was counted, and in 1983 there was a maximum of 43 flowering plants. There is no evidence that the area has ever been cultivated and it is far from human habitation. The area has been lightly grazed by sheep for at least 15 years. Fortunately the landowners are co-operating with the local naturalists' trust, the N.C.C. and the B.S.B.I. in monitoring the population and conserving the site.

Among the associated species were *Festuca ovina*, *F. pratensis* and *Cirsium acaulon* as co-dominants, together with *Filipendula vulgaris*, *Helianthemum nummularium*, *Hippocrepis comosa*, *Koeleria macrantha* and *Polygala vulgaris*, which may prove to be characteristic or constant associates.

The history of this species in Buckinghamshire is a matter of considerable interest. Reference to Druce (1926) discloses the following entry: "*Gentiana ciliata* L. Calathian Violet. Error. On a hill not far from Wendover, Miss Williams in *Journ. Bot.* 295, 1785 (sic) but the specimen is *Campanula glomerata*. See *Journ. Bot.* 44, 1879. There must be some gross carelessness in such a record, as *ciliata* is not likely to occur in England".

The reference in the *Journal of Botany* (Anonymous 1875) (not 1785) cited by Druce reads as follows: "*Gentiana pneumonanthe* in Bucks. This gentian has been collected during the autumn by a lady (Miss M. Williams) on a hill not far from Wendover, Bucks. It is not given for that county in *Topographical Botany*".

Druce's second reference is to Britten (1879), whose note contains the following sentence: "It may be well to note that some error is to be suspected with regard to the Bucks locality for this plant given in 'Journ. Bot.', 1875. p. 295 as the specimen in the British Museum Herbarium, sent by Miss Williams from Wendover, represents *G. ciliata*". It seems that Britten examined Miss Williams' specimen more carefully than Druce because R. Pankhurst has located it in **BM** and it is indeed *Gentianella ciliata*. Miss Williams' name is on the label, and it bears the date September 1875.

The evidence seems to indicate that the present site is that discovered by Miss Williams, and the plants have all the appearance of being native. It is difficult to understand why this colony has since remained undetected for over 100 years, particularly since it is close to the junction of two well-used footpaths, in an area well known to botanists, but the late flowering season (late August to October) (Polunin 1969), and the comparative insignificance of the flowers, probably provide an explanation.

Since the re-discovery of the Wendover site I have traced a further British specimen at **K**. A note on the cover states that the plant is an alien, and the label reads "Coll. A. Patterson, 22 Sept. 1910. Meadow at Swallowfield, Limpsfield, Surrey. Named by W. B. Turrill".

Pritchard & Tutin (1972) give the distribution of the species as "Europe, except the extreme west and most of the islands", and then go on to list Belgium, Holland, Germany and France among the geographical territories in which it occurs. Britain is not included in the list but, having regard to the continental distribution, it is quite possible that the Buckinghamshire and Surrey records relate to a native population in southern England, and I suggest that suitable chalk downland sites should be searched in the autumn for further populations.

ACKNOWLEDGMENTS

I wish to thank R. Maycock for tracing the references in *Journal of Botany*, and for assistance with the list of associated species; R. Pankhurst, of the British Museum (Natural History), and G. Ll. Lucas, of the Royal Botanic Gardens, Kew, for examining their collections; and Joanna Martin, of the N.C.C., for help with population counts and research into the past history of the site.

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COTYLEDON NUMBER IN *CONOPODIUM MAJUS* (GOUAN) LORET

In the autumn of 1984 I set up a field experiment designed to examine the relationship betweer seed size and establishment success in dense vegetation. The species used were a range oi Umbelliferae, including *Conopodium majus* (Gouan) Loret. When *Conopodium* seedlings begar to appear, in March and April 1985, it became immediately obvious that each had only one cotyledon. Seedlings of all the other Umbellifers I had sown had two cotyledons. I wonderec whether this unusual feature of *Conopodium* had been observed previously. I consulted Mülle (1978), which claims to have illustrations of the seedlings of all flowering plants found commonly ir the Netherlands and adjacent regions (including south-eastern England). Unfortunately Müller's book does not include *Conopodium*, but it *does* have a picture of the seedling of the closely relatec *Bunium bulbocastanum*. *Bunium* has only one cotyledon, and I was therefore reassured tha *Conopodium* probably has only one too.

I gave this matter no more thought for over a year, until I came across the entry for *Conopodiun* in Tutin (1980). Tutin stated that *Bunium* has one cotyledon, but that *Conopodium* has two. Thi opinion is shared by *Flora Europaea* (Ball 1968), which also is quite categorical that *Conopodiun* has two cotyledons.

I had by this time begun to consider the possibility that I had been mistaken. My seedlings ha been growing in tall, dense turf, which had made it difficult to get a good look at them. I therefor decided to germinate some seed in the laboratory. Accordingly I collected some fresh *Conopodiur* seed in 1986. My 1984 collection had come from Cotehele woods in Cornwall, this latest one fror Saltram woods on the edge of Plymouth. The seeds germinated well after 6–8 weeks imbibed a 6°C, and all the seedlings had only one cotyledon. It therefore seems that *Conopodium maju* noted by Tutin (1962) as being very similar to *Bunium bulbocastanum*, is even more similar tha previously thought. Certainly my *Conopodium* seedlings are identical to Müller's (1978) drawin of *Bunium*.

One question remains, however. Is the widespread belief that *Conopodium* has two cotyledor simply a mistake, perhaps deriving from wrongly identified seedlings? Or are there actuall populations of *Conopodium* with two cotyledons? Tutin (1980) cited Cerceau-Larrival (1962) a the authority on Umbellifer seedlings. Unfortunately, neither *Conopodium majus* nor *Buniu bulbocastanum* is among the list of 97 Umbellifer seedlings for which she provides detaile descriptions. The origin of the widespread belief that *Conopodium* has two cotyledons is therefo not at all clear.

For the time being however, it seems that *Conopodium* can join the short list (along wi *Bunium*, *Ranunculus ficaria* and some *Corydalis* spp.) of dicotyledons with only one cotyledon

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OCCURRENCE OF *ARMERIA MARITIMA* (MILL.) WILLD. ON AN INLAND ROADSIDE IN NORTH-EASTERN SCOTLAND

The spread of maritime species along the verges of heavily salted roads has been widely reported (Scott & Davison 1982; Scott 1985). For *Armeria maritima* (Mill.) Willd., the sea-pink, just two records are given, one for W. Kent, v.c. 16, the other for a roadside in Oxon, v.c. 23, and Scott (1985) considered that the latter plants could have a garden origin.

In recent summers there has been a colourful display of sea-pinks along the B9002 Lumsden – Cabrach road in Aberdeenshire. *Armeria* grows sparsely on adjacent moorland near outcrops of serpentine, whilst the nearest coast is 40 km away. The occurrence of *Armeria* on serpentine in north-eastern Scotland has long been known (Dickie 1860), and several of the c. 15 10-km square records in the Eastern Highlands (Perring & Walters 1962) are for this rock type.

On 7th June 1986, the verges of the B9002 were carefully checked for sea-pinks. 30 clumps were found on the southern verge on a 100 m section at GR 38/459.247, and a further 50 clumps scattered between GR 38/440.252 and 38/451.251, nearly all on the southern verge. These clumps were well established, many bearing 20–30 inflorescences; younger, smaller, non-flowering clumps would have been missed. Also present was *Cochlearia officinalis*.

The altitude of these sections of road ranges from 330 to 360 m, thus much salting might be expected. But the road bears little traffic, and, with heavy snowfall often experienced, is closed for periods of at least a week in most winters. Therefore it was of interest to find out whether the verges were salt-rich or influenced by serpentine.

Soil in the zone 1–2 m from the carriageway was sampled by augur close to *Armeria* clumps and to a depth of 10 cm. About 50 cores were bulked together for each of the two sections of the Cabrach road. A similar composite sample was obtained from the A92 Banchory – Aberdeen road known to be heavily salted (from Crathes, GR 37/736.963). Another control sample was collected from a serpentine outcrop 200 m from the Cabrach road, at GR 38/442.248 on Peddie's Hill.

The soils were dried and sieved, then exchangeable nutrients were extracted with molar ammonium acetate solution at pH 7. Concentrations of calcium, magnesium and sodium were determined using an atomic absorption spectrophotometer at Robert Gordon's Institute of Technology, Aberdeen. It was found that the roadsides along the B9002 had a much lower sodium content than at Crathes (Table 1), but similar calcium and magnesium concentrations to the Peddie's Hill serpentine soil. Comparable values for soils over serpentine on the Hill of Towanreef, of which Peddie's Hill is part, are given by Proctor & Woodell (1971).

Thus it seems that the influence of serpentine rather than winter salting explains the presence of *Armeria* along the B9002. We can only speculate why the sea-pinks occur there more densely and flower more freely than on the adjacent moorland; perhaps they are favoured by the lack of sheep grazing along the fenced verge, or by mowing.

TABLE 1. SOIL CHARACTERISTICS

Locality	Concentration (mg g^{-1} dry soil)			pH
	sodium	calcium	magnesium	
Peddie's Hill serpentine outcrop	83	1860	2210	6·0
Cabrach roadside (East)	77	532	1970	6·4
Cabrach roadside (West)	70	676	1760	6·8
Crathes roadside	270	511	51	5·3

It will be interesting to see if the present colonies of *Armeria* spread further along the Cabrach roads and extend into non-serpentine soils. Populations growing on soils rich in heavy metals have been considered a separate subspecies (Pinto da Silva 1972), and the Cabrach plants have the small capitula characteristic of subsp. *halleri* (Wallr.) Rothm.

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The soil analysis was carried out as a S.Y.S. project at Banchory Academy by the junior author. We thank Mr G. Mitchell, principal teacher of chemistry, for guidance and Dr A. R. Morisson for allowing the use of the spectrophotometer at R.G.I.T.

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Book Reviews

The ancient woodland of England: the woods of south-east Essex. Oliver Rackham. Pp. 120, with numerous black & white maps, sketches, graphs and halftones. Rochford District Council, Rochford, Essex. 1986. Price £6 (ISBN 0–9511863–0–2).

This splendid detailed account of the history, and natural history, of all the woodland in a particular area should not just be of interest to those of us in Essex familiar with many of the woods described.

Apart from listing the species occurring in each wood (about as far as most of us go), a subjective sketch map of the main tree/shrub communities is provided for each wood, together with a map of physical structure, showing features such as boundary pollards and banks, ponds, pits and earthworks and, as far as is known or can be reasonably inferred, the management history of each segment. Each wood is fitted into its historical context from information gleaned from old estate records, maps, plans and even the 1940 aerial photos taken by the Luftwaffe.

Above all, this book is an example of how one can go about recording and describing (and accounting for) in an easily visually assimilated way the semi-natural plant communities of a given area. It is however essentially a book about the trees and shrubs and woodland history. The more interesting of the ground flora species in each wood are mentioned, but not mapped, and the mosses, liverworts and lichens are dismissed by the comment "very little is known". To Rackham the past is a key to the present. In the case of these groups, however, the information readily available from local bryologists and lichenologists could perhaps have provided a richer key to the past.

What next? One hopes that this is but the first in a series of regional woodland handbooks for eastern England.

K. J. Adams

Flora of Surrey. Checklist and supplement. A. C. Leslie. Pp. 117. A. C. & P. Leslie, Guildford. 1987. Price £4·50 (£5 incl. postage, from Dr A. C. Leslie, Monksilver, 72 Boxgrove Road, Guildford, Surrey, GU1 1UD).

J. E. Lousley's *Flora of Surrey* was published in 1976. The present volume updates that Flora and at the same time provides a most useful checklist of the species, including all the aliens, that have been recorded from the county. The alphabetical checklist format, following the pattern of *A checklist of the flora of Cambridgeshire* by G. Crompton & H. K. L. Whitehouse (1983), makes the supplementary material much easier to assimilate and to use. An unfortunate omission is a map to show both the geographical features of the county and the 10-km grid squares that are listed after species to denote distributions: not everybody knows Surrey as well as the author. However, this aside, Alan Leslie is to be congratulated on his scholarship and the care with which he has assembled his material. Text entries are terse, but packed with small detail: dates, new localities, determinations by experts, references, and comments on taxonomy, distribution and status. Nomenclature is up-to-date, and there is full treatment of some difficult groups such as *Epilobium*, *Hieracium*, *Rosa* and *Rubus*. The thorough coverage of aliens, both naturalized and casual, benefits from the author's extensive knowledge of horticultural taxonomy. Succinct, but by no means severe, this most readable little volume should stimulate more fieldwork and inspire 'Surrey' botanists to provide material for a subsequent supplement that, according to the introductory section, is already in preparation. We have here a firm foundation for any future projects on the flora of a most interesting and varied county, and a model for floristic checklists.

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George William Francis, first Director of the Adelaide Botanic Garden. Barbara J. Best. Pp. xiii + 182, with 1 colour and 33 black & white illustrations and 8 maps. Botanic Gardens of Adelaide, 1986. Price $A 30·00 (or $A 31·35 incl. p. & p. from Mrs B. J. Best, 7 Fernbank Terrace, Stonyfell, S.A.5066, Australia).

The Royal Botanic Gardens, Sydney, A history 1816–1985. Lionel Gilbert. Pp. xiv + 210, with 11 colour plates, 52 black & white illustrations and end-piece maps. Oxford University Press, Melbourne, 1986. Price £23 (ISBN 0–19–554719–5).

Histories of botanic gardens in Australia may seem a long way from the concerns of British field botanists, but these two have a rather special claim on their attention. This is particularly true of Mrs Best's biography of her great-grandfather, G. W. Francis (1800–1865), for he is that same Francis whose *Analysis of the British ferns and their allies* lit the fuse of the great Victorian 'pteridomania' in 1837. In the quarter of a century before his emigration to Australia, in 1849, Francis acquired a considerable standing as a botanist in Britain, twice serving on the Council of the B.S.B.I.'s ancestor, the Botanical Society of London, and applying, albeit unsuccessfully, for the Chair of Botany at King's College London. At first a schoolmaster in Shoreditch and then, briefly, in Boulogne, he appears to have turned to full-time authorship. One of his stunning diversity of books, *A Practical Manual for Levelling Railways and Canals*, points to his having picked up somehow expertise in surveying, and it was to be by that that he was to earn his livelihood during his first years in Australia. Almost immediately on his arrival in Adelaide, however, he had begun lobbying for a publicly-funded botanic garden to be re-established and in 1855 that ambition was not only realized, but he himself was appointed Superintendent (from 1860 Director and Secretary). Far less well-known to posterity than his indifferent successor, Richard Schomburgk, Francis threw himself into the job with the utmost zeal and, with the aid of eight labourers, transformed a swamp into forty acres of horticultural magnificence. Based on extensive archival research in Adelaide and London, with eighteen letters written by Francis to the elder Hooker (eleven of them dealing, most informatively, with the London years) reproduced as an appendix, this is a valuable contribution to botanical history which British librarians should not overlook.

While the Adelaide publication was timed to commemorate the 150th anniversary of South Australia's founding as a colony, the Sydney one celebrates, considerably more lavishly, the 170th birthday of its considerably older Gardens. The British connection there is pre-eminently "the everlasting Charles Moore", younger brother of David Moore of *Cybele Hibernica*. Trained successively at Trinity College, Dublin (under Mackay), Regent's Park and Kew, he was appointed Director in 1847, on the strong recommendation of Lindley, and continued in office for the next forty-seven years. He found the Gardens badly run down and, just like Francis, left them raised to a state of excellence; but, unlike his brother, he was essentially a gardener rather than a botanist and it remained for his successor, Joseph Henry Maiden, to create a scientific establishment which quickly outshone its rival at Melbourne once that had been deprived of the great Baron von Mueller. Maiden was similarly English-trained, but in his case the training had been in London University science, which he had exchanged for its Australian counterpart as a result of poor health. The National Herbarium is the main monument of his further, 28-year Directorship.

Dr Gilbert has the advantage over Mrs Best of being an experienced professional historian and his work has a firmer touch, but both authors have produced very readable accounts, far removed from the ponderous worthiness that has traditionally been the hallmark of the history of institutions.

D. E. Allen

Systematic and taxonomic approaches in palaeobotany. Edited by R. A. Spicer & B. A. Thomas. Pp. 321, with 66 text-figures. Systematics Association Special Volume No. 31. Oxford University Press, Oxford. 1986. Price £40 (ISBN 0–19–857704–4).

This book contains 19 papers presented at an International Symposium held at Goldsmiths' College in 1985, together with a final chapter that presents an overview of the contents. There is plenty of interest to those primarily concerned with living plants, including discussions of the taxonomic problems inherent in dealing with dispersed plant fragments that make the poorest herbarium specimen seem a complete plant. The problems of interpreting fossils are often compounded by differences in their mode of preservation that make comparisons between specimens of different kinds extremely difficult. Nevertheless, several papers document the often surprising detail that can be extracted from fossilized plants.

The perennial question of the origin of angiosperms highlights distinct differences between authors in the ways that they recognize and delimit monophyletic taxa and in their concepts of the processes of evolution. J. A. Doyle & M. J. Donoghue provide an excellent phylogenetic study of the problem, in which cladograms representing different hypothetical relationships between seed plant groups are compared in an experimental way. One interesting finding is that several rather different hypotheses share approximately equal levels of parsimony. This emphasizes the need for critical studies of homologies and of particular fossils. P. R. Crane provides an example of just such a reassessment of the Bennettitales, identified by his earlier phylogenetic studies as a key group in determining the relationships of seed plants and the origins of their reproductive structures. In contrast to these two chapters, that by N. F. Hughes contends that the origin of angiosperms is most likely to be revealed by detailed investigations of mid-Cretaceous dispersed pollen. This assertion is interesting because it is a matter of some controversy whether angiosperm pollen grains possess any unique attribute by which they may accurately be recognized. Doyle & Donoghue do not provide any palynological character unique to the angiosperm clade; and, despite the great, and increasingly well documented, diversity of seed-plant pollen grains from the Cretaceous, this approach is unlikely to provide an explanation of angiosperm phylogeny.

R. A. Spicer discusses the diversity of early angiosperm leaf remains and draws conclusions concerning the evolutionary processes operating during the period of major radiation of the flowering plants. Rather than interpreting the diversity of leaf fossils as indicating the presence of many distinct taxa, he suggests that early angiosperms hybridized freely and showed great plasticity in leaf morphology. Chance long-distance dispersal of their small seeds is invoked as an important mechanism by which angiosperm populations became reproductively isolated. Plasticity in leaf form is described as improving photosynthetic activity, although no literature is cited to support this assertion, and tracing the evolution of plasticity is identified as an important priority. Spicer, like many palaeontologists, apparently views evolution during periods of major radiation as differing, in mode as well as tempo, from that occurring at other times. Perhaps palaeontologists often do differ from neontologists in their conceptual framework. R. J. Burnham, in a chapter on the Ulmoideae, states that palaeobiologists are unique in the biological sciences in their ability to include geologic time as a dimension of working hypotheses. I suspect that many phylogeneticists and biogeographers would consider their hypotheses to include a temporal element. M. E. Collinson's chapter emphasizes the continuity of time between fossil and living plants and suggests that palaeobotanical and neobotanical approaches to taxonomy should have similar principles although they require different systems of nomenclature. Time itself is the subject of P. R. Grant's contribution, which deals with the relationships between time and the continuity of the fossil record. Other contributions deal with further ramifications of the nomenclatural problems and with particular groups of fossil plants.

The volume is generally well edited and attractively presented. It provides interesting and stimulating reading for all botanists and especially those with an interest in plant evolution and diversity. Unlike some symposium volumes this one has a coherent theme which the contributors have addressed directly. In common with most such volumes it is expensive, but it is a worthwhile purchase for the specialist.

S. Blackmore

The botanists: a history of the Botanical Society of the British Isles through a hundred and fifty years. D. E. Allen. Pp. xv + 232. St Paul's Bibliographies, Winchester, 1986. Price £15 (ISBN 0–906795–36–2).

This book reflects the author's impressive knowledge of the history of British botany, his expertise and diligence in research and his ability to synthesize disparate pieces of information into a coherent account of a society that has probably had more than its fair share of crisis and forceful and fractious members. Despite the irreparable loss of the Society's records in 1864 and again in 1941, David Allen has still been able to trace the main sequence of events in its tortuous history with the aid of existing archives, personal correspondence and whatever fragments he could discover in print.

A Lambeth doctor who was a keen botanist and gardener persuaded a number of other amateur enthusiasts to support the creation of the Botanical Society of London in 1836. Unlike the conservative Linnean Society, which refused membership to women until 1904, the Botanical Society of London welcomed their involvement from the start. The first paper presented to the Society on 'The influence of light upon the Common Broad Bean' apparently "excited great interest . . . with the ladies."

It was a society of ambitions outstripping its ability to implement them adequately. A botanical garden was considered, field excursions were organized and specimens were exchanged between members. Provincial secretaries were assiduous in their recruitment of new members. When still only four years old, the Society felt sufficiently confident to publish its *Proceedings*. The *Phytologist* regularly recorded its activities and even published many of the papers presented at its meetings. It seemed to have an assured future when Hewett Cottrell Watson joined it. A well-informed amateur botanist of independent if modest means, a bachelor who positively enjoyed austerity, endowed with abundant energy and forthright to the point of rudeness, Watson was in every sense a formidable person.

It was not long before he was imposing changes and reforms upon its submissive membership. An objective he never lost sight of was his endeavour to make the Society's herbarium a record of "more complete information respecting the local botany of the British Isles . . . calculated to assist those investigations into the laws which determine the geographical distribution of plants". He initiated the practice of publishing short notes on a select number of the plants that were distributed to members. The *London catalogue of plants* which provided an up-dating of scientific names was another of his innovations. By concentrating on the Society's role in the exchange of plants, Watson believed he had provided it with a secure foundation, but portents of its impending dissolution were already apparent. There was a conflict of interest between the clubbable London members and the active collectors, the administration creaked and finances were mismanaged. The end came in November 1856 when the Society was dissolved and its library and herbarium duly auctioned.

Its invaluable service for the exchange of plants was fortunately kept going by John George Baker, President of the Thirsk Natural History Society or the Thirsk Botanical Exchange Club as many preferred to call it. The Club depended upon Baker's commitment and dedication, and when he moved south to take up an appointment at Kew in 1866 the Club, in effect, went with him. A trivial incident provoked Watson's resentment and resignation. A rapid succession of Curators created a climate of instability in the Club's affairs and almost brought it to extinction. Charles Bailey, efficient, reliable and, above all, diplomatic, pulled it out of the morass and served for 24 years, a paragon of a Secretary. Such a person was hard to follow, and in some respects George Claridge Druce was a most unsuitable successor – "inclined to be cocky" was the opinion of one acquaintance. His excessive sensitivity to criticism strained many friendships. But this Oxford shopkeeper was astute, energetic and an outstanding field botanist. During his term of office the membership continued to grow. He designed the Club's crest, choosing for historical reasons but rather incongruously the giant South American waterlily, *Victoria amazonica*. Mellowed by age he was admired – even revered – by many but still feared by a few. Without the support of his dominant personality it is doubtful whether the Club would have survived. But his death in 1932 enabled the Botanical Exchange Club to conduct its affairs in a more democratic manner.

It was another self-taught amateur, J. E. Lousley, successively Treasurer, Secretary, President and Vice-President, who led the Club to its transformation into the Botanical Society of the British Isles in 1947. Like Watson and Druce he was a touchy individual, but like his distinguished predecessors he was an accomplished field botanist who always aspired to the scientific standards of the professional. In 1949 there appeared the first issue of *Watsonia*, commemorating the man who had done so much for the Society and British botany. Five years later it was joined by the twice-yearly *Proceedings*. About the same time the ambitious Distribution Maps Scheme became a reality, culminating in the *Atlas of the British Flora* in 1962. Emboldened by this successful venture, the Society felt confident to flex its muscles. It challenged the proposed new reservoir at

Cow Green in Upper Teesdale, demonstrating to the world that botanists were now prepared to fight for the preservation of the country's threatened flora.

David Allen has related this confused and complicated history without pedantry in a vigorous style, adding here and there deft character sketches and some choice anecdotes. Although still predominantly an association of amateur botanists, there is a leavening of professionals, and this stimulating and harmonious relationship constitutes one of the strengths of a society which shows every promise of being in existence to celebrate in due course its bicentenary.

R. DESMOND

Pollen and spores: form and function. Editors S. Blackmore & I. K. Ferguson. Pp. 443, with 100 pages of black & white photographs and numerous text figures. Linnean Society Symposium Series Number 12, Academic Press, London. 1986. Price £60 (ISBN 0–12–103460–7).

This volume contains the papers presented at a joint Linnean Society and Systematics Association symposium held at the Linnean Society of London and the British Museum (Natural History) on 27th–29th March, 1985. It contains firstly a series of papers concerned with pollen ontogeny, including an interesting comparative account by Hideux & Abadie of the pollen ontogeny of various *Saxifraga* L. (Saxifragaceae) species. Barnes & Blackmore present some unusual 3-dimensional images of developing *Scorzonera hispanica* L. and *Cosmos bipinnatus* Cav. (Compositae) pollen prepared for S.E.M. by a freeze-fracture and cytoplasmic maceration technique. I should however like to see more evidence to support their theory that the final stages of the callose wall may be deposited differentially outside the plasma membrane.

There follows a group of papers concerned with the functional significance of various pollen morphological features. Chaloner presents the interesting hypothesis that features of exine sculpture may function by delaying electrostatic-charge sharing and thus prolong the adherence of pollen to a charged surface to which it is attracted (bee or stigma). There is a comprehensive review of form and function in wind-dispersed pollen by Crane. This is followed by two papers on fossil pollen, one of which is a discussion of Early Cretaceous angiosperm pollen by Walker & Walker, who suggest that the diversity of monocotyledonous pollen found at the base of the Potomac Group indicates an ancient origin of the Monocotyledons. The next two papers are concerned with pteridophyte spores; Tryon presents an interesting S.E.M. survey of spore diversity and function, and Lugardon presents a detailed ultrastructural study of exospores (in French).

The remaining papers are concerned with various aspects of pollen morphology and function, including an interesting review of the structure and function of compound pollen by Knox & McConchie. Kress, writing on exineless pollen structure and pollination systems of tropical *Heliconia* L. (Heliconiaceae), concludes that there is no relationship between pollen wall structure and pollen vector in the Zingiberales, although, as he himself admits, there is very little precise information available on this topic. He then proposes that such a relationship does not occur within the Angiosperms as a whole, a dangerous generalization which is contradicted in this volume by Ferguson, who presents evidence of a correlation between verrucate and supratectal gemmate processes and bat pollination in *Bauhinia* L. (Leguminosae). The area of pollen morphology and pollinator interactions appears to be where more critical studies are needed.

The volume concludes with a series of brief papers based on selected posters exhibited during the meeting on a range of topics including the conjectured function of intine-like components in *Canna* L. (Cannaceae) by Skvarla & Rowley and exine elasticity in *Lavandula dentata* L. (Labiatae) pollen by Suarez-Cervera & Seoane-Camba.

The volume is excellently produced, although this is reflected in the rather high cost. The black & white plates are of very good quality on the whole, although some of the S.E.M.s (for example on page 361) have rather too much contrast. I am sure that taxonomists would agree that palynologists should cite authorities for the genera and species on which they work; not all the authors of the papers in this volume do this. To conclude, this book provides an excellent resumé of modern palynological research.

C. A. FURNESS

Britain's natural heritage: reading our countryside's past. P. Colebourn & R. Gibbons. Pp. 240, with numerous colour and monochrome photographs, and maps. Blandford Press, Poole, Dorset. 1987. Price £14·95 (ISBN 0–7137–1750–5).

This large-format book should be assured of a wide sale solely on account of its stunning colour photographs, which show the British countryside at its best. Botanists will however quickly realize that there is nothing random about the choice of illustrations, which are of distinct, often famous habitats with the emphasis on sites where man has played a dominant role in shaping the plant and animal communities. The readable text interprets our countryside in terms of historical ecology, enabling anyone with a keen eye to begin to unravel their local landscapes in the light of man's influence on the land. We are becoming used to doing this for woodland, where the questions ecologists ask are: "How old is it?" and "What has been the past history of management?", because the answers give them the best clues as to which plants to expect. This book, with chapters on fields and farmscapes, ancient woods and forests, grasslands, heathlands and moorlands, wetlands, and coastlands, extends this approach to cover most habitats. The authors take as their basic premise that everything is older than we think and try to explain why, in general, the more ancient the habitat the richer the wildlife. They possess a detailed knowledge of the often widely scattered ecological literature and are good at turning dry facts into a lively account, as for example in their discussion of the plants of the Burren.

The opening chapter, on the effect of the ice age and subsequent climatic amelioration, is a good summary of current thought on 'refugia' such as Upper Teesdale, Ben Lawers, the Cairngorm Plateau, Cheddar Gorge, Avon Gorge, etc., and includes the new views on the role of Mesolithic man rather than the wet 'Atlantic' period as the cause of early forest decline in the uplands. Increasingly, mesolithic camps are being found at the old tree line and prehistoric fields located under peat deposits. The New Forest and river cliffs along the lower Wye Valley are suggested as holding some of the finest primary woodland in Britain where complex mosaics of stands, each separately adapted to local climate and soil conditions, occur. The 50 pages on woodland summarize a great deal of knowledge, ranging from medieval pasture-woodland to the ancient woods of Scotland. A number of these persisted till the 1715 rebellion, after which forfeited land was purchased by speculators who exploited the woods for shipbuilding and to fuel iron foundries. I was sorry not to see any mention of McVean's work on the role of fire in determining the regeneration of pine.

The grasslands chapter will contain something new for everyone. Particularly useful is the advice, backed up by photographs, on how to develop an eye for old grassland sites, as these, unlike ancient woodlands, cannot often be identified from maps. Five characters are given that can be used from a train, across a valley, in photographs . . . anywhere. There are also sections on water meadows, commons, enclosed meadows, secondary grassland and where downland plants come from. The chapters on wetlands, moorlands and coastlands are equally fascinating, especially in the combined use of photographs and maps to explain the history of sites.

A particularly valuable feature of the book is the way it is studded with thirty 'special studies' or essays, each half a page to two pages long, which outline the historical ecology of selected sites such as Dungeness, Farlington (grazing marsh), Breckland, Martin Down (chalk grassland), Monewden Meadows (primary meadow) and the Lizard Heaths, or cover special topics such as ridge and furrow, indicator plants of ancient woodland, looking at hedges, machair and Lammas Lands.

The book ends with a chapter on protecting and managing the more ancient parts of our countryside; but this is not a book about conservation, it is main-stream popular historical ecology. The photographs, I must stress again, are among the best I have come across. The text is readable, right up to date, and almost free from errors; it encapsulates a great deal of scattered knowledge. This is a book for those who wish to go beyond species identification, who want to understand.

O. L. GILBERT

Guide to the botanical gardens of Britain. Michael Young. Pp. 160, with 49 colour plates, 20 black & white illustrations and 1 map. Collins, London. 1987. Price £12·95 (ISBN 0–00–218213–0).

This book is both a pleasure and a disappointment. It is good to have a survey of the botanic gardens in Britain brought together in one volume, all illustrated with one or more beautiful illustrations, but for me the text did not quite succeed.

As I read the accounts of individual gardens I was reminded of the similar but equally legitimate differences between a plant portrait by a member of the Impressionist Movement and that of a botanical artist, for Michael Young's rather epithet-loaded descriptions (e.g. "sweeping vistas and painterly chiaroscuro perspectives", p. 22), while giving an often vivid impression of a particular garden, frequently failed to provide an adequate account of the scientific significance of that garden's features and activities.

In the author's Introduction, we are given a historical summary of the development of botanic gardens in Britain and an insight into their present-day roles, which sets the scene for the variable length 'chapters' on each garden that follow, alphabetically arranged. The most famous botanic gardens (like Kew and Edinburgh, Oxford and Cambridge) are, of course, included, but the coverage ranges from the Cruickshank Botanic Garden in Aberdeen to the Bedgebury National Pinetum in Kent, and from the 500-acre Westonbirt Arboretum to the half-acre garden at the South London Botanical Institute. It will probably come as a surprise to some that there are so many botanic gardens in Britain (and a number have been excluded because they are said not to be generally open to the public), so I anticipate and hope that a number of readers will be stimulated by Michael Young to visit gardens of which they had previously been completely unaware.

It is a pity that proof-reading was not better. To mention the more outstanding mistakes: *Cyphomandra befacea* (rather than *C. betacea* on p. 110) and *Echium wildfretii* (for *E. wildpretii* on p. 134); "*Clianthus puniceus* kakablak" was a puzzle on p. 94 until it was realized that Kaka's-Beak (or Parrot's-Beak) is the common name for this plant in New Zealand; on p. 22 one correctly reads that the Dawn Redwood was introduced into Britain in 1948, but on p. 73 this is given as 1941, the year of its discovery in China; more seriously perhaps, *Salix rosacea* is said to grow in the garden of the South London Botanical Institute, but there is no such species, and one can only assume that *Saxifraga rosacea* was intended.

However, despite these criticisms and one's disappointment, this is a worth-while publication for it draws attention to and brings together descriptions of nearly all this country's botanic gardens. Together they form an asset of which we may all be proud and, to echo part of the author's final comments in his introduction, "We as the visiting public should cherish these gardens and should encourage their development and their protection".

P. S. Green

Aquatic plants. A guide to recognition. D. Spencer Jones & M. Wade. Pp. 169, with numerous colour photographs. ICI Professional Products, Farnham, Surrey. 1986. Price £7·50 incl. p. & p. (ISBN 0–901747–03–3). Obtainable from Borcombe Printers Ltd., Publications Department, Unit 6, Budds Lane, Romsey, Hampshire SO51 0HA.

This is a pocket-sized guide which aims to make the identification of aquatic plants easier and quicker. The book has four keys – for narrow-leaved emergents, broad-leaved emergents, floating plants and submerged plants. Descriptions then follow of the most common and representative taxa; these are concise and clear, concentrating on key features which help in their determination and avoid confusion with similar plants. Each description is accompanied by a high-quality photograph, a line drawing and a distribution map.

The authors and publisher deserve much credit for producing a visually most attractive guide which is simply laid out, easy to use and fills a much-needed gap. It has no pretentions of being aimed at botanical students or the professional botanist and so was not expected to catch the eye of the majority of B.S.B.I. members. What it will do, however, is encourage many more people to 'boldly go where too few have gone before' and plodge in water and look at the plants therein with much more confidence. A-level students, youngsters beginning an interest in botany, water industry employees and those many tens of thousands of people who casually enjoy pursuits on and near water will find it invaluable. Many B.S.B.I. members may also gain from this colourful 'refresher course'.

N. T. H. Holmes

Plants in danger; what do we know? S. D. Davis, S. J. M. Droop, P. Gregerson, L. Henson, C. J. Leon, J. Lamlein Villa-Lobos, H. Synge & J. Zantovska. Pp. xiv + 461. I.U.C.N., Gland & Cambridge. 1986. Price £15 (ISBN 2–88032–707–5).

The plant data-base of the I.U.C.N. Conservation Monitoring Unit at the Royal Botanic Gardens, Kew contains records on just a little over 34,000 plant taxa, almost 16,000 of which are threatened in terms of the scales used in Red Data books. This volume is a concise summary of that data-base, providing data sources on plants for each country and each island group of the world. The text is arranged as a formal compendium, and the countries are described in alphabetical order. Information is provided under the following headings: area, population, vegetation, checklists and floras, field guides, information on threatened plants, laws protecting plants, voluntary organizations, botanic gardens, useful addresses and additional references.

The title does not convey the value of the contents, as the details on endangered plants occupy about a sixth of the total text. The book has more general qualities and perhaps has most value as a primary reference guide for conservationists, taxonomists and naturalists. It provides a much cheaper alternative to D. G. Frodin's (1984) *Guide to Standard Floras of the World*, which presumably inspired much of the content and layout regarding descriptive floras and checklists. However, the introductory chapters are very informative about the literature on rare, endangered and threatened plants and convey a useful picture of those areas which need the highest priorities for future coverage. The assessment of "Plants in Danger" is extremely useful. Naturally, the best-known areas are Europe, North America, Australia and parts of east Africa, but surprisingly, even the Balkan peninsula, Italy and Scandinavia require a lot more work. Least well-known are the tropics generally and the third world nations particularly; but it is encouraging to note that Red Data books are in preparation for China, India, Egypt and Cuba. Although there is a high degree of subjectivity in the way that conservation status is applied to plants, some of the estimates still present a dismal picture. For example, 669 of the 2,050 threatened species of the United States are Californian endemics; and in the United Kingdom 300 species are identified as rare and endangered, a figure that represents 17·6% of the native flora. One hopes that the book will serve to provide the right kind of ammunition for governments and a practical guide to conservation agencies, because, if the present rate of destruction of native habitats continues, the I.U.C.N./W.W.F. Plant Advisory Group estimate that by 2050 more than 60,000 of the world's species will be extinct and a significantly greater number will be threatened.

C. J. Humphries

Provisional keys to British plant galls. Edited by F. B. Stubbs. Pp. 95, with numerous line drawings. British Plant Gall Society, Leicester Polytechnic. 1986. Price £4·50 (ISBN 0–9511582–0–1).

Galls are defined as "plant tissue in which the cells have been stimulated to increase in size or in number, or in both, by an intrusive living organism". This may be a bacterium, fungus, nematode, mite, or an insect. The study of plant galls has been neglected for a long time in this country, largely because they fall into no-one's camp. The British Plant Gall Society was formed as recently as 1985, and determined to redress this neglect. This book is an important first step towards that end. It was produced in haste because of a serious gap in the available literature. No comprehensive work on British plant galls had been published for over sixty years, and only one broadly representative work; even this has been out of print for some time. This unpretentious little book is intended to bridge that gap.

It claims only to cover ". . . the majority of galls likely to be found on an average day . . .". So far use in the field has been very satisfactory, failures being due mainly to immaturity of specimens. The first step required is identification of the host plant, which should not present too much trouble for B.S.B.I. members. (But be warned; non-botanist gall hunters may present you with some very weird specimens!) Thereafter the galls are arranged by their positions on the host, leading usually to a very short list of candidates. Most galls are then given a very brief description, sometimes with a simple line-drawing as well.

The book is the combined work of members of the Society. It contains a few errors, some as a result of the speed of production, e.g. *Wachtiella* and *Wachtliella* used interchangeably. Such quibbles are a small price to pay for such a useful book.

S. L. M. Karley

Flora of the British Isles. A. R. Clapham, T. G. Tutin & D. M. Moore. Third edition. Pp. xxviii + 688. Cambridge University Press, Cambridge. 1987. Price £65 (ISBN 0–521–30985–9).

Since 1952 Clapham, Tutin & Warburg's *Flora of the British Isles* has been the standard work on the plants of these islands, and its third revised edition, awaited with interest, was published in May 1987, though with a preface dated February 1985.

The format of the last edition was good, that of the new is better, of a larger size (25 × 19 cm), with a revised layout and well printed on high quality paper. Regrettably the book has tawdry plasticized covers quite inadequate for a volume of this importance and cost. The arrangement of the Flora remains the same as that of its predecessors, though it differs from them in utilizing *Flora Europaea* as the basis for its taxonomy and nomenclature. Some descriptions of families, genera and species have been rewritten, together with keys, but many are slight amendments of those given in the second edition. Synonymy is given, but it is meagre and unsatisfactory and often unrelated to names used in previous editions.

Various genera and parts of genera have been revised, including *Erophila* (introducing two unfamiliar names, *E. majuscula* and *E. glabrescens*), *Ulmus* (now down to two species), *Myosotis* and *Mimulus*. The species of *Claytonia* appear under *Montia* though there is good evidence for keeping the two genera apart. In the *Galium palustre* aggregate *G. palustre* and *G. elongatum* are retained at species level, with *G. witheringii* reduced to synonymy under the former. The treatment of *Dactylorhiza* is always problematical, but I find it difficult to accept *D. praetermissa* and *D. purpurella* as subspecies of *D. majalis*, while the absence of *Dactylorchis* synonymy is deplorable. The accidental omission from the Flora (p. 531) of the whole of the text relating to the Zannichelliaceae is lamentable, and as a result families 136 to 150 in the 'Synopsis' (p. xix) are now numbered 135 to 149 in the text.

Species new to Britain since the last edition include *Atriplex praecox, Gentianella ciliata* and *Gagea bohemica*. A non-British species thought at one time to be a member of our flora is *Asplenium cuneifolium* Viv. (not L. as printed on p. 14); this has been confused with a serpentine taxon of *A. adiantum-nigrum* that may be worthy of subspecific status. Two other names that must disappear are *Aphanes microcarpa*, records of which should be referred to *A. inexspectata*, and *Festuca guestfalica*, for British plants so called apparently await a new name. Subspecies are invariably based on geographical distribution or ploidy level, an arrangement mostly used here. There are a number of changes from earlier editions, e.g. *Pinus sylvestris* subsp. *scotica, Caltha palustris* subsp. *minor, Nymphaea alba* subsp. *occidentalis* and *Galium palustre* subsp. *tetraploideum* have 'disappeared', the first reappearing as a variety (correctly 'race') the others going into synonymy. An ineffective use of the rank, first introduced in the second edition, is the arrangement of the *Calystegia sepium* complex as three subspecies (p. 365); all have the chromosome number $2n = 22$, and two of them are of hortal origin and show no marked geographical distribution patterns. Paradoxically *C. sepium* subsp. *roseata*, a pink-flowered plant with a well-defined Atlantic coastal distribution, is disregarded, though it was deemed worthy of inclusion in *Flora Europaea*. Two new subspecific combinations are presented – *Saxifraga rosea* subsp. *hartii* (D. A. Webb) D. A. Webb (p. 252) and, in synonymy, *Galium mollugo* subsp. *album* (Miller) Clapham (p. 429); the absence of basionym information renders both names invalid.

Details of the distribution of British and Irish species are based on information given in the *Atlas of the British Flora* and its *Critical Supplement*, but there are additional important extensions of range including that of *Equisetum × trachyodon*, new to England (Cheshire) in 1978; *Elatine hydropiper*, known from Scotland since the late 1970s; *Polygonum maritimum*, an addition to the Irish flora, and *Eleocharis austriaca*, new to Scotland, both in 1973. In addition *Scleranthus annuus* subsp. *prostratus* is possibly extinct in Norfolk, *Alisma gramineum* is reduced to a solitary station in Worcestershire and *Damasonium alisma* has been extinct in Middlesex for many years.

The treatment of aliens is an improvement on past editions, though there are still too many short descriptions of rarely seen ephemerals that could have been excluded. Likewise the space apportioned to an extensive coverage of the scarce and decreasing *Camelina sativa* aggregate (p. 105) and rare *Xanthium* taxa (pp. 450–451) could possibly have been used more usefully elsewhere. The impermanent *Dicentra spectabilis* is described but the naturalized *D. formosa* is not. *Rapistrum perenne* and *Bunias erucago*, both rare casuals, appear in the same type size as the well-established *Rapistrum rugosum* aggregate and *Bunias orientalis*, which has been naturalized in England for over a century. Well-established and increasing aliens that are missing include *Verbascum chaixii*, *Campanula poscharskyana*, *C. portenschlagiana*, *Lonicera nitida* and *Conyza sumatrensis*. *Matteuccia struthiopteris* is not confined to Ireland but occurs in many parts of England. *Hirschfeldiana incana* is not casual in S. England but is locally established and increasing. *Veronica crista-galli* may be extinct in Sussex but is known to have occurred near Bath, Somerset for over sixty years. *Picris spinulosa* has not been established in W. Kent for some fifty years, if at all, but *Chaenorhinum origanifolium* has been on walls there for over a century. *Lemna miniuscula* is widespread and increasing rapidly in S. and E. England. *Lysichiton americanum* is certainly naturalized in Ireland, but the plant found in England is usually referable to the closely allied *L. camtschatcense*.

The nomenclature used contains too many illegitimate or invalid names, e.g. *Polypodium australe*, *Thlaspi alpestre*, *Arabis stricta*, *Stellaria alsine*, *Spergularia marginata*, *Lathyrus montanus*, *Sparganium minimum*, *Ophrys fuciflora*, *Festuca tenuifolia*, *Ranunculus ficaria* subsp. *bulbifer* and *Calystegia sepium* subsp. *pulchra*, to mention a few.

The book concludes with a glossary, and an index which omits page numbers of least one family (Caprifoliaceae), two genera (*Juncus* and *Typha*), some alien species (e.g. *Ailanthus altissima* and *Dichondra micrantha*) and certain synonyms (e.g. × *Aspleniophyllitis*, *Ceterach* and *Helxine*).

Although there is much that is useful in the Flora it is a disappointment, for it contains omissions and errors, many of which could have been avoided by a study of the botanical literature of the last decade, and at £65 it is overpriced.

D. H. KENT

The correspondence of Charles Darwin, Vol. 2, 1837–1843. Edited by F. Burkhardt & S. Smith. Pp. 603. Cambridge University Press, Cambridge. 1987. Price £30 (ISBN 0–521–25588–0).

This second volume of Charles Darwin's correspondence covers the seven years following his return to England from the *Beagle* voyage, years during which he married his cousin, Emma Wedgewood, and settled at Down House in Kent, where he was to spend the rest of his life. Like the first volume (see my review in *Watsonia,* **16**:204, 1986), this one is again a testament to the enlightened scholarship of the editors and their associates, and to the skill of the publishers.

During the period under consideration Darwin was based in Cambridge (9 pp.), Great Marlborough St., London (138 pp.) and Upper Gower St., London (184 pp.), and Down House (89 pp.). Six appendices, occupying 29 pages, provide translations of letters from foreign correspondents (including a most appreciative analysis of the great Humboldt), a 'Chronology', a delightful 'autobiographical fragment', the much-quoted notes on marriage, questions about the breeding of animals and thoughts on 'the vitality of seeds'. Manuscript alterations and comments (20 pp.), a bibliography (27 pp.), a biographical register and index of correspondents (44 pp.) and an index (54 pp.), following the pattern of the first volume, complete the work.

Whilst I was able to identify with the schoolboy, student and young travelling naturalist revealed in the previous volume, the Darwin emerging here is already on a higher plane than that to which most of us could aspire. He also seemed to move from youth to middle age astonishingly rapidly. His work-load was prodigious; little wonder that he agonized over whether he could spare the time to marry! During these years he wrote and had published his *Journal of Researches* and book on *Coral Reefs*, expended much energy on his contributions to the zoology report of the *Beagle* voyage, wrote papers on the parallel roads of Glenroy, South American geology and numerous other topics; it is scarcely surprising that periodically he wrote that he was 'unwell'. He also filled five of his notebooks on the transmutation of species. His quest for knowledge led, of course, to the bulk of the material provided here. Apart from the purely domestic letters, his correspondence ranges widely over the natural sciences and involves most of the leading lights of the day – De Candolle, Gould, Henslow, Hooker, Humboldt, Lyell, Waterhouse and so on. Not all the letters are to or from Darwin, however. I particularly enjoyed the communication of Lieut. Robert Bastard James, Commander of H.M. Brig *Spey*, to Lyell, concerning the geological and chemical composition of airborne dust collected off the coast of Africa. Not only is the un-Victorian name intriguing, but this letter seems to epitomize the general climate of scientific inquiry within which Darwin was operating.

This is not a book for reviewing, but for dipping into and reading. All readers of *Watsonia* who do so will find instruction, enjoyment and, at times, amusement.

D. M. MOORE

A new key to wild flowers. John Hayward. Pp. viii + 278 with numerous text figures by Michael Hickey. Cambridge University Press, Cambridge. 1987. Price £24·95 (hard covers; ISBN 0–521–24268–1), £8·95 (paperback; ISBN 0–521–28566–6).

This lucid and useful book, with helpful text illustrations, is an excellent alternative to *The wild flower key* by Francis Rose (1981). It differs considerably in layout and owes a sizeable unacknowledged debt to Gaston Bonnier's works on the British flora: *Name this flower* (1917, translated G. S. Boulger) and *British Flora* (1925, translated E. Mellor). The page layout is 'landscaped', that is the lines of text run from the bottom to the top and the book is used on its side.

The instructions are clear (and were successfully followed by my non-botanical 'guinea-pigs'); and provided one does follow them, one will normally end up with a name for a specimen. The keys are arranged in several suites, enabling one to jump forward if the family is known or in some cases even to beyond the genus. The keys all work in the same way: one reads a list of statements in the leftmost column and continues until a true statement is reached, then one moves on to the next column and continues thus until either referred to another key or a name is found for the specimen. Keys for ferns, for non-flowering trees and some other non-flowering plants are included.

It is a very useful crib or resumé of characters for quick identifications, especially if one knows roughly what something is. The text illustrations are very effective in explaining the statements but occasionally it is difficult to see to which bit they refer. The soft-covered edition is ring-bound and opens flat – most useful. There are of course some quibbles; no reference is made to albino flowers, and as "Flowers white" comes as an early statement several times, problems could arise. No mention is made of Britain in the title, but the only real problem is the *price*! Nine pounds for a paperback and £25 for a hardback seem extremely steep to me, especially for what is a beginners' or youngsters' book. One feels the publishers must be relying on library orders. It is, nevertheless, a worthy and useful addition to the list of books for people who need aids such as drawings in order to use keys for identifying plants.

J. M. MULLIN

Wildflowers in danger. John Fisher. Pp. 194, with 11 colour plates, Gollancz, London. 1987. Price £12·95 (ISBN 0–575–03893–4).

This is the ideal botanist's bed-side book – essays of varying length from a couple of paragraphs to several pages on a subject which must excite even the soberest academic – the rare, endangered and often most beautiful of our wildflowers. John Fisher writes well and has the happy knack of using many of his 'subjects' as a starting point for a diversion into conservation issues generally, biographical details of famous botanists, travellers' tales and the kind of incident information which starts you off on the search for more.

It is sad therefore that the accuracy of John Fisher's facts do not match up to the delight of his themes, and this reviewer has been prevented from going to sleep by numerous sudden feelings that 'that can't be true'. Fisher is particularly unreliable on conservation matters. A few examples will suffice – he gives R.S.N.C. membership as 140,000 (actually over 165,000); number of reserves 1,300 (1,700) and the area protected 170 sq kms (470). He tends to panic when he comes to names of organizations and has consequently invented a few which are new to me, e.g. Nature Conservancy Trust, Scottish Naturalists' Trust. He also confuses the organizations' function, suggesting for example that for the Countryside Commission (in England and Wales) "the emphasis has been on conservation rather than access", which might be true of the Nature Conservancy Council but hardly applies to the Commission.

Even within the strictly botanical material one must be careful not to accept every fact as the truth. It was surprising to be told that *Gagea bohemica* has no English name, when the second edition of the B.S.B.I.'s recommended list gives early star-of-Bethlehem. B. Shepard will be bemused to read that there has been no new Flora of the Isle of Wight since Broomfield, whilst Dr Halliday will no doubt be excited or sceptical on the news that white rockrose grows on Humphrey Head; and Robert Lloyd Praeger may reasonably turn in his grave if the information reaches him that H. C. Watson subdivided Ireland into vice-counties. B.S.B.I. referees, too, will not perhaps have realized that they have been appointed to intervene "should disputes arise as to the identity of plants". Presumably we must now all carry whistles as well as lenses!

The species accounts are arranged in mouth-watering chapters: 'Among the rarest'; 'The most beautiful'; 'Aliens among the corn and elsewhere'. The last starts traditionally enough with pheasant's-eye, corncockle and thorow-wax, but the inclusion, at the end of the chapter, of lady orchid, heath lobelia and yellow star-of-Bethlehem is a trifle eccentric. One questions too the species selected to represent 'A hundred endangered plants', which is the running lead for most of the book. Can the inclusion of such relatively widespread or locally abundant species as golden samphire, hoary rock-rose, elecampane, sea pea and marsh helleborines really be justified, when from the 'A's alone *Alisma gramineum*, *Alopecurus aequalis*, *Althaea hirsuta*, *Anthoxanthum puelii* and *Apium repens* are omitted, though they are all 'Endangered' as defined in the second edition of the *British Red Data Book*? Could the selection perhaps have been influenced by the colour photographs taken by the author, most of which are successful in catching the spirit of the subject, though strangely golden samphire (too distant) and sea pea (shocking pink colour) are not good enough.

Perhaps it was unfortunate that this book should be given for review to a member who lives in Oundle and has spent many weeks in the Shropshire region, but with that background I could hardly fail to be startled to be told, incorrectly, that Breidden is pronounced to rhyme with our local poet, Dryden. Have another try then, Mr Fisher. This really applies to the book as a whole. A good read, I hope it goes to a second edition and that this gives the author an opportunity to produce an accurate version. He can start by correcting the statement that *Lychnis viscaria* was first found on Breidden in 1890, whereas it was recorded by Edward Llwyd before 1709 and published in the Third Edition of Ray's *Synopsis* of 1724.

F. H. Perring

Chorology of the flora of Catalan Countries. O. de Bolòs. Introductory volume of 80 pp. and a loose-leaf binder containing 19 transparent overlays and 26 distribution maps, together comprising O.R.C.A.: Noticies i Comentaris, I. Secció de ciències, Institut d'estudis Catalans, Barcelona. 1985. Price not stated. (ISBN 84–7283–069–1).

The introductory booklet to this plant atlas of the Catalan countries has a text in both Catalan and English. In it the author explains that he was inspired to start the work by Hulten's *Atlas över växternas utbredning i Norden* (1950) and the B.S.B.I. *Atlas of the British Flora* (1962). The area covered is the eastern side of the Iberian peninsula, and includes Andorra, the Départment des

Pyrénées Orientales in France and the Balearic Islands. The relief, climate, physiographic zones, soils and vegetation in this region are described, the vegetation in phytosociological terms.

The distribution maps plot records in 10 × 10 km squares of the U.T.M grid, which are therefore compatible with the 50 × 50 km grid squares of *Atlas Florae Europaea*. There are 848 10-km squares in the area covered, which is (to use a traditional unit of area) about 3½ times the size of Wales. A single symbol is used for all records of native or fully naturalized plants, irrespective of date, but additional symbols are used for poorly localized records, records of plants which are not fully naturalized or squares in which the species is probably extinct.

The 26 taxa covered in the first batch of maps are in an apparently random assortment of genera including the trees *Abies alba*, *Alnus glutinosa* and *Taxus baccata*, the mediterranean shrubs *Arbutus unedo* and *Nerium oleander*, and three species of *Asparagus*, five of *Brachypodium* and six *Lavandula* taxa.

This addition to our knowledge of European plant distribution is welcome. It is to be hoped that further maps will be issued rapidly.

C. D. Preston

Med-Checklist, 3. Dicotyledones (Convolvulaceae – Labiatae). W. Greuter, H. M. Burdet & G. Long (eds). Pp. cxxix + 395. Conservatoire et Jardin botaniques de la Ville de Genève & Secrétariat Med-Checklist, Botanischer Garten & Botanisches Museum Berlin-Dahlem. 1986. Price SF 98 (ISBN 2–8277–0153–7; 2–8279–0006–8).

The *Med-Checklist* details the species and subspecies of vascular plants which occur in the circum-Mediterranean countries, citing for each the synonyms from 64 "Basic Floras" which cover the area. Volume 3 is in fact only the second to be published, and it follows its predecessor after a commendably short interval of 2 years. It includes the families from Convolvulaceae to Labiatae in alphabetical sequence, and is thus dominated by the Cruciferae (138 pp.) and Labiatae (118 pp.), which together occupy two-thirds of the systematic section. Volume 2 (Compositae) will be published later.

The format of the *Med-Checklist* has been described by S. L. Jury in his review of Volume 1 (*Watsonia*, **16**: 94–95). If anything the editors have adhered to this format too consistently in Volume 3. I wish they had included widespread, vegetatively reproducing hybrids in the account of *Mentha*. In their absence the treatment of this genus is rather unrealistic.

There are again considerable differences between the *Med-Checklist* and other recent taxonomic treatments, notably that of *Flora Europaea*. Many of these changes affect members of the British flora, the most far-reaching being those which involve the realignment of generic boundaries. *Acinos*, *Calamintha*, *Clinopodium* (and *Micromeria*) are all included in *Satureja*, which is thus swollen to 75 species in the *Flora Europaea* portion of the *Med-Checklist* area alone (*Flora Europaea* recognizes 12). *Cheiranthus* is included in *Erysimum*, *Gentianella* in *Gentiana* and *Lamiastrum* in *Lamium*. There is no space here to discuss the merits of these rearrangements, but at least the broad generic concept the *Med-Checklist* usually adopts has spared us segregates such as *Calathiana*, *Ciminalis* and *Holubogentia* (of *Gentiana*) and *Oreosedum*, *Petrosedum* and *Poenosedum* (of *Sedum*). Taxonomic changes at a lower level include the reduction of *Geranium purpureum* to *G. robertianum* subsp. *purpureum* and of *Erica erigena* to a subspecies of *E. herbacea*, so that its name becomes *E. herbacea* subsp. *occidentalis*. The change from *Thymus praecox* subsp. *arcticus* to *T. praecox* subsp. *britannicus* for the plant known until recently as *T. drucei* is inevitable for nomenclatural reasons, as *britannicus* was the first epithet to be used at subspecific rank. However the resurrection of *Hypericum quadrangulum* from the limbo of *nomina ambigua* to replace *H. tetrapterum* was surely unnecessary: those who think that the name is ambiguous (and they include N. K. B. Robson) can point to the fact that eight of the Basic Floras use it for *H. maculatum*.

Most of these changes will need to be evaluated before they are adopted in British Floras. Whether or not they are accepted, there can be no doubt about the value of the *Med-Checklist*. It has already established itself as a basic work of reference. A checklist, however, is a means to an end, not an end in itself. Only if the *Med-Checklist* inspires botanists to write critical modern floras of the Mediterranean countries, and monographs of their more significant genera, will the efforts devoted to its production have been fully rewarded.

C. D. Preston

Modern aspects of species. Edited by K. Iwatsuki, P. H. Raven & W. J. Bock. Pp. xvii + 240, with numerous text-figures. University of Tokyo Press, Tokyo. 1986. Price unknown.

This unexpected volume represents the proceedings of the *First International Symposium on Biology*, held in Tokyo in November 1985, in connexion with the award to Professor E. J. H. Corner of the *First International Prize for Biology* to celebrate the sixtieth year of reigning of the Emperor of Japan. Although the volume contains papers of varying depth and specialization, a number are of exceptional interest to British botanists and should be much-read and widely cited.

After the opening series of addresses and introductions and a special lecture by the recipient, the real substance of the book is represented by the papers given at an Open Meeting and at separate Botanical and Zoological Meetings. These comprise twelve articles prepared by seven Japanese, two Americans, an Austrian and a Frenchman. Five of these strike me as particularly important.

Two general botanical papers are presented by P. H. Raven, on the biological species concept today, and F. Ehrendorfer, on modern studies of chromosome evolution. Raven re-examines the relationship of biosystematics (especially the extent of gene-flow in the wild) and classification and finds little correlation between them; the biological species concept is therefore rejected, in line with his earlier papers on this subject. Ehrendorfer covers the whole field of chromosome data as applied to taxonomy and evolution, with special reference to karyotypes (especially banding patterns), DNA-values, chiasma frequency and *in situ* hybridization with cloned DNA; his paper is worth studying for many reasons, not least the impressive Figure 8 on p. 74, showing three sequential treatments of the same mitotic spread.

L. D. Gottlieb discusses speciation in the annual genus *Clarkia*, showing how much modern techniques of isozyme electrophoresis and molecular biology (notably restriction enzyme fragmentation of chloroplast-DNA) can advance our understanding of a group already well worked in the 1950s and 1960s by standard biosystematic methodology. K. Suzuki provides a revealing study of speciation via hybridization at the diploid level in the genus *Epimedium*. This is a most welcome and useful example of a little-understood phenomenon that must actually be common in nature; pollinator preferences seem to be one critical factor. Y. Watano used isozyme electrophoresis to investigate two adjacent populations of *Osmunda lancea*, and was able to demonstrate that one of them probably arose via selfing of a gametophyte that was dispersed as a single spore from the other.

This book demonstrates very well that modern frontier research in plant taxonomy and evolution is very much in the hands of those who have access to the most sophisticated (and expensive) techniques of molecular biology. Regrettably this renders it increasingly remote from amateurs and even from many professionals.

C. A. Stace

Seed identification handbook. R. J. Flood & G. C. Gates. Pp. 72, with 184 colour photographs. National Institute of Agricultural Botany, Cambridge. 1986. Price £7·50 (Obtainable from The Librarian, N.I.A.B., Huntingdon Road, Cambridge, CB3 0LE).

This booklet illustrates seeds and other small propagules (the title using the agricultural concept of a seed) of crops or common impurities. While primarily British in scope, the book includes some frequent contaminants of imported seed.

Though the sequence of taxa appears haphazard, the seeds are ordered mainly by size, which the authors argue is one of the most obvious characters. Gramineae provide the main exception and are grouped at the end. Such an unusual sequence detracts from the utility of the book. For example, fruits of *Anthriscus caucalis* (p. 29) resemble and overlap in size with those of *Torilis* *nodosa* (p. 33), yet they are placed several pages apart. Direct comparison is needed for identification, yet the reader must continually check a large proportion of the book for similar species. A sequence based on shape, surface morphology, or some taxonomic system would be an improvement, as would the addition of keys.

The authors should be congratulated on the generally high and even quality of the illustrations, though this was marred by poor colour registration on some pages of the review copy. Magnifications of ×2 or ×4 used throughout have the advantage of making photographs directly comparable, but smaller seeds lack detail. For example, *Hypericum hirsutum* (p. 7) has a tuberculate testa, mentioned in the text, but the photograph has insufficient resolution to show such detail. A magnification of ×8 or ×10 might provide a solution, as might an additional low-magnification scanning electron micrograph.

Seed material used appears to be in good condition and gives an indication of morphological variation, including propagules both with and without external structures which may become detached. An exception is *Linaria vulgaris* (p. 24), which consists largely of immature or damaged seeds. Most descriptions use general terms, but specialized terminology employed for grasses would be more accessible with an annotated diagram. Colour descriptions are largely superfluous and often at variance with the colour photograph.

The booklet fills a gap in existing seed publications, which are few, often old, out of print, with poor-quality illustrations or of limited application. It will prove useful to anyone regularly involved in seed identification in Britain and, it is hoped, will stimulate more publications of this nature.

D. A. Sutton

The Englishman's Flora. Geoffrey Grigson, foreword by Jane Grigson and introduction by William T. Stearn. Pp. 478, with frontispiece and 44 illustrations. J. M. Dent & Sons Ltd., London. 1987. Price £25 (ISBN 0–460–07007–X).

Admirers of Geoffrey Grigson's *The Englishman's Flora* who have not been able to acquire a copy of the hardbound first (1955) edition have had to manage with poorly bound paperback editions for many years. The first edition is currently offered by booksellers at £50, so this edition, which has the dignity and durability of the first edition and is enriched by a foreword by Grigson's widow and a short introduction by W. T. Stearn, is to be warmly welcomed.

The Englishman's Flora, a rich compilation of plant names and plant-lore, was written at a time when folklore studies were at a low ebb in Britain. Folklore as a discipline had been in decline since the end of the nineteenth century. The small enthusiastic band who had struggled to keep folklore scholarship alive throughout the war years was aged and lacked energy. To a certain extent Grigson's knowledge and use of sources not usually appreciated by folklorists compensates for the sad state of folklore scholarship, but his work inevitably reflects the period in which it was produced. Thus it contains a great deal of rather speculative material which today's folklorists would reject.

None the less, the *Flora* remains a valuable reference work for plant names and is, above all, a stimulating and entertaining read. The articles on individual species give a good impression of the impact that these species have had on human life and thought, and together with the extensive bibliography, to which Stearn provides a supplement, provide a key which unlocks doors to many curious aspects of man's relationship with plants. £25 may seem expensive, but the volume's dignified presentation together with its thought-provoking contents should ensure many hours of pleasant browsing. It is, however, too large and heavy for reading in bed, so the tattered paperback editions will continue to be needed for comfortable bedtime reading.

A. R. Vickery

Obituaries

EDWARD AUGUSTINE ELLIS
(1909–1986)

Ted Ellis, who died on Tuesday, 22nd July 1986, was an outstanding naturalist. He was almost self taught, being very observant. His writings proved his talents beyond any doubt. In recent years there have been few all-round British naturalists with his abilities. One can say that in many ways he can be likened to the 18th century naturalist Gilbert White of Selborne.

He was born in Guernsey, and at a very early age showed great interest in the various creatures of the rock pools. I am happy to have known him for very many years. When he was eleven the family left Guernsey and moved to Gorleston, Norfolk. Very soon Ted met the local naturalists and joined the Great Yarmouth Natural History Society. He became the young disciple of A. H. Patterson, the author of several books on the natural history of East Norfolk. Such was his knowledge and keenness that Dr George Claridge Druce made him a member of the Botanical Society and Exchange Club in 1925 and also paid his subscription.

In 1928 he was appointed Keeper of Natural History at Norwich Castle Museum, a post he held until 1956 when he resigned to become a free-lance naturalist. He had by then moved to Wheatfen Broad, Surlingham, Norfolk, and in ideal surroundings was able to study the life of the Norfolk Broads. This work culminated in 1965 with the publication of his book on 'The Broads', in the New Naturalist Series.

Although an all-round naturalist Ted specialized in the Micro and Rust Fungi, discovering several very rare species and at least one he described as new to science. For his work he was awarded in 1970 an Honorary Doctorate of the University of East Anglia. His services were always in great demand, giving talks, leading field meetings and on radio and television programmes. He had a heavy post bag so he would frequently make a very early start by getting up at 3.30 a.m. to answer the correspondence and also to type his daily 'Countryside' notes for the Eastern Daily Press. This contribution dates from 1946, although in earlier years he used to compile a column of Nature Notes published weekly in that paper. Since 1964 he had been a regular contributor to *The Guardian*'s 'A Country Diary'. A selection of his various contributions, thoughts and poems was published in 1982 as 'Ted Ellis's Countryside Reflections' and illustrated by David Poole.

Many societies, school parties and others visited his reserve and Mrs Ellis would provide a large urn of tea. During the thirty years he lived there the fen carr was not coppiced as he believed it should be left to develop naturally. It was difficult, with his knowledge, to show him anything which he had not already recorded. However on one visit I was able to add a sedge, *Carex binervis*, to his reserve records.

I first met Ted on Sunday, 24th July 1932, at Northfield Wood, Onehouse, Suffolk. He had cycled all the way from Gorleston and was quite exhausted after such a long ride. There was some difficulty for him to get away on Sundays as at that time he used to be singing in the church choir and was said to be 'leading the boys'. My diary for that day records that we saw in Northfield Wood, *Primula elatior*, *Paris quadrifolia* and *Habenaria [Platanthera] chlorantha*. All subsequent meetings with Ted were very rewarding botanically. We would even have our little jokes. One day at Trimley, near Felixstowe, when by the old oyster beds, I said 'look *Bromus*'. Ted looked vainly for a grass. There was no grass really but only an old broom sticking out of the mud!

A very well attended Memorial Service was held at Norwich Cathedral on the 31st October 1986. A Ted Ellis Trust is to be established to preserve Wheatfen, his house and records, so that naturalists may be able to continue to come and enjoy the wild life which meant so much to Ted.

F. W. SIMPSON

EDWARD CHARLES WALLACE
(1909–1986)

Edward Charles Wallace, known as Ted to all his friends, died in Sutton Hospital, Surrey, from kidney failure related to cancer on 23rd July 1986. Ted was born on 12th February 1909 in the Blackfriars area of London. When he was two his parents moved to Sutton, Surrey, and he lived in the same house there until a day or so before his death.

Ted was an only child. He had no family background of botany or natural history. His father was a printer at the time of his birth, and later became a taxi-driver. He had no sympathy with his son's botanical interests, but his mother, though she had no personal interest in natural history, was always sympathetic to Ted's ruling passion for plants. Ted's interest in flowers and pond life seems to have begun when he was about five years old. By the time he was thirteen he was discovered by Anthony Gepp, then Assistant Keeper of Botany at the British Museum (Natural History), trying to name mosses he had collected with the aid of a framed collection in the Botany Department's public gallery. Gepp introduced him to W. R. Sherrin, then Curator of the South London Botanical Institute, who also worked part-time in the B.M. It seems to have been Sherrin – a born teacher – who really set Ted on his way as a botanist.

Ted was educated at Sutton County Grammar School, but had no encouragement there or at home, it seems, to take up botany professionally or to attempt a degree. He certainly would have benefited from such studies; but no doubt money was too short, and at the age of sixteen he joined W. H. Smith and Son, the newsagent and booksellers, with whom he remained until his retirement in 1972, apart from war service in the R.A.F. This gave him an opportunity to do some botanizing in India and Burma, where he was a medical orderly.

During his working life, Ted spent all his weekends botanizing, mostly in the Home Counties, in Hampshire with the late P. M. Hall, and often in the post-war years in Kent with myself or in Surrey and Sussex with the late Ron Boniface and others. His summer holidays in earlier years were spent exploring the Highlands of Scotland, mostly in the company of his great friend Robert Mackechnie of Glasgow.

In later years (the 1960s and after his retirement), however, he travelled more and more abroad, not only in various parts of Europe, but further afield, to Japan, Kashmir, Florida, Alaska, Canada and Australia.

I recall with particular pleasure my own excursions with him. One was to Germany and Austria in 1964, when we studied both the splendid bogs of southern Wurttemberg (with such plants as *Scheuchzeria palustris*, *Liparis loeselii* and *Inula salicina*) and the flora of the western Austrian Alps. Another was to northern French fens and chalk downlands, in 1967; and yet another to the then almost unexplored area of Knoydart in Westerness, where we camped out in a disused shepherd's hut, and were assaulted by ticks by day and bed-bugs by night!

Ted never had, nor did he ever learn to drive, a car; but he was a great traveller. Naturally conservative in his diet, habits, clothes and political views, he came to enjoy foreign food and customs the more he travelled abroad, and became quite cosmopolitan in many ways; he 'got by' in many countries with the aid of his own unique but comprehensible brand of the French language. Ted never married, and in his later years, after his mother's death in about 1967, seemed to have no close relatives left.

His health and vigour remained unimpaired until 1975, when he was taken ill during the International Botanical Congress in Leningrad with severe nose-bleeding due to high blood pressure. He was, to his surprise and pleasure, greatly impressed with the excellent treatment he obtained in a Soviet hospital. His health began to deteriorate in 1978; in that summer, on Colonsay with my wife and myself, he admitted to angina trouble, and in subsequent years he found it more and more difficult to climb hills or to get over stiles. He must have found this as severe a trial to himself as it was a source of anxiety to his friends, but he remained cheerful and complained little.

His determination to explore localities for interesting plants at this time, in spite of all the difficulties, was most impressive. He became really ill in Japan in 1983 with severe prostate trouble, but made an amazing recovery, and continued to make excursions at home and abroad to within ten days of his death. In April 1986 he visited Rhodes with a B.S.B.I. party, in particular to look for the rare *Carex illegitima*; he was successful in this quest.

Ted was one of the greatest British amateur botanists of this century, and a good all-round naturalist and conservationist. His main interests lay with the bryophytes; he was Secretary of the British Bryological Society for many years (1947–69) and became President of that society in 1972 and an Honorary Member in 1974. Indeed, the majority of his (comparatively few) scientific publications were concerned with bryology.

However, Ted was an outstanding vascular plant botanist as well. He joined the B.S.B.I. (under its former name of the B.E.C.) in 1932, and was Assistant Editor, Editor or Distributor of many B.E.C. reports. He was a founder member of the B.S.B.I. Maps Committee from 1954, a member of the Records Committee till his death, a member of the Publications Committee from 1954–77, and also the Society's Archivist and Recorder for v.c.13 for many years. His special interests among the phanerogams were the Carices and the Willows. He published very little on the vascular plants, but, particularly in Scotland, made many outstanding discoveries. Among these was the first record of *Carex ericetorum* outside East Anglia in Britain, at Burton Leonard in v.c.64, made while he was in the R.A.F. during the war; this find led others to look for it elsewhere (successfully) in northern England. Among his Scottish finds of note were *Saxifraga cernua* (until then believed to be only on Ben Lawers) on Bidean nam Bian with P. R. Bell in 1949; and of new sites for such plants as *Carex norvegica* and *C. atrofusca*. His major contributions to knowledge of our vascular plants as well as bryophytes, however, were made in areas of N.W. Scotland hitherto unknown or little explored botanically, such as Beinn Dearg, Seanna Braigh and the lesser-known parts of Breadalbane.

Ted was a kind and gentle person, not given much to wit, but with an excellent quiet sense of humour. He was very approachable (and unlike some other eminent botanists I have known), always delighted to share his immense knowledge and experience with others, particularly with young botanists. In my earlier days I (and many others) learnt an immense amount from his patient but enthusiastic instruction in the field, and always enjoyed his companionship. He led countless field excursions, but gave few formal lectures. He did not keep very detailed notes of his finds, perhaps because of his formidable memory, but he formed one of the last and greatest private herbaria of any recent British botanist. He was awarded the H. H. Bloomer Award of the Linnean Society in 1964, and was only the second botanist to receive this (his friend J. E. Lousley was the first).

With Ted's death, many of us feel that we have lost a dear and valued friend and field companion.

I would like to end with a brief anecdote which perhaps gives the essence of the man. In 1975, after our excursion to Knoydart, Dr B. J. Coppins and I travelled home on a beautiful summer's evening along the Highland Railway line from Fort William to Edinburgh. As we passed each mountain and corrie along that spectacular route, Ted gave us a continuous, enthusiastic and informative commentary on all the interesting species he had recorded on each crag or corrie that came into view; some he had not visited for over forty years. Brian Coppins and I were dazzled by this virtuoso performance and listened in silence for some time. Eventually Brian said: "Is all this written down somewhere, Ted? I hope so!" Ted replied: "Most of it isn't, I'm afraid, but then all the important records are represented in my herbarium".

Since his death, study of his herbarium of vascular plants (now at Reading University, **RNG**) has revealed what a rich storehouse of information it is.

F. Rose

Report

ANNUAL GENERAL MEETING, 9th May 1987

The Annual General Meeting of the Society was held in the Reardon-Smith Lecture Theatre, National Museum of Wales, Cardiff at 12 noon, with 70 members present. Mr D. E. Allen, retiring President, opened the meeting in the chair, thanking the Trustees of the Museum for the opportunity to hold this meeting in the impressive setting of the lecture theatre.

Apologies for absence were read, and it was noted with particular regret that Dr J. G. Dony was unable to attend; a card of good wishes, dymuniadau gorau, was signed for him by those present. The Minutes of the 1986 Annual General Meeting, as published in *Watsonia*, **16**: 361–362 (1987), were approved unanimously and signed by the President.

REPORT OF COUNCIL

The President reviewed the year with a summary of B.S.B.I. events in 1986 as reported by Council, including the sesquicentenary celebrations; publication of another volume in the B.S.B.I. Handbook series and *The Botanists*, and the two conferences held during the year. The lower recruitment in the year was attributed to the increased subscription rate, but the year had been notable for the large sum in bequests left to the Society. Adoption of the Report was proposed by Mr R. G. Ellis, seconded by Mr B. A. Gale, and passed unanimously.

TREASURER'S REPORT AND ACCOUNTS

The Treasurer, presenting his Report, commented on the large total of bequests, from the late Mrs Barbara Welch and from others, amounting to a sum unprecedented in the history of the Society. Mr Walpole suggested that in leaving these bequests the donors had shown their appreciation of the work and aims of the B.S.B.I. Adoption of the Report was proposed by Mr P. C. Hall, seconded by Mr E. F. Greenwood, and unanimously approved.

ELECTION OF PRESIDENT

Introducing Professor C. A. Stace, President-elect, Mr Allen recalled that Professor Stace, who had given long service to the Society as Editor and to botany as lecturer and author, now held a personal Chair in Taxonomy at the University of Leicester – a stronghold of systematic botany in scientific academia. Professor Stace then took the Chair, to the applause of the meeting, and looking ahead in these times of rapid change, as President he suggested that the Society should take positive steps to ensure that changes would be in the direction that we wanted, and that we should not allow the Society to drift with circumstances. Thanking the voluntary Officers for their considerable work for the Society, Professor Stace particularly mentioned the retiring President and Hon. Historian, to whom the Society was indebted for his book, *The Botanists*, which had been acclaimed outside the Society (but in spite of this had met with a disappointing response from members, who should be encouraged to purchase this most interesting and readable history of the Society through the past 150 years). Professor Stace also warmly thanked all the Officers, and the Editors, notably Dr R. J. Gornall, Receiving Editor of *Watsonia*, and Mr R. G. Ellis, Editor of *B.S.B.I. News* – which under the imprint of his predecessor, Mr E. D. Wiggins, had become an established publication of the Society much appreciated by members – who had been responsible for its new format. Professor Stace also thanked the other Editors, Committee Secretaries and all members of the Committees who undertook considerable and valuable work in running the Society's affairs.

ELECTION OF VICE-PRESIDENTS

From the chair, Professor Stace proposed the election of three Vice-Presidents as nominated by Council: Dr H. J. M. Bowen, Dr F. H. Perring and Dr A. J. Richards, all active and well-known members of the Society. Their election was approved by all present with applause.

RE-ELECTION OF HONORARY GENERAL SECRETARY AND HONORARY TREASURER

Mrs M. Briggs and Mr M. Walpole, officers in the posts of Honorary General Secretary and Honorary Treasurer for 15 and 16 years respectively were eligible and willing for re-election. The President, with warm thanks, proposed their re-election from the chair and this was carried by the meeting with applause.

ELECTION OF COUNCIL MEMBERS

In accordance with Rule 10, nominations had been received for Miss M. E. Young, Mr A. J. Byfield, and Mr B. A. Gale; they were elected unanimously.

ELECTION OF HONORARY MEMBER

Council had proposed Dr W. A. Sledge; this was seconded at the meeting by Dr F. H. Perring, who outlined Dr Sledge's long and valuable contribution to Yorkshire botany, and to the Society as B.S.B.I. Recorder and Editor. His election was approved with applause.

RE-ELECTION OF HONORARY AUDITORS

The Honorary Treasurer, saying that we were greatly indebted to the Honorary Auditors for the excellent service given to the Society, proposed that Grant Thornton be re-elected as our Honorary Auditors. This was seconded by Mr D. E. Allen and carried unanimously. The President would write to express our appreciation.

ANY OTHER BUSINESS

The President reported with regret the death of Professor D. H. Valentine, past President of the Society; the Honorary General Secretary would write to Mrs Valentine on behalf of the Society.

Mr J. F. M. Cannon then spoke on the new admission charges at the British Museum (Natural History) and outlined the procedure for members visiting the Department of Botany. The Honorary General Secretary announced a field meeting change of date; an exhibition on plants of churchyards; the availability of corrigenda slips for Handbooks; Linnean Society of London expeditions to Sweden and to Lapland in 1988; requested the address of an ex-member, and any spare copies of *Planting Native Trees & Shrubs* by K. & G. Beckett (1975) – now out of print. Mr R. G. Ellis announced programme plans for the afternoon and evening, and the meeting closed at 12.47 hours.

M. BRIGGS

INSTRUCTIONS TO CONTRIBUTORS

Papers and Short Notes concerning the systematics and distribution of British and European vascular plants as well as topics of a more general character are invited.

Manuscripts must be submitted in duplicate, typewritten on one side of the paper only, with wide margins and double-spaced throughout. They should follow recent issues of *Watsonia* in all matters of format, including abstracts, headings, tables, keys, figures, references and appendices. Note particularly use of capitals and italics. *Only underline where italics are required.*

Tables, appendices and captions to figures should be typed on separate sheets and attached at the end of the manuscript. Names of periodicals in the references should be abbreviated as in the *World list of scientific periodicals*, and herbaria as in Kent & Allen's *British and Irish herbaria*. Line drawings should be in Indian ink on good quality white card, blue-lined graph paper or tracing paper. They should be drawn at least twice the final size and they will normally occupy the full width of the page. Lettering should be done in Letraset or by high-quality stencilling, though graph axes and other more extensive labelling are best done in pencil and left to the printer. Photographs can be accepted only in exceptional cases.

Contributors are strongly advised to consult the editors before submission in any cases of doubt. 25 offprints are given free to authors of papers and Short Notes. Further copies may be purchased in multiples of 25 at the current price. The Society takes no responsibility for the views expressed by authors of articles.

Papers and Short Notes should be sent to Dr R. J. Gornall, Botany Department, The University, Leicester, LE1 7RH. Books for review should be sent to Dr N. K. B. Robson, Botany Department, British Museum (Natural History), Cromwell Road, London, SW7 5BD. Plant records should be sent to the appropriate vice-county recorders. Reports of field meetings should be sent to Dr B. S. Rushton, Biology Department, The University of Ulster, Coleraine, Co. Londonderry, N. Ireland, BT52 1SA.

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