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C. A. STACE AND D. L. WIGSTON

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Printer's Error

p. 63 line 18 should read:
. . . *Luzula sylvatica*, a dominant of the ground flora. An area of the South Wood fenced by the Nature . . .

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Morphological variation in the *Vicia sativa* L. aggregate

E. HOLLINGS

12 Stivichall Croft, Coventry

and

C. A. STACE

Botanical Laboratories, University of Leicester

ABSTRACT

Wild and cultivated strains of *Vicia sativa* L. agg. (incl. *V. angustifolia* L. and *V. segetalis* Thuill.) and *V. lathyroides* L. have been examined for 50 primary and many other derived morphological characters. None of the characters commonly used to differentiate the various segregates recognized in the literature or by us was found to be significantly affected by environmental factors, but several of them (e.g. flower-length, pod-length, absolute leaflet-shape) show continuous variation which renders them of very little taxonomic value. Characters such as heterophylly, tendril form, petal colour, pod colour, seed conspicuousness in the pod and seed texture may be used to separate four main taxa: *V. lathyroides, V. angustifolia, V. segetalis* and *V. sativa.*

The taxonomic status of these will be discussed in a later paper dealing with breeding and hybridisation data.

INTRODUCTION

Vicia sativa L. agg. is widespread over much of Europe, western Asia and North Africa as a native plant and, due to its frequent cultivation for green manure and fodder, it has become naturalized over an even wider area of the northern hemisphere.

The taxonomy of this species aggregate, and indeed its distinction from some close relatives, has been confused ever since Linnaeus' time. Much of this confusion is due to the inbreeding which is predominant in the aggregate and, in more recent times, to the large number of cultivated strains which have been bred and then grown on a field scale, and which have subsequently escaped from cultivation and intermingled with the native populations. The work described here is part of an attempt to place the taxonomy of the aggregate on a more logical basis than hitherto, with particular reference to the taxa occurring in the British Isles and adjacent parts of the Continent.

Vicia sativa agg. may be separated from all other European species of the genus by its annual habit; 1- to few-flowered, shortly pedunculate inflorescences; leaves with *c* 3–8 pairs of leaflets and a terminal, usually branched tendril; glabrous, usually reddish-purple corollas; equal calyx-teeth; and smooth seeds with a hilum occupying $\frac{1}{8}$ to $\frac{1}{4}$ the circumference.

Its closest relative, at least in western Europe, is *V. lathyroides* L., which is smaller in all its parts, has leaves with usually fewer leaflets and unbranched tendrils, and has tuberculate seeds. This species is, however, very often confused with small plants of *V. sativa*, particularly in the field, and for this reason it has been included in the present survey.

V. lutea L., another closely related species, differs from *V. sativa* in its unequal calyx-teeth; yellow corollas; strongly pubescent, deep pods; and seeds with a hilum $\frac{1}{3}$ to $\frac{1}{2}$ the circumference. Variants of *V. sativa* with white or yellow corollas occasionally occur and have sometimes been misidentified as *V. lutea*, but the calyx, seeds and pods of the latter species are distinctive.

At maturity most individuals of *V. sativa* agg. are much-branched, sprawling or climbing plants bearing 1- to 2-flowered inflorescences in most of the upper leaf-axils. The shape of the leaflets on the lower leaves is often markedly different from that of those on the upper leaves which bear flowers in their axils; plants with this character well developed are termed heterophyllous. The leaves on the primary shoot of the young seedling are usually different again from any of those on the floriferous shoots, both in the shape of the leaflets and in the possession of a simple tendril or in lacking a tendril. The primary shoot never bears flowers; these are formed on the lateral shoots which develop from the lowest few nodes of the primary shoot, and on similar secondary or higher-order laterals. The overall vegetative vigour of a plant is an expression not only of the size of each shoot but of the numbers and orders of the laterals, which soon over-top the short-lived primary shoot.

In many cases the production of high-order laterals continues throughout the growing season. In certain plants very short laterals are formed low down near the ground, late in the season, when most of the older laterals possess ripe or ripening fruits. These short laterals bear small leaves and often very small flowers, which may be cleistogamous and give rise to small, few-seeded pods. In yet other plants, laterals produced very close to ground level become subterranean and develop as whitish shoots with rudimentary leaves and minute, whitish, cleistogamous flowers. The latter form whitish-brown, 1- to 2-seeded, subterranean pods, often in great quantity, which are thus conspicuously different from the earlier epigeal ones and contain seeds often also distinguishable from those formed above ground. Subterranean seed-production is typical of the taxon known as *V. amphicarpa* Dorthes, and we shall use the term amphicarpy to describe the feature.

V. lathyroides is a less vigorous plant with usually far fewer branches and less pronounced differences in leaf-shape between main and lateral branches. Cleistogamy and amphicarpy have not been observed and, moreover, the primary shoot does on a few occasions bear one or two flowers. Most of these differences are probably related to the ephemeral life-cycle of this species.

PREVIOUS CLASSIFICATIONS OF *VICIA SATIVA* AGG.

In the past *V. lathyroides* has almost always been recognized as a species distinct from *V. sativa* agg. In British Floras the latter has either comprised a single species with or without subspecies and varieties, or two species, *V. sativa sensu stricto* and *V. angustifolia* L., which differ in size, leaflet-shape, flower-colour and fruit-shape and -colour. The former treatment was adopted, for instance, in *Flora Anglica* (Hudson 1762), *English botany* (Syme 1864) and *Flora of the British Isles*, 2nd ed. (Tutin 1962); the latter in *The English flora* (Smith 1825), *The British flora* (Hooker 1830) and *Flora of the British Isles*, 1st ed. (Tutin 1952). *V. angustifolia*, whether treated as a species or a subspecies of *V. sativa*, was frequently separated into two varieties usually known as var. *angustifolia* and var. *bobartii* (E. Forst.) Koch (e.g. Tutin 1952). The former variety is also known as var. *segetalis* (Thuill.) Koch, and it appears, in fact, that var. *bobartii* is the type variety and hence the one to be known as var. *angustifolia*. Var. *segetalis* is a more robust plant than var. *bobartii*, and in several characteristics falls somewhere between the latter and *V. sativa*.

Continental authors have shown a similar degree of variation in their treatment of *V. sativa* agg., but because of the greater number of variants found in southern Europe the situation is much more confused. Rouy (1899), for example, recognized six distinct taxa in the aggregate, which he called *V. communis* Rouy. These taxa were termed 'formes', intermediate in rank between subspecies and variety, and among them a further ten varieties and three sub-varieties were recognized. Ascherson & Graebner (1909) divided *V. sativa* into four subspecies, which were largely equivalent to Rouy's formes (although two of the latter were reduced to synonymy), but in addition they recognized a very large number of varieties and other infra-specific categories.

The most important taxonomic studies of recent years have been made by Mettin & Hanelt (1964), who divided the aggregate into six species: *V. sativa, V. angustifolia, V. amphicarpa, V. incisa* Bieb., *V. cordata* Wulfen ex Hoppe and *V. macrocarpa* (Moris) Bertol. Later (Hanelt & Mettin 1966) they added a seventh species, *V. pilosa* Bieb. The first two of these are the two species which have been recognized by British authors, and the second of them was divided by Mettin & Hanelt into subsp. *angustifolia* and subsp. *segetalis* (Thuill.) Gaud.

Ball (1968) based his treatment for *Flora Europaea* on the work of Mettin & Hanelt, but preferred to consider the segregates as subspecies of *V. sativa*. Under this scheme *V. angustifolia* must be called subsp. *nigra* (L.) Ehrh. Moreover, Ball included *V. pilosa* with it, so that he recognized a total of only six subspecies. They are: subsp. *sativa*, subsp. *nigra*, subsp. *amphicarpa* (Dorthes) Asch. & Graeb., subsp. *cordata* (Wulfen ex Hoppe) Asch. & Graeb., subsp. *incisa* (Bieb.) Arcangeli and subsp. *macrocarpa* (Moris) Arcangeli.

Much important work on this aggregate has also been carried out by Yamamoto (e.g. Yamamoto 1966). The results of his breeding experiments have important taxonomic implications but Yamamoto has not sought to use these to propose modified systems of classification.

Plitmann's (1967) valuable contribution on Middle-Eastern species of annual *Vicia* includes a careful survey of *V. sativa* agg. In it he, like Ball (1968), recognized the main variants as subspecies of *V. sativa*, but subsp. *pilosa* is not treated (not occurring in the region concerned) and subspp. *cordata* and *incisa* are amalgamated as a single subspecies. Moreover, in the main text, *V. segetalis* is placed with subsp. *cordata* rather than with subsp. *angustifolia* (= *nigra*), although a 'corrigendum' (p. 128) reverses that decision. In the *Flora of Turkey*, Davis & Plitmann (1970) recognized the same five subspecies.

Most previous systems of classification of the *Vicia sativa* aggregate have been based on a small, subjective selection of characters, both quantitative and qualitative, with little regard to their mode of variation. Some of the most frequently used characters, notably flower and pod length, are in fact continuous variables and the points in the scale of variation used by different authors to separate the taxa has varied a great deal (cf. Figs. 2 & 3). They have probably been selected for use because they are readily observable on herbarium material, whereas many other characters (often taxonomically more useful) are usually poorly preserved or demand floral dissection.

The work reported here has, therefore, sought to determine the pattern of variation in the morphological characters, as well as their points of discontinuity (if any) and the existence of any correlation between them, and has attempted to ascertain to what extent any groups so defined correspond with the segregates which have been recognized in the past.

For convenience we shall in this paper use the classification (i.e. the delimitation of the segregates and their nomenclature) of Mettin and Hanelt, but in addition shall recognize *V. segetalis* Thuill. as a distinct species. It is in several ways as distinct from *V. angustifolia* as are some of the other species and, in the British Isles at least, it has in fact been confused with *V. sativa* more frequently than with *V. angustifolia*. It is likely that only *V. angustifolia* of the above species is native in northern Europe, including the British Isles, but *V. sativa* and *V. segetalis*, and to a lesser extent *V. cordata* and *V. amphicarpa*, are cultivated there and occur as escapes from cultivation. The last two, however, have not to our knowledge been found wild in the British Isles. The decline of *V. sativa* as a cultivated plant in the British Isles has been documented by Killick (1975). We shall not be concerned with the other three taxa (*V. pilosa, V. incisa* and *V. macrocarpa*).

The main characters which may be used to separate these five segregates of *V. sativa* agg. and *V. lathyroides* are best summarized in the following key:

1 Seeds tuberculate .. .. *V. lathyroides*
1 Seeds smooth
  2 Plants with subterranean stems bearing cleistogamous flowers and whitish, few-seeded pods .. .. *V. amphicarpa*
  2 Plants without subterranean stems
    3 Pods constricted between seeds .. .. *V. sativa*
    3 Pods not constricted between seeds
      4 Calyx-teeth longer than calyx-tube .. .. *V. cordata*
      4 Calyx-teeth shorter than calyx tube
        5 Plant markedly heterophyllous .. .. *V. angustifolia*
        5 Plant not or scarcely heterophyllous .. .. *V. segetalis*

MATERIALS AND METHODS

Seed samples of wild, known origin were collected personally or by colleagues, or were obtained from the seed exchange schemes of various botanic gardens. The 45 samples so gathered are listed with their chromosome numbers in Hollings & Stace (1974, Table 2). In addition, a large number (*c* 160) of samples of cultivated material was used, mostly of agricultural origin from various seedsmen and research stations. We feel this is justified because, as previously stated, many of the 'wild' populations found in the British Isles today originate as escapes or relics from such sources. For most of the work only about 30 or 40 of the cultivated strains were utilized. Since these plants are annuals, fairly regular re-sowing and seed harvest had to be carried out, although seed viability can last for several years in laboratory conditions. Representatives of all samples used were grown under field conditions and specimens were dried and pressed to provide a comprehensive herbarium. Flowers were more difficult to preserve adequately as they fade and wither very rapidly. Freshly opened flowers were therefore dissected into their component organs and spread out flat on the adhesive surface of transparent, self-adhesive tape, which was then inverted and mounted on stiff cards. These preserve the floral organs indefinitely for measurement and examination.

Measurements were standardized as far as possible, particularly in relation to the part of the plant sampled. Floral measurements are means from at least 10 freshly open flowers; leaf and fruit characters are means of 20 measurements. Seeds were measured with the aid of a Vernier travelling microscope or Vernier screwgauge. Where possible, leaf measurements were taken from the lowest flowering node, unless otherwise noted; stipules were scored from the two nodes below the lowest flowering node (where they are best developed).

Optical densities of wing and standard petals were taken from known weights of tissue (approx. 0·5 g) extracted in 5 ml of 1% methanolic HCl. Optical density at 530nm was determined for each sample using an Eel Spectrometer and corrected to a value for 1g of tissue. 1% methanolic HCl was used as a blank standard.

Cultivation experiments were carried out in crowded (10 plants per 5 inch pot) and isolated (1 plant per 5 inch pot) conditions, in constant (15°C, 16h day, 40% rel. humidity) glasshouse or changing outdoor conditions, and in four types of soil (sand, loam, clay, John Innes No. 1 compost). The cultivation experiments therefore comprised 16 different treatments. The soil types were prepared with regard to texture only; in particular it should be noted that the sand was low in calcium and thus resembled the soil of inland sandy heaths rather than that of most maritime dunes.

DEFINITION OF CHARACTERS INVESTIGATED

The characters chosen for this survey included most of those which had been used taxonomically in the past, plus many which clearly varied and might therefore be of taxonomic value. From this basic list many additional characters were derived, either ratios or measurements from different parts of the plant. The list is clearly by no means exhaustive, as the measurements of a flower such as that of *Vicia* can be extended almost indefinitely. Moreover, many other, mainly qualitative, characters were omitted from the detailed study, e.g. detailed patterns of testa coloration, presence of a blackish spot (extra-floral nectary) on the stipules, as well as a number of very variable quantitative features, e.g. plant height.

The following 50 primary characters were scored, 37 being quantitative and 13 qualitative.

a. *Flowers:*
   1. Flower length, from base of calyx to apex of lateral petal
   2. Number of flowers per node
   3. Cleistogamy, as one of three categories: cleistogamous flowers absent; aerial cleistogamous flowers present; subterranean cleistogamous flowers present

b. *Calyx:*
   4. Calyx-tube length, from base of mid-ventral tooth to base of calyx-tube
   5. Calyx-tube width, across base of calyx-teeth of opened-out calyx
   6. Midventral calyx-tooth length, from base to apex along mid-vein
   7. Midventral calyx-tooth width, across base

c. *Standard petal:*
8. Petal length, from base of claw to apex of limb along mid-line
9. Petal-limb length, from apex of limb to its junction with claw along mid-line
10. Petal-limb width, across widest point
11. Petal-claw length, from base to its junction with limb
12. Petal-claw apical width, at its junction with limb
13. Petal-claw greatest width, at widest point
14. Petal-notch depth, from tip of petal-lobes to base of notch
15. Optical density at 530nm of pigment from 1g tissue in 5ml 1% methanolic HCl

d. *Lateral petals:*
16. Petal length, from base of longer claw to apex of limb
17. Petal-limb length, from apex of limb to its junction with claws
18. Petal-limb width, across widest point
19. Long petal-claw length, from base to its junction with limb
20. Short petal-claw length, from base to its junction with limb
21. Optical density at 530nm of pigment from 1g tissue in 5ml 1% methanolic HCl

e. *Keel:*
22. Keel-pouch length, along greatest length parallel to claws
23. Keel pouch depth, from dorsal opening to ventral suture
24. Keel-claw length, from base to junction with pouch
25. Keel-pouch pigmentation extent, from dorsal opening to further edge of dark pigmentation

f. *Androecium:*
26. Stamen-tube length, along mid-ventral line
27. Stamen-tube width, across widest point when opened out
28. Free filament length, from its junction with stamen-tube to its junction with anther

g. *Gynoecium:*
29. Ovary length, from base to its junction with style
30. Ovary width, across widest point
31. Style length, from its junction with ovary to base of style

h. *Pod:*
32. Pod length, from its junction with pedicel to base of beak
33. Pod depth, from dorsal to ventral suture
34. Pod colour, as five categories: yellow; yellow-brown; brown; brown-black; black
35. Seed conspicuousness, as smooth or moniliform pods
36. Number of seeds per pod
37. Pod pubescence, as glabrous or pilose

i. *Seeds:*
38. Seed length, across widest point parallel to hilum
39. Seed depth, across widest point from dorsal (hilum) to ventral side
40. Seed width, across widest point at right angles to both 38 and 39
41. Testa colour, as five categories: white; yellow; green; brown; black
42. Testa mottling, as mottled or unmottled
43. Testa texture, as smooth or tuberculate

j. *Leaves:*
44. Leaf length, from base of petiole to point of attachment of apical leaflets
45. Leaflet number
46. Leaflet length, from base of apex along midrib, including mucro if present
47. Leaflet width, across widest point
48. Leaflet-apex shape, as five categories: acute; obtuse; truncate; truncate-emarginate; emarginate (Fig. 1)
49. Stipule-tooth number, as mean number of primary teeth per stipule
50. Tendril type, as short and simple or long and branched.

Of the various ratios derived from these primary characters only the heterophylly index, designed to measure the difference in leaf-shape between leaflets on upper and lower leaves, requires further explanation. The heterophylly index is defined as the ratio of average leaflet ratio of the leaf on the eighth node/average leaflet ratio of the leaf on the first node of the first lateral shoot, where average leaflet ratio is the ratio of average leaflet length/average leaflet width.

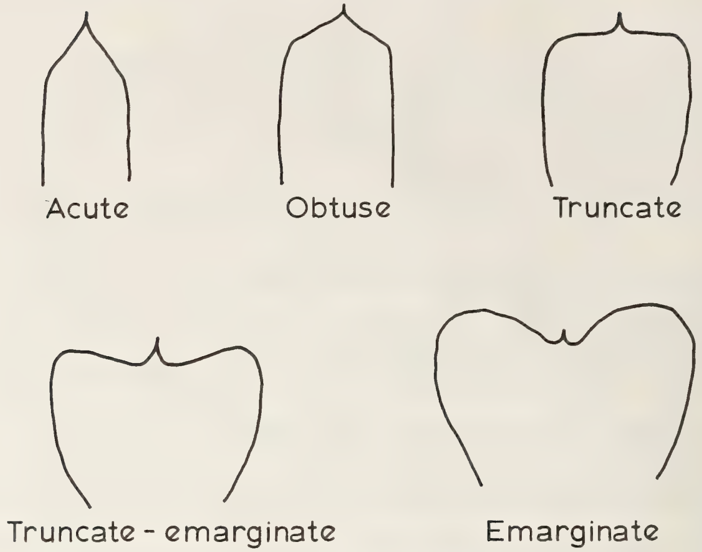

FIGURE 1. Terms used to describe leaflet-apex shapes

RESULTS

MORPHOLOGICAL CHARACTERS

As expected, no single character, either primary or derived, affords complete separation of the six taxa defined in the Introduction.

The quantitative characters fall into two main categories, with continuous and discontinuous distributions. In the former case the histograms obtained mostly show normal or near-normal distributions (Fig. 2), although sometimes slightly skewed, but a few show evidence of multimodal curves (e.g. flower length, Fig. 3). Some of these probably indicate artificial clustering, caused by the rounding up and down of figures, but others are the results of separate curves, with different modes from the various taxa, superimposed on each other. These separate, unimodal curves, however, overlap greatly and such characters are not alone reliable for delimiting taxa, despite the fact that they have been much used by previous authors. In fact they merely serve to illustrate an increase in size of most vegetative and reproductive parts across the aggregate, from *V. lathyroides* at the lower end of the scale to *V. sativa* at the upper.

The only quantitative characters showing truly discontinuous distributions are two ratios: optical density of lateral petals/optical density of standard petal (characters 21/15) (Fig. 4), and heterophylly index (Fig. 5). A low optical density ratio (1/8 to 1/13) indicates a conspicuous difference between the pigmentation of the lateral (dark) and standard (light) petals, while a high one (1/1 to 1/4) indicates little difference. A high heterophylly index (4—5·5) represents a plant with relatively broad leaflets on lower leaves and narrow leaflets on upper (flowering region) leaves, and a low index (0·5—2·5) represents a plant with relatively little change in leaflet shape. Because of the disjunction of both of these characters, each separating the aggregate into two groups, they can be equally expressed qualitatively as concolorous and bicolorous flowers and as isophyllous or heterophyllous stems, although we do not claim that with wider samples than ours intermediates would not be found in both characters.

Many quantitative characters, especially various floral dimensions and seed measurements, are strongly correlated. Such straight-line relationships illustrate the fairly constant shape of these organs irrespective of absolute size or of the segregate, and are particularly well-marked in characters of the gynoecium, androecium and keel (Fig. 6), probably due to the importance of maintaining the critical floral dimensions needed in the floral biology of the aggregate. They are therefore of little taxonomic use.

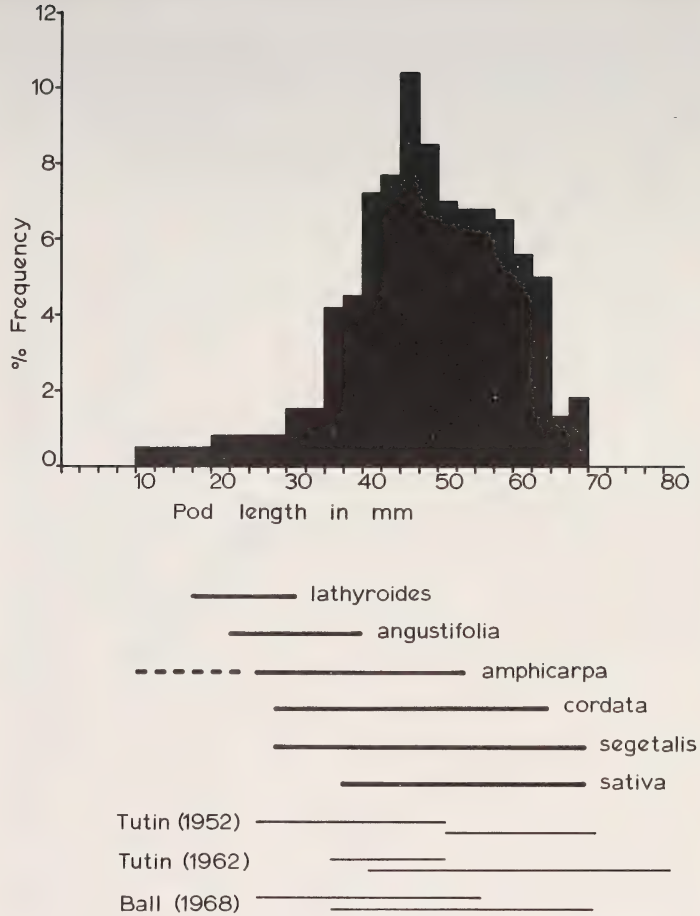

FIGURE 2. Histogram of pod lengths of *Vicia sativa* agg. The thick lines below the histogram indicate ranges in our material exhibited by each of the six segregates (exceptional ranges in broken lines) as delimited by Mettin & Hanelt (1964) except that we have for the purpose included all strains producing cleistogamous flowers under '*V. amphicarpa*'. The thin lines below these represent the ranges of *V. angusifolia* (left) and *V. sativa* (right) given in three representative Floras.

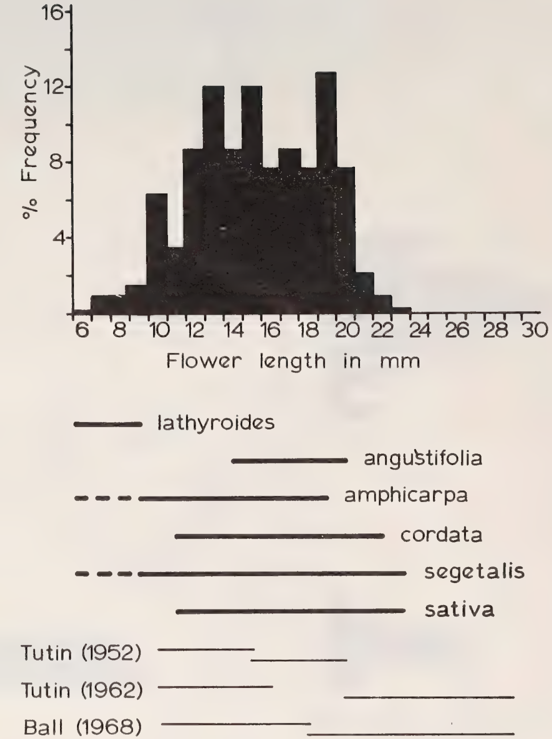

FIGURE 3. Histogram of flower lengths of *Vicia sativa* agg. Thick and thin lines below the histogram as in Figure 2.

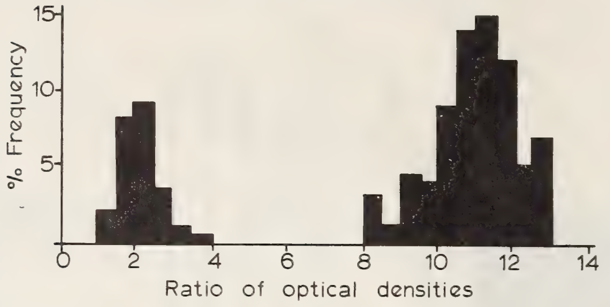

FIGURE 4. Histogram of ratio of optical densities of lateral and standard petals in *Vicia sativa* agg. See text for definition.

FIGURE 5. Histogram of heterophylly index in *Vicia sativa* agg. See text for definition.

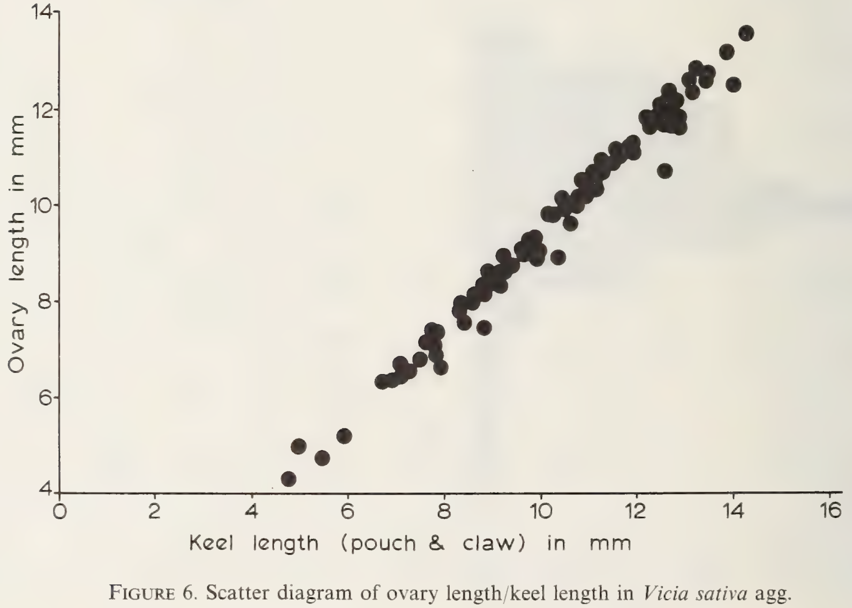

FIGURE 6. Scatter diagram of ovary length/keel length in *Vicia sativa* agg.

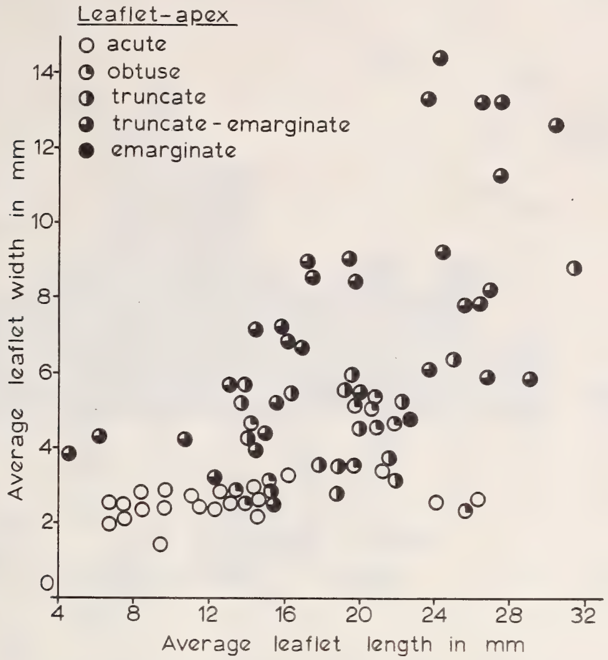

FIGURE 7. Scatter diagram of leaflet width/leaflet length in *Vicia sativa* agg.

On the other hand, most pod and leaf dimensions are rather poorly correlated, indicating that leaflets (Fig. 7) and pods vary greatly in shape. These variations are not closely correlated with the characters used to define the segregates, and are thus no more useful for delimiting them than are the absolute dimensions.

Certain characters are, however, correlated with the two discontinuous variables (heterophylly index and optical density ratio) and serve to further discriminate between separate groups of plants. Plants with a high heterophylly index have mostly smaller pods (Fig. 8), seeds and leaves and fewer stipule-teeth than plants with a low heterophylly index. Furthermore, whereas isophyllous plants exhibit a wide range of flower length, strongly heterophyllous plants fall into two groups with respect to this character: one with flowers 6–9mm and one with flowers 14–19mm long (Fig. 9). Fig. 9 also shows that strongly heterophyllous plants possess concolorous petals, while isophyllous plants possess bicolorous ones. The other floral character which has been used by several previous workers in the aggregate, ratio of calyx-tooth length/calyx-tube length, is not in itself a very useful discriminant (Fig. 10) and is not very well correlated with other characters. For example, although plants with a high heterophylly index all have calyx-teeth/calyx-tube ratios equal to or less than 1·0 (100 in Fig. 11), plants with a low heterophylly index may have ratios well below or well above 1·0 (Fig. 11). The calyx-teeth/calyx-tube ratio is also not well correlated with any of the important qualitative characters such as smooth or moniliform pods.

Many of the qualitative characters, both those systematically scored and many more not so, exhibit a reticulate-type variation, obeying Vavilov's (1951) Law of Homologous Series. Thus they are found in almost infinite combination with other such characters, and show extensive parallels between related taxa, so that they are of very little value in orthodox taxonomy. Characters of this type are testa colour, patterns of testa mottling, albinism, pubescence, and presence or absence of a black spot on the stipules.

A number of qualitative characters are, however, fairly closely correlated with each other and with various quantitative characters. Plants with tuberculate seeds mainly have small, dark, smooth pods; small, concolorous flowers; a high heterophylly index; and simple tendrils. The rest of the aggregate

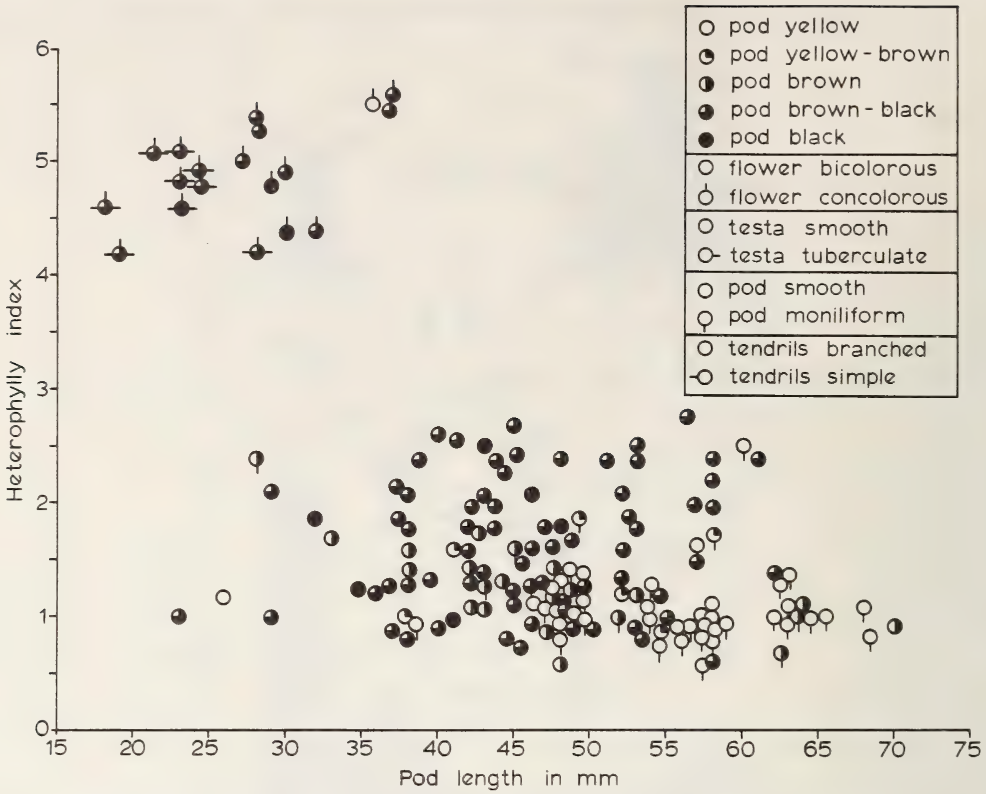

FIGURE 8. Scatter diagram of heterophylly index/pod length in *Vicia sativa* agg.

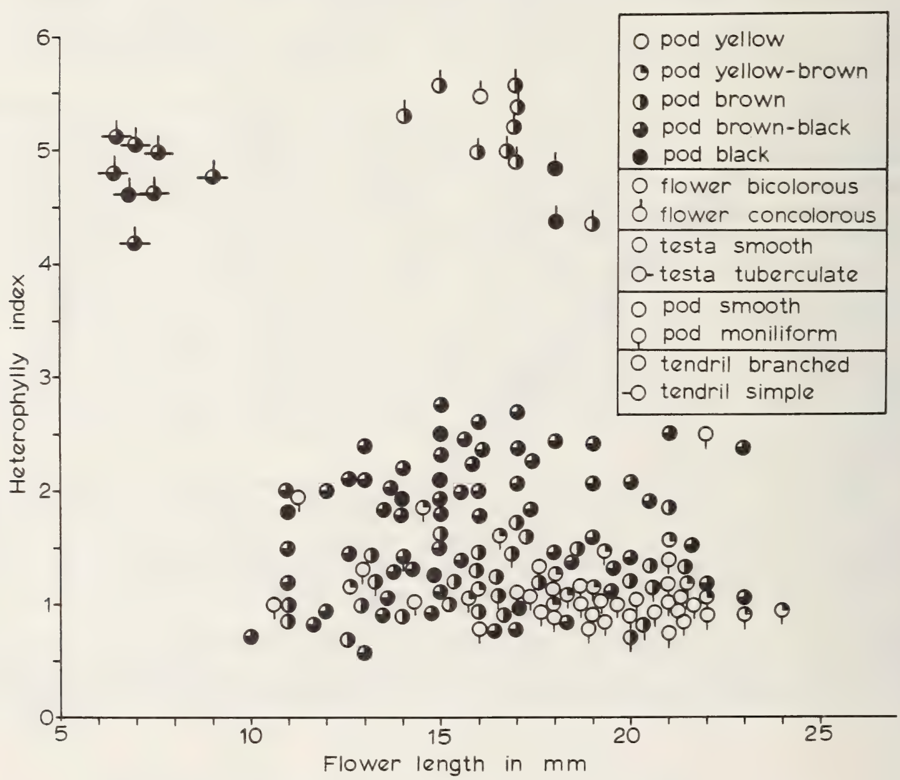

FIGURE 9. Scatter diagram of heterophylly index/flower length in *Vicia sativa* agg.

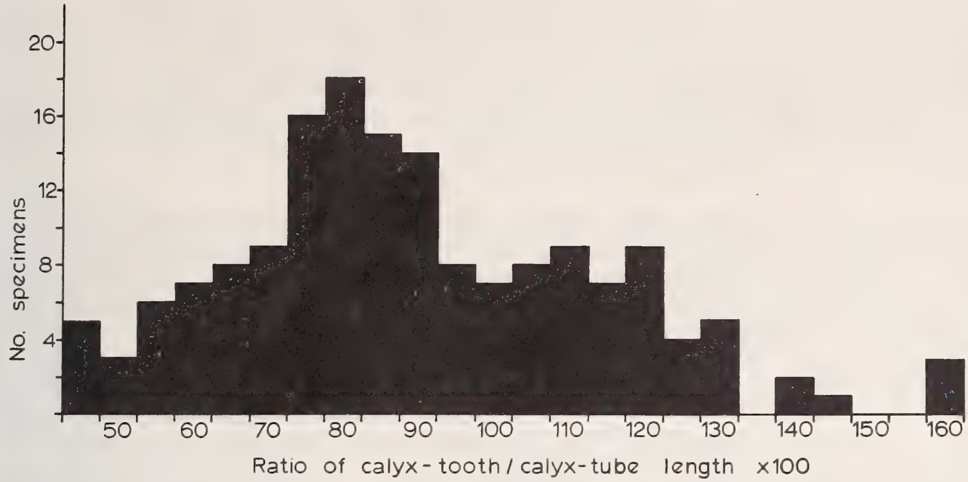

FIGURE 10. Histogram of ratio (× 100) of calyx-tooth length to calyx-tube length in *Vicia sativa* agg.

FIGURE 11. Scatter diagram of heterophylly index/ratio (× 100) of calyx-tooth length to calyx-tube length in *Vicia sativa* agg.

have smooth seeds and (usually) branched tendrils. Pods which are moniliform are usually also pale-coloured and pilose; whilst those which are smooth are usually glabrous and dark-coloured, although dark, moniliform pods and pale, smooth pods do occur. The shape of the leaflet apex is to some extent correlated with leaflet width, acute and obtuse apices being confined to narrow leaflets, but emarginate apices are found on very narrow as well as very broad leaflets, and leaflet apex shapes are not well correlated with the characters usually used to separate the segregates.

Cleistogamous underground flowers, supposed to be indicative of *V. amphicarpa*, occur on only one of the living strains studied (from Turkey). On this plant the aerial flowers are also small and cleistogamous, which is not the case in most plants of *V. amphicarpa* described in the literature. Other strains, with smooth or moniliform and pale or dark pods, with bicolorous or concolorous, large or small flowers, and with isophyllous or heterophyllous stems, produced aerial cleistogamous flowers, either on the main laterals or on short laterals formed low down late in the season, or produced subterranean whitish branches with flower primordia, which presumably would have later produced subterranean pods. We therefore conclude that neither cleistogamy nor amphicarpy, being scarcely correlated with other characters, are very useful taxonomic discriminants, at least of major taxa.

The best separation of the variants is effected by plotting heterophylly index against flower length, together with a number of qualitative characters (Fig. 9). This demonstrates three main groups of plants:

1. Plants with high heterophylly index; simple tendrils; concolorous flowers; calyx-teeth shorter than calyx-tube; small, smooth, dark pods; and tuberculate seeds. These correspond with *V. lathyroides*.
2. Plants with high heterophylly index; branched tendrils; larger (14–19mm) concolorous flowers; calyx-teeth shorter than calyx-tube; rather small, smooth, dark pods; and smooth seeds. These correspond with *V. angustifolia*.
3. Plants with low heterophylly index; branched tendrils; bicolorous flowers; larger pods; and smooth seeds. These comprise: *V. sativa, V. segetalis, V. cordata* and *V. amphicarpa*. These vary in the other characters mentioned under groups 1 and 2, but on the basis of qualitative characters two sub-groups may be recognized: with pale, moniliform, often pilose pods (corresponding to *V. sativa*); and with dark, smooth, usually glabrous pods (corresponding to *V. segetalis* and *V. cordata*). As mentioned above, *V. amphicarpa*, as usually defined (on the basis of amphicarpy), cannot be accommodated in this system of grouping.

CULTIVATION EXPERIMENTS

Although many of the qualitative characters are known to be genetically determined, the large number of quantitative characters which help distinguish the variants seemed very likely to be affected by environmental factors, especially as the number of variants and the breadth of variation shown by each in any one locality is small. Moreover, sandy heaths and sand-dunes support the smaller, weaker variants, particularly *V. lathyroides* and *V. angustifolia*, whilst richer inland soils often support the more luxuriant variants.

Nevertheless, preliminary observations, gained from cultivation of many wild strains in standard conditions, suggested that habitat has little effect on morphology, and Blum (1966) showed that plant density scarcely changed pod and seed size, although it affected the production of lateral shoots.

The results of cultivation experiments on eight selected strains covering the segregates *V. sativa, V. segetalis, V. angustifolia* and *V. lathyroides* were remarkably consistent. In all cases plants were more robust and produced more laterals in isolated than in crowded, and in outdoor than in glasshouse, conditions. They were also more robust in potting compost than in loam or clay, and less robust still in sand. Differences were mostly statistically highly significant and were of similar magnitude for all segregates.

On the other hand, detailed analysis of 16 quantitative and qualitative characters, including almost all those considered taxonomically important, in no cases showed any significant differences between treatments. Qualitative characters were completely unchanged and quantitative measurements all fell well within the range expected from previous observations. In particular, environmental factors appear to have negligible or no effect on flower, pod and leaf measurements; heterophylly index; flower, seed and pod colour; seed texture and conspicuousness in pod; and tendril branching.

CONCLUSIONS AND DISCUSSION

The cultivation experiments show that the complex pattern of variation found in *V. sativa* agg. is not the result of phenotypic responses to different habitats but is genetically determined.

The quantitative characters mostly vary in such a way that the four British segregates, *V. lathyroides, V. angustifolia, V. segetalis* and *V. sativa*, differ by increasing size of most of their parts (in the order of taxa given). However, there is a wide measure of overlap so that these characters are not alone sufficient for distinguishing the segregates.

In particular, flower length and pod length have been much used in the past as discriminants. Figs. 2 and 3, besides providing a breakdown of the ranges of variation shown in our material by the individual segregates, also illustrate, by reference to three selected treatments, the very variable interpretation which has been placed on these characters by past workers. It should be noted that, in these selected treatments, *V. segetalis* was nomenclaturally contained in *V. angustifolia*, but that a proportion of *V. segetalis* plants was probably included under *V. sativa*. Flower length alone may be useful in distinguishing *V. lathyroides* from the other taxa, except that cleistogamous, late-season flowers of the latter frequently fall into the size range of normal *V. lathyroides* flowers. In general, vegetative characters, particularly absolute measurements of leaves and the shape of the leaflet apex, are of little taxonomic value.

Two quantitative characters which appear to be good discriminants, heterophylly index and colour difference in standard and lateral petals, may for convenience be scored qualitatively, as explained previously. These, and certain other qualitative characters, notably seed conspicuousness, pod colour and seed texture, are the best diagnostic characters in the aggregate and can be used to separate the four segregates. It is arguable that this effects a very artificial separation, in that a few discontinuous characters have been carefully chosen from a much greater number of continuous variables, but it is the taxonomist's aim to search for discontinuities and, where they are found, express them in taxonomic terms by naming the discrete units so separated.

V. cordata is usually separated from *V. angustifolia* and *V. segetalis* on the basis of the calyx-teeth/calyx-tube ratio and chromosome number, *V. cordata* having $2n = 10$ and a ratio over 1·0 (100 in Figs. 10 & 11), the latter two having $2n = 12$ and a ratio under 1·0. However, in a previous paper, we (Hollings & Stace 1974) failed to find precise correlation between these two characters, and, moreover, plants of *V. sativa* also have a calyx-tooth/calyx-tube ratio varying from below to above 1·0. Thus on morphological features alone *V. cordata* is scarcely worthy of recognition. On the basis of our observations, plants corresponding with *V. cordata* can be quite easily accommodated in *V. segetalis*, which agrees well with the preliminary conclusion of Plitmann (1967), but not with his later decisions.

V. amphicarpa, delimited simply by the presence of subterranean pods originating from cleistogamous flowers, is otherwise very variable both in morphology and in karyotype (Hollings & Stace 1974). The recognition by Rouy (1899) of two varieties, var. *pseudosativa* and var. *pseudoangustifolia* (amphicarpous variants of *V. sativa*-like and *V. angustifolia*-like plants respectively) reinforces the opinion that '*V. amphicarpa*' as normally understood is not a taxon but a series of variants of other taxa possessing only amphicarpy in common.

The four segregates revealed by our studies may be distinguished by the following diagnoses:

V. lathyroides: Strongly heterophyllous; tendrils simple; flowers 6–9 mm, concolorous (usually dull purple); pods 18–30 mm, brown to black, smooth, glabrous; seeds tuberculate.
V. angustifolia: Strongly heterophyllous; tendrils branched; flowers 14–19 mm, concolorous (usually bright pink); pods 23–38 mm, brown to black, smooth, glabrous; seeds smooth.
V. segetalis: More or less isophyllous; tendrils branched; flowers 9–26 mm, bicolorous (with standard petals paler than lateral petals); pods 28–70 mm, brown to black, smooth, usually glabrous; seeds smooth.
V. sativa: More or less isophyllous; tendrils branched; flowers 11–26 mm, bicolorous (with standard petals paler than lateral petals); pods 36–70 mm, yellowish to brown, moniliform, often pilose; seeds smooth.

As stated in the Introduction, it is likely that only the first two of these are native in the British Isles.

On the basis of morphological characters there is not a strong argument for separating *V. lathyroides* from the rest of this aggregate. However, there are differences in the suspected pattern of karyotype evolution of *V. lathyroides* from that of the rest (Hollings & Stace 1974), and there is a strong breeding barrier between it and the other taxa (Hollings & Stace, unpublished).

V. angustifolia, V. segetalis and *V. sativa* are not genetically isolated, and their rather complex pattern of variation is almost certainly the result of extensive inbreeding and, in this country at least, of the cultivation and subsequent escape of many non-native variants. These segregates (as well as others such as *V. macrocarpa, V. pilosa* and *V. incisa*) therefore represent groups of variants representing modes in a spectrum of largely continuous variation. Although they are usually separable by the characters given above, plants of intermediate status, or with one or two anomalous characters, are not uncommon. Indeed they are to be expected from an application of the Law of Homologous Series, which proves to be a useful concept in this group of plants and applies to karyotype variation as well as to morphological characters. The most appropriate rank for the main segregates will be discussed in a later paper dealing with breeding and hybridisation data.

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Cytotaxonomic studies on the *Cochlearia officinalis* L. group from inland stations in Britain

J. J. B. GILL

Department of Genetics, University of Liverpool

H. A. McALLISTER

University of Liverpool Botanic Gardens, Ness, Neston, Wirral

and

G. M. FEARN

Department of Chemistry and Biology, Sheffield City Polytechnic

ABSTRACT

The results of a cytotaxonomic survey of *Cochlearia Officinalis* L. *sensu lato* from inland sites in Britain are reported. One diploid and two tetraploid cytotypes exist. The diploid ($2n = 12$) occurs at moderate altitudes and appears to be restricted to base-rich habitats. It corresponds both ecologically and cytologically with *C. pyrenaica* DC. and, although, in the authors' experience, it cannot be readily distinguished from the tetraploid *C. officinalis* L. *sensu stricto* on morphological grounds, it is most meaningfully regarded as forming an extension to the range of *C. pyrenaica.* The two tetraploids are distinguishable from each other both morphologically and cytologically and usually occur at higher altitudes than the diploid, although the $2n = 24$ cytotype occasionally is found at lower altitudes. The $2n = 24$ cytotype, which frequently contains B chromosomes, is assigned to *C. officinalis* L., while the cytologically constant $2n = 26$ cytotype represents *C. micacea* Marshall. On the basis of the ecology and chromosome numbers of the above three species, it is suggested that *C. alpina* (Bab.) Wats. is best regarded simply as an inland ecotype of *C. officinalis* L.

The probable post-glacial history of the genus is discussed.

INTRODUCTION

The genus *Cochlearia* L. is widely distributed in the British Isles, where it occurs in both maritime and inland-upland habitats. It is generally agreed that the coastal populations fall into three or possibly four species. These are *C. officinalis* L., *C. danica* L., *C. anglica* L. and possibly *C. scotica* Druce. The first three are common round much of the coasts of the British Isles, except that *C. anglica* is apparently absent from Orkney and Shetland. *C. officinalis* is an extremely common plant of sea-cliffs and the drier parts of salt-marshes, and it also occurs inland; *C. danica* is common on the drier parts of sea-cliffs and in sandy places by the sea and occurs rarely inland; and *C. anglica* is locally abundant on muddy salt-marshes. *C. scotica* is a plant of the north and west, although it may possibly occur as far south as Berwick in the east. Gill (1971) has, however, cast some doubt on the reported distribution of *C. scotica.*

The inland-upland populations have been recognized as belonging to *C. alpina* (Bab.) Wats., *C. pyrenaica* DC., *C. officinalis*, or *C. micacea* Marshall. It has, however, been suggested that neither *C. alpina* nor *C. micacea* are entirely montane plants but may descend nearly to sea-level at least in the islands of northern and western Scotland (Druce 1932). The status of the inland populations of *Cochlearia* have been much disputed, with even the same author recognizing the taxa at different levels at different times—Clapham (1952) recognized both *C. alpina* and *C. micacea* but in 1962 submerged both in *C. officinalis* as *C. officinalis* L. subsp. *alpina* (Bab.) Hook. Chater & Heywood (1964) included

C. alpina in *C. pyrenaica*. Like Clapham (1962), these authors did not distinguish *C. micacea*, regarding it only as a narrow-fruited variant of *C. pyrenaica*. In their treatment of *C. officinalis*, Chater & Heywood included a note—'Plants from Scotland approach the following species' [*C. pyrenaica*].

At least some of the taxonomic confusion which exists in *Cochlearia* has arisen because the characters which are used to distinguish between the taxa are mostly quantitative or plastic, or both. The literature abounds with comparisons such as leaves *fleshy* versus leaves *not* or *hardly fleshy* (Clapham 1952), silicula *ovoid to globose* versus silicula *ovoid-ellipsoid* (Chater & Heywood 1964) or pedicels *usually longer* than silicula versus pedicels *equalling or shorter* than the silicula (Chater & Heywood 1964). Occasionally there occurs absolute contradiction between the keys and the descriptions of the species; Clapham (1952) separated *C. alpina* and *C. micacea* from the rest of the genus by

'Inland, usually alpine plants with leaves not or hardly fleshy'—*C. alpina* or *C. micacea*
'Maritime plants with fleshy leaves'—other species including *C. officinalis*,

yet his description of *C. officinalis* states 'reaches 2,800 ft on Ben Creachain'.

The taxonomic uncertainties which exist are to some extent reflected in the various chromosome numbers which have been reported for these species (Table 1).

TABLE 1. PREVIOUSLY PUBLISHED BRITISH COUNTS FOR *COCHLEARIA ALPINA, C. OFFICINALIS* AND *C. MICACEA*

Species	Locality	Author	2*n*
C. alpina	Scotland	Crane & Gairdner 1923	28
	Malham, Mid-W. Yorks, v.c. 64	Gill 1965	12 (+0–2 B)
	Helvellyn, Cumberland, v.c. 70	Gill 1965	12 (+0–1 B)
C. officinalis	St Davids, Pembs., v.c. 45	Crane & Gairdner 1923	28
	Teesdale, Durham, v.c. 66	Saunte 1955	24
	Ben Bulben, Sligo, v.c. H28	Saunte 1955	24
	Black Head, Clare, v.c. H9	Saunte 1955	24
	Lauragh, S. Kerry, v.c. H1	Saunte 1955	24
	Birdsay, Orkney, v.c. 111	Gill 1973	24
	Yecansby, Orkney, v.c. 111	Gill 1973	24
	Wick, Caithness, v.c. 109	Gill 1973	24 (+0–2 B)
	Coast of Isle of Skye, Mid Ebudes, v.c. 104	Gill 1973	24
	Banff, Banff., v.c. 94	Gill 1973	24 (+0–1 B)
	Carnoustie, Forfar, v.c. 90	Gill 1973	24
	Lamlash, Arran, Clyde Is., v.c. 100	Gill 1973	24 (+0–1 B)
	Caernarvon, Caerns., v.c. 49	Gill 1973	24
	Hook Farm, Pembs., v.c. 45	Gill 1973	24
	Parkgate, Cheshire, v.c. 58	Gill 1973	24
C. micacea	Scotland	Crane & Gairdner 1923	34–36
	Ben Lawers, Mid Perth, v.c. 88	Gill 1973	26
	Meall nan Tarmachan, Mid Perth, v.c. 88	Gill 1973	26
	Beinn Heasgarnich, Mid Perth, v.c. 88	Gill 1973	26
C. sp. (Probably *C. officinalis*)	Various coastal localities in the northern and western Scottish islands	Gill 1971a	24

As orthodox taxonomic methods had failed to produce any agreement on the status of the inland populations of *Cochlearia*, the present work was initiated to determine the extent of the morphological and cytological variation in the group.

METHODS

Material was collected in the wild and identified on morphological criteria as either *C. officinalis* or *C. micacea* (for criteria see Discussion). The majority of the plants were grown on at the the University of Liverpool Botanic Gardens until root-tips and/or flower-buds could be taken for the determination of chromosome numbers. These chromosome counts were made by J.J.B.G. who was kept ignorant of both the taxonomic identities and localities of collection of the material until after the chromosome numbers were determined. Chromosome counts were also made by G.M.F. on flower-buds collected in the field or on root-tips and/or flower-buds from plants grown on at the University of Sheffield Experimental Garden. Chromosome counts were made by the methods previously described (Gill 1965, Fearn 1971).

RESULTS

Of all the populations examined only those from Beinn Dearg and Glas Maol were initially identified as *C. micacea*. These were also the only populations which gave a constant chromosome count of $2n = 26$, thus agreeing with the chromosome number for *C. micacea* previously published by Gill (1973). All the other populations were originally identified as *C. officinalis* but formed two cytotypes. The $2n = 24$ cytotype, which frequently contains B chromosomes, corresponds with *C. officinalis sensu stricto* and was collected from high-altitude stations (above 800m) and from a single low-altitude locality at Cheddar Gorge. All the high-altitude stations were well flushed and presumably relatively base-rich. The $2n = 12$ cytotype, one population of which contains B chromosomes, was collected exclusively from highly base-rich habitats at intermediate altitudes (150–750m).

All the chromosome numbers determined in this investigation are summarized in Table 2 and are included with all previously published counts in Fig. 1.

FIGURE 1. Map showing all published chromosome counts in *Cochlearia* together with those reported in this paper (all counts made by the present authors blacked in).

△ = $2n$ = 12(+ 0–2B)
○ = $2n$ = 24(+ 0–5B)
□ = $2n$ = 26

TABLE 2. CHROMOSOME COUNTS OF *COCHLEARIA* SPECIES MADE IN THIS INVESTIGATION

Species	Grid Reference	Locality	Habitat notes	No. of plants	$2n$
C. pyrenaica	35/71.31	Green Castle, Westmorland, v.c. 69	Carboniferous limestone. High altitude flush, 732m	2	12
	35/757.387	Tynehead, Durham, v.c. 66	Old mine spoil, calcareous, 480m	14	12
	35/852.308	Teesdale, Durham, v.c. 66	Streamside in calcareous meadow, 420m	7	12
	34/98.89	Woodall, N.W. Yorks., v.c. 65	Carboniferous limestone Streamside near old lead mines, 214m, pH 6·7	several	12
	34/99.64	Grassington, Mid-W. Yorks., v.c. 64	Carboniferous limestone. Mud banks of River Wharfe, 168m, pH 7·0	1	12
	43/15.82	Dirtlow Rake, Derbys., v.c. 57	Carboniferous limestone. Spoil heaps of old lead mines, 336m, pH 7·4	several	12
	34/73.18	Entwistle, S. Lancs., v.c. 59	Carboniferous sandstone. Shingle bed and banks of stream, 198m, pH 7·3	3	12 12(+ 2B)
C. officinalis	18/858.596	Tom na Gruagaich, Beinn Alligin, W. Ross, v.c. 105	Wet rock ledges, 875m	4	24 24(+ 1B) (2 plants) 24(+ 2B)
	28/992.032	Coire an t'Sneachda, Cairngorm, Westerness, v.c. 97	Bryophyte flushes on cliff, 1,200m	2	24(+ 1B) 24(+ 2B)
	37/258.856	Black Spout, Lochnagar, S. Aberdeen, v.c. 92	Flushed ledges, 1,200m	3	24 (2 plants) 24(+ 5B)
	27/070.305	Coire Cruitein, Beinn Dorain, Main Argyll, v.c. 98	Wet rock faces, 1,200m	2	24(+ 4B) 24(+ 5B)
	23/600.500	Clogwyn y Garnedd, Snowdon, Caerns., v.c. 49	Wet bryophyte flushes, 1,100m	5	24, 24(+ 1B), 24(+ 2B) 24(+ 3B) (2 plants)
	31/46.54	Cheddar Gorge, N. Somerset, v.c. 6	Carboniferous limestone. Roadside verge, 75m	5	24
C. micacea	28/255.818	Beinn Dearg, W. Ross, v.c. 105	Wet, shady rock crevices in N. facing cliffs, 1,000m	5	26
	37/16.77	Glas Maol, Forfar, v.c. 90	Granite. Damp hollow, 839m, pH 5·6	3	26

DISCUSSION

It is apparent from Table 2 that in Britain there exist inland populations of *Cochlearia* with chromosome numbers of $2n = 12$ (+ 0 or 2B), $2n = 24$ (+ 0 – 5B) and $2n = 26$. These numbers agree with those already published by Gill (1965, 1971a, 1973) for British populations identified as *C. pyrenaica, C. officinalis* and *C. micacea* respectively. The counts of $2n = 28$ for *C. alpina* and $2n$ = 34–36 for *C. micacea* reported by Crane & Gairdner (1923) were not corroborated, so these early counts must remain very doubtful.

The count of $2n = 28$ for *C. alpina* has been discussed by Saunte (1955), who has pointed out that, in Crane & Gairdner's drawing of the somatic chromosomes of this species, there are apparent four chromosomes which are smaller than the others. Saunte interpreted these as being accessory chromosomes and therefore regarded the count as in reality $2n = 24 + 4B$. This interpretation of course gives Crane & Gairdner's material the same chromosome number as *C. officinalis* (Saunte 1955, Gill 1973) and indeed Saunte, who was unaware of the existence of the diploid ($2n = 12$), did not regard the British inland material known to her as being other than *C. officinalis*. It has been well established by both Saunte (1955) and by Gill (1971a, 1973) that specimens of *C. officinalis* containing four B chromosomes, and thus giving chromosome counts of $2n = 28$, are common. Crane & Gairdner's count appears to have been derived from only a single specimen and it is therefore quite possible that it represented an atypical individual from a population of *C. officinalis*. Crane & Gairdner do not give the locality for the collection of their material and it has not proved possible to trace either this or their voucher specimens, so that no direct check of their count can be carried out. The type locality for *C. alpina* is Lochnagar (Druce 1904) and our three plants from this locality had chromosome numbers of $2n = 24$ (2 plants) and $2n = 29$. It would thus appear that our population from the type area was a population of plants with $2n = 24 + 0$–5B chromosomes. The situation in *C. alpina* is further complicated by the fact that in Smith's (1811) description of Don's material from Lochnagar the plant is said to have extremely fleshy basal leaves, while Clapham (1952) separated *C. alpina* from *C. officinalis* on the absence of fleshiness in the leaves of the former species. Although the absence of fleshiness in the basal leaves was used by Gill (1965) to separate the diploid material from Malham and Helvellyn from the *C. officinalis* populations then known to him, it was found that many of the inland $2n = 24$ (+ 0–5B) populations also had non-fleshy basal leaves. It is perhaps worth noting here that the fleshiness or non-fleshiness of the leaves is one of those quantitative characters much used in *Cochlearia* but extremely difficult to apply objectively.

Of all the tetraploid counts only three are from low or moderate altitudes. Two of these (Ben Bulben and Cheddar Gorge) are near to the coast and may be interpreted as being remnant coastal populations of *C. officinalis*, isolated as inland populations with the falling of the sea-level during the post-glacial period. The count of $2n = 24$ from Teesdale (Saunte 1955) should be treated with some suspicion as, despite extensive sampling in that area, the present authors are able to report only diploid counts.

The results suggest, therefore, that the diploid is confined in Britain to apparently base-rich habitats at moderate altitudes (cliffs, streamsides, old mine spoil-heaps), but that near the sea, even on base-rich soils, it may be replaced by the tetraploid. At high altitudes the tetraploid occurs in areas which may or may not be base-rich. Confirmation of such distributions must, however, await more extensive sampling of upland calcareous areas in Scotland and a general survey of upland populations in Ireland.

The status of *C. alpina* is still difficult to ascertain. The authors are conscious that despite the demonstration that material from the type locality (Lochnagar) is tetraploid they have not yet seen the herbarium specimens of either Don or Crane & Gairdner and therefore cannot with certainty identify *C. alpina*. They would, however, suggest that, as Lochnagar is not a base-rich habitat, it is unlikely that the diploid would occur there and that it is therefore unlikely that Don's material was diploid. The extreme difficulty of separating *C. alpina* from *C. officinalis* on morphological grounds together with the extremely doubtful differentiation on chromosome number leads them to suggest that *C. alpina* should be treated only as an inland ecotype of *C. officinalis*.

The diploid material can be identified, using existing Floras, with equal facility as *C. pyrenaica* or *C. officinalis* and it has the same chromosome number as *C. pyrenaica* (Rohner 1954; Dersch 1962, 1968; Gill 1971b; Kakes 1973). *C. pyrenaica* in Europe has long been recognized as a plant of base-rich habitats (Hegi 1919, Hiemans 1971) and this also appears true of the diploid populations in Britain. It is thus apparent that, despite the lack of morphological distinguishing characters, the $2n = 12$

populations in Britain are best regarded as forming an extension of the known range of *C. pyrenaica*. The tetraploid $2n = 24(+ 0\text{–}5B)$ populations are best treated as inland populations of *C. officinalis*.

Those populations which gave a constant count of $2n = 26$ as well as comprising a unique cytotype also form a morphological entity and can, in the experience of the authors, be taxonomically distinguished as *C. micacea*. The chromosome number of this species has been discussed by Gill (1973). The characters which are used to define *C. micacea* are the much darker green of the foliage of this species when compared with the rest of the inland plants, together with the low-growing habit and strong tendency to produce a perennating woody rootstock with some slight vegetative reproduction by lateral shoots. These characters are, however, all comparative characters and, to use them successfully, it is necessary to be well acquainted with the other inland plants. When, however, these characters are combined with the chromosome number and the known genomic constitution of the taxon (Gill 1973), the authors can see no conclusion other than the maintenance of *C. micacea* as a separate species. Such a conclusion agrees with that of Pobedimova (1971) and is supported by the constant distinction of *C. micacea* from *C. alpina* by McVean & Ratcliffe (1962). The details of the distribution of *C. micacea* must await further investigation but it appears to be a plant of high altitudes usually above 800m. It may indeed be a British endemic but there is some suggestion that it may also occur in Scandinavia (Hylander 1945).

The extreme morphological similarities of the three species recognized here and the difficulties experienced by orthodox taxonomists are to be expected if the evolutionary relationships between the different chromosome levels are as suggested by Gill (1973). He demonstrated that *C. officinalis* is essentially an autotetraploid of *C. pyrenaica* and that *C. micacea* may be regarded as a primary tetrasomic of *C. officinalis*. These relationships would result in the only unique genes or alleles possessed by any of the species being those which arose by mutation shortly after speciation. Such mutations would be very rare and, therefore, if the evolutionary pathways suggested by Gill are accepted, it would be expected that the differences between *C. pyrenaica, C. officinalis* and *C. micacea* would be those arising from the differing number of gene copies in the three species. Such differences would almost certainly be quantitative rather than qualitative but must account for the differing ecological amplitudes of the taxa.

The tetraploid *C. officinalis*, if it originated from a highly heterozygous diploid, would have a greatly increased variance for many loci and could, therefore, be much superior to the diploid in its ability to colonize new habitats. The inland distribution of *Cochlearia* is typical of one much affected by glaciation and it is tempting to suggest, because of the existence of the Polish endemic *C. polonica* Borb. and the possible endemic status of *C. micacea*, that much of the speciation in the European members of the genus occurred either during or at the end of the last glaciation. The great number of new habitats made available by the retreating ice would have produced a selective regime in which increased variance would be of considerable advantage. Such a situation would seem to be ideal for the establishment and spread of an autotetraploid species such as *C. officinalis*. The diploid parent of any autotetraploid would almost certainly be in competition with its tetraploid offspring, but the continued existence of both may also be due to the differences in copies of gene loci between them. The diploid, because of the small number of copies of each locus present, would be able to fix a genetic trait much more quickly than the tetraploid and, in the face of competition from the tetraploid, could retreat into some extreme or relict environment similar to that to which it has already been exposed. In this extreme environment the relative lack of variance of the diploid could well enable it to compete successfully against the tetraploid and eventually, by the accumulation of new mutations, to become so highly and specifically adapted to the particular extreme habitats into which it had retreated that competition from the tetraploid ceased. The habitats at present occupied by *C. pyrenaica* in northern England would appear to be sufficiently extreme to be accountable for by the events suggested above.

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Notes on British *Rubi*, 5

E. S. EDEES

23 Dartmouth Avenue, Newcastle, Staffs.

ABSTRACT

Rubus fuscus Weihe & Nees is discussed and two new species are described, *viz*. **R. anglofuscus** and **R. informifolius**. *R. nemoralis* P. J. Muell. is confirmed as the correct name for *R. selmeri* Lindeb.

1. *Rubus fuscus* Weihe & Nees in Bluff & Fingerh., *Comp Fl. Germ.*, **1**: 681 (1825)

British batologists have misunderstood this taxon. They have applied the name too loosely. Rogers (1900) called *R. fuscus* 'variable' and 'seldom quite typical with us' and (note on specimen in **BM**) 'notoriously one of our most hopelessly aggregate species.' The herbarium of W. C. Barton and H. J. Riddelsdell in **BM** contains about 100 sheets labelled *R. fuscus*, but, as far as I can ascertain, only one of them, a specimen collected by Focke in 1875 from Weihe's original station (see below), is correctly named. Focke is partly to blame for the confusion. He knew very well what Weihe meant by *R. fuscus*, but in later life broadened his interpretation of the name to accommodate related taxa which he had found in England and other European countries. He wrote (Focke 1914): 'Planta typica species vel prospecies bene distincta videtur, sed innumerae occurrunt formae, in quibus omnes partes leviter variant, ita ut alias species imitentur. Limites *R. fusci* igitur dubii et variabiles sunt.' W. C. R. Watson began by trying to define *R. fuscus* precisely, but ended like Focke in a generalization. In 1949 he correctly distinguished two taxa, one from The Chart, Limpsfield, Surrey, v.c. 17, which he claimed to be the true *R. fuscus*, and one from the west of England, which he identified with *R. fusciformis* Sudre. But in 1958 he united them and called them both *R. fuscus*.

The lectotype of *R. fuscus*, designated by Professor H. E. Weber in 1976, is a specimen in **BR** collected by Weihe. It consists of a panicle and a piece of the barren stem with one leaf. The label in Weihe's handwriting reads as follows: '*Rubus fuscus* Weihe in montibus circa Altena comitatus Mark.' It is undated, but, as Weihe is known to have visited Altena only once, there is no doubt that it is one of the specimens referred to in the original description. There are other undated specimens from the same locality in **MSTR** and yet another in Focke's herbarium in **BREM**, but these are mite-infested and therefore less satisfactory. I have not seen the lectotype, but Weber has given me three photographs of it, one showing the whole plant and two showing a flower head and the barren stem enlarged. The specimen in **BM** collected by Focke at Altena in 1875 matches the photographs very well and so does an undated specimen in **K** collected by G. Braun (Herbarium Ruborum germanicorum no. 93), 'Auf mergeligem Boden im Amte Sternberg, Lippe—Detmold, sehr verbreitet.' Weber visited the *locus classicus* in 1970 without finding *R. fuscus* there, but he said it was more or less plentiful in southern Westphalia as far as the Lippe district, especially at Blomberg. I have two recent specimens from Blomberg, collected by A. Newton and Weber in 1974, which tally very well with the lectotype and which are, to quote Weber (*in litt.* 1975), 'certainly true *R. fuscus* with all the characteristic features.'

The following description is based on the Blomberg specimens:-

Stems angled, clothed with numerous, short (*c* 0·5–1 mm) hairs, acicles and stalked glands, many of the glands (as distinct from some gland-tipped acicles) being shorter than the hairs. Prickles numerous (*c* 12 every 5 cm), about as long as the stem diameter, subequal, declining.

Leaves quinate (one ternate), pedate. Leaflets green and thinly hairy on both sides; upper surface dark, matt green. Terminal leaflet broadly elliptic to obovate with somewhat straight sides and tapering to a fine point; base emarginate or truncate. Serration uneven, with the principal teeth more prominent than the others and sometimes slightly retrorse. Petiolule about 1/3 length of blade.

Inflorescence leafy for 2/3 of its length with ternate and simple leaves subtending peduncles; lower peduncles 6 cm, upper 2 cm long; upper leafless part of inflorescence more or less cylindrical, with short, subequal peduncles; all peduncles divided near the top into short pedicels producing dense clusters of flowers. Rachis densely hairy with many stalked glands almost as long as the hairs. Prickles numerous, slender, declining or curved.

Sepals grey-felted with many acicles and stalked glands, reflexed. Petals pinkish, broadly elliptic; filaments equalling pinkish-based styles; carpels and receptacle pilose.

The description in Weihe & Nees (1826) differs in a few ways, but the full page illustration in that book (t. xxvii) is wonderfully accurate. The prickles on the barren stem are said to be sparse, but the illustration shows them to be numerous. The terminal leaflet is said to be cordate-ovate, but again the illustration shows it as described above, though with a slightly more indented base. The most serious discrepancy is in the shape of the petals, which are said to be suborbicular and are so drawn in the illustration. But Focke (1877), soon after he had studied the living bushes in Weihe's locality, wrote: 'Petala obovato-cuneata alba vel rosea.' The barren stem-piece is very well drawn and shows the short glands, hairs and acicles to perfection.

I am not sure that typical *R. fuscus* has yet been discovered in the British Isles. Newton and Weber found a bramble at Lee Clump, near Wendover, GR 42/911.046, Bucks., v.c. 24, 17/7/1976, which they both thought was *R. fuscus*. But the specimen I have seen is not in my judgment identical with the Blomberg plant. For one thing the toothing of the leaflets is not the same. Weber's latest opinion (*in litt.* 1977) is that it is an extreme form of *R. fuscus*, though it was not the leaf serration but the relatively long glands and short hairs which seemed to him atypical.

Of the many taxa which have been labelled *R. fuscus* by British batologists, several deserve recognition as new species. Two which occur in Staffordshire are described below.

2. **Rubus anglofuscus** E. S. Edees, **sp. nov.**

Turiones obtuse angulati, in apricis rubescentes, interdum pruinosi, dense pilosi. Aculei numerosi (10–15 per 5 cm), e basi lata declinati, inaequales, impariter dispositi aculeolis tuberculisque saepe interspersi. Aciculae et glandulae stipitatae pilos aequantes vel eis breviores, vulgo sparsiores.

Folia ternata aut quinata pedata. Foliola laete viridia, supra strigosa, subtus leviter pilosa, dentibus latis inaequaliter serrata. Foliolum terminale parum obovatum, breviter acuminatum, basi emarginatum, petiolulo proprio quadruplo longius.

Rami floriferi pilis patentibus dense vestiti. Aculei declinati. Aciculae glandulaeque stipitatae non rarae. Inflorescentiae foliaceae, e ramulis brevibus, adscendentibus, 1-7-floris compositae.

Sepala aculeolata et glandulosa, primo laxe reflexa, demum patentia vel suberecta. Petala alba, late obovata. Stamina alba stylos rubros aequantia vel parum superantia. Carpella et receptacula pilosa.

Stems bluntly angled, red, densely clothed with patent hairs (*c* 1 mm long), sometimes pruinose. Prickles numerous (10–15 per 5 cm), slightly declining from a broad base, unequal in length and unevenly distributed, often interspersed with pricklets and tubercles. Acicles and stalked glands equal to or shorter than the hairs, usually few and sometimes rare or absent.

Leaves ternate or quinate pedate. Leaflets bright green, strigose above, thinly hairy beneath, biserrate with broad teeth. Terminal leaflet obscurely obovate, with short acuminate point and emarginate base, about four times as long as its petiolule.

Flowering branches clothed with many patent hairs and numerous acicles and stalked glands. Prickles more strongly declining than those of the stems. Panicles with short, ascending peduncles bearing 1–7 flowers, sometimes leafy throughout, but usually with a short leafless extension. Leaflets like those of the stem-leaves in shape, colour, texture and serration.

Sepals aculeolate, glandular, at first reflexed, then patent or suberect. Petals white, broadly obovate. Stamens white, equalling or slightly exceeding the red or reddish-based styles. Carpels and receptacles hairy.

HOLOTYPUS: Wigginton Heath, GR 42/3.3, Oxon, v.c. 23, 24/7/1931, *H. J. Riddelsdell*, as *R. fuscus* Weihe & Nees, no. 3007 in herb. Barton & Riddelsdell (**BM**)

R. anglofuscus differs from *R. fuscus* in several ways. In *R. anglofuscus* the stalked glands on the barren stems may be as long as the patent hairs, but are usually few and sometimes rare or even absent. *R. fuscus* on the other hand has a rather dense clothing of short acicles and stalked glands, which Weihe & Nees (1826) described thus: 'Aciculae semilineam vix longae nudoque oculo fere inconspicuae, sed tactu sine negotio distinguendae.' The leaves of the two taxa have a very different appearance. Those of *R. fuscus* are usually quinate. Weihe & Nees (1826) said, 'Folia omnia quinata'. But those of *R. anglofuscus* are often ternate. However there are too many exceptions on both sides to make this a reliable distinction. There is a much more important difference in the shape and serration of the terminal leaflets. Those of *R. fuscus* have fine acuminate points and rather straight sides reminiscent of *R. pallidus* Weihe & Nees, whereas the terminal leaflets of *R. anglofuscus* have shorter, broader points, more rounded sides and markedly broader teeth. The colour of the foliage is another difference. The leaflets of *R. anglofuscus* are normally a bright, fresh green contrasting with the brick-red colour of the stems; the leaflets of *R. fuscus* are darker, 'saturate viridia' (Weihe & Nees 1826). The sepals of *R. fuscus* are reflexed; those of *R. anglofuscus* become patent or erect after anthesis. The petals of *R. fuscus* may be pink or white; those of *R. anglofuscus* seem to be always white.

R. anglofuscus is a common bramble of the west Midlands from Oxford north to Staffordshire. I have specimens in my herbarium (*herb. E. S. Edees*), all collected by myself, from the following localities: Norton near Stourbridge, GR 32/8.8, Worcs., v.c. 37; Sutton Park, GR 42/1.9, and Edge Hill, GR 42/3.4, Warks., v.c. 38; Trysull and Seisdon, GR 32/8.9, Arley Wood, GR 32/8.8, Enville, GR 32/8.8, Baggeridge Wood, GR 32/8.9, and Wrottesley, GR 33/8.0, Staffs., v.c. 39; Puleston Common, GR 33/7.2, and near Claverley, GR 32/8.9, Salop, v.c. 40; and another collected by myself from the type locality.

Watson's specimens from The Chart, Limpsfield, Surrey, v.c. 17, which he distributed through the Botanical Exchange Club in 1945 as *R. fuscus*, are probably *R. anglofuscus*, though on the two sheets I possess the barren stem is not sufficiently hairy to be typical and the short acicles and stalked glands, which do not exceed 0·5 mm, resemble those of *R. fuscus*. There are early specimens of *R. anglofuscus* (all labelled *R. fuscus*) in **CGE** from Warwickshire, collected by J. E. Bagnall and others. The earliest I have seen is one in Babington's herbarium in **CGE** from Sutton Park, collected by W. Mathews in 1850. In Barton and Riddlesdell's herbarium in **BM** there is an excellent series from Wiggington Heath, Oxon., v.c. 23, collected by H. J. Riddelsdell between 1916 and 1935, and a specimen from Seven Springs, Bourton-on-the-Water, GR 42/131.226, E. Gloucs., v.c. 33, collected by Riddelsdell in 1935.

Finally it is probable that this taxon also occurs in France. There is a specimen in **MANCH** of Sudre's Rubi rari no. 215, gathered in the Rhine Province in 1911, which seems to me identical with *R. anglofuscus*. Sudre named it *R. erubescens* Wirtg., but it is certainly not that.

3. **Rubus informifolius** E. S. Edees, **sp. nov.**

Turiones obtuse angulati, in apricis rufescentes, pilis brevibus (*c* 1 mm) vestiti, aciculis glandulisque stipitatis (*c* 0·5 mm) obsiti. Aculei numerosi (*c* 10–15 per 5 cm), inaequales (*c* 2–6 mm longi), paulo declinati. Glandulae stipitatae nonnunquam sparsae.

Folia quinata pedata. Foliola pallide viridia, supra glabrescentia, subtus ad nervos leviter pilosa sed non tomentosa, non profunde crenata, ad marginem undulata. Foliolum terminale, ubi perfectum, late ovatum vel obovatum vel suborbiculare, sed non raro plane informe, cordatum vel emarginatum, breviter acuminatum.

Rami floriferi dense pilosi, aciculis multis brevibus muniti. Aculei graciles declinati vel curvati. Inflorescentiae subpyramidatae, ramulis inferioribus longis saepe divaricatis instructae, fere usque ad apicem foliosae. Foliola illis turionum pilosiora sed nequaquam tomentosa. Ramuli superiores uniflori vel in medio divisi et 2-4-flori. Pedicelli glandulis breviter stipitatis crebris aculeolisque multis tenuibus flavis praediti.

Sepala albo-marginata, appendiculata, aculeolata, glandulosa, erecto-patentia. Petala alba, late obovata sed non contigua, paulo indentata. Stamina alba stylos virides vix superantia. Carpella subglabra. Receptacula hirsuta.

Stems bluntly angled, reddish in the sun, clothed with short hairs (*c* 1 mm). Prickles numerous (*c*

10–15 per 5 cm), unequal (*c* 2–6 mm long), slightly declining. Acicles and stalked glands rather short (*c* 0·5 mm), not exceeding the hairs. Stalked glands sometimes rare.

Leaves quinate pedate. Leaflets yellowish-green, slightly hairy on both surfaces, but glabrescent above and hard to the touch beneath, without felt; serration shallow; margins undulate. Terminal leaflet broadly ovate or slightly obovate in general outline, but often shapeless with humps and indentations; base emarginate or cordate; point shortly acuminate.

Flowering branches clothed like the stems with many short hairs, acicles and stalked glands. Prickles slender, declining or curved. Panicles subpyramidal, with long, often divaricate, lower branches, leafy nearly to the top. Leaflets hairier than those of the stems, but green on both sides and not felted. Upper peduncles sometimes with a single flower, but more often deeply divided and 2-4-flowered. Pedicels clothed with many fine, yellow acicles and stalked glands of varying length.

Sepals white-bordered, long-pointed, aciculate, glandular, patent to erect. Petals white, broadly obovate but not contiguous, slightly indented. Stamens white, only very slightly longer than the green styles. Carpels subglabrous. Receptacles hairy.

HOLOTYPUS: Cranmoor Park, Wrottesley, GR 33/85.00, Staffs., v.c. 39, 20/7/1958, *E. S. Edees* 12732 **(herb. E. S. Edees)**

R. informifolius is common in the Wyre Forest and in the neighbouring parts of Hereford, Worcester, Staffordshire and Salop. In addition to the holotype, the following exsiccata may be cited as representative:

Wood west of Buckenhill Common, Bromyard, GR 32/6.5, Hereford, v.c. 36, 22/7/1952, W. H. Mills, det. W. C. R. Watson, as *R. aristisepalus* (Sudre) W. C. R. Wats., **CGE**

Tedstone Delamere, GR 32/6.5, Hereford, v.c. 36, 6/8/1924, H. J. Riddelsdell, herb. Barton & Riddelsdell, no. 957, **BM**

Clifton (probably Clifton-on-Teme), GR 32/7.6, Worcs., v.c. 37, undated, W. C. R. Watson, as *R. aristisepalus,* **CGE**

Southstone Rock, GR 32/7.6, Worcs., v.c. 37, 24/7/1972, E. S. Edees, **herb. E.S.E.**

Sheep Walks, Enville, GR 32/81.85, Staffs., v.c. 39, 31/7/1954, E. S. Edees, **herb. E.S.E.**

Wyre Forest, near Cleobury Mortimer, GR 32/6.7, Salop, v.c. 40, 15/7/1953, W.C.R. Watson, as *R. fusciformis* Sudre, **CGE**

Whitcliff, Ludlow, GR 32/5.7, Salop, v.c. 40, 8/7/1953, W. C. R. Watson, as *R. fuscus* Weihe, syn. *R. fusciformis* Sudre, **herb. E.S.E.**

Woodland near Billingsley, GR 32/70.84, Salop, v.c. 40, 9/7/1965, E. S. Edees, **herb. E.S.E.**

R. informifolius has several distinctive features, *viz.* broad, often shapeless leaflets with ungainly humps and indentations, which are hard to the touch beneath and which have broad shallow teeth sometimes coalescing near the point of the leaflet; fine rachis prickles, of which a few are strongly curved; rather long, somewhat divaricate peduncles; pedicels with fine, needle-like, yellow prickles; long-pointed, spreading sepals; and a general yellowish-green hue.

4. *Rubus nemoralis* P. J. Muell., *Flora (Regensb.),* **41**: 139 (1858)

R. selmeri Lindeb., Herb. Rub. Scand. no. 33 (1884)

The object of this note is to justify W. C. R. Watson's identification of *R. selmeri* Lindeb. with *R. nemoralis* P. J. Muell. Watson first declared these two to be the same taxon in 1938, though he advanced no evidence. He had probably seen E. Mueller's paper, published in 1937, in which the same identification was made. E. Mueller (not to be confused with P. J. Mueller) said that *R. selmeri* occurred plentifully at Kaiserslautern and was 'ohne Zweifel der Müllersche *Rubus nemoralis*'. I have a specimen in my herbarium collected by E. Mueller at Kaiserslautern, Rheinpfalz, Germany, 3rd August 1935, which is named in the collector's handwriting '*Rubus nemoralis* P. J. Muell. (= *Rubus selmeri* Lindeb.)'. This specimen is undoubtedly identical with *R. selmeri* or at any rate with the common British bramble which has been given that name. The specimen came to me from F. Rilstone and he agreed that it was 'certainly *selmeri*'. I have not seen the lectotype of *R. selmeri* designated by Beek (1974), but there is no reason to doubt the identity of the British and Norwegian plants.

The question remains, is *R. selmeri* identical with *R. nemoralis*? W. C. Barton (manuscript notes) thought it was not. He admitted that the descriptions were similar but thought that there were differences between the type specimen of *R. nemoralis* (Reissbach, 20th July 1857, P. J. Mueller, no. 473, **LAU**) and English specimens of *R. selmeri* which could not be explained away. However, Professor H. E. Weber has labelled Mueller's no. 473 '*Rubus nemoralis* P.J.M. 1858 (= *R. rotundatus* P.J.M. ined.) = *R. selmeri* Lindeberg 1884, holotypus.' A. Newton and I have examined the specimen independently and have reached the same conclusion that Barton was wrong and Weber right. The specimen is not convincingly the same as *R. selmeri* at first sight, because the panicle prickles are not strongly curved, most of them being straight and declining. But a close examination reveals the presence of other characters which bring the specimen within the range of *R. selmeri*. The leaves are digitate, the leaflets glabrous on the upper surface, the sepals loosely reflexed to patent, the stamens short, the carpels pilose and, though the petals are difficult to examine, one of them at least is plainly notched. I have a specimen from Alum Chine, Bournemouth, S. Hants., v.c. 11, collected by W. M. Rogers in 1907, which closely matches Mueller's type and which Rogers did not hesitate to call *R. selmeri*.

Therefore will collectors please note that specimens named *R. selmeri* by me should be re-named *R. nemoralis*? Both names are taxonomically correct, but *R. nemoralis* has priority.

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The occurrence of *Solanum nigrum* L. × *S. sarrachoides* Sendtn. in Britain

A. C. LESLIE

Botany School, Downing Street, Cambridge

ABSTRACT

Solanum × **procurrens** Leslie, **hybr. nov.** (= *S. nigrum* L. × *S. sarrachoides* Sendtn.), a sterile hybrid, is described, with chromosome counts, from localities in south-eastern Britain.

INTRODUCTION

Gamlingay village lies 18 miles south-west of Cambridge near the boundary of Cambridgeshire, v.c. 29, with Bedfordshire, v.c. 30. Here the Lower Greensand has its botanically most important outcrop in Cambridgeshire and the area formerly held the best acid bogs in the county. These almost entirely disappeared during the last century as the land was drained and ploughed, with the result that the majority of the ground is now devoted to market-gardening, which prospers on the light soil.

To the west of the village, around the area known as the Cinques, several cultivated fields support large mixed populations of two *Solanum* species, the South American alien *S. sarrachoides* Sendtn. and the ubiquitous weed *S. nigrum* L. In September 1975 putative hybrids were found, easily recognized by their large size and abundant flowers. Dr J. M. Edmonds tentatively confirmed that these might be hybrids and further investigation has verified the original determination.

DESCRIPTION OF HYBRID

Stace (1975) recorded no British or European hybrids in the Solanaceae and no other literature records of this hybrid have been traced. Since the hybrid was widespread at Gamlingay, occurs in similar habitats in Bedfordshire and is likely to occur in other established mixed populations, it seems desirable that it be formally described:

Solanum × **procurrens** Leslie, **hybr. nov.**

Hybrida inter *Solanum nigrum* L. et *S. sarrachoides* Sendtn.

Herba plerumque annua vegeta, pilis glanduliferis brevibus (1–2 cellulis) patentibus numerosis et longis (4–7 cellulis) ascendentibus vel adpressis paucis pilis simplicibus longis (4–7 cellulis) ascendentibus vel adpressis numerosis vestita. Caulis principalis ad 45cm altus, erectus; rami infimi divaricati, in plantis bene evolutis decumbentibus, interdum ad nodos radicantes. Folia 40–120 × 20–45mm, viridia, aliquando ad marginem atrocaerulea, trullata vel late trullata, apice acuta, integra vel sinuato-dentata, basi subtruncata vel late cuneata.

Cymae extra-axillares, racemosae, laxae, 3–7 floribus; pedunculi sub anthesi 9–22mm longi divaricati, interdum post anthesi reflexi; pedicelli sub anthesi leviter arcuati vel erecti, post anthesi reflexi. Calyx vix vel non accrescens; lobi triangulares acuti. Corolla 10–17mm in diametro, alba (interdum extra malvini suffusa); tubo brevissimo, lobis triangularibus vel late triangularibus. Antherae bene evolutae, sed pollinibus irregularibus praecipue (98–100%) sterilibus. Bacca interdum non evoluta vel plerumque parva (2·5–4·5mm lata) nigra caduca sine seminibus, saepe bacca pedicello cadua.

Usually a vigorous annual with numerous short (1–2 celled) spreading glandular hairs, few long (4–7 celled) ascending or adpressed glandular hairs and numerous long (4–7 celled) ascending or adpressed simple hairs. Stems to 45cm, erect; lowest branches divaricate, long-decumbent in well-developed plants and occasionally rooting at the nodes. Leaves 40–120 × 20–45mm, green, sometimes suffused bluish-black on the margin, trullate or broadly trullate, acute at apex, entire or sinuate-dentate, truncate or broadly cuneate at base.

Cymes extra-axillary, racemose, lax, with 3–7 flowers; peduncles 9–22mm long at anthesis, divaricate, sometimes slightly reflexed in fruit. Calyx not or scarcely accrescent; lobes triangular, acute. Corolla 10–17mm diameter, white (sometimes tinged mauve externally); tube very short; lobes triangular or broadly triangular. Anthers well developed but pollen irregular and largely (98–100%) sterile. Berries either not developed or more usually small (2·5–4·5mm wide), black, caducous, without seeds, and often shed with the pedicels.

HOLOTYPUS: sandy, market-garden field, Gamlingay Cinques, Cambs., v.c. 29, GR 52/228.530, 26 October 1975, *A. C. Leslie* no. 1029/1975 (**CGE**)

The epithet (*procurrens*, extending) was suggested by the habit of well-developed plants. A single specimen grown at the Botany School Field Station in Cambridge made a circular patch over 4m in diameter with very long decumbent branches, before being killed by the first frosts. Both parents can exhibit this behaviour, but neither in the field nor usually in cultivation is this feature so pronounced. Voucher specimens of both parents from the same locality as the holotype of the hybrid have been placed in **CGE**.

Both parents are variable species and to some extent *S.* × *procurrens* reflects this, especially as regards leaf shape. *S. nigrum* is represented at Gamlingay by subsp. *nigrum*, and plants of this with either entire or sinuate-dentate leaves occur, as well as plants having either normal or deeply divided corollas with very narrow lobes (var. *stenopetalum* Döll). A similar, apparently un-named corolla variant of *S. sarrachoides* occurred in a field at Potton, just over the border in Bedfordshire; this plant also had entire leaves. Specimens of *S. sarrachoides* with the latter character are frequent in the Gamlingay populations in company with sinuate-dentate plants.

S. × *procurrens* can be distinguished from its parents by the characters shown in Table 1.

TABLE 1. COMPARISON OF *S. NIGRUM* L. SUBSP. *NIGRUM* AND *S. SARRACHOIDES* SENDTN. WITH THE HYBRID *S.* × *PROCURRENS* LESLIE

	S. nigrum subsp. *nigrum*	*S.* × *procurrens*	*S. sarrachoides*
Longest stem hairs	Appressed, eglandular	Ascending or appressed, occasionally glandular	Patent, glandular
Calyx (in fruit)	Not accrescent	Scarcely or not accrescent	Strongly accrescent
Calyx-teeth (at anthesis)	Broadly triangular, obtuse	Triangular, acute	Narrowly triangular, acute
Corolla-lobes	Longer than broad	About as long as broad	As long as broad
Berry colour	Black	Black	Green (or purplish-brown)
Sclerotic granules in berry	Absent	Absent	Present
Pollen fertility (%)	*c* 100	0–2	*c* 100
Chromosome number	$2n = 72$	$2n = 48$	$2n = 24$

The hybrid might otherwise be confused with *S. luteum* Miller, which differs in its fertile, red, orange or yellow berries and the peduncles usually shorter than the pedicels; or with *S. nigrum* L. subsp. *schultesii* (Opiz) Wessely, in which the long glandular hairs are patent and the berries are fertile.

CHROMOSOME NUMBER

Root-tips of the parents and the hybrid were obtained from individuals transplanted to the University Botanic Garden and the Botany School Field Station (hybrid only) and were pretreated with either a 0·05% solution of colchicine or a saturated aqueous solution of 1–bromonaphthalene for three hours and fixed in acetic-alcohol (1:3) overnight. Root-tip squashes were then made using the Feulgen method. Three counts from each of the two hybrid plants all gave the tetraploid number of $2n = 48$. *S. nigrum* and *S. sarrachoides* were confirmed to be hexaploid ($2n = 72$) and diploid ($2n = 16$) respectively. The natural occurrence of this tetraploid hybrid is of particular interest in the light of experimental hybridization, which suggests that there may be a *S. sarrachoides* genome in *S. nigrum* (Edmonds in press).

DISTRIBUTION OF THE HYBRID

Apart from the fields in the vicinity of the Cinques, *S.* × *procurrens* has been noted in the following sites, all on the greensand:

Market-garden field, Mill Hill, south of Gamlingay, Cambs., v.c. 29, GR 52/236.510, 26 October 1975

Market-garden field, Potton, Beds., v.c. 30, GR 52/230.501, 26 October 1975, *A. C. Leslie* no. 1033/1975 (**herb. A.C.L.**)

Market-garden field, Sutton, Beds., v.c. 30, GR 52/230.577, 26 October 1975

It undoubtedly occurs elsewhere in this area and should be looked for wherever the two parents are established together; potential sites exist in the East Anglian Breckland and on the sands to the south of Guildford, Surrey, v.c. 17.

The occurrence of *S. sarrachoides* at Gamlingay was first formally noted in 1972 (R. J. Pankhurst, card index of the Cambridgeshire flora in **CGE**), but it has evidently been established for a much longer time and it is known to the local farmers as the 'White Nightshade'. It has a longer recorded history in Bedfordshire, being listed for Potton by Dony (1953). It may well have been originally introduced with wool shoddy, which is still used irregularly at Sutton. Another South American annual, *Galinsoga parviflora* Cav., is also well established over the whole area.

DISCUSSION

Leslie (1976) showed that most British alien material named *S. sarrachoides* Sendtn. is in fact *S. nitidibaccatum* Bitter, whilst *S. sarrachoides* Sendtn. emend. Bitter is a much rarer plant. Continental authors (e.g. Ooststroom & Reichgelt 1966, Ludwig 1973) have come to similar conclusions. However the relationship of these two taxa is uncertain, for, although European alien material can be clearly divided into two, the variation in this group in South America is complex and other similar taxa occur. In view of the uncertainty about the distinction between the South American taxa *S. nitidibaccatum* Bitter and *S. sarrachoides* Sendtn. emend. Bitter, in this paper *S. sarrachoides* refers to the complex. However, if the two are distinguished, *S.* × *procurrens* strictly refers to the hybrid between *S. nigrum* subsp. *nigrum* and *S. nitidibaccatum.*

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Derelict industrial land as a habitat for rare plants in S. Lancs. (v.c. 59) and W. Lancs. (v.c. 60)

E. F. GREENWOOD

Merseyside County Museums

and

R. P. GEMMELL

Joint Reclamation Team of Greater Manchester and Lancashire County Councils

ABSTRACT

The importance of derelict land in S. and W. Lancs. as refugia for regionally rare and local species is demonstrated with particular reference to colonies of marsh orchids (*Dactylorhiza* species and hybrids). The significance of the sites for research and nature conservation is discussed.

INTRODUCTION

During the last ten years or so a number of sites containing marsh orchids (*Dactylorhiza* species and hybrids) have been found in the Watsonian vice-counties of S. and W. Lancs. (now forming parts of the administrative counties of Cheshire, Greater Manchester, Lancashire and Merseyside) where earlier workers (Wheldon & Wilson 1907, Savidge *et al.*1963) reported them to be rare. Our studies of these sites have revealed that many of the orchid-rich habitats have been formed from derelict industrial land, being either grossly modified by man or entirely man-made.

In this study 35 sites containing large populations of marsh orchids were discovered. 22 of these are located in the more industrialized vice-county of S. Lancs, where only two sites, including one of a series of locations on the coastal sand-dunes, are in natural or semi-natural habitats.

Altogether 25 of the sites were found to be entirely man-made or grossly modified by man and it is the significance of these that is discussed.

THE HABITATS

In the semi-natural habitats the substrates were generally base-rich and damp, as in coastal dune-slacks. Inland habitats were frequently old meadows or commons where, usually through grazing, scrub and woodland development had been prevented.

The man-made habitats were always base-rich but not necessarily marshy or damp. They varied from old cultivated fields, reclaimed salt-marshes and disused railway cuttings to tipped industrial waste and abandoned clay pits. Table 1 lists 21 man-made sites and indicates the kind of site involved together with the date of abandonment. None of the sites existed 100 years ago and the earliest records for orchid colonization date from 1915 (Rainford Junction) and 1942 (Cop Lane, Penwortham), but most records are much more recent. It is probably worth noting, however, that at Rainford Junction and Cop Lane it took 57 and 60 years respectively before the sites were known to be colonized by marsh orchids, whereas in the more recently abandoned sites colonization has occurred much more quickly. At some sites, e.g. Marton railway cutting, colonies have been noticed less than ten years after the site had been abandoned.

TABLE 1. THE ORIGIN OF SOME INDUSTRIAL SITES

Site	Origin	Date of abandonment (where known)
v.c.59		
Banks Marsh, GR 34/38.23	Reclaimed salt-marsh after building of embankment	1895
Chat Moss, GR 33/69.97	Formerly raised bog, cut over for peat and dominated by *Molinia caerulea.* High lime content unexplained but possibly from agriculture	
Cop Lane, Penwortham, GR 34/52.27	Railway cutting started for sidings	1882
Darcy Lever, Bolton, GR 34/73.07	Leblanc process waste	1920s
Failsworth Golf Course, GR 34/88.01	Hollow adjacent to railway cutting	—
Hart Common, GR 34/63.05	Damp hollows between colliery spoil heaps	—
Haskayne railway cutting, GR 34/35.09	Railway cutting	1953/4
Hightown meadows, GR 34/30.03	Arable fields reclaimed from Link Sands, then used as hay-meadows	*c*1968
Ince Moss, GR 34/59.02	Colliery subsidence, colliery washery waste, boiler ash, lime waste and peat remnants	1960s
Kirkless Lane, Ince in Makerfield, GR 34/60.06	Blast-furnace slag and boiler ash	1930s
Lightshaw Hall Flood, GR 33/61.99	Colliery subsidence	—
Longton Brickworks, GR 34/48.25	Clay pit used for brickworks	1965
Nob End, Little Lever, GR 34/74.06	Leblanc process waste	*c*1900
Pollard Moor, Hapton, GR 34/79.31	Lime waste and gas-lime tip	*c*1935
Rainford Junction, GR 34/47.02	Triangle of land at railway junction	1858
Rixton clay pits, GR 33/68.90	Clay pits used for brickworks	1960s
Westwood Power Station, Wigan, GR 34/58.04	Power-station ash tipped into subsidence flash	*c*1963
v.c.60		
Broadwater, Fleetwood, GR 34/32.45	Waste land, formerly reclaimed salt-marsh	—
Heysham Flash, GR 34/40.59	Old sand-dunes enclosed by construction of Heysham Harbour and tipped boiler ash	1900s
Marton railway cutting, GR 34/33.33	Marsh orchids appeared on banks when management ceased on closure of railway	1967
Salwick Atomic Energy Works, GR 34/46.31	Alkali waste	1963/4

Of particular interest are the habitats associated with tipped waste material; Table 2 lists five principal types of waste that can be recognized. The raw, unweathered wastes from which the tip soils are derived were strongly alkaline and ranged from pH 8.5 (lime waste) to pH 12.7 (Leblanc process waste). Observations of exposed profiles of colonized Leblanc process waste (Table 3) revealed the development of rendzina soils. However, older and more weathered wastes were less base-rich due to leaching and carbonate formation from calcium hydroxide; this has allowed invasion by willow and hawthorn scrub to occur. At the same time, surface humification has encouraged the establishment of various species including legumes, particularly *Lotus corniculatus*, with a consequent enrichment of soil nitrogen leading to eventual formation of closed grassland communities. Such successional changes may, in time, destroy the floristic richness of the sites.

THE FLORA OF MAN-MADE SITES

The industrial habitats characterized by the marsh orchid populations contained a number of other species regarded as rare according to a recent systematic survey of W. Lancs. (Table 4). In this survey. rare species were defined as those occurring in 10 (2·6%) or fewer tetrads (2 × 2km squares of the National Grid). A similar list of rare species can be prepared for S. Lancs. using *Travis's Flora of South Lancashire* (Savidge *et al.*, 1963), but *Carex pseudocyperus* and *Glyceria maxima* are more common there whilst *Eleocharis uniglumis*, widespread in W. Lancs. coastal habitats, is rare. Also *Dactylorhiza incarnata* and *Blackstonia perfoliata* are widespread on the S. Lancs. coastal sand-dunes but inland they are rare. None of the species is nationally rare (Richards 1972), although a number are either only found occasionally or are at the limits of their distribution in Britain (Perring & Walters 1962).

TABLE 2. THE PRINCIPAL TYPES OF WASTE WHICH PROVIDE HABITATS FOR ORCHID POPULATIONS

Type of waste	Contribution to soil reaction	Type of flora
Leblanc process	$CaCO_3$, $Ca(OH)_2$, hydrolysis products of CaS	Open, herb-rich, calcicolous associations. *Festuca rubra* dominant. Invasion by *Crataegus* and *Salix* scrub
Lime waste and gas lime	$CaCO_3$, hydrolysis of CaS	Open, herb-rich, calcicolous associations. *Festuca rubra* dominant. Invasion by *Salix* scrub
Power station ash	Hydrolysis of calcium silicate minerals	Calcicolous vegetation under *Salix* scrub. Herb-rich in clearings
Blast furnace slag and boiler ash	$CaCO_3$, $Ca(OH)_2$ and hydrolysis of basic silicates	Very open, herb-rich, calcicolous associations. Marsh vegetation on boiler ash in damp hollows
Colliery washery waste and slurry	Carbonate minerals	Open herb-rich associations. Invasion by *Salix* scrub

TABLE 3. SOIL PROFILE OF HABITAT ON LEBLANC PROCESS WASTE AFTER 60–80 YEARS EXPOSURE AND COLONIZATION

Depth (cm)	pH	Profile description
0–5	7·7	Black, surface humus
5–15	7·7	Dark, partially humified waste
15–25	7·8	Yellowish-brown waste stained
25–35	8·0	with deposited ferric salts
35–45	9·4	Yellowish, partially weathered
45–55	9·7	waste. Ferric salts present
55–65	12·2	White, unweathered waste,
65–75	12·1	calcium hydroxide present

TABLE 4. RARE W. LANCS. SPECIES FOUND IN MAN-MADE SITES IN S. AND W. LANCS.

Apium inundatum	*Epipactis palustris*
Blackstonia perfoliata	*Glyceria maxima*
Carex pseudocyperus	*Gymnadenia conopsea*
C. riparia	*Ophrys apifera*
Dactylorhiza incarnata subspp. *coccinea* and *incarnata*	*Orchis morio*
D. praetermissa	*Orobanche minor*
D. purpurella	*Osmunda regalis*
Echium vulgare	*Pyrola rotundifolia* subsp. *maritima*
	Ranunculus trichophyllus

There is evidence, therefore, that man-made sites are providing additional habitats for regionally rare or localised species, especially in urbanized areas. This is particularly true for the two species *Dactylorhiza purpurella* and *D. praetermissa,* which are near the southern and northern limits respectively of their ranges of distribution in Britain. Further, the occurrence of presumed hybrid swarms between these and other orchid species suggests that the presence of these sites may contribute to the breakdown of isolating mechanisms between species by providing new habitats. So far the following hybrids are thought to have been found: *D. fuchsii* × *D. purpurella, D fuchsii* × *D. praetermissa, D. fuchsii* × *D. incarnata, D. incarnata* × *D. praetermissa, D. incarnata* × *D. purpurella* and *D. fuchsii* × *Gymnadenia conopsea.* Much less certain is the occurrence of *D. praetermissa* × *D. purpurella.*

TABLE 5. SPECIES CHARACTERISTIC OF ORCHID-RICH INDUSTRIAL HABITATS IN S. AND W. LANCS. (PRESENT IN > 70% OF SITES)

Angelica sylvestris	*Juncus inflexus*
Arrhenatherum elatius	*Lotus corniculatus*
Carex nigra	*Plantago lanceolata*
Centaurea nigra	*Ranunculus acris*
Cerastium fontanum	*Rumex acetosa*
Cirsium arvense	*Salix cinerea*
Dactylis glomerata	*Senecio jacobaea*
Epilobium angustifolium	*Taraxacum officinale*
Equisetum arvense	*Trifolium pratense*
Festuca rubra	*T. repens*
Heracleum sphondylium	*Vicia cracca*
Holcus lanatus	
Hypochoeris radicata	

Floristic lists, compiled for most of the sites mentioned in Table 1, have revealed several species with a high degree of constancy (Table 5). Of the grasses, *Festuca rubra* and *Dactylis glomerata* occurred in over 75% of the sites and were often the dominant or most frequent grasses, as illustrated by the three alkaline waste sites for which species lists are given in Table 6. The most constant and abundant dicotyledons were *Centaurea nigra* and *Tussilago farfara,* followed by *Angelica sylvestris, Lotus corniculatus* and *Plantago lanceolata* (Tables 5 and 6).

Most of the species found in the man-made sites are common and widespread ruderals which have colonized the sites from nearby habitats. Surprisingly, there were few aliens, although the continued presence of *Sisyrinchium bermudiana* at Little Lever is noteworthy in view of its rarity at inland locations.

In S. Lancs. there are few natural or semi-natural habitats away from the Irish Sea coast and these are mostly relict raised bogs. These acid 'mosses' covered much of the area and, although most of the man-made sites containing marsh orchids are base-rich, acid conditions were found at a few of the sites allowing calcifuge species such as *Calluna vulgaris, Carex curta, Eriophorum angustifolium* and *Molinia caerulea* to occur. Of more significance was the occurrence of *Empetrum nigrum* at Hart Common and *Osmunda regalis* and *Potamogeton polygonifolius* at Haskayne. At both sites, natural or semi-natural habitats have disappeared from the vicinity.

Surprisingly, a number of the plants found at the inland, man-made sites are more characteristic of coastal habitats in north-western England (Table 7). Of the species listed (Table 7), 12 are rare in S. and W. Lancs. and of these *Pyrola rotundifolia* subsp. *maritima* is especially noteworthy. This subspecies was formerly confined in Britain to the coasts of Lancashire and Norfolk but during this century, and particularly since about 1950, it has been extending its range along west coast sand-dune systems (Kay *et al.* 1974). The site at Haskayne is, however, only the second inland record for this subspecies. In Cheshire, Lee (1975, 1977) has similarly reported a number of coastal species from inland saline and alkali waste sites.

SIGNIFICANCE OF THE SITES

Kelcey (1975) has presented evidence that industrial development in Britain has contributed much to the continued existence of certain rare and unusual species as well as preventing some common species from becoming rare. It is difficult, however, as Davis (1976) has pointed out, to compare the overall gains and losses through industrial development, although our observations support Kelcey's

TABLE 6. DESCRIPTION OF FLORA COLONIZING LIME WASTE HEAPS AT THREE SITES IN S. AND W. LANCS.

Species	Abundance (Domin scale) Nob End, Little Lever	Darcy Lever	Pollard Moor
Festuca rubra	4–6	6–7	5–6
Centaurea nigra	4–6	3	x–1
Dactylis glomerata	4–5	4	2–3
Tussilago farfara	3–5	4	4–5
Linum catharticum	3–4	3–4	3–4
Lotus corniculatus	3–4	1	1
Agrostis tenuis	2–4	1–2	1
Festuca ovina	2–4	3–4	2–3
Succisa pratensis	2–4	x–1	
Sisyrinchium bermudiana	3		
Angelica sylvestris	2–3	x–1	1
Centaurium erythraea	2–3	2–3	
Crataegus monogyna	2–3	2–3	x–1
Dactylorhiza incarnata	2–3	1	3
Deschampsia cespitosa	2–3	1	x
D. flexuosa	2–3		
Erigeron acer	2–3	1–2	
Euphrasia nemorosa	2–3	3	3
Gymnadenia conopsea	2–3	x	
Pilosella officinarum	2–3	1	3–4
Plantago lanceolata	2–3	2	1
Potentilla erecta	2–3	x–1	2
Trifolium pratense	2–3	1	x
T. medium	2–3		
Aster novi-belgii	1–3	x	x
Carlina vulgaris	2		
Dactylorhiza purpurella	2		
Hieracium vulgatum	2	2–3	2
Leontodon hispidus	2	x	2
Luzula multiflora	2	1	1
Vicia cracca	2	x–1	
Achillea millefolium	1–2	x	x
A. ptarmica	1–2		x
Agrostis stolonifera	1–2	3	2–4
Arrhenatherum elatius	1–2	1–2	1
Bellis perennis	1–2	2	x
Cirsium arvense	1–2	2–3	2–3
Dactylorhiza fuchsii	1–2	x	3
Heracleum sphondylium	1–2	x–1	2–3
Juncus inflexus	1–2		
Senecio jacobaea	1–2	1–2	1–2
Agrostis gigantea	x–2		
Arabis hirsuta	1		
Carex flacca	1		2
Epilobium angustifolium	1	1	2–3
Hieracium umbellatum	1	1–2	1
Holcus lanatus	1	x	x
Juncus effusus	1		
Orobanche minor	1		
Ranunculus acris	1		
Solidago canadensis	1		
Sonchus oleraceus	1		

TABLE 6—*continued.*

Species	Abundance (Domin scale) Nob End, Little Lever	Darcy Lever	Pollard Moor
Taraxacum officinale	1	3	3–4
Tragopogon pratensis	1		1–2
Trifolium repens	1	2	1
Vicia sepium	1		
Cerastium fontanum	x–1	1–2	x
Hieracium glandulosum	x–1		
H. maculatum	x–1		
Hypochoeris radicata	x–1	x	2–3
Lathyrus pratensis	x–1		
Plantago major	x–1		
Poa pratensis	x–1		
Rumex acetosella	x–1		
Rubus fruticosus	x–1	1–2	x
Acer pseudoplatanus	x	1–2	
Carex hirta	x		
C. nigra	x	x	
C. ovalis	x		
Cirsium palustre	x		
C. vulgare	x	x–1	1–2
Equisetum arvense	x	x	1
Festuca arundinacea	x		
F. tenuifolia	x		
Hieracium vagum	x		
Juncus bufonius	x		
Lolium perenne	x		
Molinia caerulea	x		
Nardus stricta	x		
Orchis morio	x		
Potentilla anglica	x		
Rumex acetosa	x		
R. crispus	x		
R. obtusifolius	x		
Sagina procumbens	x		
Salix caprea	x		
S. repens	x	x–1	2
Solidago gigantea	x		
Betula pendula			x
Calystegia sepium		1	
Chrysanthemum leucanthemum			1
Eupatorium cannabinum		x	x
Leontodon autumnalis		x	2
L. taraxacoides			x
Potentilla reptans			2
Prunella vulgaris		1	2–3
Salix cinerea		x	x
Sambucus nigra		x	x
Solanum dulcamara		x	x
Sorbus aucuparia		x	
Triglochin palustris			x

conclusions. We consider that all the sites mentioned in Table 1 are of botanical interest because of their floristic diversity and significance as refugia for regionally rare and localized species. As such they have been included in a list of 252 sites of scientific interest prepared by the Lancashire Naturalists' Trust. Man-made sites account for only 16% of these sites in rural W. Lancs. but for 41% of the sites in the more urban S. Lancs., where the more natural sites are largely coastal or rural.

TABLE 7. SPECIES WITH A PREDOMINANTLY COASTAL DISTRIBUTION IN S. AND W. LANCS. BUT FOUND ON INLAND MAN-MADE SITES

Species	Characteristic coastal habitat
Anthyllis vulneraria	Fixed sand-dune
Apium inundatum	Wet dune-slack
Blackstonia perfoliata	Fixed sand-dune
Carex arenaria	Mobile sand-dune
Dactylorhiza incarnata subspp. *incarnata* and *coccinea*	Damp dune-slack
D. praetermissa	Damp dune-slack
Echium vulgare	Fixed sand-dune
Eleocharis uniglumis	Brackish marsh
Epipactis palustris	Damp dune-slack
Gymnadenia conopsea	Fixed sand-dune
Juncus gerardii	Salt-marsh
Oenothera spp.	Mobile sand-dune
Ophrys apifera	Damp dune-slack
Orobanche minor	Fixed sand-dune
Pyrola rotundifolia subsp. *maritima*	Damp dune-slack and fixed sand-dune
Ranunculus trichophyllus	Wet dune-slack
Salix repens subsp. *argentea*	Damp dune-slack
Schoenoplectus tabernaemontani	Brackish marsh

The sites also provide valuable opportunities for research, including studies of the origin and development of populations of *Dactylorhiza* and other species, problems of habitat management, possibilities of deliberate habitat creation and the planning of industrial activities to achieve natural resource benefits.

We conclude from our studies of industrial waste sites and disturbed areas in S. and W. Lancs. that certain types of industrial development and waste disposal provide exciting possibilities for the deliberate creation of habitats of high wildlife interest. To achieve this, new industrial sites, particularly those involving extractive and waste disposal operations, should be carefully planned with a view to habitat development and future natural history interest upon their eventual closure. How to achieve this with different industrial processes, particularly modern ones, opens up a whole new field of research into the use of landscape modelling techniques, placement of materials both during and after industrial operations, different soil fertilizer treatments and soil moisture or drainage control as methods of providing specific habitat types or a variety of conditions for colonization. Such sites provide opportunities for the documented introduction (with the prior approval of the Nature Conservancy Council) of indigenous plant taxa including ones which are isolated geographically from native populations and which do not have effective long-range dispersal mechanisms.

We believe that suggestions of this kind should be given greater attention if the conflicts between industrial development and nature conservation are to be minimized.

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The flora of walls in south-eastern Essex

R. M. PAYNE

49 Galton Road, Westcliff-on-Sea, Essex

ABSTRACT

The flora of 650 walls in south-eastern Essex is analysed, with emphasis on the relative frequency of species on walls of different kinds. Comparisons are made with other surveys of wall-flora.

AIM AND SCOPE OF THE SURVEY

During the four years 1973–1976, I kept 650 walls and series of walls in south-eastern Essex under observation, with the primary aim of discovering the relative frequency of different species of flowering plants and ferns in such habitats. The area covered was that part of S. Essex, v.c. 18, roughly east of a line running south from Chelmsford through Billericay to Tilbury.

Of the 650 walls surveyed, 278 (43%) were urban garden walls (or series of walls), 182 (28%) were churchyard walls, 47 (7%) railway walls, 41 (6%) walls of secular buildings other than railway buildings, 44 (7%) retaining walls (including some also in the other categories) and 79 (12%) walls in relatively rural areas (other than churchyard, railway and retaining walls). River and sea walls were wholly excluded. Separate lists were made of the species found on these different types of walls.

Little attention was paid to the composition of walls, because, apart from some church walls of Kentish ragstone, almost all walls in south-eastern Essex are made of bricks. The size of the task and limitations of time precluded consideration of ecological factors (aspect, shade, adjacent vegetation, etc.).

NOTES ON THE METHODS USED

The unit for the survey was either a single wall or a series of adjacent walls of similar construction and age. Thus in churchyards the stone fabric of the church and the brick perimeter wall of the churchyard would be treated as separate units.

Each wall included in the survey supported at least one plant at some time during the four years, and each was visited at least twice, at different seasons, though most of the walls were visited much more often.

Plants growing at the extreme base of a wall were ignored, since these would probably be rooted in the ground and therefore not truly rupestral. Similarly, wall-tops with an obvious accumulation of soil were excluded from the survey.

On garden walls, all plants not likely to have been deliberately planted were included. It was of course usually practicable to list only the plants growing on the outside of garden walls, to which species of horticultural origin would be likely to have spread by natural means.

THE FLORA IN GENERAL

A total of 286 species was recorded, of which 83 (29%) were probably or certainly of horticultural origin; included in this category are not only obvious garden escapes such as *Aster* cf. *novi-belgii*, *Campanula portenschlagiana* and *Linaria purpurea*, but also such species as *Tanacetum parthenium*, *Fagus sylvatica*, *Polystichum setiferum* and *Sorbus aucuparia*, which are either not native in south-eastern Essex or, as wall plants, are highly likely to be derived from garden specimens.

Of the 286 species, 200 (70%) were found on fewer than ten of the 650 walls, 164 (57%) on fewer than five walls, and indeed 85 (30%) on only one wall. The order of frequency of the 47 species which occurred on at least 5% of the walls is shown in Table 1.

TABLE 1. PERCENTAGE OCCURRENCES (≥5%) ON ALL WALLS

* of garden origin		† status doubtful	
Poa annua	54	*Phyllitis scolopendrium*†	9·5
Sonchus oleraceus	35	*Lamium album*	9·1
Senecio vulgaris	33	*Capsella bursa-pastoris*	8·9
Epilobium adenocaulon	32	*Sagina apetala*	8·5
Senecio squalidus	29	*Epilobium angustifolium*	8·3
Hedera helix†	27	*Acer pseudo-platanus*	8·0
Dryopteris filix-mas†	22	*Anthriscus sylvestris*	7·4
*Antirrhinum majus**	20	*Sedum acre*†	7·2
Sambucus nigra	19	*Hordeum murinum*	6·9
*Corydalis lutea**	18·3	*Campanula portenschlagiana**	6·9
Mercurialis annua	18·2	*Poa pratensis*	6·8
Sagina procumbens	18·2	*Pteridium aquilinum*	6·6
Cymbalaria muralis	17·4	*Lolium perenne*	6·2
Lamium purpureum	16·6	*Poa angustifolia*	6·2
Urtica dioica	16·0	*Agropyron repens*	6·0
Taraxacum officinale agg.	15·7	*Ballota nigra*	6·0
Stellaria media	14·6	*Conyza canadensis*	6·0
Rubus fruticosus agg.	14·5	*Euphorbia peplus*	6·0
Bromus sterilis	14·3	*Holcus lanatus*	6·0
Veronica sublobata	14·3	*Aster* cf. *novi-belgii**	5·7
Galium aparine	11·9	*Centranthus ruber**	5·7
Arrhenatherum elatius	11·7	*Convolvulus arvensis*	5·2
Dactylis glomerata	11·4	*Plantago lanceolata*	5·1
Poa trivialis	10·3		

Table 2, which is based on a similar table published by Kent (1961), compares the frequency of the 20 commonest wall plants in the present survey with the frequency of some of them as recorded in wall surveys in Middlesex, the London area, Durham and Cambridge.

Poa annua stands out as the predominant species in four of these lists, but other plants show remarkable dissimilarities in frequency. Durham might be expected to have a different flora from Essex, being 350 km to the north and with a colder, wetter climate. Indeed, nine species among the commonest 14 on Durham walls (Woodell & Rossiter 1959) do not appear in Table 2: these are *Epilobium angustifolium, Dactylis glomerata, Epilobium montanum, Acer pseudo-platanus, Lolium perenne, Plantago lanceolata, Poa pratensis* agg., *Rumex obtusifolius* and *Senecio jacobaea*. (The last-named was found on only four walls in south-eastern Essex). Species prominent in the Cambridge survey (Rishbeth 1948) but considerably less so in south-eastern Essex are *Festuca rubra, Arenaria serpyllifolia, Tanacetum parthenium, Acer pseudo-platanus, Capsella* and *Epilobium angustifolium*. Of the two segregates of *Arenaria serpyllifolia* in Essex, I found *A. leptoclados* twice as frequently as *A. serpyllifolia* (as did Grose (1957) on Wiltshire walls); neither occurred on urban garden walls. *Epilobium adenocaulon* has clearly increased enormously in south-eastern England even in the 15 years since the Middlesex survey, when both *E. angustifolium* and *E. montanum* were much commoner wall species. The high figures shown for *Corydalis lutea* reflect the greater proportion of garden walls in the Essex survey. *Mercurialis annua* and *Veronica hederifolia* agg., neither of which figures prominently in any of the other surveys, are abundant urban weeds in south-eastern Essex. All rupestral specimens of the latter that I examined appeared to be the segregate *V. sublobata*, which Kent (1975) states to be also the usual Middlesex plant.

TABLE 2. PERCENTAGE OCCURRENCES IN VARIOUS SURVEYS OF THE 20 COMMONEST SPECIES IN THE PRESENT SURVEY

	650 Essex walls	500 Middlesex walls	72 London walls	66 Durham walls	Cambridge walls*
Poa annua	54	48	37·5	40	(1)
Sonchus oleraceus	35	18·6	12·5		
Senecio vulgaris	33	9·2	13·9	28	(8)
Epilobium adenocaulon	32	4			
Senecio squalidus	29	25	22·2		
Hedera helix	27	2			
Dryopteris filix-mas	22	34·8	27·8		
Antirrhinum majus	20	7	4·2		(4)
Sambucus nigra	19	5·6	1·4	41	(7)
Corydalis lutea	18·3	2			
Mercurialis annua	18·2	0·2			
Sagina procumbens	18·2	17·4	9·7		
Cymbalaria muralis	17·4	23·6	6·9		(5)
Lamium purpureum	16·6	2			
Urtica dioica	16	4			
Taraxacum officinale agg.	15·7	12·6	11·1	64	(2)
Stellaria media	14·6	3·6			
Rubus fruticosus agg.	14·5	1·6		23	
Bromus sterilis	14·3	2			
Veronica sublobata	14·3	0·6			
Total number of species	286	204	83	168	186

* order of frequency

Table 3 lists the commonest species on each of the six types of walls studied. In each column only those species which occurred on at least 20% of the walls are included.

URBAN GARDEN WALLS

150 species were recorded from garden walls in built-up areas, a surprisingly large number perhaps partly accounted for by the prevalence in the Southend conurbation of burr walls, i.e. brick walls made of clinkers, which provide a more favourable habitat for seedlings than the conventional smooth brick wall. Among native plants particularly associated with urban garden walls were *Mercurialis annua* (86% of its sites), *Epilobium montanum* (73%), *Euphorbia peplus* (69%), *Veronica sublobata* (67%) and *Lapsana communis* (60%); all except *Lapsana* are common garden weeds in this area. It is perhaps surprising that as many as 47% of the sites for *Pteridium aquilinum* were walls of this type, since this is neither a garden plant nor a common garden weed. *Calystegia silvatica*, slightly commoner throughout the survey than *C. sepium*, was predominantly (86%) a plant of urban garden walls, whereas *C. sepium* occurred equally on urban and rural walls.

CHURCHYARD WALLS

Although churchyard walls in south-eastern Essex tend to be rich in numbers of species (160 species in total), I have not found such a marked disparity between these and other walls as Kent (1964) noted in Middlesex, where he ascribed the disparity partly to a colonizing of churchyard walls from relict populations of wild plants still growing in the churchyards though extinct in the surrounding urban areas. This is probably because even now south-eastern Essex is, on the whole, more rural than Middlesex. Nevertheless, the following 13 species were seen only on churchyard walls during the present survey: *Cynosurus cristatus, Fragaria vesca, Fraxinus excelsior, Ligustrum vulgare, Oxalis* *exilis, Potentilla sterilis, Ranunculus repens, Raphanus raphanistrum, Ribes nigrum, Sonchus arvensis, Tussilago farfara, Urtica urens* and *Veronica agrestis.* In addition, five species were found mainly on churchyard walls: *Glechoma hederacea* (84% of its sites), *Symphoricarpos rivularis* (75%), *Parietaria diffusa* (67%), *Potentilla reptans* (61%) and *Veronica chamaedrys* (57%).

I am uncertain to what extent *Hedera helix* is a genuine rupestral plant; I endeavoured to record it only where it appeared to be rooted in a wall, but whether it can survive indefinitely without contact with the ground may be doubted.

It is interesting to compare the fern flora of these Essex churchyard walls with that of similar sites in Norfolk, which were investigated by Silverwood (1965). The most striking difference is the much greater frequency of *Polypodium* in Norfolk. In his survey, Silverwood found ten species of ferns, of which *Polypodium vulgare* agg. was slightly more numerous than *Dryopteris filix-mas*, the other species in order of decreasing frequency being *Phyllitis scolopendrium, Asplenium adiantum-nigrum, Asplenium ruta-muraria* and *Asplenium trichomanes,* with *Polystichum aculeatum, P. setiferum, Ceterach* and *Pteridium* all very scarce. In the rather drier and much more polluted south-eastern Essex, I found eight species on church walls, of which *Dryopteris filix-mas* was much the commonest, followed by *Phyllitis*; considerably rarer were *Asplenium adiantum-nigrum, A. ruta-muraria, Polypodium* and *Pteridium*, with *Asplenium trichomanes* and *Dryopteris dilatata* very scarce. As I suggested in an earlier paper (Payne 1960), the retention of its fronds by *Polypodium* throughout the year may make it less able to withstand pollution than some other ferns; sulphur dioxide pollution is known to be more intense in the autumn and winter months.

TABLE 3. PERCENTAGE OCCURRENCES (≥20%) ON DIFFERENT TYPES OF WALLS

	Urban Garden Walls	Church-yard Walls	Railway Walls	Retaining Walls	Rural Dividing Walls	Walls of Buildings
Poa annua	73	26·4		39	73	44
Senecio squalidus	36·3		45	36	28	46
Sonchus oleraceus	50		26	25	43	24
Epilobium adenocaulon	36·0			32	47	41
Senecio vulgaris	48	20		23	43	
Hedera helix		52	21	25	28	
Dryopteris filix-mas	23				24	56
Arrhenatherum elatius		24·7	30	32		
Urtica dioica		25·3		23	37	
Lamium purpureum			23	32	27	
Rubus fruticosus agg.		27	30	23		
Sambucus nigra		25·8			24	22
Dactylis glomerata			23	25	23	
Bromus sterilis				20	28	
Taraxacum officinale agg.				23	24	
Lamium album			21	23		
Antirrhinum majus	41					
Corydalis lutea	38					
Mercurialis annua	36·3					
Cymbalaria muralis	29					
Capsella bursa-pastoris					28	
Galium aparine					27	
Pteridium aquilinum						27
Phyllitis scolopendrium			26			
Sagina procumbens	22					
Veronica sublobata	22					
Poa angustifolia			21			
Sagina apetala					20	
Stellaria media					20	

RAILWAY WALLS

Railway walls proved to have a more distinctive flora than those of churchyards. Of a total of 110 species, the following 15 were found only on railway walls (which comprise both dividing and retaining walls, as well as walls of stations and other railway buildings): *Bromus ramosus, Cardamine flexuosa, Ceterach officinarum, Epilobium lanceolatum, Equisetum arvense, Heracleum sphondylium, Hieraceum perpropinquum, Inula conyza, Pastinaca sativa, Senecio erucifolius, Sinapis arvensis, Smyrnium olusatrum, Solidago canadensis, Leucanthemum vulgare* and *Triglochin maritimum* (on a bridge over a brackish dyke). In addition, 75% of *Stellaria holostea* sites were railway walls, as were 69% of sites for *Asplenium trichomanes* and 60% for *Artemisia vulgaris.*

Senecio squalidus is revealed as the railway wall plant *par excellence*, but a remarkable absentee from this column of Table 3 is *Poa annua*, which was recorded from only 13% of railway walls. Yet grasses in general, mainly perennial species, were found to occupy six of the top 22 places, compared with only two (both annuals) in the overall list, doubtless because of the proximity of grassy railway banks to most of these wall sites. Ferns are also prominent, *Dryopteris filix-mas* surprisingly ranking below four other species. *Asplenium adiantum-nigrum*, though occurring in slightly fewer sites than the other two Spleenworts, is much more numerous where it does occur, hundreds of plants growing on the brick walls of several bridges over the derelict Woodham Ferrers—Maldon line which opened in 1889 and closed in 1939, an interesting parallel to Cambridgeshire, where Walters (1969) records an old railway wall containing 'hundreds of plants . . . more than all the other Cambridgeshire sites put together.'

Of the 47 walls in this category, ten were on derelict lines, and on the whole these had the more varied flora, presumably because they were subject to less disturbance; indeed, every piece of railway brickwork examined on the long-abandoned Maldon line produced plants, whereas very many walls and bridges on active lines were quite barren (and therefore excluded from the survey).

RETAINING WALLS

This category, with a total of 114 species, overlaps with railway walls, and very slightly also with churchyard and garden walls. It supported ten species not found on dividing walls: *Bromus ramosus, Cardamine flexuosa, Carex divulsa, Ceterach officinarum, Equisetum arvense, Heracleum sphondylium, Polygonum cuspidatum, Senecio erucifolius, Smyrnium olusatrum* and *Leucanthemum vulgare*. Eight of these were in fact confined to railway retaining walls. As Woodall & Rossiter (1959) remarked, it is difficult to determine whether a plant on a retaining wall has extended its roots through to the soil behind. *Equisetum arvense* and *Polygonum cuspidatum* must be particularly suspect here.

RURAL DIVIDING WALLS

This category comprises walls surrounding country estates and large gardens in semi-rural areas, farmyard walls and other walls outside the built-up areas. It does not include any churchyard, railway or building walls.

This is another category with a rich (154 species) and distinctive flora. No less than 18 species were found only on these walls, those marked * being of horticultural origin: *Asparagus officinalis**, *Cerastium semidecandrum, Erodium cicutarium, Fagus sylvatica**, *Geranium dissectum, G. lucidum, G. pusillum, Matricaria recutita, Papaver argemone, Pentaglottis sempervirens**, *Phleum bertolonii, Ribes rubrum**, *Rubus laciniatus**, *Spergularia rubra, Taxus baccata**, *Tragopogon pratensis, Verbascum nigrum* and *Vinca minor**. A further eight species were found predominantly on these rural walls: *Agrostis tenuis* (64% of its sites), *Arabidopsis thaliana* (63%), *Erophila verna* (75%), *Hypochoeris radicata* (57%), *Ilex aquifolium* (67%), *Saxifraga tridactylites* (80%), *Sisymbrium officinale* (54%) and *Vulpia bromoides* (71%).

WALLS OF SECULAR BUILDINGS (other than railway buildings)

Dryopteris filix-mas is the commonest species on walls of this category (80 species in total). *Pteridium* is also frequent and, together with *Buddleja davidii, Epilobium angustifolium, Lolium perenne, Hordeum murinum* and *Conyza canadensis*, was more commonly seen on these than on other walls.

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Short Notes

THE DISTRIBUTION OF *CAREX DIGITATA* L. IN BRITAIN

Carex digitata L. and *C. ornithopoda* Willd. (section *Digitatae*), like *C. montana* L. of the related section *Montanae*, are Eurasian sedges that in England reach the north-western limit of their range. The centre of that range, however, is more northern and eastern (i.e. more continental) than that of *C. montana*. *C. digitata* and *C. ornithopoda* are found in Norway, Finland, and northern Russia, and penetrate further into Siberia, while not approaching the Atlantic or the Mediterranean so nearly.

The distribution of *Carex digitata* in Britain is as disjunct as that of *C. montana* (David 1977) but is more easily explicable, for the requirements of this sedge may be precisely defined: a soil with a high calcium content (pH so far measured ranges between 7·29 and 7·99, with one reading at 6·32), and good drainage yet with some protection against drying out. These conditions are exactly met in the beechwood 'hangers' on the Gloucestershire oolite, where the plant is widespread and plentiful in a narrow band from Birdlip in the north-east to Dursley in the south-west, and again, at least formerly, on the southern edge of the North Yorkshire moors from Thirsk eastwards to Scarborough. It is also frequent on shaded pavements of the mountain limestone, for example in the Wye valley and in Silverdale, and occurs, very sporadically, here and there on the limestone ridges of the Midlands. There is a single record from the southern chalk.

In most of its British stations *Carex digitata* is at risk. Jackdaw Crag at Boston Spa, Aysgarth 'Freeholds', and the Avon gorge at Bristol have become public scrambling-grounds. The pavements of Silverdale have been (and still are being) broken up to supply profitable rockery stone. In North Yorkshire, afforestation with conifers, and still more the widening of tracks to facilitate access for the foresters, have reduced the area available to the sedge. Even under natural conditions the crumbling banks favoured by it are a precarious habitat, while the trees or scrub whose shade prevents it from drying out may at last so overshadow it that it cannot flower, or may choke it altogether. It would seem that in any case the individual plants are short-lived as compared with the steadily maturing tussocks of *C. montana* or of *C. humilis*, but set seed more certainly and more freely than the former and much more so than the latter. The seed may lie dormant until the appropriate conditions reappear, and this may partly explain the variations in the estimates of particular populations from one year to another and the reappearance of the sedge in localities where it has been given up for lost. The results of the present survey indicate that *C. digitata* is commoner in Britain than is usually believed. The reason for this belief is that the sedge is easy to overlook when not in flower; even where it flourishes it may be confined to one or two isolated colonies, and such a colony, containing perhaps over a hundred plants, may occupy no more than a few square metres in a terrain that is often difficult to explore. *Carex digitata* should be looked for on banks and cleared slopes, usually but not invariably south-facing; a favourite habitat is the steep side of a woodland ride where rather more light penetrates than in the wood itself. The plant is best observed in early April when the new shoots, emerging from the overwintered crown, present a characteristic fountain-like outline resembling the green tufts on the heads of the pineapples so beloved by the Rococo decorators. They also show a striking colour-contrast between their pale olive-green and the dark bronzy green of the old leaves. At that season, too, the commoner sedges of the habitat, *C. flacca* and *C. sylvatica*, have made no such pronounced growth.

The known British stations are listed below. All that can be located have been surveyed since 1970, and letters indicate the present size of each population: A = 1 to 20, B = 21 to 100, C = 101 to 1000, D = over 1000. Estimates are approximate, for a reason opposite to that which makes a census of *C. montana* difficult: *C. digitata* never makes the composite mats of that species, but the individual plants are often scattered and small so that some are likely to be missed. Where the sedge has not been refound, the date of the last known sighting and the location of herbarium specimens whose authenticity has been confirmed are given.

N. Somerset, v.c. 6: 31/5.7, Leigh Woods (B); 31/7.5, Hinton Abbey, 1838, **CGE**.

N. Wilts., v.c. 7: 31/8.6, Box, 1869, **BM**; 31/8.7, Lucknam, 1861, **BM**; Colerne Park, extinct *c* 1960 (Horton 1975), **BM, CGE, K**; Slaughterford, 2 places (B, B). 'Box' and 'Lucknam' may refer to one of the other stations, but there is still suitable ground for the sedge at least at Box.

Dorset, v.c. 9: 30/8.8, Wool, 1912, **BMH**.

E. Gloucs., v.c. 33: 32/8.0, Toadsmoor Valley, 2 places (B, C); Slad Valley, 2 places (C, C); Painswick (D); 32/8.1, Cranham (C); 32/9.0, 'between Bisley and Daglingworth, 1955', record in Biological Records Centre, no specimen traced; 32/9.1, near Cranham, 2 places (B, D); 32/9.2, Thrift Wood, and 42/0.2, Whittington Wood (Notcutt 1862). Specimens from 'near Cheltenham' in **BIRM, K, OXF**. Thrift Wood is much denuded since cattle had access and Whittington Wood was largely grubbed *c* 1900.

W. Gloucs., v.c. 34: 31/5.7, Clifton (A); 31/5.9, Pen Moel, 4 places (A, A, B, B); 31/7.9, Dursley (C); 31/8.9, Nailsworth (A); 32/5.9, Symonds Yat (B); 32/8.0, Woodchester, 3 places (C, C, C); Roborough, Amberley (Riddelsdell *et al.* 1948), no specimens traced.

Mon., v.c. 35: 31/5.9, Wyndcliff (B); Blackcliff (B); Itton, 1852, **BM, K.** Itton is off the limestone and the record may refer to one of the two preceding stations.

Hereford, v.c. 36: 32/5.1, Dowards, 2 areas (C, D); Coppet Hill (Purchas & Ley 1889), no specimen traced; 32/5.3, Capler (B).

Worcs., v.c. 37: 32/7.7, Bewdley North Wood (Lees 1867), **MANCH** 'Bewdley 1857'. Wood grubbed *c* 1970.

Salop, v.c. 40: 33/6.0, Tickwood (B).

Notts., v.c. 56: 43/5.6, Pleasley Wood, 1838, **CGE, K.**

Derbys., v.c. 57: 43/1.7, Monsal (B); Taddington (B); 43/2.7, Calver (B).

W. Lancs., v.c. 60: 34/4.7, Cringlebarrow, 1904 (Wheldon & Wilson 1907), no specimen traced; Eaves Wood, 2 places (A, C); Gaitbarrows, 2 places (A, C); Leighton Beck (B, not seen by R. W. D.).

N. E. Yorks., v.c. 62: 44/5.5, Clifton Ings, 1860, **BM**, may be the same as 'near York, N. Jacke' in **OXF**. This water-meadow is an impossible place for *C. digitata* but the second York record suggest that there may be something other than a mislocation behind the first; 45/5.8, Hawnby (B); Rievaulx (B); Ouldray (A); 45/5.9, Laskill, 1860, **BM**, now intensely afforested; 45/6.8, Sleightholme Dale, 2 places (A, C); 45/9.8, Ayton (C); 45/9.9, 'Hackness', record in Biological Records Centre, is probably the same as the last, for Hackness itself is off the limestone.

S. W. Yorks., v.c. 63: 43/5.8, Anston Stones (A); 43/5.9, Roche Abbey, 1949 (Sledge 1950), **BM, CGE, K**; 44/5.0, Levitt Hagg Wood, 1844, **CGE**.

Mid-W. Yorks., v.c. 64: 34/7.7, Settle, 1834, **OXF**, 1859, **BM**; 44/2.6, Mackershaw (C); 44/2.7, Tanfield (A); 44/4.4, Thorp Arch (Boston Spa), 1927 (W. A. Sledge *in litt.* 1977), **BIRM**, **BM**, **CGE**, **K**.

N. W. Yorks., v.c. 65: 44/0.8, Aysgarth, 1887, **BM**.

Westmorland, v.c. 69: 34/3.8, Roudsea Wood (C); 34/4.7, Eggarslack (A, not seen by R. W. D.); Arnside Knott, 1894 (Wilson 1938), no specimen traced; Middlebarrow, 2 places (B, C); Slackhead, 3 places (A, B, B); Beetham Fell, 5 places (A, A, B, B, C); 34/4.8, Sandside (B); Witherslack, 2 places (B, B); 34/4.9, Scout Scar (Wilson 1938) and 34/5.7, Hutton Roof (Baker 1885), no specimens traced. In both localities *C. ornithopoda* Willd. may have been taken for *C. digitata*. The finder at Scout Scar, G. E. Martindale, reported that both species were present, but his specimens in **LIV** and **MANCH** are all *C. ornithopoda*, correctly named. I. Hindson's record from Hutton Roof is pre-1872 and *C. ornithopoda* was not identified in Britain until 1874. On the other hand, all but one of the records from Slackhead, Beetham, and Sandside were first reported as *C. ornithopoda* in a survey of limestone pavements recently carried out by the Institute of Terrestrial Ecology.

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R. W. David

CYTISUS STRIATUS (HILL) ROTHM. IN BRITAIN

A few shrubs subsequently identified by B. E. Smythies as *Cytisus striatus* (Hill) Rothm. were found by me in July 1973 growing with *C. scoparius* (L.) Link on a roadside bank by the village of Milton, near Drumnadrochit, Easterness, v.c. 96. They differ from the latter species chiefly in the less flattened pods which are densely covered with greyish hairs. Flowering specimens, collected in May 1976, were quite difficult to distinguish from *C. scoparius* except for the slightly paler yellow corolla and the remains of last year's pods still persisting here and there. Specimens have been deposited in **BM**.

C. striatus is a native of Portugal and Spain and has almost certainly been planted at Milton. A. O. Chater (*in litt.* 1977) reports that this species (det. B. E. Smythies) was planted on a new earth slope above the A487 road between Aberystwyth and Penparcau, Cards., v.c. 46, about 1970, and has since spread so that it is scattered along *c* 400m of the length of the slope. It flowers and fruits there abundantly.

It is possible that *C. striatus* has been overlooked in this country and has become naturalized in similar habitats elsewhere.

U. K. Duncan

CEPHALANTHERA DAMASONIUM (MILL.) DRUCE × *C. LONGIFOLIA* (L.) FRITSCH

This hybrid has been recorded in France and Germany under the name *Cephalanthera × schulzei* Camus, Berg. & A. Camus (Camus *et al.* 1908); the purpose of this note is to record what appears to be its first known occurrence in the British Isles.

Two plants apparently of this hybrid were found in May 1974, growing on the borders of eastern Hampshire in a woodland site which carries a thriving population of both *Cephalanthera damasonium* (Mill.) Druce and *C. longifolia* (L.) Fritsch. The plants were of a similar size, equal in height to surrounding plants of both putative parents. The lower leaves resembled those of *C. damasonium*, being borne in two ranks, ovate and well ridged, but the upper stem leaves were more elongated. These graded into the bracts, which in the upper flowers were narrow, linear and equalled the ovary.

The larger plant bore ten well-spaced flowers carried more or less parallel to the stem. The flowers were pure white in colour, like those of *C. longifolia*, with long pointed outer perianth segments, and tended to open fairly well, exposing the yellow epichile of the labellum. This yellow colour closely resembled the colour of the labellum of *C. damasonium,* but the epichile had three ridges on it, whereas in *C. damasonium* there are usually five.

One of the most marked features was the conformation of the ovary. In the flowers of *C. damasonium* examined, the ovary averaged 20mm in length, being broader just before its distal end. The ovary itself was not twisted. In the flowers of *C. longifolia* the ovary averaged 12mm in length, being narrow and more or less cylindrical. It was twisted anticlockwise through 180°. In the flowers of the putative hybrid the ovary averaged 20 mm in length, being narrow and cylindrical. It was twisted anticlockwise through 180°.

Measurements were taken of the ovary and outer perianth segments of ten flowers each of both the species and of the putative hybrid:

C. damasonium— Ovary 20 mm, broader near tip, untwisted; outer perianth segments 22 mm × 9 mm maximum;

C. longifolia— Ovary 12 mm, narrow and cylindrical, twisted through 180° anticlockwise; outer perianth segments 16 mm × 5 mm maximum;

Putative hybrid— Ovary 20 mm, narrow and cylindrical, twisted through 180° anticlockwise; outer perianth segments 25 mm × 7 mm maximum.

The two plants recorded here flowered again in May 1975, when a third plant of similar morphology was found nearby. A set of coloured photographs of the hybrid plants is preserved by us.

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D. C. Lang & J. L. S. Lansley

SPINELESS-FRUITED *CERATOPHYLLUM*

An investigation of the genus *Ceratophyllum* in the Ouse levels above Newhaven, E. Sussex, v.c. 14, has revealed some curious features. The Spineless Hornwort, *C. submersum* L. (leaves obscurely denticulate, 3 or 4 times forked), is rare there, but where it does occur it fruits freely and its fruits are warty and spineless and easily recognizable. In contrast the very abundant Hornwort, *C. demersum* L. (leaves spinose-denticulate, twice forked), seems to fruit hardly at all, even in the hot summer of 1976 when the plants of these ditches did so well. Eventually, however, in September, a short stretch of water, a few yards long, produced *C. demersum* with well-ripened fruits; these were scarcely warty and smaller than those of its relative, but without the spines at the base which, most of the literature says, are their distinguishing feature. It seemed curious, too, that only the one small area produced plants with fruit.

Inspection of the material of *Ceratophyllum* in **BM** confirmed these observations. Specimens of *C. submersum* there bear plenty of fruits, but those of *C. demersum* bear relatively few. Among these, a number are cracked and crumbling, and it is impossible to distinguish the character of the fruit; one or two appear to be spined and one collected by E. Milne-Redhead in Beds., v.c. 30, in 1946, is clearly so. But the majority, like those from the Ouse ditches, while corresponding with the description of *C. demersum* in every other way, have fruits which are totally lacking in spines.

One such specimen, collected at Castle Morton, Worcs., v.c. 37, in August 1914, has attached the following comment by C. E. Moss: 'This plant is in my opinion *C. demersum* var. *apiculatum* = *C. apiculatum* Cham. . . . The var. *apiculatum* is intermediate between *C. demersum* and *C. submersum* and it is somewhat arbitrary to refer it to one of the species rather than the other.' In a way more revealing is an undated page of a letter from R. Brown to A. Bennett on a sheet of *C. demersum* from Lydiate, 10 miles north of Liverpool, S. Lancs., v.c. 59: 'Last July. . . it was fairly well in fruit but with only a specimen here and there with the two spines developed at the base. Last Tuesday I paid another visit . . . expecting to find any quantity of ripe fruit but to my astonishment found matters asleep as if no progress had been made in the two months. In fact I hardly could find any fruit with the developed spines. The plant agrees in all particulars with *C. demersum.*' This letter evidently refers to a meeting of the Liverpool Naturalists' Field Club; their Proceedings (Brown 1888, p. 25) says: 'A very small quantity of the fruit appeared to develop the two basal spines. In most cases it seemed to ripen without these appendages.' The writer remarks further that in 1887 a third *Ceratophyllum* 'has been added to the British flora by Mr Alfred Fryer who has discovered *C. apiculatum* in a ditch by Earith Stanch in Huntingdonshire . . . The peculiarity of its fruit is that at the base are two minute blunt tubercles instead of spines.'

The note by Scannell (1976) on the fruiting performance of *C. demersum* in the Grand Canal near Dublin in the summer of 1975 states that, at the end of that warm season, 'the canal fruits were not in accord with the published descriptions "warty, beaked with spines",' and goes on to suggest that the reason for this may be that the fruits were not properly matured. She also quotes the remarks of H. B. Guppy, referring to the hot summer of 1893, to the effect that the plant needs heat to mature its fruits and only does so in 'the superheated water of shallow pools'.

The fruiting specimens of *C. demersum* from the Ouse washes, of which I have deposited a voucher specimen in **BM**, were not in shallow water, but in water 2–3 feet deep. Nor did they show the basal tubercles which are suggested as distinguishing characters of *C. apiculatum*.

While there is an obvious need for further investigation of fruit production and morphology in *Ceratophyllum*, one may conclude that the presence or absence of spines is clearly not a good character to use in separating *C. demersum* and *C. submersum*.

ACKNOWLEDGMENTS

I am indebted to Miss M. J. P. Scannell for help with the literature references and to Mr E. J. Clement for reading my draft and suggesting amendments.

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E. G. NORMAN

ISOETES ECHINOSPORA DURIEU NEW TO NORTHERN ENGLAND

Isoetes echinospora Durieu was located for the first time in Cumberland, v.c. 70, on December 29th, 1974, when some detached leaves and uprooted plants were recognized in strand-line drift at Cogra Moss reservoir (GR 35/09.19). This is also the first record from England north of Dorset. The identification was confirmed by A. C. Jermy. *Isoetes lacustris* L. is abundant there and counts of drift samples suggest a relative abundance of about 10:1, assuming equal susceptibility to dislodgement. *I. echinospora* grows under 10 cm or more of water, with *I. lacustris*, either in patches with plants almost touching, or singly among the abundant *Juncus bulbosus* L. and *Eleogiton fluitans* (L.) Link. Most of the plants in shallow water are small and stocky, with spreading, curved leaves up to 5 cm long; others have straight, erect leaves up to 13·5 cm long. Accompanying plants of *I. lacustris* are similar in size, but reach 23 cm in deep water.

Since 1974, most of the lakes and tarns in Cumberland and Westmorland, v.c. 69, have been visited without any further sites for *I. echinospora* having been found. It is clear that the plant is extremely scarce in this area and may well be confined to this single station. Whether this is so or not, its presence there presents an interesting problem. The nearest known locality for *I. echinospora* is in North Wales*, 150 km to the south; the Scottish Highland sites are 200 km or more to the north (Perring & Walters 1962). The reservoir is completely artificial and is the result of a dam built in about 1880 across what then was a boggy valley through which Moss Beck flowed. The nearest standing water was and is 3 km distant at Ennerdale Water to the south and Loweswater to the north-east.

Isoetes spreads by the dissemination of the spores and this is clearly an efficient method of ensuring transport between waters. Birds, such as swans and the vegetarian ducks, and fish eat the leaves and many spores must be ingested. Spores could also be carried externally by birds. The megaspores of both species are covered with rough protuberances and cling readily to feathers, particularly to the downier body feathers. Most waterfowl on the Cumbrian tarns are winter visitors, so that if *I. echinospora* was brought in by birds it is likely to have come from the north. It is relevant that the plant is widespread in Scandinavia, whence come many of our wintering ducks, and frequent in Iceland and the Scottish Highlands, on the route of our wintering swans.

I. echinospora may be overlooked because of inadequate or inaccurate descriptions in British Floras, and a note on field characters may be useful. Most works describe *I. lacustris* in some detail and then give the differentiating features of *I. echinospora*, usually in terms of plant size, number of leaves, leaf posture, and megaspore colour. Although *I. lacustris* is on average larger, and usually much larger, there is a considerable overlap. The posture of the leaves (spreading or erect) has no specific

* *Isoetes echinospora* has recently been found in Wigtown, v.c. 74. EDS.

significance, depending solely on the situation of the plant. The number of leaves is also variable and quite unreliable as a character. The megaspores, in their natural (wet) state, may be off-white or yellowish in either species, or darker if stained or muddy. When allowed to dry they suddenly turn white, a quality of the siliceous material in the spore walls, and I have found no specific colour difference. Lid (1963), in his excellent account, describes the megaspores as being greyish-white in *I. lacustris* and chalky-white in *I. echinospora*. The ornamentation, respectively of warty excrescences or of spines, is the best distinction, but is not a field character. They also differ in size and this is evident, with experience, even without optical aids.

A preliminary character for locating *I. echinospora* in the field is the grass-green colour of the leaves. The inner immature leaves of *I. lacustris* may be as pale a green, but most are much darker. The leaves of the latter species are stiff and brittle, while those of *I. echinospora* are supple—the one good character given in most descriptions. Lid (1963) describes the leaves of *I. echinospora* as being stiff at the base, but adhering like a brush when taken out of the water. Young slender leaves of *I. lacustris* may occasionally adhere and old, outer leaves of *I. echinospora*, if spreading, may not, but otherwise this is a valid and useful field character.

The best, and a definitive, character is the leaf-shape. This is mentioned by Lid, but not in any English text. The leaves of *I. lacustris* vary considerably in length, thickness and degree of ridging, but in all cases do not taper much for most of their length, narrowing in the last half centimetre or so to an asymmetric point. In contrast, the leaves of *I. echinospora* taper gradually and evenly throughout to a long, hair-like tip. This is easy to see and is absolutely distinctive in all fresh specimens examined, but not when the plant is dried.

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R. Stokoe

Book Reviews

The life of Joshua Gosselin of Guernsey, 1739–1813, Greffier and soldier, antiquary and artist, plantsman and natural historian. David McClintock. Pp. 32, with 5 illustrations. Toucan Press, Guernsey. 1976. Price 75p.

It seems a long time since we had a major biographical resuscitation as a by-product of local Flora work. Apart from Readett on Henry Holden, have there in fact been any since Kent on John Blackstone and Edees on Robert Garner?

Now Mr McClintock has restored another 'lost' figure: Joshua Gosselin, known hitherto merely as the author of a lengthy list published in 1815 as an appendix to W. Berry's *History of Guernsey*. Begun in 1788, when Gosselin was 41, this runs to no fewer than 528 species (473 of them vascular plants) and constitutes a remarkably comprehensive account of the island's flora for so early a period. What is more, as has emerged in only the last few years, it is backed up by an extensive collection of voucher specimens with localities (though the localisation is not to particular identifiable gatherings). 'No other area,' writes Mr McClintock with justifiable pride, 'surely has so magnificent an early start for the recording of its wild flowers.'

Till now no account of Gosselin has extended 'to more than ten lines of print'. Mr McClintock found there was copious material in family archives, which he has duly quarried with commendable thoroughness, and this 32-page booklet is the result. Local historians must count themselves fortunate that the subject came to the attention of the one person all-familiar with the botanical background and thereby alive to the full scientific implications (though they will grumble at his failure to observe scholarly convention in particularizing his manuscript sources, not least those run to earth in that largely trackless wilderness, the Public Record Office).

Greffier (or Clerk of the Royal Court) as well as an officer in the militia, Gosselin comes to life as a man of wide culture and accomplishments who was meticulous in all he undertook. Considering that he mainly relied on a copy of the utterly antiquated Parkinson, it is a measure of the care and discernment that he brought to his study of the island's plants that he proves to have missed astonishingly little. Would that his like had existed in every local area at that period!

An unexpected feature, which enhances his interest, is the re-emergence of an enthusiasm for plants among some of his latter-day descendants. One of these was a flower painter of distinction, Charlotte Trower, bequeather of the Trower Fund, which for many years enriched the reports of the Botanical Exchange Club with otherwise prohibitively costly plates; another is a leading horticultural writer, Mrs Betty Massingham. And from a throwaway reference in the Introduction to 'my cousin Mrs Joan Gosselin' it would appear that the lineage extends, very fittingly, also to the author himself.

It is sad that the publisher has let the author down with such poorly-reproduced illustrations. But it is a disaster that he has compounded this with a bibliographical enormity: a title on the cover sharply different from the one that appears on the title-page. Confronted with both, who will ever know which of them to cite?

D. E. Allen

Index to European taxonomic literature for 1970. Compiled by D. H. Kent & R. K. Brummitt. Pp. 215. Published in conjunction with the Flora Europaea Organisation by the Bentham-Moxon Trustees, Kew. 1977. Price £3·00. Obtainable from the Secretary, Bentham-Moxon Trust, Royal Botanic Gardens, Kew, Richmond, Surrey, U.K.

The *Index to European Taxonomic literature* was started by Dr Brummitt in 1970, and five parts of it appeared as volumes of *Regnum Vegetabile* covering the years 1965–1969. In 1971 this *Index* was subsumed under *The Kew record of taxonomic literature*, compiled by the staff of the Royal Botanic

Gardens and closely following the style of the earlier *Index* but extended to cover the whole world. Although four volumes of the *Kew Record* have now appeared, the final volume of the *Index*, covering taxonomic literature relevant to Europe published in 1970, has, infuriatingly, had to remain unpublished because of financial problems. With the aid of a grant from the Flora Europaea Organisation, the Bentham-Moxon Trustees have now been able to publish it. The volume is very neatly and readably produced from typed copy and, within these limits, follows the style of the earlier volumes; it matches them exactly in format. It should be bought by anyone who has either the previous volumes of the *Index*, or the succeeding volumes of the *Kew Record*, or both. The price of £3 is less than one eleventh of the price of the latest volume of the *Kew Record*, which contains only three times as many entries; it is also less than the price of the 1969 *Index* on its publication in 1972. It is a pleasure to see the work of the indefatigable compilers at last available, and to know that a gap will now be cheaply and satisfactorily filled on the shelves of, one hopes, every botanical library of significance in Europe and beyond.

A. O. Chater

Dictionary of British and Irish botanists and horticulturists. R. Desmond. Pp. xxvi + 747. Taylor & Francis Ltd, London. 1977. Price £40·00.

Until recently, one of the most useful tools in any botanical library was the *Biographical index of deceased British and Irish botanists*, generally referred to under the surnames of the two compilers 'Britten and Boulger'. However, as the last edition was published as long ago as 1931 it became increasingly clear that the volume badly needed bringing up to date. With the publication in April of last year of Ray Desmond's *Dictionary of British and Irish botanists and horticulturists*, including plant collectors and botanical artists, 'Britten and Boulger' has been superseded by a work of far greater scope, which includes nurserymen, gardeners and horticultural writers as well as botanists, plant collectors and botanical artists.

This fat volume of 747 pages is well bound in a sturdy and attractive green cover. The book is well produced and opens easily. The pages have wide margins enabling manuscript notes to be made. Following the preface, a historical introduction by W. T. Stearn, and an impressive list of books and periodicals consulted in compiling this work, are the biographies. These entries give information such as the dates and places of birth and death of each person listed, short biographical details, a selected list of publications, and locations of plant collections, manuscripts, drawings and portraits. Mention is also made of any genus or species dedicated to a person listed. A new feature is the subject index at the end of the book, which classifies many of the entries under profession, plants or the country where the flora had been collected and studied. Specialists can be found under the name of the subject they studied, such as algology, ecology, lichenology and mycology. British botanists and nurserymen are also listed under the places in the British Isles where they collected or worked. The names under each heading are chronologically arranged.

In a work covering such a wide field it would be impossible not to have some errors and omissions. For example, no mention is made of the important manuscripts concerning Elizabeth Blackwell and her *Herbal*, preserved in the British Museum (Bloomsbury), and little information is given on Lieutenant Commander Christopher Maitland Stocken D.S.C., R.N., born Bristol 17 April 1922 and killed 23 August 1966 while leading the Royal Naval Expedition to East Greenland. In 1969 his *Andalusian flowers and countryside* was published posthumously, edited by A. P. Hamilton. *Silene stockenii* Chater was named after him.

Compared with the entry for F. Kingdon Ward, scant notice has been taken of the two great collectors Frank Ludlow and George Sherriff, who made several expeditions into Bhutan and south-eastern Tibet between 1933 and 1950. Their botanical collections, now in the British Museum (Natural History), amount to over 21,000 gatherings, and their journeys enriched our gardens by the introduction of many plants new to science, such as *Aconitum fletcheranum, Gentiana marquandii, Primula ioessa, Rhododendron tsariense* and *Saxifraga montanella*. Six new plants were named after Ludlow and seven after Sherriff.

The compiler of the above *Dictionary* was formerly Chief Librarian and Archivist at the Royal Botanic Gardens, Kew. He spent nearly eight years in the preparation of the work, and he is to be congratulated on the large number of entries it contains—almost four times as many as the publication of 1931. The book fills a great need and to many it will be an indispensable tool. Inevitably the price of the work is high, but it is to be hoped that many public and private institutions, including of course botanical and horticultural libraries, will purchase such a useful book for their reference shelves.

B. HENREY

Flowers of Greece and the Aegean. Anthony Huxley & William Taylor. Pp. vi + 185, with 483 coloured illustrations and 77 line drawings. Chatto & Windus, London. 1977. Price (in U.K.) hardback £6·50, paperback £3·95.

This handy-sized popular guide to the more eye-catching plants of Greek lands follows the same pattern as Polunin & Huxley's *Flowers of the Mediterranean* (1965), with the valuable addition of a number of line drawings by Miss Victoria Gordon as text-figures. These are admirably clear and greatly enhance the descriptions of the species so illustrated. In all, a total of 660 species and infraspecific taxa are described in brief, non-technical outline and over 500 are also shown in colour photographs or line-drawings. The authors are to be congratulated on the accumulation and presentation of so many illustrations. Short introductory chapters, one on Geography and Climate and others on the plants particularly associated with the main vegetational types likely to be encountered, paint a general picture of the Greek landscape and flora. As this introduction must be intended for those with little knowledge of the flora, the omission of references to the illustrations against the many plant names mentioned seems strange, requiring as it does use of the index in every case.

The usefulness of this book for identification has its limits set by the ability to cover, in a handy volume, only about a tenth of the flora and by a bias towards certain of the more 'popular' families at the expense of others. The orchids are very well represented with ample photographs showing, for the Ophryses, the chief colour and pattern variants likely to be encountered. On the other hand, grasses, which increasingly have their devotees, are almost excluded, whilst the huge legume family gets only a little more space than the Ranunculaceae in the broad sense and the Compositae less than the Liliaceae, Omissions are debatable of course, but the reviewer would have expected to see included *Osyris alba,* for example, and *Erysimum graecum* rather than the rare Cretan endemic *E. raulinii.* More serious than the omissions themselves is the failure to indicate their size, thus leaving the newcomer to the flora without the guidance of knowing whether a family or genus is completely covered or more-or-less largely omitted. Suppose he has a clover to name, unwarned of the 90 or so species not mentioned, he may be misled into thinking it ought to correspond with one of the four species described; or, having a *Medicago*, fail to recognize it as such at all when, of the 30 species in the area covered, the two depicted are distinctive rather than typical.

Some criticism must be made of the colour photographs, since much depends on them in a book intended for the interested layman and in which no keys are provided to aid comparison of descriptions. It must be said that not all are good enough to lead to easy recognition. Whilst some are admirably clear, many lack either sufficient size (the smallest are 40mm square), clarity or faithful colour rendering to be a useful introduction to the plants portrayed. Surely better and more typical photographs exist of *Silene colorata* (fig. 28) or *Gynandriris sisyrinchium* (fig. 402), for example. A general browning mars others and is serious where it gives a false impression of colour contrast between similar species e.g. *Paronychia argentea* (fig. 24) and *P. capitata* (fig. 25), *Legousia pentagonia* (fig. 285) and *L. speculum-veneris* (fig. 286) or *Cyclamen persicum* (fig. 193) and *C. creticum* (fig. 196).

Despite lapses from the ideal the book will be welcomed by flower-lovers visiting Greece and the Islands as guide and souvenir, and for the amusing, if sometimes puzzling, footnotes on the uses, real and mythological, to which the plants have been put from classical times onwards.

S. S. HOOPER

A Flora of the Maltese islands. S. M. Haslam, P. D. Sell & P. A. Wolseley. Pp. lxxi + 560, with 66 plates and 29 figures. Malta University Press, Msida, Malta. 1977. Price £M3·50 (£4·75).

The successive appearance of four of the five volumes of *Flora Europaea* has inspired the production of new regional Floras and various popular works and pinpointed the principal gaps in our knowledge of European plants. *A Flora of the Maltese islands* is the latest in a line of regional Floras to adopt its concise, diagnostic style for descriptions; and, although this is a reasonable practical expediency for rapid production, such a procedure has its obvious draw-backs. For example, most of the keys and descriptions for species and genera have been based on, and often lifted straight out of *Flora Europaea* and are, therefore, distinctly uncritical. The majority of the original descriptions are to be found in the Monocotyledon accounts (which have been compiled by Pat Wolseley with considerable help from Dr Martin Rix and guidance on the Gramineae from Dr Alexander Melderis) and, of course, that of the Compositae, written competently by Peter Sell. Nearly all the cited chromosome numbers are based on extra-Maltese material, and several of the descriptions mention variation that is not known to occur in Malta. Furthermore, uncritical decisions have led to the inclusion of several taxa of dubious occurrence within the islands.

Nevertheless, this new work is justified in being called a comprehensive Flora since there is such a lot of useful information besides the diagnostic elements. Common English names are given to every species, and Maltese ones too are cited, when available. Distribution data for the islands are based on the localities given by Gulia, Duthrie, Delicata, Sommier, Gatto, Borg, Lanfranco, Kramer and Westra, as well as on the personal observations of Pat Wolseley. The general distribution of each species is also given, and ecological statements are based on published work together with the field notes of Haslam and Wolseley. The illustrations are a highlight, and it is always a pleasure to see Pat Wolseley's rather sparse but distinctive line drawings. These are arranged on 66 plates providing an illustration of at least one species for each genus described in the Flora. However, this is a poor idea, and such expertise would have been better employed by concentrating on taxonomically difficult groups. The introductory chapters provide valuable comments on the history, geography, geology, ecology, vegetation and relationships of the flora. Maltese collaboration is evidenced by a chapter by Prof. J. Borg on fruit-growing, the island's main agricultural activity, and an account of medicinal plants by the late Prof. Henry Micallef.

The editing has suffered from the attentions of 'too many cooks.' At the same time, although transcriptions of Maltese names into English have been, to say the least, variable and spelling or type-setting errors such as *Opyhrs* and *Black Horebound* are unforgivable, the general layout and consistency of the work is good and must be commended. The printing quality is medieval, especially for the photographs and the line drawings, which are rendered useless in several instances. The practical life of the book will be short, since there are far too many pages for a paperback edition and the binding is very poor. My copy is falling apart already, which is a serious consideration for a work principally aimed at field students. However, despite all criticism the Flora represents a considerable updating of Borg's (1927) work, and it is fair comment to say that it will be the standard work of the Maltese islands for the next 50 years.

REFERENCE

BORG, J. (1927). *Descriptive Flora of the Maltese islands, including the ferns and flowering plants.* Msida, Malta.

C. J. HUMPHRIES

Atlas zur Flora von Südniedersachsen. H. Haeupler. Pp. 367, with 10 plates and 1818 maps. Scripta Geobotanica X, Verlag E. Goltze, Göttingen. 1976. Price DM36.

After the publication of the *Atlas of the British flora* in 1962, several European Institutions decided to follow suit and produce, along similar lines, an *Atlas of the flora of Central Europe*. As far as I know, the most comprehensive and best organized project so far is the proposed mapping of the flora of Bavaria (Arbeitsgemeinschaft zur floristischen Kartierung Bayerns), which involves the largest region of the Federal Republic of Germany. The work to be reviewed here is based on a much smaller region, namely southern Lower Saxony, comprising an area of 140km square. In all, the work contains 1746 distribution maps, produced by the dot-grid method. In addition to all species indigenous to the area, it contains numerous microspecies as well as most of the established introductions. The taxonomy is based on Ehrendorfer's *Liste der Gefässpflanzen Mitteleuropas* (1967, 1973). The bulk of the records was gathered between the years 1967 and 1971, mainly by field work (90%) but also from literature and from herbarium material.

The introduction contains a map of the area and 30 smaller maps showing geomorphological, climatological and phytogeographical details. The entire work is beautifully produced and printed on high-quality art paper. The colour illustration (*Viola odorata*) on the cover is splendid indeed. One cannot help wondering on what grounds so much enthusiasm and certainly money was lavished on the production of a distribution atlas of such an insignificantly small area; local patriotism may be the answer. Despite all the effort and industry invested in the project one finds the smallness of the individual maps (six to the page) rather irritating: the topographical background is condensed to such a degree that anyone not familiar with the area finds it hard to recognize the given distribution patterns. Another handicap is the fact that a large part of the area covered is situated within the German Democratic Republic (most of the Harz Mountains and the adjacent plains stretching almost to Magdeburg), to which none of the field workers had any access. The list of co-operators (pp. 28–30) shows a pretty thin representation from the G.D.R. Nevertheless, if this work is a foretaste of things to come and if the projected *Atlas of Central Europe* is as painstakingly prepared as this book, one should eagerly await its arrival.

E. Launert

Neuste Anweisung, Pflanzen nach dem Leben abzudrucken. E. W. Martius. Wetzlar. 1784. Facsimile print, introduced and edited by Armin Geus (limited edition of 100 copies numbered in Roman and 400 copies in Arabic). Pp. xxvi + 80, with one figure. Basilisken-Presse, Marburg. 1977. Price DM28.

By definition antiques cannot be produced; but due to the rapid expansion of the Scientific community and the subsequent foundation of new universities and scientific libraries, the number of people who want to consult 'antique books' is ever increasing and their demands have pushed up the prices of most of the works, which occasionally come on to the open market, to astronomical levels. No wonder that for this reason the reprinting of rare old scientific works has become a major industry. Reprinting not only makes rare books widely available but it often helps to preserve valuable works of reference from being damaged by constant use. In contrast to most publishers who concentrate on the reproduction of 'useful' scientific works, the Basilisken-Presse of Marburg has the bibliophile foremost in mind. After their beautiful facsimile edition of Cosmos Conrad Cuno's *Observationes Microscopia*, they have, as a second venture, unearthed not only a neglected rarity of the first order but also a most delightful little book: in it E. W. Martius, father of the famous author of the *Flora Brasiliensis*, K. F. Ph. von Martius, gives the 'Latest Instructions' on nature printing. To the historian of scientific illustration this method is of passing interest only, since its shortcomings are obvious. Nevertheless, during the 18th century and even in the first half of the 19th a number of German books were illustrated by this method. Nearer home one should, of course, mention T. Moore's *Ferns of Great Britain and Ireland*, which, due to the two-dimensional nature of these plants, showed nature printing at its most successful. For the English reader of the book it is interesting to see Martius disputing the assumption that the credit for the invention of the method should be given to 'Dr Sherard aus England'. The author, who lived from 1756–1849, was a pharmacist and founded, together with D. H. Hoppe, in 1790 the Regensburger Botanische Gesellschaft (the first botanical society in Europe), wrote his book in Wetzlar after he had studied and acquainted himself with various existing methods of nature printing. In a disarming pedantic fashion—'von Bäumen und allen grossen Pflanzen nimmt man nur Zweige"—he describes his own method and relates the history of the process in great detail.

This book, provided with a scholarly preface by Prof. A. Geus, printed on high quality paper, furnished with beautiful end papers and attractively bound, can be recommended to every lover of fine books.

E. Launert

Welsh timber trees, native and introduced. H. A. Hyde, 4th edition, revised by S. G. Harrison. Pp. xii + 165, with 45 half-tone plates and 52 text-figures. The National Museum of Wales, Cardiff. 1977. Price £3·00 plus p. & c. 47p.

This charming little book, with its detailed descriptions and beautiful illustrations, has always had relevance beyond the Welsh borders and must be known to many readers. It is noticed here because the much-enlarged edition of 1960, now out of print, was not reviewed in these pages. The new text is little altered from the earlier one; only the general sections on Welsh forests and woodlands (pp. 17–26) have been rewritten. Some comments on uses and diseases have been added, a fresh distribution map and one Plate substituted and 37 items added to the Bibliography. The statistical Appendix has been dropped, as also, sadly, has the glossary element from the Index; the 37 'personal communications' in the Bibliography might have been better spared.

This edition is therefore largely a reprint. The opportunity has not been taken to increase the forestry content; the text is still more about trees than timber. Mr Harrison could have augmented the conifer section especially; for example, his account of the Mountain Pine has not been brought into line with that in his revision of Dallimore & Jackson (1966), and the Hybrid Larch and Hybrid Cypress, at least, deserve fuller treatment. However the book remains a handy, reasonably priced text on the common trees of Britain; and the inclusion of Mr A. F. Mitchell's records has certainly brought the references to notable specimens up to date.

REFERENCE

Dallimore, W. & Jackson, A. B. (1966). *A handbook of Coniferae and Ginkgoaceae*, revised by S. G. Harrison. London.

J. Lewis

Tree rings and climate. H. C. Fritts. Pp. xii + 567, with numerous text figures. Academic Press, London. 1977. Price £16·00.

Dendroclimatology is a branch of dendrochronology, both marginal to the study of the British flora. So, only a short reference to this long book (much of which is technical) is justified here. Nevertheless the subject is fascinating and of ever-growing importance, as is shown by this volume with its 19 pages of references and by the holding last in July 1976 at Greenwich of the five-day symposium on 'Dendrochronology in Northern Europe'.

The science was pioneered by A. E. Douglass from 1901, who established in 1937 the Centre for Tree-Ring Research in the University of Arizona at Tucson. But the earliest observation on the subject had been made in 1737 by Duhamel and Buffon, who recognized frost damage 29 rings in from the bark. Just a score of years ago, the science revealed the existence of the 4,600 years old Bristle-cone Pine, *Pinus longaeva* as it was named, and from it a chronology of no less than 8,500 years has now been established.

This book claims to be no more than a progress report (albeit thorough) on a rapidly developing subject, deducing past climates from the size and nature of tree rings, which 'can give a view of what the climate . . . is most likely to be in the future'. To help to do all this, a close knowledge is required of the physiology of trees, which is here gone into in detail. The book also, of course, sets out the principles and techniques of the science, and mentions some of its practical applications. It seems to me the job has been well done.

D. McClintock

Reports

ANNUAL GENERAL MEETING, MAY 7th, 1977

The Annual General Meeting of the Society was held in the Learning Resources Centre, Plymouth Polytechnic, on Saturday, May 7th, 1977 at 14.00 hours, with 45 members present.

Mr E. L. Swann (retiring President) took the Chair, and Dr D. L. Wigston read a letter of welcome from Lord Morley, Chairman of the Board of Governors of Plymouth Polytechnic, who expressed regret at being unable to join the meeting.

The minutes of the last Annual General Meeting, as published in *Watsonia*, **11**: 271–272 (1977), were passed after the election of Council Members at that meeting (Dr Q. O. N. Kay, Dr J. L. Mason, Mr J. M. Brummitt and Dr J. Dransfield) had been recorded.

REPORT OF COUNCIL

The Report of Council for the calendar year 1976 had been circulated to members and was adopted by the meeting.

TREASURER'S REPORT AND ACCOUNTS

The Accounts showed a gain in total net assets of £2,199, but rising costs were a continuing problem. The Treasurer's Report was carried unanimously, and the Treasurer particularly thanked Dr F. H. Perring, who had taken over responsibility for sales of B.S.B.I. publications, and Miss E. Young, for preparing the tax repayment on covenants.

QUESTIONNAIRE TO MEMBERS RESIDENT IN SCOTLAND

The organization of B.S.B.I. activities in Scotland had been raised at the Annual General Meeting in 1975. Discussion since had led to the sending of a questionnaire to the 159 members in Scotland asking if they would like a B.S.B.I. Committee for Scotland, or if they would prefer the organization in Scotland to remain, as at present, through the Committee for the Study of the Scottish Flora. Mr Swann announced the results: 98 replies had been received, 58 in favour of a B.S.B.I. Committee for Scotland, 38 in favour of the organization as at present, and 2 abstentions.

ELECTION OF PRESIDENT

The retiring President, Mr E. L. Swann, thanked all officers, especially the Honorary General Secretary, for support and help during his presidency and proposed Professor D. H. Valentine for election. This was carried unanimously and Professor Valentine then took the Chair, thanking Mr Swann for his work for the Society.

ELECTION OF VICE-PRESIDENTS

Mr J. P. M. Brenan and Mr J. F. M. Cannon were unanimously elected as Vice-Presidents and the retiring Vice-Presidents, Mrs H. R. H. Vaughan and Dr W. T. Stearn, were thanked by the President.

ELECTION OF OFFICERS

The following officers nominated for re-election were elected en bloc: Mrs M. Briggs, Honorary General Secretary; Mr M. Walpole, Honorary Treasurer; Mrs J. M. Mullin, Honorary Meetings Secretary; Miss L. Farrell, Honorary Field Secretary; Mrs R. M. Hamilton, Honorary Membership Secretary; Dr G. Halliday, Dr N. K. B. Robson and Dr C. A. Stace, Honorary Editors. Dr S. M. Coles and Dr D. L. Wigston, nominated for election as new Honorary Editors, were unanimously elected.

ELECTION OF COUNCIL MEMBERS

Mr R. W. David, Captain R. G. B. Roe, O.B.E., R.N., and Mrs A. C. M. Duncan had been nominated and were elected unanimously; their order of precedence, as given, was determined by ballot.

ELECTION OF HONORARY AUDITORS

Messrs Thornton Baker and Co. were gratefully re-elected as Honorary Auditors.

ANY OTHER BUSINESS

The suggestion that the thanks of the meeting be sent to Mr F. Perring (Senior) for handling the sales of B.S.B.I. posters and books by post from Oundle Lodge was warmly applauded.

The meeting closed at 14.35.

M. BRIGGS

PAPERS READ AT THE ANNUAL GENERAL MEETING

A NEW COUNTY FLORA FOR DEVON

The decision to start work on a new Flora was taken late in 1969 by the Botanical Section of the Devonshire Association with the cooperation of the Department of Biological Sciences of the University of Exeter. The existing Flora, by the Rev. W. Keble Martin and G. T. Fraser, published in 1939, was not only out of date by modern county Flora standards, but also gave little information on the occurrence of the commoner species. Its records had been collected on a Parish basis over a very considerable period.

The *Atlas of the British flora* and several new county Floras use the 10km grid square or a subdivision for recording, and the new Devon Flora adopts this basis. Devon essentially represents vice-counties 3 and 4, though boundary changes have occurred. The new county Flora boundary is taken as shown on the 7th edition O. S. maps, scale 1:63,360. The 2 × 2km tetrad is used as the basis for recording flowering plants and ferns. 1843 tetrads are represented within the county boundary as defined, but some very small portions of marginal tetrads are included in the most appropriate adjacent one. Lichens and bryophytes are now also being recorded in 10 × 10km squares.

The data are initially stored on punched cards and then transferred to on-line disc storage using the University of Exeter computer. An associated computer programme allows a range of output data, including a map of the number of species recorded from each tetrad. Records are now sufficiently numerous for maps to reveal individual species distribution patterns, and to identify suspect records.

Woodell (1975) examined the problems of writing a county Flora and the following examine his points in the light of the Devon Flora experience:

Number of visits/visitors per tetrad. Two recorders and two visits to a tetrad are essential, but the most efficient recording is carried out by individuals.

Accessibility. Devon is a large county with many narrow lanes, and evenly-spread recording without a car is impossible. The weakest parts are the agricultural areas of the north, centre and south, which are often botanically 'dull'.

Marginal tetrads. These have presented few problems, dealt with by recorders making specific excursions in conjunction with the distribution maps to ensure that all tetrads are recorded.

Identification. This has been the major problem. Grasses and critical genera are under-recorded. The misidentification of common plants is almost impossible to detect, but it is hoped that the numbers of such are small compared with the total and that the less common species with interesting or important distribution patterns are reasonably accurately identified.

FRASER, G. T. & MARTIN, W. (1939). *Flora of Devon.* Arbroath.

WOODELL, S. R. J. (1975). Five years of a county Flora project. *Watsonia,* **10**: 265–272.

R. B. IVIMEY-COOK

THE FLORA OF THE TAVISTOCK WOODLANDS

The Tavistock Woodlands were part of the Duke of Bedford's Devonshire Estates from 1539 to 1959. There is a remarkably complete series of records for the Estate which allow interpretation of the changing patterns of coppice, coppice-with-standards, and clear-fell plantation forestry (Wigston 1976). Dates of introductions can often be identified, such as *Fagus sylvatica* (not native to the south-west peninsula) for pure beech stands, *Quercus cerris* and *Rhododendron* spp. (apparently for amenity), and *Picea sitchensis* with the initiation of plantation forestry. The variety of tree species compartments and their range of age-structure also leads to a diversity of under-storey and epiphyte species, such as *Vaccinium myrtillus* and *Luzula sylvatica* dominating under oak coppice, and *Rubus fruticosus* agg. and *Pteridium aquilinum* under old spruce canopy. Species lists are currently being compiled and phenological changes under various canopies being monitored by Mrs M. Harris. A recent and unexpected record is of *Erica vagans* on the edge of a ride.

In 1959 the Woodlands were purchased by the Earl of Bradford, who has initiated a selection forestry scheme in the estate—the Bradford-Hutt continuous canopy system (Hutt 1975). Under this management, tree-species diversity, both of conifers and hardwoods, begins to develop as soon as the system is introduced into existing stands (which may be of conifers, closed canopy hardwoods, or relict coppice). Self-seeding of non-crop species (e.g. native oak) occurs, and is allowed to remain until the appropriate thinning, or, if suitable, it may be incorporated into the management programme. Species lists show that under-storey species diversity is also encouraged. For example, under old stands of *Pinus nigra* var. *maritima*, only three understorey and two epiphyte species were recorded; under canopy of the same species following 15 years of Bradford-Hutt management, five introduced trees were recorded (including the hardwood *Nothofagus procera*), with three self-sown hardwoods (*Q. robur, Q. cerris, Sorbus aucuparia*), thirteen understorey flowering plants and ferns, and seven epiphytic bryophytes and lichens.

Floral diversity under the system is currently being investigated. Initial impressions suggest that such management is a remarkable combination of economic exploitation and ecological conservation. Compared with normal coniferous forest plantation, the Tavistock Woodlands Estate is an area of considerable interest for botanists.

HUTT, P. (1976). The Bradford Plan continuous canopy forestry system. *Practical Education* (*South West*), **72**: 20–24.

WIGSTON, D. L. (1976). Ecological aspects of woodland management and forestry practice (paper read to the Institute of Environmental Science and Forestry Commission symposium *Forest Ecology*, Farnborough College of Technology, December 1976).

D. L. WIGSTON

GALLS ON DEVON OAKS

Plant-galls are caused by a number of different organisms including aphids, mites, beetles and Hymenopteran wasps. The gall structure itself is plant tissue laid down in response to a chemical initiation by the gall causer. Galls occur on most parts of the host tree—on roots, leaves, catkins, buds, bark, twigs and, in the case of oaks, acorns and acorn-cups. By far the most differentiated galls are those caused by the Hymenopteran family Cynipidae, some 30 species of which are known to cause galls on the indigenous British oak species, *Quercus robur, Q. petraea* and hybrids. Many wasps have alternate sexual and agamic generations which give rise to different gall structures; these may occur on the same host taxon or on different *Quercus* species. For example, the spread of the marble gall, *Andricus kollari*, following its introduction in the 1830s for tannin production, was probably facilitated by the introduction of its sexual generation host, *Q. cerris*, in the 1720s.

A number of *Quercus robur, Q. petraea* and hybrid sites in Devon are being monitored for gall occurrence and distribution, both within individual tree canopies and within and between populations. Initial findings from the study are:

(a) exposed oaks are more heavily infested than sheltered trees;
(b) *Q. robur* is attacked by larger numbers of gall-causing species and in higher densities than is *Q. petraea* or hybrids;
(c) one or both generations of some gall causers may be host-specific. Thus, the knopper gall, *A. quercus-calicis*, appears to be restricted to *Q. robur*, as is the catkin gall, *A. quercusramuli*;
(d) gall distribution is largely restricted to the lower canopy.

The spread of *A. quercus-calicis*, first reported in Britain in 1962, has been followed with particular interest in view of its possible effect on the natural regeneration potential of British oaks. A previously unreported observation is the galling of the acorn itself in addition to the cup. The distribution of this gall increased considerably in Devon during 1976, reaching as far west as Plymouth. As much as 80% of a tree's mast can be galled, and in germination experiments 60% or more of uninfested acorns developed into seedlings, but only 7% of infested (knoppered) acorns. No chalcid parasites of this gall (known to occur on the Continent) have been found in this study.

M. H. Martin

NATIONAL VEGETATION SURVEY—A PROGRESS REPORT ON THE SOUTH-WEST REGION

The major treatise on the vegetation of the British Isles is still that of Tansley (1939), the last printing of which appeared in 1949. Although it will remain a landmark in British ecology, the work is out of date; much detailed work is now available on areas of British vegetation, but, with the exception of McVean & Ratcliffe's (1962) work on the Scottish Highlands, there has been little attempt at a synthesis to follow the work of Tansley. In 1974 the Nature Conservancy Council issued a contract to produce a 'dictionary' of vegetation types covering the plant communities of all natural, semi-natural and major artificial habitats occurring in Great Britain. The dictionary is intended to be a reference description of discrete, named and systematically arranged vegetation units, but of a form to be widely useable by workers in plant and animal taxonomy and ecology, nature conservation, land-use planning and description.

The survey is based on five essentially climatic and geographical regions; the South-West Region, based at Exeter, consists of South Wales in addition to the south-western peninsula. Each region has a supervisor and a research assistant. The experience of the supervisor and the increasing familiarity of the assistants with their region is complemented by the local experience of research workers, B.S.B.I. recorders, Naturalists' Trusts, etc.

The relevé approach is used, and the initial work has involved establishing the range of homogeneous vegetation types within the region, from floristic lists and associated site data. It is already clear that the varied geography and history of the South-West Region has produced a multiplicity of vegetation types whose limits remain to be defined. All flowering plants, gymnosperms, pteridophytes, bryophytes and macrolichens are recorded. A list of critical taxa has been compiled, including *Rosa, Rubus fruticosus* agg., *Hieracium, Quercus robur/petraea*, and exchange of information with the editors of the projected new Flora of Great Britain and Ireland is intended. Voucher material of these taxa has been collected from the outset.

Tansley, A. G. (1939). *The British Islands and their vegetation.* Cambridge.

McVean, D. N. & Ratcliffe, D. A. (1962). *Plant communities of the Scottish Highlands.* Monographs of the Nature Conservancy, 1. London.

M. C. F. Proctor & P. Wilkins

EXCURSIONS HELD IN CONNECTION WITH THE ANNUAL GENERAL MEETING

MOUNT EDGCUMBE PARK, CORNWALL. May 7th

Early arrivals for the Annual General Meeting gathered at Admiral's Hard, Stonehouse, for the 10.15 Cremyll Ferry across the mouth of the river Tamar to Cornwall and Mount Edgcumbe Country Park. The formal gardens were visited first, and fine specimens of *Ginkgo biloba* and *Quercus suber* were observed, and also the unique *Q. ilex* hedge. Particularly admired was the 'English Garden', restored as an Elizabethan Knot Garden. In addition to the formal plantings, interesting self-introductions were seen, including *Polypodium australe* on the sea-wall.

From the formal gardens the party went on to the open parts of the estate. Of special interest were characteristic specimens of *Ulmus glabra, U. procera* and *U. carpinifolia* within a few yards of one another. The pond below Edgcumbe house was covered by *Azolla filiculoides,* which in one year had largely ousted *Lemna* spp. and *Wolffia arrhiza.*

The visit was necessarily short, but lunch in the Edgcumbe Arms suitably prepared the members for the afternoon Annual General Meeting.

D. L. Wigston

WISTMAN'S WOOD, DEVON. May 8th

Some 25 members of the Society gathered at Two Bridges, Dartmoor, to take the footpath to the highest *Quercus robur* population in the British Isles, Wistman's Wood. Ominous rainclouds suggested that we were to receive some of the 60 or more inches of rain that the Wood experiences each year.

Beyond Crockern Farm the party paused to view the Forestry Commission plantation at Beardown. The management strategy of single-species, uniform-age-compartment, clear-fell forestry was clearly seen. The associated paucity of understorey species and severe gully-erosion on slopes was noted.

On reaching Wistman's Wood, the late flushing of these high-level oaks was evident, although there was much less attack by *Tortrix viridana* and other defoliators this year. Expanded leaves clearly showed the features of *Q. robur*. The unusual growth-form and population structure of the oaks was examined; the distinction between old, prostrate, low-branching forms and younger upright trees was seen. The party was fortunate in including Dr M. & Mr G. Spooner, who have conducted much research into the visible changes in Wistman's Wood from photographs dating from Victorian times onwards. In particular Mr Spooner was able to locate positions from which A. G. Tansley obtained photographs, and showed that the Wood was expanding and regenerating vigorously. The party went on to examine the rich understorey and epiphyte flora for which the Wood is renowned. *Sorbus aucuparia* was noted as an epiphyte on some older oaks! *Polypodium vulgare* was another common epiphyte along with many bryophyte species. Grazing within the wood was clear from the cropped accompanied by *Equisetum fluviatile*. A Dactylorchis was subsequently determined by Mr Wood as Conservancy to eliminate the effects of grazing, was examined. *L. sylvatica* was particularly luxuriant, but impenetrable *Rubus fruticosus* agg. was dominant. The lower part of the enclosure extending below the woodland boundary contained many young oaks, established after the erection of the fence. Although the Wood is expanding, grazing of seedlings must be a major population-regulating factor. The party then proceeded to the junction of the South and Middle Woods; with the expansion of the population these two areas, distinct in Tansley's time, have now nearly merged. The party lunched by a young prostrate oak regarded by Mr Spooner as typical of the growth-form of most of the oaks earlier this century.

The North Wood was then visited, and the members moved on to examine the flora of Longford and Littaford Tors. Typical habitats for plants as diverse as *Lycopodium selago*, *Hymenophyllum wilsonii*, and *Endymion non-scriptus* were observed, but not the plants themselves. The weather had proved remarkably kind, and the party returned to Two Bridges and thence to the Spooners' house at Yelverton for tea, where photographs of Wistman's Wood at various dates were displayed. Many members were delighted by the garden, which contained, amongst other plants, *Thelypteris oreopteris*, *Erica vagans* and *Polygonatum multiflorum*.

The hour was late and the party began to break up. One stalwart went on to see *H. tunbrigense* at Shaugh Prior, and those members staying in Plymouth returned to see the Plymouth Pear at Estover, and the Plymouth Thistle and Bladder Campion on Plymouth Hoe.

D. L. WIGSTON

SLAPTON LEY, DEVON. May 9th

The previous day's good fortune with the weather was not repeated. Some 15 members gathered in intense rain on Slapton Sands. Undaunted, they were met by John Griffin, the Deputy Warden of Slapton Ley Field Studies Centre, who led the party along the shingle ridge to observe characteristic species such as *Calystegia soldanella*, *Glaucium flavum*, *Euphorbia paralias* and *Cakile maritima*. The sea pea, *Lathyrus japonicus*, was observed—a recent introduction following a Royal Marines exercise from Portland.

The backslope of the ridge was seen to be a more stable habitat, with *Silene maritima* and *Armeria maritima*. The considerable variability in the form of *Geranium molle* was discussed. As we proceeded across the bridge between the Higher and Lower Ley, the dense reed beds could be clearly seen. Along the edge of the Ley the locally rare Lusitanian species *Taraxacum hispanicum* was collected for the British Museum herbarium. The exterior bracts of this plant serve to distinguish it from all other members of the genus. The Lower Ley Marsh was characterized by the dominance of *Phragmites* and Sallows; *Equisetum fluviatile* and *Oenanthe crocata* were much in evidence.

As we passed into France Wood, *Allium ursinum* was apparent both visually and aromatically, and later garnished one member's sandwiches. The management of the woodland to maintain its mixed character was pointed out.

D. L. Wigston

CONFERENCE REPORT

THE POLLINATION OF FLOWERS BY INSECTS

This symposium was organized by Dr A. J. Richards at Castle Leazes Halls, University of Newcastle upon Tyne, from April 14th–17th, 1977, for the B.S.B.I. in association with the Linnean Society. Of the 150 participants, no less than 40 came from abroad, and nearly half of those from Holland, but representatives from Norway, Denmark, Austria, Israel, Eire, South Africa, New Zealand, Canada and the U.S.A. were also present. British members included many amateurs, some with anthecological or ambrosial leanings, but also a strong professional contingent, and about 25 students.

During a protracted arrival on the Thursday, participants learnt the complex infrastructure of the building, so typical of modern campus architecture. The conference started on Friday morning in the Junior Common Room of Freeman's Hall. This commodious room also doubled as a bar and area for a flower display; meals were next door and exhibits immediately downstairs. Professor K. Faegri gave an introductory address on trends in research in pollination ecology, after welcomes by Professor S. L. Ranson, on behalf of the University, and Professor D. H. Valentine, on behalf of the B.S.B.I. This was followed, after coffee, by papers on pollinator behaviour by Dr S. R. J. Woodell (directionality in coastal bumble bees), Dr N. B. M. Brantjes (on how moths find flowers), and Dr Sarah Corbet (on variation in nectar content in *Echium* and its effect on pollinators).

After lunch, Dr M. C. F. Proctor, who had brought with him a series of his magnificent photographs of pollination, one of which had formed the motif for the conference, talked on the evolution of insect-pollinated flowers with respect to habitat-type, followed by Dr P. Kevan who gave a most enlightening lecture on how insects see flower colours. After tea, Professor S. Vogel, who astounded participants throughout the conference with his encyclopaedic knowledge, talked on deception in pollen flowers, followed by Professor A. D. J. Meeuse, who gave a graphic illustration of the heat generation in aroids.

Participants then walked to the Department of Plant Biology, relishing the fresh air and exercise, where they were entertained with sherry. After dinner, we saw three films: one by Professor Valentine on *Impatiens*; a short but exciting view of hawk-moths pollinating *Echium* in the Breck by Dr Corbet; and a long film on pollination of *Rhinanthus* by Dr N. Kwak. An even longer, but no less professional, film covering the whole of the Rhinanthoideae was shown by Dr Kwak to interested parties the following night.

We had hoped to see some 8mm films, but the lack of a suitable spool prevented this for nearly an hour. Some Dutch ingenuity finally allowed us to see Professor Vogel's film on oil-collecting wasps in *Lysimachia*, and Dr Brantjes' excellent sequences of a seed-eating moth-larva.

The next day concentrated on population biology, and opened with Dr A. J. Richards reading Professor D. A. Levin's important, if somewhat weighty, paper on the effect of pollinator behaviour on population structure (Professor Levin was unfortunately not able to be present). Two papers on the effect of pollination on flower-colour polymorphism by Dr Q. O. N. Kay, and his ex-student, Dr D. Mogford, were followed by Dr Richards' and Miss H. Ibrahim's work on population size in *Primula veris*, and Dr A. J. Beattie's most excellent paper on seed and pollen dispersal in *Viola*.

After lunch, Professor L. van der Pijl (who regaled us throughout the conference with a succession of entertaining stories) talked on floral functions, their integration and sexual disharmony, followed by Professor Valentine, who gave an account of the biology of the British *Impatiens*. After tea, Dr D. Eisikowitch showed that even the Israel sea-shore is a windy place, and that plants seem to be dwarf in response to the low-flying requirements of pollinators. Two final papers, discussing insect pollination in apparently wind-pollinated plants (*Plantago* and *Salix*), from Professor Meeuse and P. Stelleman, brought the papers read to 18 and the paper-reading sessions to a close. After a sherry party, given by the University and hosted by Professor D. H. Whiffen, Dean of Science, came the conference dinner, attended by about 70 and followed by some memorable speeches.

The weather had been cold and the season late, even by north-eastern standards, so it was with some trepidation that about 40 people set out for the Farne Islands. In the event, it was indeed very cold, and rising wind caused a hasty and premature evacuation, but close views of many of the nesting birds and the seals were afforded to many, even if pollinators were scarce! About 25 went to Corbridge, where 'Kilbryde', Randall Cooke's old garden, now the property of the University of Newcastle, was examined with interest, although, due to the very late season, the amount in flower was disappointing. A visit to the Roman fort at Corstopitum was very cold, but enlivened by a guide who is researching at the site. On the way home a hybrid population of *Primula* was visited briefly.

It remains to comment that proceedings throughout were lively and interesting, and socially as well as intellectually enjoyable, and thanks are due to the authorities at Castle Leazes Halls for making arrangements so efficiently, as well as to speakers, exhibitors, and volunteer helpers from the Department of Plant Biology, without whom the conference would not have been possible. One name must be selected for special mention: E. M. Caldwell, administrator of the Department of Plant Biology, who undertook much of the strenuous and tedious work of registration, booking and finance.

A. J. Richards

FIELD MEETINGS 1976

CHANNEL ISLANDS

GUERNSEY. MAY 27TH—JUNE 2ND

The B.S.B.I. and the Wild Flower Society joined forces with La Société Guernesiaise for six days in the Guernsey bailiwick. The occasion was launched by Old Government House bursting at the gunwales to hear a talk on the local wild flowers illustrated by some 150 of the superb slides of John Bichard. The object of the visit was to see how the recent *Wild flowers of Guernsey* worked in the field. To the gratification of the author, it did this well; not that some 30 visitors, plus an always welcome daily posse from La Société (in Sark also from the newly-founded Société Serquaise), did not add to the records.

For example, *Gaudinia fragilis* was spotted well-naturalized in satisfactory quantity in a fresh area of the central pasture of La Grande Mare; and more plants were seen of *Centaurea aspera*, near what had seemed the last, ailing, three. Near by, at Vazon, *Ophrys apifera* was most happily refound in a long-lost locality. *Tragopogon porrifolius*, even if it was only one plant, was a nice find in a lane at St Peter's, at the opposite end of the island from its small but long-established colony. The *Amaranthus deflexus* by the St Sampson's power station was not only flourishing despite attrition by the tidiers, but one plant had blotched leaves; and *Polygonum rurivagum* was near by.

In Sark, *Festuca caesia* (*glauca*) was on a hot, dry cliff by La Coupée, and *Geranium purpureum* down the path to the west. *Sibthorpia europaea* turned up in a gully near Le Fort: and *Oxalis exilis, Euphorbia lathyrus* and *Papaver somniferum* confirmed at Clos Jaon, all new to the island. So is *Potentilla argentea*, many plants of which were seen in a bed and path at the Seigneurie garden.

Herm had *Crambe maritima* on both western and eastern sides (it seems to be increasing locally); there were two good plants of *Rumex rupestris* on the west coast, and *Polygonum maritimum* surviving ball games on the east.

Alderney. The weather throughout was perfect, including, from the organizers' point of view, the Monday. That was spent, from 7am, mostly quietly in the airport waiting, in vain, for the fog to lift, a welcome respite for them, above all for Mrs Ryan, the Botanical Secretary of La Société who had put so much work into the preparations and the day before entertained the party to tea. But it was a sad gap for most of the visitors—all they got was a dander in the afternoon to be shown *Polypodium vulgare* subsp. *serrulatum*, growing, extraordinarily enough, in deep shade near a path by the southern cliffs.

This is not the report the visitors would have written, most of whom were adding to their diaries and lists many new plants which were not, however interesting, new to the Guernsey tally. But it was a pleasure to be able to share so much in such a short time with such a wholly delightful gathering.

D. McClintock

ENGLAND

TEWKESBURY, GLOUCS. MAY 8TH

On a bright, sunny morning a party of 21 members and friends from eight counties met at Tewkesbury. Mrs S. C. Holland had planned a route that enabled me to demonstrate the variation in habit and appearance of the Black Poplar (*Populus nigra*). A short walk down Lower Lode Lane introduced the party to the first Black Poplar, a fine female tree, covered with green catkins, growing in a hedgerow in the flood-plain of the River Severn. This tree, the finest female Black Poplar in Gloucestershire, is, I believe, protected by a T.P.O. Another Black Poplar was noticed on the opposite side of the lane, probably an offspring taken as a cutting from the nearly mature tree.

We then moved over the Mythe Bridge and into Worcestershire, where at Lower Marsh Lane, Longdon, two fine male trees were admired. The red male catkins had already fallen, in contrast to the green catkins of the female tree, which it holds till June. At Glenberrow, a few miles further west, we came to a magnificent spreading tree on the village green. It had been pollarded many decades ago and lacked the characteristic arching lower boughs, but the furrowed trunk and leaf characters placed it firmly in *P. nigra*. We then turned back to our next port of call, Corse Lawn, where the mile-long village green supported a large number of ancient, frequently pollarded, male trees, many growing by ponds. Here a picnic lunch was taken in the shade of some of the poplars.

Back in Gloucestershire the party stopped to inspect four fine male pollards at Tirley, and after crossing the Severn by Haw Bridge, a dying veteran near Apperley. The final port of call was Boddington, where the owners of Boddington Home Farm gave us permission to have a close look at a particularly fine specimen in their orchard, at least 100 feet high and probably more than 150 years old. Other trees of various sizes were growing along an old drainage channel on the farm, one of these can be clearly seen from the M5. All these Boddington trees are characteristic in habit and leaf characters, but they lacked the development of large bosses on thin trunks, so demonstrating that exceptionally this diagnostic character may be lacking.

After the meeting ended, a few enthusiasts went to the Badgeworth Nature Reserve where the smallest *P. nigra* tree in Gloucestershire was seen. This is a sapling grown from a cutting taken from a tree at Down Hatherley, and planted by Mrs Holland in 1973 to mark 'Plant a Tree in '73' year.

I would like to thank Mrs Holland for her admirable planning which made the meeting so profitable for those who attended. It was good to meet so many people interested in my favourite British tree.

E. MILNE-REDHEAD

HAM MEADOW LANDS, GREATER LONDON. JUNE 6TH

A party of 23, including members of the B.S.B.I. and the London Natural History Society, met at Ham House car park to study the flora of Ham meadow lands.

A large number of both spring and early summer grasses were seen flowering, one of the dominant being *Zerna erecta*. Naturalized trees of *Robinia pseudacacia* and *Colutea arborescens*, which had been growing here since this area was a rubbish dump, attracted attention. Other naturalized garden remnants included masses of *Armoracia rusticana* and *Galega officinalis*.

J. L. GILBERT

SOUTHAMPTON COMMON, S. HANTS. JULY 3RD

This meeting was the first to be held in southern England for some years expressly as an introduction to that most difficult of genera, *Rubus*. The locality was chosen for its combination of accessibility and richness (in bramble terms it is the Putney Heath of Wessex), and because in a normal year the plants here tend to be exceptionally far advanced, affording the maximum opportunity of seeing and learning some of the species right at the start of the season.

Unfortunately, this was far from being a normal season. The long drought combined with temperatures well in the nineties through much of the preceding week had resulted in all but a few of the brambles being deprived of their petals, thereby drastically reducing the possibilities of demonstrating the species. A day of ferocious heat also induced mass wilting on the part of the 11 members who attended, and it says much for their enthusiasm that the original programme was able to survive in its essentials and all persisted until the end.

11 species were demonstrated, all of them widespread or at least locally abundant in Britain and including representatives of each of the sections. The prevalence of hybrids in some localities—of which this Common is a particularly marked example—also made a firm, if unwelcome impression.

The more important purpose of the meeting, however, was to provide those proposing to embark on the genus with some useful guidelines. Among the points made under this head were: the desirability of first thoroughly learning a species in the field before submitting a specimen of it for naming; the overriding necessity of collecting suitable material; the need for systematic exploration of whole areas instead of sampling at random; the great difficulty of identifying brambles from descriptions (or from the keys or plates in Watson's book); the existence of so many, still-unnamed, local forms, which bedevil the task of the national specialists. No one should contemplate taking up *Rubus*, it was suggested, without an excellent visual memory, the diligence to collect carefully and copiously and the self-discipline to make extensive notes.

D. E. Allen

PENNINE FELLS (WARCOP RANGE), CUMBRIA. JULY 17TH–21ST

Since 1972 a small party from the Department of Plant Biology, University of Newcastle has been spending a few days each summer centred on Appleby, and exploring the great range of fells that stretch from Hartside, in the north, south to Brough, and which provide the largest continuous area of land above 2000 ft in England. This scarp and plateau is notable for being largely difficult of access (with the exception of the radar road to the summit of Great Dun Fell, which, at 2780ft, is the highest metalled-road in Britain), and for being previously little worked, apart from the National Nature Reserve at Moorhouse. There are very large exposures of limestones, with at least some outcrops in most 1km squares, whilst the Whinsill has impressive exposures in most of the main dissections, as at High Cup, Knock Ore, Middle Tongue, Crowdundle and Black Door. Other notable features include sinkholes in plenty, very good mesotrophic spring-fed mires, heavy-metal spoil, and high-level sandstone block-scree. All have their share of interesting plants which include *Saxifraga hirculus* (ten sites), *Alopecurus alpinus* (six sites), *Phleum alpinum, Poa alpina, Myosotis alpestris* (three sites), *Dryopteris assimilis* (locally common) and *Dryopteris villarii*. In common with the more widespread species *Sedum rosea, Vaccinium uliginosum, Carex bigelowii, Epilobium anagallidifolium, Alchemilla glaucescens* and *Euphrasia scottica*, these rarities are not found in neighbouring Teesdale. However, the area also shares with Teesdale such species as *Orthilia secunda, Gentiana verna, Primula farinosa, Potentilla crantzii, Polygonum viviparum, Carex capillaris, Thalictrum alpinum, Thlaspi alpestre, Draba incana, Asplenium viride, Juncus triglumis, Saxifraga hypnoides, S. aizoides, S. stellaris, Myosotis stolonifera, Epilobium alsinifolium, Minuartia verna, Lycopodium alpinum, Plantago maritima* and *Viola rupestris*. Thus, although little known, its importance can scarcely be over-emphasized. In order to describe this area, to record the frequency and distribution of the less common plants, and to document sites of high conservation priority, higher plants and Bryophytes have been mapped on 1 km squares.93 of these have now been completed, and some 20 more remain to be covered.

In order to help with recording, a B.S.B.I. party met at Appleby. Altogether 18 members took part on one or more days, including several local members. It had been hoped to concentrate on the M.o.D. range at Warcop, but a late change in firing dates only allowed access on the first day, which was distinguished chiefly by the discovery of the very rare necrophilous moss *Haplodon wormskjoldii*. *Plantago maritima* was also found, by a path, and thus possibly introduced; this constituted the first record for the area. Several species mostly restricted to the southern part of the range such as *Saxifraga tridactylites, Carduus nutans, Pimpinella saxifraga, Scabiosa columbaria* and *Geranium lucidum* were also recorded.

The Tuesday brought a drive up the radar road, and members saw well-known sites for *Saxifraga hirculus* (in flower), *Myosotis alpestris, Juncus triglumis* and *Potentilla crantzii*. The rediscovery of *Phleum alpinum* (three plants), in what may be its sole remaining English station, brought pleasure only equalled by the sight of the Howitts' 50 year-old Rolls negotiating the road with contemptuous ease. Equally remarkable in this *annus mirabilis* was some very heavy rain. Unworked squares on the back of Little Dun Fell provided more sites for *Alopecurus alpinus* and *Juncus triglumis*.

On the Wednesday we worked an area further south than any previously covered, to the north-east of Brough. Here we were guided by Lancelot Henderson who has worked this previously little-known area thoroughly. A flourishing colony of *Draba incana* was followed by a hill-top site with very dwarf, non-flowering *Galium boreale* and *Saxifraga granulata* (at nearly 2000ft, surely the highest British site for the latter?). *Minuartia verna* and *Botrychium* were also found. Later in the day we found a fine series of flushes with a large colony of *Saxifraga hirculus*, and *Sedum villosum* and *Epilobium alsinifolium*. To our surprise we were able to add two species to Lancelot's very thorough lists, *Gymnocarpium dryopteris* and *Epilobium anagallidifolium*.

After a ragged start, the Thursday's work progressed in the area to the west of Cross Fell. The very extensive limestone scars proved very dull (as are those at Melmerby), with no better plants than *Saxifraga hypnoides* and *Asplenium viride*. However, one party climbed higher on to the sandstone block-scree, and in addition to such characteristic species as *Lycopodium selago* and *Carex bigelowii* (which is abundant everywhere at and above 2200ft, but rarely drops even 50ft lower), they found good quantities of *Dryopteris assimilis*, only previously found by us in one site above High Cup. In all, it was recorded from four squares. Growing with small forms of *D. austriaca*, it is readily known by the yellow-green, shiny fronds: closer examination reveals the very long, lower bottom pinnule and pale brown scales. A large and handsome *Dicranum* later proved to be the very rare *D. starkei*, new to v.c. 70.

On the final day, a reduced party worked squares between Little Dun Fell and Moorhouse, and were rewarded early on by a small colony of *Lycopodium alpinum* on a spoil heap; nearby grew *Antennaria*. An extensive search for an old site for *Saxifraga hirculus* revealed only the very untypical and confusing flush form of *S. hypnoides*. However, the day finished splendidly, with the discovery of a large and flowering colony of *S. hirculus* in a quite new area, and in company with such distinguished plants as *Juncus triglumis* and the two montane *Epilobia*. Also present with typical *Carex lepidocarpa* was the distinctive and puzzling plant we find quite frequently, and call, for want of a better name, *C. lepidocarpa* subsp. *scotica*.

So ended a most valuable five days in which 28 squares (25 new) were examined, and in which most of the local specialities were seen, many in new localities. I should like to thank all participants for the hard work they put in, and the Nature Conservancy Council and the Ministry of Defence for access to their lands.

A. J. Richards

KENT. AUGUST 7TH–8TH

A very pleasant weekend was spent visiting nine tetrads and adding 172 new records to the Flora. On Saturday, the party of 12 walked along the prom from Folkestone to the outskirts of Dover and back again following the cliff path on the Warren. *Orobanche maritima* fitting the C.T.W. description was found, associated with *Daucus carota*. Other species of interest were *Rubia peregrina, Frankenia laevis, Crambe maritima, Crithmum maritimum* and *Inula crithmoides*.

The Sunday was spent exploring dykes in the Lydden Valley, fishing for *Potamogeton—P. natans, P. coloratus, P. perfoliatus, P. berchtoldii, P. crispus* and *P. pectinatus*. A debate ensued over submerged plants of *Baldellia ranunculoides* with only the flowering parts above water. Other species of interest were *Callitriche stagnalis, C. obtusangula, Myriophyllum verticillatum, Sparganium erectum* subspp. *erectum* and *oocarpum*, and *S. emersum*.

E. G. Philp & L. Farrell

BRAMPTON, CUMBRIA. AUGUST 21ST–22ND

Nearly 20 people, members and non-members, Cumbrian residents, emigrés and aliens, converged on Brampton for a late summer weekend in perfect weather recording for the Flora of Cumbria project. Despite the inadequacies of the hotel headquarters, the group maintained its floating population and the result was a stimulating and useful two days.

On both days the party dissolved into twos and threes, disappearing into the botanically little-known hinterland north-east of Brampton—the remote heather and cloudberry moors and sandstone tors behind Bewcastle (not forgetting its Saxon cross) and extending to the Scottish border, the lonely upper reaches of the River Irthing which here forms the border with Northumberland, and the rolling country alongside Hadrian's Wall.

The residual areas of Walton Moss, a lowland moss north of Brampton, produced *Andromeda polifolia* and *Genista anglica*. One member undertook the long walk north to Glendhu Hill (still in

Cumbria!) and down to the Border but found little of note except for *Lycopodium clavatum* and *Spergularia rubra*, the latter growing at 1300ft along a new forestry track through the infant Sitka spruce plantations. Shaded cliffs by the waterfalls near Irthing Head had *Thelypteris dryopteris*, *T. phegopteris* and *Rubus saxatilis*. In the calmer reaches of the river east of Paddaburn a sedge was collected which has been provisionally identified as *Carex aquatilis*; if confirmed, this would be the first record for Cumberland. It was only one of the 18 species of *Carex* recorded on or around the Butterburn S.S.S.I.; other species included *C. pauciflora* and *C. paupercula*. The distinctive *Eleocharis austriaca* was seen in several places by the river, nearly always in quiet 'backwaters'. Early in the summer the hay meadows around Butterburn have a rich array of orchids but they are increasingly threatened by the pressures of forestry and changing agricultural practices.

The remarkable number of 35 tetrads were visited, the number of species per tetrad varying from about 50 on the uplands to between 150 and 200 in the lowlands, but it is difficult to generalize—Butterburn produced the surprising total of 169. Mention must be made of the pre-breakfast feat of one member who recorded almost as many species from Lanercost Priory.

Few members knew the area before; most vowed to return, perhaps regretting having botanized the area so thoroughly.

G. Halliday

WALES

STRUMBLE HEAD, PEMBS. JUNE 12TH

A party of 11 walked along the two miles of coastal footpath between Strumble Head and Pwll Deri, botanically perhaps the richest stretch of sea-cliffs on the northern and western coasts of Pembrokeshire. The rocks of this exposed peninsula are mainly pillow lavas with rhyolite and basic intrusions, all of Ordovician age. In the extensive maritime heaths, which are a special feature of the area, *Genista pilosa* is very frequent and some stands were found to be still in flower.

About midway, a diversion into a valley mire disclosed numerous plants of *Eleocharis multicaulis* and brought the total of sedges for the day to 12 species: *Carex hostiana, C. binervis, C. demissa, C. panicea, C. flacca, C. hirta, C. pilulifera, C. caryophyllea, C. nigra, C. echinata, C. ovalis, C. pulicaris. Dactylorhiza purpurella* was a feature of the valley and on a dry site *D. maculata* subsp. *ericetorum* provided an attractive sight where earlier in the year there had been a purple and yellow carpet of *Orchis mascula* and *Primula veris*. There was *Osmunda regalis* beside a stream and a fine plant in a flush below the cliff-top.

On return to the cliff-top, about 50 clumps of *Schoenus nigricans* were seen in a *Molinia*-dominated depression surrounded by species-poor heath. *Baldellia ranunculoides* was picked out amongst the emergent vegetation of a shallow farm pond just off the path.

In the 1973/74 winter a large area of gorse and maritime heath had been burned and the resultant pattern of sea-cliff vegetation was observed with interest. The more open conditions had resulted in seedlings, including those of *Genista pilosa* and *Veronica spicata* subsp. *hybrida*, becoming established. It was, however, felt that the widespread local dominance of *Ulex europaeus* and *U. gallii* is largely attributable to a history of irregular fires.

The last item of special interest to be seen was a flourishing colony of *Asplenium billotii* growing in sheltered crevices on a dolerite promontory.

S. B. Evans & T. A. W. Davis

SCOTLAND

THE UPPER TWEED, PEEBLES. JUNE 12TH–19TH

This meeting was attended by numbers varying from six to 12 depending on the weather and the commitments of those living locally. Its purpose was primarily to record in lesser known 5km squares but also to confirm old and dubious records.

The party met after lunch on June 12th in Peebles and explored both sides of the Tweed up to Manor Bridge. This square is already quite well known but *Scirpus sylvaticus, Mimulus luteus* and *Sagina* *subulata* were noteworthy additions. *Equisetum pratense*, recorded by Lyall in 1858, was not refound.

On the following day we met at Talla Reservoir in fine weather. The local flora is interesting and a number of calcicoles were seen including *Saxifraga hypnoides, Trollius europaeus* and *Melica nutans*. Garelet Hill also yielded *Galium boreale*, a purple form of *Viola lutea* and *Hieracium anguinum*, previously known only from v.c. 72. After lunch the party drove past Talla Linn into the Megget valley where a reservoir is to be built. Separate groups worked the Linghope and Winterhope burns. The main party soon came across *Oxycoccus palustris* on their way towards a scrub wood on the lower slopes of Craigdilly. The wood was mostly of *Sorbus aucuparia* and *Betula pubescens* with *Thelypteris phegopteris, Ranunculus ficaria* and *Ajuga reptans* locally in the under-storey. *Trollius europaeus* was by the Black Burn in small quantity and *Galium sterneri* elsewhere. *Hieracium caledonicum* was collected from rocks by the Winterhope Burn. The day's prize however went to the finders of *Listera cordata* in full exposure among *Sphagnum* on a windblown saddle at 1700ft. All in all a good first day even for the small boy of one member who moved enthusiastically from hairy caterpillar to hairy caterpillar for much of the afternoon.

June 14th was cooler but still dry and was spent mostly in the grounds of Portmore House and the Black Barony hotel. Little of note was found by Portmore loch so early but the adjacent woods were rich in ferns including *Dryopteris carthusiana*; the old Harcus mill-pond was a sheet of *Cardamine amara* and a number of aliens near the house were extending their range, including *Tellima grandiflora* and *Polygonum cuspidatum*. *Luzula luzuloides* was seen in two places but a single flattened shoot at Black Barony was all that could be traced of the formerly abundant *Poa chaixii*. The garden wall at Portmore had an abundance of *Asplenium ruta-muraria, A. trichomanes* and *Cystopteris fragilis*, while a farm road near Harelaws had a large patch of *Senecio squalidus*.

On June 15th we visited the shingles of Leithen water, a known locality for small annuals. A soft but penetrating drizzle threatened all our cards with transformation into porridge and we rapidly became appreciative of the merits of a VW caravan as the ideal botanizing vehicle, complete with supplies of tea and fruitcake. *Teesdalia nudicaulis* was common together with small *Vicia angustifolia, V. hirsuta, Trifolium dubium* and a *Filago* too young to determine. Two very dissimilar sedges later both proved to be forms of *Carex rostrata*. *Veronica anagallis-aquatica* was seen in a backwater together with both *Mimulus guttatus* and *M. luteus*. After a steamy lunch a reduced party worked the Williamslee Burn, in drier conditions, nearly to its head. We failed to confirm *Hypericum humifusum* from Craigie Cleuch but found a suspiciously decumbent form of *H. pulchrum*. *Saxifraga hypnoides* and *Alchemilla vestita* were not uncommon, but *Saxifraga stellaris* absent. *Carex lepidocarpa, Dryopteris abbreviata, Cryptogramma crispa* and *Juniperis communis* were all seen in small quantity and the sight of a long-tailed large raptor, possibly a Hen Harrier, being mobbed by small birds rounded off an interesting day.

Wednesday June 16th also started wet and the hopes of refinding a series of calcicolous rarities reported from Glen over 100 years ago gradually evaporated. However, there were compensations: *Chrysoplenium alternifolium* very locally above Loch Eddy, *Galium sterneri* and *Asplenium adiantum-nigrum* similarly in Glendean and *Hieracium duriceps* in profusion. *Poa chaixii* was thriving near the house and *Listera cordata* was in rank heather at 1500ft. The day's success was crowned by David Ellis's finding *Valeriana dioica* in an upland marsh, the first record for over 50 years.

June 17th was intended to be a short day to enable some stock-taking, but in the event the groups working the squares on either side of the road to Moffat, near the v.c. boundary, had plenty to do. 277 records were made, the most interesting habitats being a wet meadow near Tweedshaws and basic outcrops up the Glenwhappen and Old Burns which yielded *Poa nemoralis* and *Carex lepidocarpa*. *Ranunculus hederaceus* was seen at 1450ft where the old coach road crosses into Dumfriesshire.

On June 18th we met in threatening weather at Whim. The pond margins provided a second station for *Scutellaria galericulata* and a raised bog had *Oxycoccus palustris* and *Dryopteris carthusiana*. There was a good stand of *Cicerbita macrophylla* by the main road but little else noteworthy, so in deteriorating conditions a short visit was made to Rachan in the afternoon, which to everyone's pleasure resulted in the refinding of *Linnaea borealis* in a dripping pinewood, despite the felling of the original trees some years ago. *Geranium lucidum* was noted on a roadside nearby.

On Saturday June 19th, the day being fine but windy, a small group paid a quick visit to the high ground about Broad Law which confirmed earlier records of alpines including *Salix herbacea* and, very locally, *Thalictrum alpinum, Epilobium anagallidifolium* and *Chamaepericlymenum suecicum*.

Judged by its original purpose the meeting was a considerable success. Members of the party were enthusiastic and covered much ground during the week, resulting in nearly 760 new square records for the county. *Sagina subulata*, *Linnaea borealis* and *Valeriana dioica* were refound; three stations each for *Dryopteris carthusiana* and *Listera cordata* were discovered; *Luzula luzuloides* and *Tellima grandiflora* were flourishing in two locations and *Poa chaixii* in one; N.C.R.'s were made for *Polygonum cuspidatum*, *Senecio squalidus*, *Hieracium anguinum* and *H. caledonicum*. Finally the special interests of Alan Silverside were satisfied by not only finding *Mimulus luteus* in several spots, but also a series of hybrids with *M. guttatus* and *M. cupreus*!

D. J. McCosh

KINDROGAN, PERTHSHIRE. JUNE 24TH–29TH. WILLOW MEETING

Kindrogan proved an excellent centre for willow studies, and six days of fine weather contributed to the success of the survey. Out of 18 indigenous or thoroughly naturalized British species, 16 were seen; only two, *Salix triandra* and *S. pentandra*, could not be found. The former, lowland and mainly southern in distribution, was not to be expected, while *S. pentandra*, though a northern species, scarcely extends beyond the lowlands of Scotland, except where planted.

The date of the meeting was well chosen; almost all the willows, including the arctic-alpines, were sufficiently developed for the demonstration of leaf characters, while many retained some catkins, at any rate the diagnostically more useful female catkins, to allow for the examination of catkin-scales, ovaries, styles and stigmas.

Thursday, June 24th. Devoted to the inspection of willows growing in the immediate vicinity of Kindrogan House. *Salix caprea* L. was found in abundance by roadsides and on the margins of plantations on the lower slopes of Kindrogan Hill, though missing from long stretches of wet ground along the banks of the River Ardle. The local populations varied only within narrow limits, but were uniformly distinct from southern British populations of this species in having relatively narrow, obovate or elliptic leaves with entire or subentire, flat margins, tapering bases and acute (or almost acuminate) apices. In these respects they agree with typical *S. caprea* from Sweden and, if the species were to be subdivided, it is the southern representatives (with broad, blunt-based, undulate-margined leaves) which would have to be reckoned atypical. Further comment on the relationship of 'Scottish' *S. caprea* with *S. coaetanea* (Hartm.) Flod. (*S. sphacelata* Sm., *S. caprea* subsp. *sericea* Anderss.) will be found later (Tuesday, June 29th) in this report. It would appear that *S. caprea* hybrids are uncommon in the Kindrogan area, though one satisfactory bush of *S. caprea* × *S. cinerea* (subsp. *oleifolia*) was found by the pond near Kindrogan House. *S. cinerea* L. subsp. *oleifolia* Macreight (*S. atrocinerea* Brot.) was locally frequent on the lower slopes of Kindrogan Hill, and along the margins of the River Ardle and River Brerachan; some hybrids with *S. aurita* L. were found though, as with *S. caprea*, such hybrids were distinctly uncommon. *S. aurita* became increasingly abundant as one ascended the Hill, sometimes growing with *S. repens* L.; hybrids between the two (*S.* × *ambigua* Ehrh.) were found by the edges of forest tracks at three places. *S. nigricans* Sm. (*S. myrsinifolia* Salisb.) was scattered everywhere, along roadsides, in marshy ground by the pond, on the hillside and by the river. It was tolerably uniform in all these situations, with thin, pubescent, dull green leaves, small but usually well-developed stipules, and dull, greenish twigs and shoots (current year's growths). For the most part the ovaries of the female plants were glabrous but, as was to be found later, pubescent ovaries were not infrequent in otherwise typical specimens. The undersides of the leaves were often distinctly glaucous, with the glaucosity 'wearing off' towards the leaf-apex (a characteristic sometimes regarded as diagnostic for this species) but plants with the leaves green on both surfaces were also found. *S. phylicifolia* was much more problematical. It was less common in this vicinity than *S. nigricans*, and seldom quite typical, though one specimen, from a gravel spit on the River Ardle, had the characteristic lustrous, subcoriaceous leaves, polished brown twigs and pubescent ovaries of the species. Elsewhere leaves and stems exhibited varying degrees of pubescence, and ovaries were commonly glabrous. The leaf-undersurface was generally glaucous, but sometimes the glaucosity showed signs of 'wearing-off' at the leaf-tip as in *S. nigricans*. No distinction could be seen in the marginal toothing of the leaves, but, on the whole, the stipules of local '*S. phylicifolia*' were smaller and less conspicuous than in *S. nigricans*. The problem of separating the two species was to exercise us for the rest of our stay in Scotland.

Friday, June 25th. In the morning a long visit was paid to rich marshes near Blairgowrie. Here a wealth of Cyperaceae and Orchidaceae might have distracted attention had the willow flora not proved equally attractive. An old tree of *Salix cinerea* near the entrance to the first swamp, agreed closely with the ashy-pubescent subsp. *cinerea*, and had the well-developed, persistent stipules of this subspecies. Elsewhere *S. cinerea* subsp. *oleifolia* (*atrocinerea*) tended to predominate, though, at the date of the visit, the characteristic rusty hairs of this common willow were just beginning to be evident. The occurrence of *S. cinerea* subsp. *cinerea* so far from East Anglia is perhaps not as surprising as one might suppose. It is very likely to prove more widespread in the British Isles than the records suggest, and will probably be found elsewhere in base-rich fens and swamps where, in the past it was often named *S. aquatica*, and where, at present, it is commonly passed by as *S. cinerea* subsp. *oleifolia*. In many areas it tends to intergrade with subsp. *oleifolia*, possibly through hybridization. *Salix nigricans* was frequent and not very variable, in the same swamp, and two other lowland willows, *S. viminalis* L. and *S. purpurea* L., together with the hybrid *S. cinerea* × *S. viminalis* (*S. smithiana* Willd.) were also seen; these, together with *S. alba* L., found in an adjacent swamp, had evidently been planted. No *S. caprea* or *S. repens* was seen in this locality, and no 'good' *S. phylicifolia*, though one or two bushes of *S. nigricans* diverged in this direction. *S. aurita* was represented by one, typical bush.

A brief halt close to Marlee Loch led to the finding of more *S. alba*, growing with the Bedford Willow, *S. fragilis* L. var. *russelliana* (Sm.) Koch, both relics of former plantings.

The next site to be visited was by the side of the River Tay near Caputh Bridge. Here *S. cinerea* subsp. *oleifolia* was abundant, together with a wholly bewildering assemblage of *S. nigricans* and *S. phylicifolia*, the former predominant on margins of woodland at higher levels, the latter apparently more abundant on shingle close to the water's edge, but with so many apparent intermediates that satisfactory discrimination was difficult, if not impossible. Solitary bushes of *S. aurita* and *S. purpurea* were seen in the same area.

After this frustration, it was a relief to find a fairly straightforward situation in the swamps at Bloody Inches (near Meikleour); here *S. cinerea* (both subsp. *cinerea* and *oleifolia*) were abundant, together with a little *S. nigricans* and a female bush of *S. cinerea* × *S. nigricans* (*S.* × *strepida* Forbes), with sterile catkins. A few specimens of *S. aurita* and *S. aurita* × *S. cinerea* grew on relatively dry roadside banks nearby.

Saturday, June 26th. Devoted to a search for alpine willows on the mountains above Lochan na Lairige near Ben Lawers. On the slopes above the loch (Creag an Lochain) *S. arbuscula* L. was found to be abundant, both on ledges and on moist grassy slopes below the cliffs. Here it grew with dwarfed *S. nigricans*, and showed little tendency to vary or hybridize, though *S. arbuscula* × *S. repens* L. was reported from near the waterfall by the outlet of the hydro-electricity dam, and a very curious plant, collected about halfway along the cliff-face, must be *S. arbuscula* × *S. reticulata* L. (*S.* × *ganderi* Huter ex Zahn). A third hybrid, found as a solitary bush, was first thought to be *S. arbuscula* × *S. nigricans*, but, on closer inspection, must be identified as *S. arbuscula* × *S. lapponum* L. (*S.* × *pseudospuria* Rouy). *S. lapponum* was not seen in the immediate vicinity, but is known to grow on the range. *S. reticulata* was seen in one place, and reported to grow in greater quantity towards the north end of the Creag an Lochain cliffs. A solitary bush of *S. caprea* subsp. *sericea* (*S. sphacelata, S. coaetanea*) stood out conspicuously against a dark range of cliffs halfway along the loch.

In the afternoon the party moved across the valley to examine cliffs and scarps on Meall Corranaich. These were found to be exceptionally rich, with *S. lapponum* appearing for the first time, together with an abundance of *S. arbuscula* and *S. reticulata*. Most of the *S. reticulata* appeared to be male, and when, finally, a female plant was found, it was noticed that the old (previous year's) dehisced catkins were still firmly attached, while those of the current year were just beginning to develop, an odd situation in view of the fact that the male catkins were in full anthesis. It was nice to note that seedlings and young plants of *S. reticulata* were frequent, and to have evidence that the species is regenerating in this locality. A small quantity of *S. herbacea* L. was seen on the crest of a grassy ridge between two cliff ranges, but it is not common at this (2,500ft) altitude.

Sunday, June 27th. After the exertions of the previous day, most of the morning and early afternoon was spent in the neighbourhood of Kindrogan. Some planted bushes of *S. viminalis*, not a common willow in the area, were seen near Straloch Church, and interesting populations of *S. aurita, S. cinerea* subsp. *oleifolia, S. nigricans/S. phylicifolia* and *S. aurita* × *S. cinerea* were seen on a small islet in the Brerachan Water near West Lodge. In an attempt to elucidate the *nigricans-phylicifolia* problem, individual bushes were scored on what were reckoned useful diagnostic characters. A little further along the same road, at Straloch terminal moraine, the party examined a very extensive population of

S. repens. The population demonstrated the great variability of this species, some plants (at the *S. repens sensu stricto* end of the spectrum) having very slender, prostrate stems, small, narrowly elliptic, subglabrous leaves and glabrous capsules, whilst those at the other extreme were relatively stout and ascending, with broadly oblong, shortly acute, sericeous leaves and pubescent capsules. Whilst some of the latter approached *S. arenaria* L. (*S. repens* L. var. *argentea* (Sm.) Wimm. & Grab.) nothing as robust or sericeous as the sand-dune form of this species (or infraspecies) was found. It was noted that the capsules of plants at the *arenaria* end of the spectrum were mostly fully ripe and dehiscing, while those at the *repens* end were not quite mature, and, with a few exceptions, conspicuously glossy and crimson. Continuing along the Brerachan Water to Dalnavaid, further *nigricans-phylicifolia* populations were scored, and a very handsome bush of the rare *S. caprea* × *S. repens* (*S.* × *laschiana* Zahn) was found by the roadside. This hybrid (here a low, spreading bush about 1m high, with broad, rather silky leaves and sterile capsules) has not been recorded in Britain except from Scotland. Numerous bushes of *S. aurita* were scattered over adjacent moorland.

Later in the afternoon the party journeyed to Ballinluig Island in the River Tummel, finding the by now familiar assemblage of *S. nigricans*/*S. phylicifolia* on shingle by the river, here growing with a limited quantity of *S. cinerea* subsp. *oleifolia*. A few bushes of *S. fragilis* L. var. *decipiens* (Hoffm.) Koch (the true *S. fragilis* of many European authors) and *S.* × *smithiana* were seen, planted, nearby at the edge of a cottage garden.

The day ended in pursuit of *S. triandra* L., reported from the banks of the River Tay at Delvine House, but all the willows seen there turned out to be *S. fragilis* var. *decipiens* intermixed with a few trees of *S. fragilis* var. *russelliana*.

Monday, June 28th. A strenuous day at the head of Caenlochan Glen. The cliffs were approached from Meall Odhar across a sward of *Salix herbacea*, possibly more abundant here than anywhere else in Britain. The alpine willows were strictly confined to the cliffs, and even then to the more inaccessible pinnacles and ledges, the only exception being a very lush and luxuriant, emerald green form of *S. herbacea* growing at one spot amongst damp moss and *Vaccinum myrtillus*. All the hoped-for species were seen in the following order of abundance: 1. *S. myrsinites* L. 2. *S. lapponum* 3. *S. lanata* L. 4. *S. reticulata*. Most of these were in full flower, though in *S. myrsinites* the male catkins were past their best, which may possibly explain why male plants are so seldom represented in British collections of the species. Hybrids were very rare, the only possible one proving, on examination, to be most probably an aberrant form of *S. lanata*. An interesting population of willows was seen by the river near the Spittal of Glenshee, but time did not allow for a further stop.

Tuesday, June 29th. A very useful foray into relatively unknown ground up Gleann Fearnach from Straloch and across the watershed to the limestones of Gleann Mor as far as Fealar Lodge. At the first halt, near Crannach, the usual streamside populations of *nigricans-phylicifolia* were scored, but once across the watershed it was found that the *phylicifolia* element was missing and that all the *nigricans* was 'pure' and readily identifiable. With it grew *S. caprea* (the 'Scottish' form), *S. aurita* and occasional *S. repens* on the drier hillocks. At one place the hybrid *S. caprea* × *S. nigricans* (*S.* × *latifolia* Forbes) was collected, and a solitary specimen of *S. aurita* × *S. repens*, but hybrids were exceptional.

A single specimen of *S. lapponum*, probably a stray from higher altitudes, was found on the rocky sides of the Gleann Mor River at the furthest point reached upstream (1,600ft).

Immediately below Fealar Lodge the riverside vegetation became lush, and *S. phylicifolia* reappeared in quantity, including an old bush, high above the river, with all the characteristics of the typical plant. An extensive population of 'Scottish' *S. caprea* included several bushes with the conspicuous, ashy-sericeous foliage (looking like *Sorbus aria* at a distance) of *S. caprea* subsp. *sericea* (*S. sphacelata* Sm.). It is clear that such plants are no more than extreme variants of the *S. caprea* found throughout this part of Scotland; they tend to predominate in exposed situations towards the upper altitudinal limit of the distribution of the species.

R. D. MEIKLE

DALRY, AYR. JULY 11TH

The meeting at Dalry of the C.S.S.F. and the Andersonian Naturalists of Glasgow was very poorly attended with only the field leader accompanied by one other person undertaking an investigation of the varied environment east of Dalry.

The first locality visited was Gooseloan Pond (GR 25/32.46 & 33.46) with a brief examination of a fine spread of *Senecio aquaticus* × *S. jacobaea* covering several fields, the more or less permanently wet conditions on the heavy clay there apparently being the main factor in the development of the hybrid swarm. Gooseloan pond lived up to its reputation with the discovery of an array of species, including *Butomus umbellatus, Alisma lanceolatum, Nuphar luteum, Glyceria maxima, Ranunculus lingua* and a heady luxuriance of large shining leaves, minus flowers, which we tentatively identified as *Calla palustris.* The surrounding wood held several fine mounds of *Rosa arvensis* and a wet ditch cradled a colony of *Berula erecta.*

Moving on to rendezvous II we found *Platanthera chlorantha, Sieglingia decumbens,* with a few open panicled forms, and *Euphrasia borealis* all in one damp *Juncus*-infested field.

Our second site was a disused, water-filled sandstone quarry where we grapnelled for aquatic plants but hooked only a great mass of *Chara* sp. Among the more usual terrestrial species we noted several strong young plants of *Cotoneaster simonsii.*

The afternoon was terminated with a visit to a nearby moss, Auchentiber Moss (GR 26/35.47 & 36.47), with a fine birch wood on its eastern edge. Here we found a number of plants of *Dryopteris carthusiana* associated with *D. austriaca.* Splendid silky hummocks of the moss *Pleurozium schreberi* can be seen here and we noticed several specimens of the fungus *Russula claroflava* in the locality. Finally we moved over to a small patch of moorland adjacent to the road and noted masses of *Drosera rotundifolia,* a fine swathe of *Myrica gale* and a curious clump of throw-outs growing on the edge which included a *Pulmonaria* sp., *Sidalcea* 'Rose Queen', an *Aconitum* sp. and what appeared to be a *Delphinium* sp.!

B. Simpson

TYNDRUM, W. PERTH. JULY 18TH

A party of 24 members and friends, including children, attended this meeting, one of the objects of which was to examine the flora of Coille Coire Chuilc, a remnant of the old Caledonian Forest of Scots Pine which formerly covered much of the area. It was also the intention to explore gorges on the course of the Allt Coire Dubhchraig and to ascend the northern slopes of Beinn Dubhchraig, as far as time would permit. In spite of the onset of rain later in the afternoon, these objectives were achieved by most of the party.

The scattered pines of Coille Coire Chuilc were soon reached after leaving the cars near the bridge over the Fillan, about a mile and a half south-east of Tyndrum. The woodland area is heavily grazed and the ground flora was not remarkable except for the occurrence of *Melampyrum pratense* and *Listera cordata* in considerable quantity. Nearby, wet heathy areas yielded *Rhynchospora alba, Carex pauciflora* and an *Oxycoccus* which was probably *O. microcarpus* but bore neither flowers nor fruit.

It soon became evident that the local schist rocks were quite calcareous. A gorge on the Allt Dubhchraig supported an interesting flora which included *Hymenophyllum wilsonii, Asplenium viride, Geranium sylvaticum, Rubus saxatilis, Saxifraga aizoides, Orthilia secunda* and *Melica nutans.* Beyond the limit of the trees, the stream banks had *Juniperus communis, Thalictrum alpinum, Silene acaulis, Saxifraga oppositifolia, Polygonum viviparum. Salix phylicifolia, Antennaria dioica, Saussurea alpina* and *Helictotrichon pratense.* Nearby flushes produced *Selaginella selaginoides, Tofieldia pusilla, Juncus triglumis, Carex lepidocarpa* and *C. capillaris.*

In worsening weather conditions some members examined briefly the north-facing crags of Beinn Dubhchraig. The species observed here indicated a rather rich flora including *Botrychium lunaria, Sibbaldia procumbens, Salix lapponum, Coeloglossum viride, Carex vaginata* and *C. atrata.* Flushes below the crags had *Carex saxatilis* while heathy ground yielded *Rubus chamaemorus* and *Vaccinium uliginosum.*

A total of 185 species was recorded during the day in quadrant 27/32 NW, 21 of which were apparently new for the 10km square and five were confirmations of pre-1930 records.

A. McG. Stirling

HUNTLY, N. ABERDEEN. JULY 31ST–AUGUST 7TH

The purpose of the meeting was to investigate underworked areas in N. Aberdeen. Since only two bookings were received, it was decided to curtail the programme, and activities began on the Sunday when the Northern Naturalists of Aberdeen were invited to join us.

So on August 1st a party of five, led by Mr D. Welch, explored Wartle Moss, some seven miles north-west of Inverurie. In this large area of basin mire *Carex rostrata* predominates, and *Carex curta, C. diandra, C. pulicaris. Eleocharis palustris, Menyanthes trifoliata* and much *Parnassia palustris* were seen; 22 species were added to the master card for the 10km square.

The next day we examined a small marsh at Cairnie Junction, finding *Carex hostiana, Crepis paludosa, Eleocharis quinqueflora* and *Lotus uliginosus*, then we moved on to the Daugh of Invermarkie. Heavy rain had set in, and as the moorland proved uninteresting and the wet places yielded only *Carex dioica* and *Hippuris vulgaris* additional to the species previously encountered, we adjourned early.

On Wednesday 4th August we met at Duncanston. The basin mire to the south-west proved less rich than Wartle Moss, but *Campanula latifolia, Montia sibirica* and *Rosa rubiginosa* were found on nearby roadsides, and *Glyceria declinata* and *Rumex longifolius* by a stream near Leslie. In the afternoon we drove on to Rhynie and explored the eastern end of the Hill of Towanreef. The interesting but impoverished flora on the serpentine outcrops included *Aira praecox, Asplenium cuneifolium, A. viride* (no material approaching *A. adulterinum* was encountered), *Cochlearia officinalis, Helictotrichon pratense, Lycopodium selago, Minuartia verna* and *Selaginella selaginoides*.

The last two days were spent in the three 10km squares with fewest recorded species in N. Aberdeen. On the 5th we examined various habitats in the New Deer and Old Deer squares, adding more than 50 species. Here, as in most of the vice-county, the flora is not rich, the most noteworthy plants seen being *Carex curta* and *Hippuris vulgaris* in Annochie Moss, *Glyceria* × *pedicellata* near West Crichie, *Mentha arvensis* near Cairnbanno, and *Fumaria muralis* and *Gnaphalium uliginosum* at Little Millbrex. On the 7th a visit to the Culsalmond square led to the discovery of a colony of *Cryptogramma crispa* on the Hill of Foudland. This confirms the record for v.c. 93 in Druce's *Comital Flora*, which was described as non-localizable in the *Atlas of the British flora* (1962).

Several others of the above-mentioned species, although apparently new to the vice-county, have either been recorded in the B.S.B.I. mapping scheme or previously reported e.g. *Asplenium viride*. So the meeting did not contribute greatly to the botanical knowledge of N. Aberdeen, which is not surprising in view of the disappointing attendance; nevertheless we added some 140 records to the master cards for the nine 10km squares visited.

D. Welch

IRELAND

KINSALE, CO. CORK. MAY 22ND–23RD

The primary object of this meeting was to complete record cards for the 10km squares W54 (v.c. H3), W64 (v.c. H3/4) and W65 (v.c. H4).

A party of seven, led by Tony O'Mahony, Maura Scannell and James White, met on Kinsale quay. Our first visit was to the Kinsale site for *Veronica crista-galli*. The referee, Mr P. Benoit, had kindly confirmed the identity of the Russian Speedwell only the week before. This site is one of only two outlying stations away from the main Cork City populations, where the species has been naturalized for over 70 years. *Allium vineale* and *Erodium moschatum* were also seen here. *A. vineale* is a rare and very local Cork plant, whereas *A. triquetrum* is abundant in this whole area.

At Ring-Na Nean wood near Belgooly, *Euphorbia amygdaloides* was seen in flower for over a mile of roadside. Whilst its status here is dubious, it probably is native along the Bandon river. Other interesting species recorded were *Rubia peregrina, Rosa arvensis, R. micrantha, R. dumetorum, Melica uniflora, Cotoneaster microphyllus* and *Vinca major*. A small clump of *Euphorbia hyberna* grows with the *E. amygdaloides* on the sloping estuary-bank beside the bridge. A colony of *Allium scorodoprasum* grows in this area, but was not visited. After a quick snack in Kinsale, we made for James Fort, situated directly across the Bandon estuary. The tiny beach still held the small colony of *Lepidium latifolium* known to the Rev. Thomas Allin in 1874. Unfortunately we did not refind his equally old station for *Asplenium billotii*. This disappointment was soon offset by finding *Trifolium ornithopodioides*. This represents the first W. Cork station: the only other Cork record has not been seen since 1900. *Verbascum thapsus* and *Petroselinum crispum* were also seen. This concluded field work for Saturday, but a satisfying steak dinner in town allowed botanical chit-chat to continue late into the evening.

A pre-breakfast ramble on Sunday morning found *Medicago arabica* still flourishing in its long-established station at Scilly. The delightful coastal walk to Summercove gave us a patch of *Carex muricata* and *Linaria vulgaris*, the latter not yet in flower, and plenty of *Rubia peregrina*. *Brassica nigra* was common on coastal rocks. After breakfast, we set course for Garrylucus Marsh, behind Garristown beach. Puzzling, beautiful Dactylorchids evoked much speculation as to their identity. There was obviously a very mixed hybrid swarm, with perhaps some 'pure' species still remaining. A sample of one form, which was sent to Mr J. Wood at Kew, was tentatively identified as *Dactylorhiza maculata* × *D. majalis*. The marsh fringe had the leaves of *Rumex hydrolapathum*, noted by Allin a century ago. Few species occurred here, but all were of great interest. *Thelypteris palustris* and *Juncus subnodulosus* were locally abundant, and new to the Cork flora. Some fine stands of *Cladium mariscus* were admired; the species is not recorded for v.c. H5, while the only remaining v.c. H4 station is at Blarney Lake. A beautiful Emperor moth received his due admiration, while those amongst us with ornithological leanings performed quite amazing optical gymnastics, by trying to view plants and birds simultaneously!

A final trip late in the evening to Howe's Strand brought our weekend outing to a close. *Allium triquetrum* was seen here, and we had a good find in *Equisetum* × *litorale* (*E. arvense* × *E. fluviatile*) which was common in marshy ground by a stream. *Berula erecta* grew on the stream margin, accompanied by *Equisetum fluviatile*. A Dactylorchis was subsequently determined by Mr Wood as 'closest to the hybrid *D.* × *formosa* (T. & T. A. Steph.) Soó (*D. maculata* × *D. purpurella*).

The combination of a charmingly contented and enthusiastic group and delightful weather and plants, will surely have etched an indelible memory on the minds of all of us lucky to have attended.

T. O'Mahony

GARRON PLATEAU, CO. ANTRIM. JULY 16TH–19TH

The basalt scarps and high moorland of the Garron Plateau were the venues for the Saturday and Sunday of this meeting. On the first day, however, a small party elected to visit Craigagh Wood, near Cushendun, where *Listera cordata* had recently been reported and both *Hymenophyllum wilsonii* and *H. tunbrigense* are known to occur. *H. tunbrigense* was not seen on this occasion, but the other two plants were eventually found and *Thelypteris limbosperma* was also noted.

On the Saturday, a party of four took the narrow lane which affords civilized access to Lloyd Praeger's '. . . treeless, roadless, houseless, stretch.' *Cicerbita macrophylla*, new to Antrim, was recorded on waste ground near Carnlough and a fine display of wayside grasses, including *Zerna ramosa*, *Brachypodium sylvaticum*, *Festuca gigantea*, *Milium effusum* and the intergeneric hybrid × *Festulolium loliaceum*, provided topics for discussion before the accompanying vegetation took on a very different character as open moorland was reached. *Equisetum pratense* was seen in a rocky defile of the Carnlough river. *Polystichum setiferum* and *P. aculeatum* also occurred here, together with a plant which could not readily be attributed to either taxon. (A similar plant collected near this locality by John Hopton in 1974 has been determined as *P. aculeatum* var. *cambricum*). The party then progressed upwards, following a tributary of the Carnlough river which provides what is probably the only presently known Irish station for *Gymnocarpium dryopteris*, discovered here by Arthur Stelfox in 1949. After lunch, *Cryptogramma crispa* and *Thelypteris phegopteris* were successfully searched for amongst the tumbled boulders of a nearby scarp, *T. phegopteris* appearing particularly luxuriant in favourable crevices. Before descending to Carnlough via the Cranny Burn, we visited a small, rapidly 'shrinking' lochan where *Carex rostrata*, *C. limosa*, *C. paupercula* and *C. curta* were all observed growing in the encroaching marginal *Sphagnum*.

On Sunday, the object of the exercise was to relocate *Saxifraga hirculus* in Praeger's station near Collin Top. This entailed tramping across acres of *Trichophorum-Eriophorum* bog, the kind of terrain which typifies these 'northern' mountain moorlands. Gradually it became wetter underfoot and *Drosera intermedia* was encountered for the first time. Distant clumps of *Schoenus nigricans*, a species which usually indicates 'good' ground in upland Antrim, enticed the party into a very wet 'stretch' and in a short space of time *Selaginella selaginoides*, *Pinguicula lusitanica*, *Eriophorum latifolium*, *Carex lasiocarpa* and *Carex pauciflora* had all been recorded. But *Saxifraga hirculus* proved elusive in all the likelier situations.

On the final day of the meeting, five members and friends journeyed westwards to Lough Neagh, where, in direct contrast to the situation on the Basaltic Plateau, many plants from the central lowlands of Ireland are permitted a northern extension to their range. At Shelshan, *Cicuta virosa, Berula erecta, Alisma lanceolatum, Butomus umbellatus, Juncus inflexus* and *Carex riparia* were seen around the fringes of the Lough, or in the adjoining marshes. Again, the 'speciality' of the locality, in this instance *Hierochloe odorata*, could not be found. Nevertheless, it was generally agreed that, in the time available, a decent attempt had been made at sampling a range of the more characteristic vegetational facies which occur in Antrim. It could only lead to a desire to enquire further.

D. S. LEDSHAM

INISHMORE, ARAN ISLANDS. SEPTEMBER 2ND–7TH

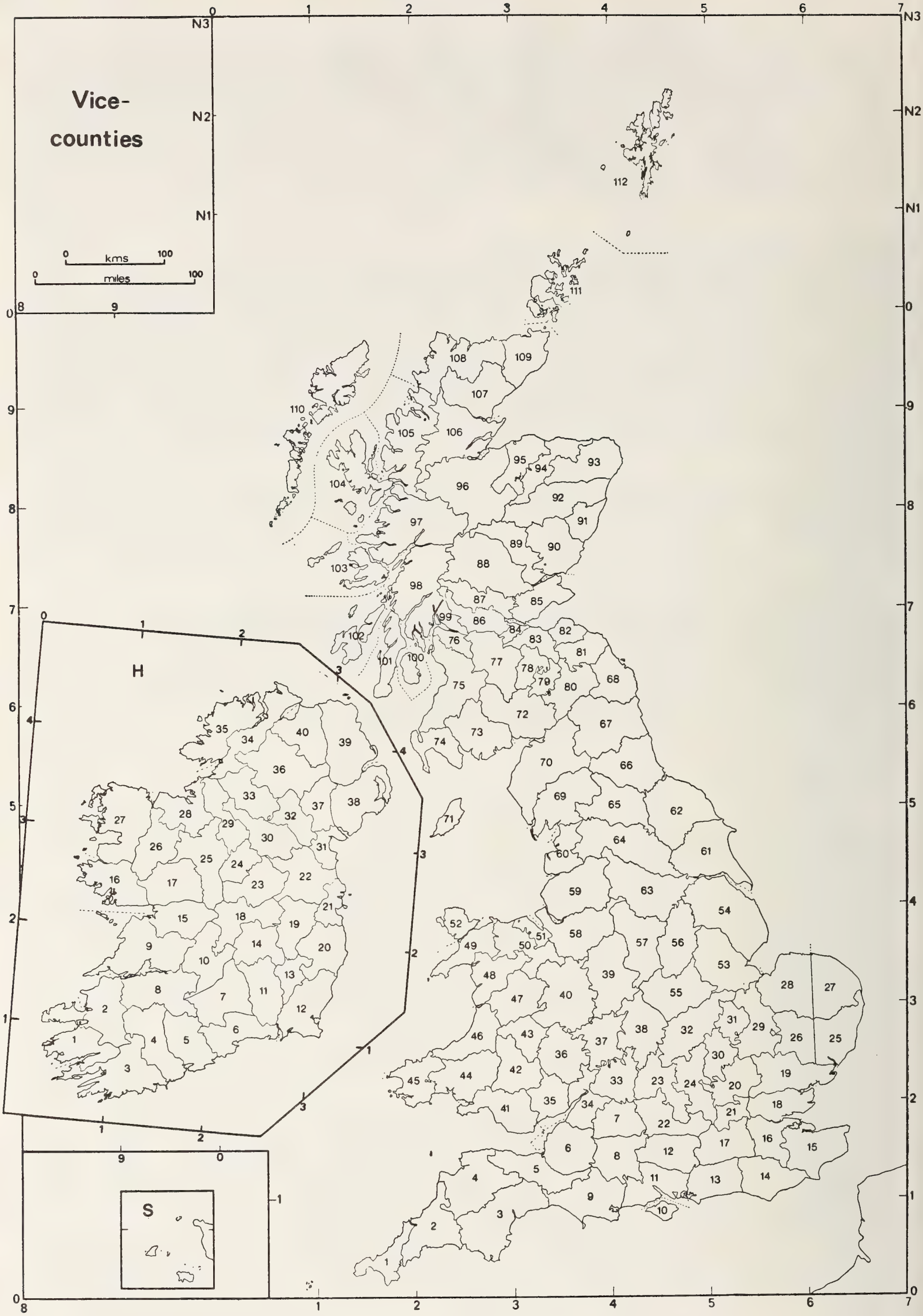
The meeting on Inishmore, Aran Islands was attended by several members and friends and favoured by the remaining days of the long dry summer. The effect of the drought on the vegetation was quite striking on this craggy island: pasture and roadside vegetation was withered and brown and quite uninviting botanically. We sought wet places rather avidly in the circumstances and botanized them diligently. A resident of Inishmore, Mr T. P. Robinson, helped us in the search for the less conspicuous wet ground. Several new records were added to the island flora thereby, including *Rorippa islandica, Polygonum minus, Juncus subnodulosus* and *J. conglomeratus*. In a damp hollow in the limestone pavement, Mr Robinson showed us his station for *Pinguicula vulgaris*, previously unrecorded for Inishmore.

Other species on the island included *Crambe maritima, Helianthemum canum, Silene alba, Lavatera arborea, Astragalus danicus, Cornus sanguinea, Limonium transwallianum, Lithospermum officinale, Atriplex laciniata, Spiranthes spiralis, Allium babingtonii, Zostera marina, Calamagrostis epigejos, Ophioglossum vulgatum, Adiantum capillus-veneris, Dryopteris pseudomas, Polypodium australe*, to cite somewhat eclectically from the flora.

Most of the group visited Straw Island by currach one morning and recorded its shore and sand-dune flora. The early 19th Century records of *Matthiola sinuata* from the island were a botanical inducement, but no trace was seen of it by any of the eight keen-eyed botanists.

The detailed results of the species newly recorded or reconfirmed for Inishmore on this trip will be published later in a survey of the flora of the Aran Islands being undertaken by D. A. Webb, in which the records obtained on this and on previous visits have been collated.

J. WHITE



Vice-
counties
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0 miles 100
H
S

ENGLAND, WALES AND SCOTLAND

1. W. Cornwall
1b. Scilly
2. E. Cornwall
3. S. Devon
4. N. Devon
5. S. Somerset
6. N. Somerset
7. N. Wilts.
8. S. Wilts.
9. Dorset
10. Wight
11. S. Hants.
12. N. Hants.
13. W. Sussex
14. E. Sussex
15. E. Kent
16. W. Kent
17. Surrey
18. S. Essex
19. N. Essex
20. Herts.
21. Middlesex
22. Berks.
23. Oxon.
24. Bucks.
25. E. Suffolk
26. W. Suffolk
27. E. Norfolk
28. W. Norfolk
29. Cambs.
30. Beds.
31. Hunts.
32. Northants.
33. E. Gloucs.
34. W. Gloucs.
35. Mon.
36. Hereford
37. Worcs.
38. Warks.
39. Staffs.
40. Salop
41. Glam.
42. Brecon
43. Radnor
44. Carms.
45. Pembs.
46. Cards.
47. Montgomery
48. Merioneth
49. Caerns.
50. Denbigh
51. Flint
52. Anglesey
53. S. Lincs.
54. N. Lincs.
55. Leics.
55b. Rutland
56. Notts.
57. Derbys.
58. Cheshire
59. S. Lancs.
60. W. Lancs.
61. S.E. Yorks.
62. N.E. Yorks.
63. S.W. Yorks.
64. Mid-W. Yorks.
65. N.W. Yorks.
66. Durham
67. S. Northumb.
68. Cheviot
69. Westmorland
69b. Furness
70. Cumberland
71. Man
72. Dumfries
73. Kirkcudbright
74. Wigtown
75. Ayr
76. Renfrew
77. Lanark
78. Peebles
79. Selkirk
80. Roxburgh
81. Berwick
82. Haddington
83. Edinburgh
84. Linlithgow
85. Fife
86. Stirling
87. W. Perth
88. Mid Perth
89. E. Perth
90. Forfar
91. Kincardine
92. S. Aberdeen
93. N. Aberdeen
94. Banff
95. Moray
96. Easterness
96b. Nairn
97. Westerness
98. Main Argyll
99. Dumbarton
100. Clyde Is.
101. Kintyre
102. S. Ebudes
103. Mid Ebudes
104. N. Ebudes
105. W. Ross
106. E. Ross
107. E. Sutherland
108. W. Sutherland
109. Caithness
110. Outer Hebrides
111. Orkney
112. Shetland

IRELAND

H1. S. Kerry
H2. N. Kerry
H3. W. Cork
H4. Mid Cork
H5. E. Cork
H6. Waterford
H7. S. Tipperary
H8. Limerick
H9. Clare
H10. N. Tipperary
H11. Kilkenny
H12. Wexford
H13. Carlow
H14. Leix
H15. S.E. Galway
H16. W. Galway
H17. N.E. Galway
H18. Offaly
H19. Kildare
H20. Wicklow
H21. Dublin
H22. Meath
H23. W. Meath
H24. Longford
H25. Roscommon
H26. E. Mayo
H27. W. Mayo
H28. Sligo
H29. Leitrim
H30. Cavan
H31. Louth
H32. Monaghan
H33. Fermanagh
H34. E. Donegal
H35. W. Donegal
H36. Tyrone
H37. Armagh
H38. Down
H39. Antrim
H40. Londonderry

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Quercus robur L. and *Quercus petraea* (Matt.) Liebl.: a multivariate approach to the hybrid problem, 1. Data acquisition, analysis and interpretation

B. S. RUSHTON

School of Biological and Environmental Studies, The New University of Ulster, Coleraine, N. Ireland

ABSTRACT

A method of examining and evaluating populational variability of *Quercus robur* L. and *Q. petraea* (Matt.) Liebl., using a combination of principal component analysis and cluster analysis, is described. Applying the techniques to 6,673 trees in 135 oak population samples from Wales, the Midlands, and East Anglia, together with pollen viability as supplementary evidence, indicated that seven population types could be recognized: 1. pure *Q. robur*; 2. pure *Q. petraea*; 3. mixed populations; 4. *Q. robur* populations with a range of intermediates probably of F_1, F_2 and backcross hybrid status; 5. *Q. petraea* populations of similar type to 4.; 6. populations with a very high proportion of apparent F_1 hybrid and backcross derivatives; and 7. *Q. robur* and *Q. petraea* populations which differ from the corresponding pure populations by having significantly smaller leaves. The level of hybridization recorded was between 7·72% (515 trees) and 12·63% (843 trees), depending on the limits set for hybrid definition. Despite the presence of hybrids within the populations, it is argued that the specific rank of these two taxa be maintained.

INTRODUCTION

The taxonomic status of trees morphologically intermediate between *Quercus robur* L. and *Q. petraea* (Matt.) Liebl. has been discussed by Carlisle & Brown (1965), Cousens (1962, 1963, 1965), Gardiner (1970), Jones (1959, 1968), Rushton (1974) and Wigston (1971, 1974). Davis & Heywood (1963) have argued that the more closely two species resemble each other, the more difficult hybridization is to detect, but the more likely it may be to occur. This is particularly pertinent to the problem of variation in British oaks. The hybrid oak controversy (Gardiner 1970) appears to centre around the acceptance of morphological data alone as evidence of hybridity, in a genus notorious for variation of morphological characters (Muller 1952, Palmer 1948). Although the sole use of morphology to establish the case for hybridization between these two species cannot be wholly justified, it represents nevertheless the only evidence that can be quickly, cheaply and efficiently assessed. However, the lack of a single diagnostic character (Cousens 1963, Rushton 1974, Wigston 1975) emphasises the need for a multivariate approach if morphological data alone are to be used to assess taxonomic status. There are several multivariate techniques for the analysis of O.T.U.* × character matrices, the form in which the majority of the data on oak populations are collected. For example, Ledig *et al.* (1969) and Wigston (1971, 1974, 1975) have used discriminant function analysis of oak populations. The work reported in this paper differs from the approach of Wigston (1971, 1974, 1975) in three important respects:

1. The data have been analysed using a combination of principal component analysis and cluster analysis, following the well-established dual approach of numerical taxonomy (Sneath & Sokal 1973).
2. The area of study encompassed Wales, East Anglia and the Midlands, instead of the south-western peninsula.
3. Pollen viability was assessed to provide supplementary evidence for establishing the case for hybridization between *Q. robur* and *Q. petraea*.

This first paper is concerned with the methodology employed in the assessment of the taxonomic status of oak populations; a second paper will consider the results on a geographical scale.

* Operational Taxonomic Unit.

A

DATA ACQUISITION

SAMPLING: POPULATIONS AND INDIVIDUALS

Since *Q. robur* and *Q. petraea* are anemophilous, any attempt to define an oak population on grounds of reproductive isolation presents severe practical difficulties. For example, Semerikov & Glotov (1971), investigating the degree of genetic isolation shown by populations of *Q. petraea*, determined that trees on opposite sides of a glade full of shrubs and 500m wide effectively belonged to the same population. Under open conditions, pollen may well spread much further. A working definition of an oak population was therefore proposed as a group of trees spatially isolated from other groups of oak trees by at least 1 km. Thus, groups of trees closer than 1 km were treated as sub-populations. This is not an ideal solution since the possibilities of gene flow between sub-populations and populations may be high under conditions favourable to long distance pollen transport.

The choice of populations similarly proved difficult. Some populations were included since they had been used for studies on artificial hybridization (Rushton 1977), but most were included on the recommendation of vice-county recorders. Although the use of a random sample of populations was thought important, the difficulties that this posed for fieldwork proved insurmountable. The main criteria employed in the choice of populations were geographical position and maturity of trees, but this did not preclude some samples from hedgerow trees and comparatively young populations. No attempt was made to confine the samples to 'natural' woodland, since a survey of the variation of *Q. robur* and *Q. petraea* within the sampled area was considered the main objective of the investigation.

135 populations (and sub-populations) were chosen for this survey and sampled over three years from 1968 to 1970. Individual trees within populations were sampled using a random walk, but edge trees were eliminated to negate the 'edge-effect' (Finney & Palca 1949; Rushton 1974). Preliminary work (Rushton 1974) had suggested that the character differences between *Q. robur* and *Q. petraea* were enhanced in the lighter parts of the canopy. Since Cousens (1963) had sampled from the southern aspect, this position at a height of 6m was chosen for sampling. Preliminary work indicated that five mid-shoot leaves represented a sufficiently large sample taxonomically to characterize each tree. The majority of the population samples consisted of 50 trees, but in small populations this was reduced to 25. Sampling was usually confined to late August/September. Care was taken not to include samples of lammas growth. No attempt was made to limit the sampling area within the population (cf. Olsson 1975).

TAXONOMIC CHARACTERS

The characters used to distinguish *Q. robur* and *Q. petraea* have been well documented, e.g. Carlisle & Brown (1965), Warburg (1962), Cousens (1962, 1963) and Jones (1959, 1968). Rushton (1974) has provided a discussion on how some of these characters vary with respect to canopy position. 17 leaf characters were assessed; these will not be discussed in detail except where they were measured or assessed differently from those in other published accounts.

1. *Lamina regularity* (*LR*)

Scored as an index ranging from 0 to 4. A perfectly regular lamina scored 4 and one index unit was deducted for each of the following irregularities:

a. Presence of subsidiary lobes on the sides of the main lobes;
b. Lobe depths of opposite sides of the lamina markedly different;
c. Different number of lobes on opposite sides of the lamina;
d. Leaf outline on opposite sides markedly different.

Thus a leaf showing all the above traits scored zero.

2. *Basal shape of the lamina* (*BS*)

Scored as an index 0 to 4; a cordate base scored 0, a cuneate base 4. A series of type leaves was used for comparison (see Rushton 1974).

3. *Auricle development* (*AU*)

Scored as an index 0 to 4; a strong auricle scored 0, no auricle 4. A series of type leaves was used for comparison (see Rushton 1974).

4. & 5. *Simple* (*SPH*) *and Stellate* (*STH*) *abaxial pubescence*

Wigston (1975) discussed the different types of abaxial pubescence of *Q. robur* and *Q. petraea*. He recognized five types, but regarded only two as of discriminatory value: type (a), large stellate hairs with ascending rays along the midrib and the axial portion of the large lateral veins, which appear as tufts of simple hairs under a hand lens, are here described as simple abaxial pubescence (SPH); type (b), small stellate hairs with rays appressed to the lamina, here described as stellate abaxial pubescence (STH). Wigston (1975) scored these as present (diagnostic for *Q. petraea*) or absent (*Q. robur*). In this study an abundance scale from 0 to 4 was used, with a series of type leaves for comparison. A glabrous leaf scored zero.

6. *Number of lobe pairs* (*LN*)
This count did not include the terminal lobe. Cases where the number of lobes on each side of the lamina varied were usually resolved by reference to lamina venation.

7. *Number of intercalary veins* (*SN*)
Decisions as to what constituted an intercalary vein proved difficult, and in consequence the following definition was used: An intercalary vein was deemed to be present if a vein ran more than half-way to the sinus, and was a vein of equal or nearly equal size to those running to the tips of the lobes. This in practice proved a useful definition, but it should be noted that Wigston (1971, 1975) found difficulty in scoring this character and later abandoned it. The character was scored as a simple count of the number of intercalary veins per leaf.

8. *Percentage venation* (*VN*)
A ratio expressed as:

$$\frac{\text{Number of intercalary veins} \times 100}{\text{Total number of lamina sinuses}}$$

9. *Petiole ratio* (*PP*)
A ratio defined as:

$$\frac{\text{Total leaf length}}{\text{Length of petiole}}$$

10. *Total leaf length* ($L+P$)
The total leaf length including both lamina and petiole.

11. *Length of petiole* (*PL*)

12. *Lamina shape or obversity* (*OB*)
A ratio defined as:

$$\frac{\text{Lamina length}}{\text{Length of lamina from the lamina base to the widest part}}$$

13. *Lamina length* (*LL*)

14. *Length of lamina from the lamina base to the widest part* (*WP*)

15. *Lobe depth ratio* (*LDR*)
Lobe depth ratio has been calculated as the ratio of the width of the lobe to the depth of the sinus immediately below, e.g. Maze (1968), Silliman & Leisner (1958), Tucker (1963). This method of assessment was retained for that lobe at, or immediately below, the widest part of the lamina.

16. *Lobe width* (*LW*)
Measured from the midrib to the tip of the lobe at, or immediately below, the widest part of the lamina.

17. *Depth of sinus* (*LD*)
Computed as follows: Lamina width measured from midrib to the base of the sinus at, or immediately below, the widest part of the lamina $=$X. Then LD$=$LW$-$X

The 17 leaf characters were measured or assessed for the five leaves representative of each tree. For each tree, a mean value for each character was calculated.

In most taxonomic studies, quantitative characters such as petiole length, lobe depth, etc. are corrected for variation in leaf size by expressing them as a ratio of leaf size. However, there are no *a priori* reasons for supposing that the uncorrected characters will give poor taxonomic separation. Indeed, the use of ratios represents 'information' loss. In the present study, single measurements have been used as well as ratios derived from them. Jeffers & Richens (1970) have used similar arguments against the use of ratios in their study of elm populations and they disregarded ratios for the analysis of their results.

During initial survey work, peduncles and acorns were also collected from trees. The sample sizes varied considerably, but were never greater than 20 and never less than 4 acorns/peduncles per tree. Samples were collected from approximately the same canopy position as the leaf samples.

The following characters were measured on the acorn and peduncle samples:

1. *Acorn shape*
Derived as the ratio:

$$\frac{\text{Acorn length}}{\text{Acorn breadth}}$$

2. *Peduncle length*
Measured from the point of attachment to the first acorn.

3. *Peduncle diameter*
Measured at the middle of the peduncle with a micrometer.

TABLE 1. CORRELATION COEFFICIENTS BETWEEN VARIOUS LEAF CHARACTERS OF *Q. ROBUR* AND *Q. PETRAEA* AND THREE REPRODUCTIVE CHARACTERS

	Reproductive characters		
Leaf characters	Acorn shape	Peduncle diameter	Peduncle length
Leaf regularity (LR)	−0·044	0·305	−0·222
Basal shape of lamina (BS)	−0·305	0·531	−0·339
Auricle development (AU)	−0·279	0·489	−0·402
Simple hairs (SPH)	−0·096	0·466	−0·359
Stellate hairs (STH)	−0·155	0·517	−0·427
No. of lobe pairs (LN)	0·052	0·310	−0·190
No. of intercalary veins (SN)	0·038	−0·347	0·339
Percentage venation (VN)	0·000	−0·387	0·345
Petiole ratio (PP)	−0·165	0·570	−0·405
Total leaf length (L+P)	−0·163	0·358	−0·129
Petiole length (PL)	−0·142	0·520	−0·400
Lamina shape (OB)	−0·093	0·029	0·071
Lamina length (LL)	−0·148	0·271	−0·045
Lamina length to the widest part (WP)	−0·081	0·368	−0·187
Lobe depth ratio (LDR)	0·075	0·036	0·146
Lobe width (LW)	−0·152	0·211	−0·007
Depth of sinus (LD)	−0·030	0·083	−0·159
Acorn shape	1·000	−0·126	0·044
Peduncle diameter	−0·126	1·000	−0·626
Peduncle length	0·044	−0·626	1·000

The correlations are based on raw data.
Levels of significance: P=0·05, 0·138; P=0·01, 0·181. N=205 trees

Mean values for these three characters for each tree were calculated. Correlations established between these three characters and the 17 leaf characters (Table 1) indicated that there was good correlation between the two peduncle characters and the leaf characters (Peduncle length × Leaf characters, 13 characters significant at the 5% level; Peduncle diameter × Leaf characters, 14 characters significant at the 5% level). Acorn shape gave 8 significant correlations at the 5% level. The obvious restriction of sampling to fruiting trees introduces considerable bias into hybrid studies; the inclusion of both fruiting and non-fruiting trees gives incomplete data sets and thus problems of analysis. The good correlation established between peduncle and leaf characters persuaded the author to use only leaf material for the main analyses. However, fruit material was collected when available, and some analyses were completed on both.

RESCORING POPULATIONS

Since several characters were of a qualitative nature, a system of rescoring was introduced in an attempt to minimise error. The following procedure was adopted:

After every 20 leaves scored, the first leaf was rescored; after every 10 trees, the first tree was rescored; after every eight populations, the first population was rescored.

If minor errors were found during rescoring, these were easily rectified; major errors necessitated rescoring up to eight populations.

HYBRID INDICES

Calculation of hybrid indices has proved useful in hybrid studies (e.g. Woodell 1965; Muller 1961), since they enable inter-populational variation to be compared over a series of characters. This can be performed more efficiently using multivariate analysis, but the hybrid index is a useful initial step in data handling, since it can be quickly and easily calculated. Hybrid scores were derived for each quantitative character, values representative of *Q. robur* being scored as 0, those of *Q. petraea* 4, and intermediate values 1, 2 or 3. The delimitation of the classes of the character hybrid scores was based on a range of reference material of the two species derived from a variety of sources: herbaria, fresh material from specimen trees in arboreta and botanical gardens, and from trees sampled in the wild. Published accounts of the range of variation of individual characters were also utilised, as well as extensive information on character variation derived from preliminary work. For each of the quantitative characters measured, frequency histograms were constructed. These separated the species well, and each species generally showed a normal distribution for each quantitative character. These were then divided into the following character states:

- 0 A range encompassing the extreme 66% of the normal distribution of the *Q. robur* character histogram
- 4 A range encompassing the extreme 66% of the normal distribution of the *Q. petraea* character histogram
- 1, 2, 3 The range between the end of state 0 and the beginning of state 4 was divided into 3 equal states, the one closest to *Q. robur* being 1, the one closest to *Q. petraea* being 3, and the intermediate state 2.

(It should be noted that states 1 and 3 encompass part of the distribution expected of the 'pure' species.) Qualitative characters were collected on a 0–4 scale and therefore did not require conversion.

Hybrid indices were calculated by the summation of the hybrid scores of each of the 17 characters.

DATA PREPARATION

A matrix of individual tree characters was prepared for each population and this was transferred to computer cards, one card per individual tree. This matrix was incomplete in the sense that characters derived as ratios were not incorporated on the cards, but were calculated during data input to various programs. Similarly, all conversions of raw data to hybrid indices were completed during data input.

DATA ANALYSIS

The traditional approach to population studies of hybrids has followed that of Anderson (1949, 1953), using the pictorialized scatter diagram (PSD). A bivariate scatter diagram is produced using two quantitative characters, and further characters are encoded on to each point to produce a pictorialized dot or metroglyph (Anderson 1957). Although it is useful to summarize the variation within and between populations, interpretation of a PSD may be difficult and misleading. For example, in Figs. 1 and 2, the same two populations have been plotted using different quantitative characters. Position of the individuals in the scatter, rather than ornamentation, is of paramount importance in determining whether a particular individual is critically examined or not. Thus, in Fig. 1, since the scatters for the two populations are restricted, few of the individuals would be closely examined. However, in Fig. 2,

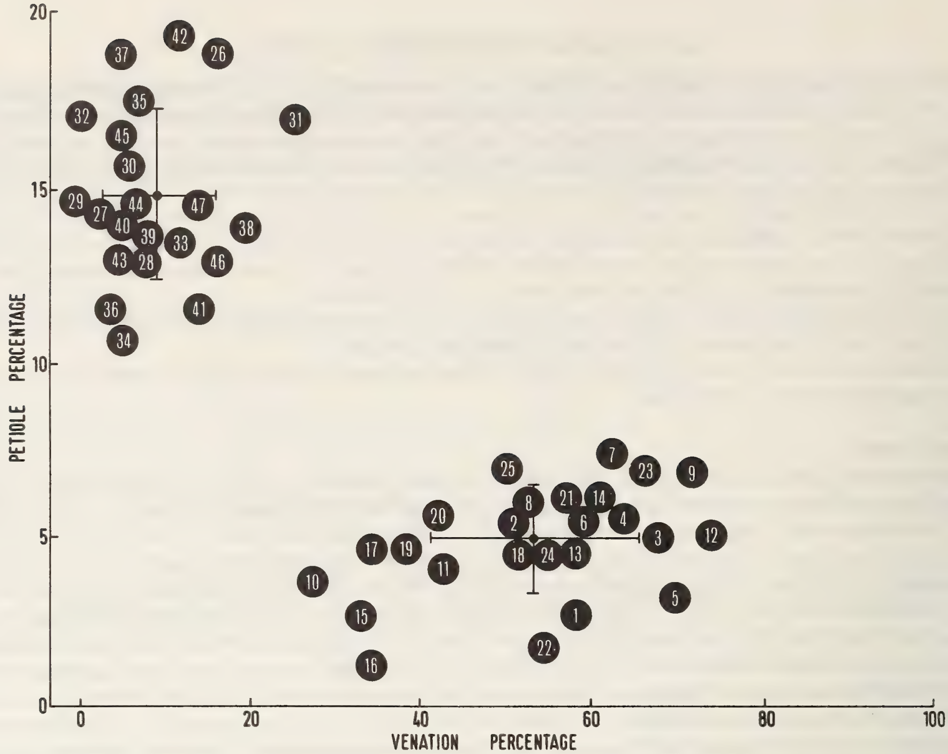

FIGURE 1. Bivariate scatter diagram showing the relationship between petiole ratio (PP) and venation percentage (VN) for two *Quercus* populations: R, tree numbers 1–25; P, tree numbers 26–47. The populational means and standard deviations are also shown.

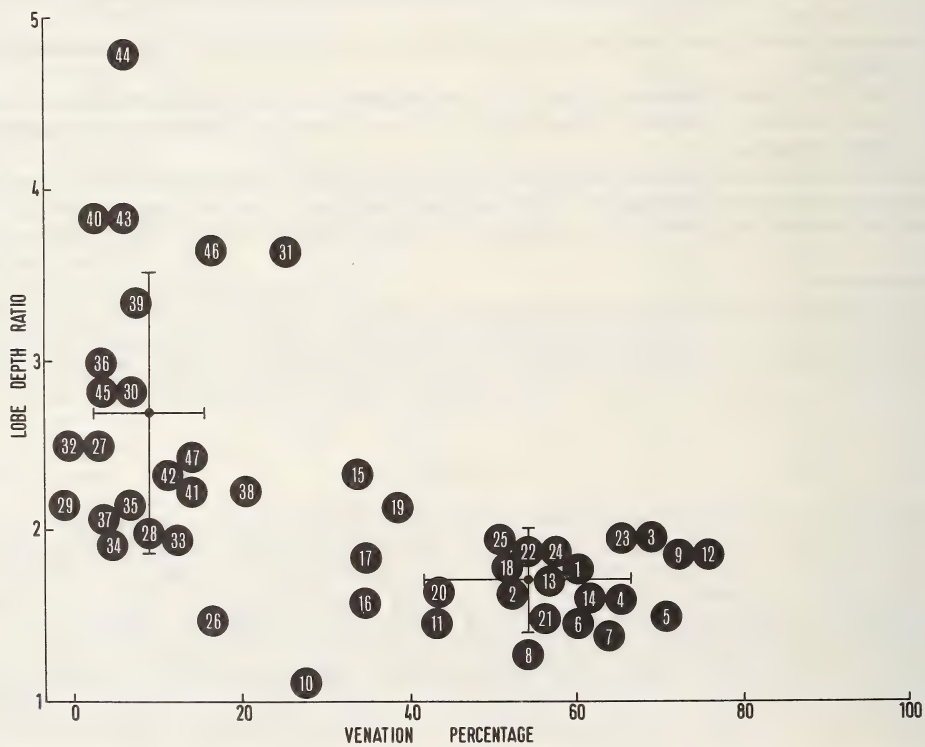

FIGURE 2. Bivariate scatter diagram showing the relationship between lobe depth ratio (LDR) and venation percentage (VN) for two *Quercus* populations: R, tree numbers 1–25; P, tree numbers 26–47. The populational means and standard deviations are also shown.

the scatters are more diverse and, indeed, some overlap occurs between the two populations. The outliers of the populations would, in this case, be closely examined. Although there is reasonably close agreement between the position of the individuals in Figs. 1 and 2, some major discrepancies do occur. For example, individual 46 in Fig. 1 lies in the zone where it might be critically assessed, whilst, in Fig. 2, it lies well away from the intermediate zone. Similar behaviour is exhibited by individual 36. Individual 26 behaves differently—in the intermediate zone in Fig. 2 and at the extreme in Fig. 1. Consequently, the metroglyphs that are closely examined depend on the initial choice of the quantitative characters for the construction of the PSD. The overall interpretation is thus highly dependent on the choice of character axes. Fig. 1 could be interpreted as consisting of two pure populations; Fig. 2 as consisting of two populations with a range of intermediate (and therefore possibly hybrid) forms. The construction of a PSD is also time-consuming and, unless constructed by a graph plotter, prone to error. The interpretation of the PSD depends largely on positional information, and since the human mind is better able to grasp positional information than a confusing array of metroglyphs, an alternative approach to data analysis has been adopted in this study.

PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) has been extensively used in taxonomic research, and therefore the mathematical background to the analysis will not be discussed here. Jeffers (1964, 1967) provided an excellent discussion of its use and interpretation, as applied to taxonomic research. Standardization of taxonomic data is normally obligatory, since characters are usually a combination of lengths, indices, etc. Although, in this study, two analyses were always completed, i.e. with each character standardized to zero mean (covariance matrix) and with each character standardized to zero mean and unit variance (a correlation matrix), the results of the latter are more appropriate to the data under discussion.

The analysis of individual populations using PCA is problematical, since the data structure of an individual population is not particularly illuminating. What is important is the data structure of a population compared to that of some reference point. Taxonomists are usually more interested in, for example, the PCA scatter of species within a genus (e.g. Lubke & Phipps 1973) rather than 'testing' a population against a reference point. Unfortunately, this approach leads to the difficulty of defining a suitable reference point. Three approaches appeared available:

1. A 'population' where each individual was represented by a series of characters scored from a herbarium sheet. This approach was rejected on the grounds that herbarium specimens are frequently 'typical' specimens.

2. A spurious 'population' artificially created from published accounts of the diagnostic characters and their ranges for the species. Again, this was rejected as being difficult to produce and prone to bias.

3. The approach finally adopted was to utilize the results from actual populations. These populations should, in all respects, conform to what would be expected of a pure population. All 135 populations were sorted to determine if suitable populations could be found. Two populations were finally chosen, one representing 'pure' *Q. robur* (R) and one representing 'pure' *Q. petraea* (P). Both populations had been sampled on two consecutive years, and both had been used for subsidiary studies, so that the composition of the woods was intimately known. The population sample of 25 trees from the P population showed three trees that did not conform to the *Q. petraea* type, and these were deleted from the analyses leaving 22 trees in the P population. The three non-conformist trees consisted of two *Q. robur* trees and an intermediate. Evidence is presented later that, on the grounds of pollen viability, these two populations, excluding the three abnormal trees, may also be considered to consist of pure individuals.

Data analysis of each population consisted of combining the data for a given population with those of the two reference populations, and completing a single PCA on the combined data set.

CLUSTER ANALYSIS

Cluster analysis (CA), although frequently used for taxonomic studies, is rarely used for hybrid studies. The analysis is applicable to hybrid studies in that the clustering properties of suspected hybrids may be determined. Several clustering techniques have been applied to the data, using options available in CLUSTAN 1A, a suite of FORTRAN IV programs (Wishart 1970). The one discussed here is Ward's Error Sums of Squares method, a polythetic, agglomerative clustering strategy, using squared Euclidean distance as the similarity coefficient (Ward 1963, Wishart 1969). Again, in order to present

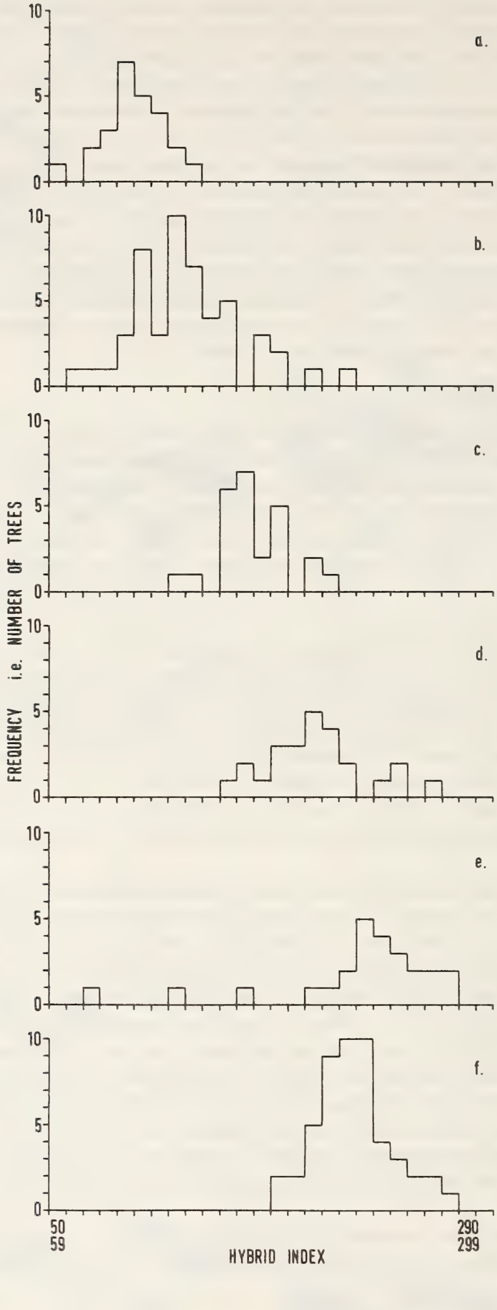

FIGURE 3. Frequency histograms of hybrid indices for six populations of *Quercus*. Hybrid index range 0–340, based on 17 leaf characters measured on 5 leaves/tree, each character providing a minimum score of 0 and a maximum score of 4. Populations: a. R, b. IR, c. H, d. IP, e. P, f. AP.

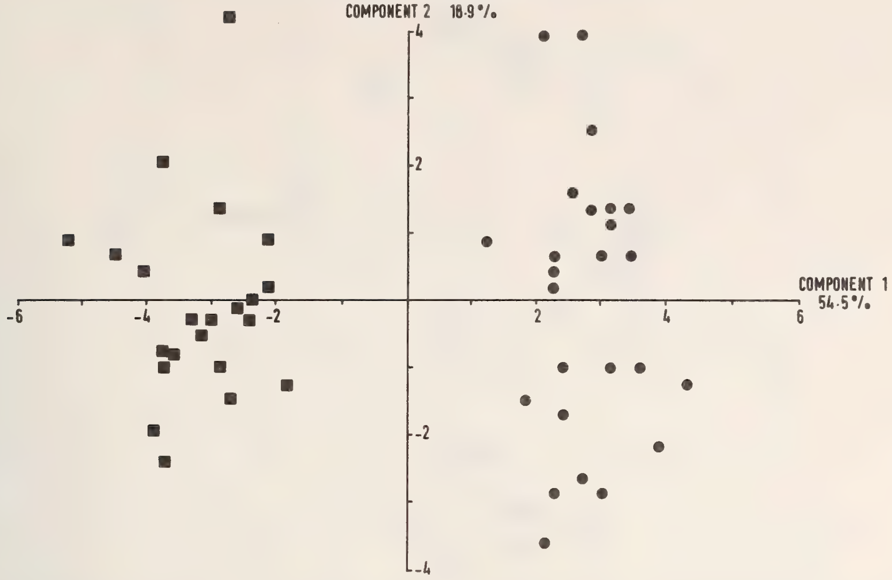

FIGURE 4. PCA of the two reference *Quercus* populations, R(●) and P(■). The first two components of the correlation matrix are shown together with the percentage of the total variance accounted for by each component.

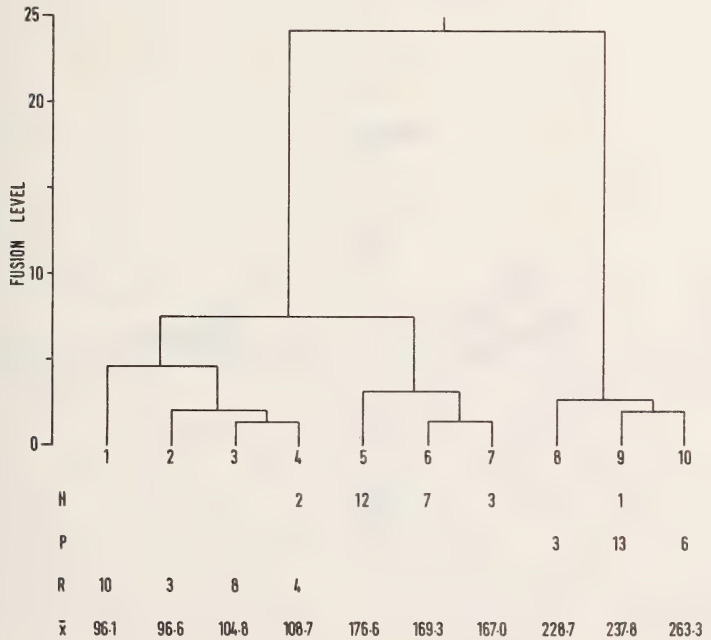

FIGURE 5. CA of the two reference *Quercus* populations, R and P, using Ward's error sums of squares method. The membership of each cluster is shown together with the mean hybrid index ($\bar{x}$) of each cluster.

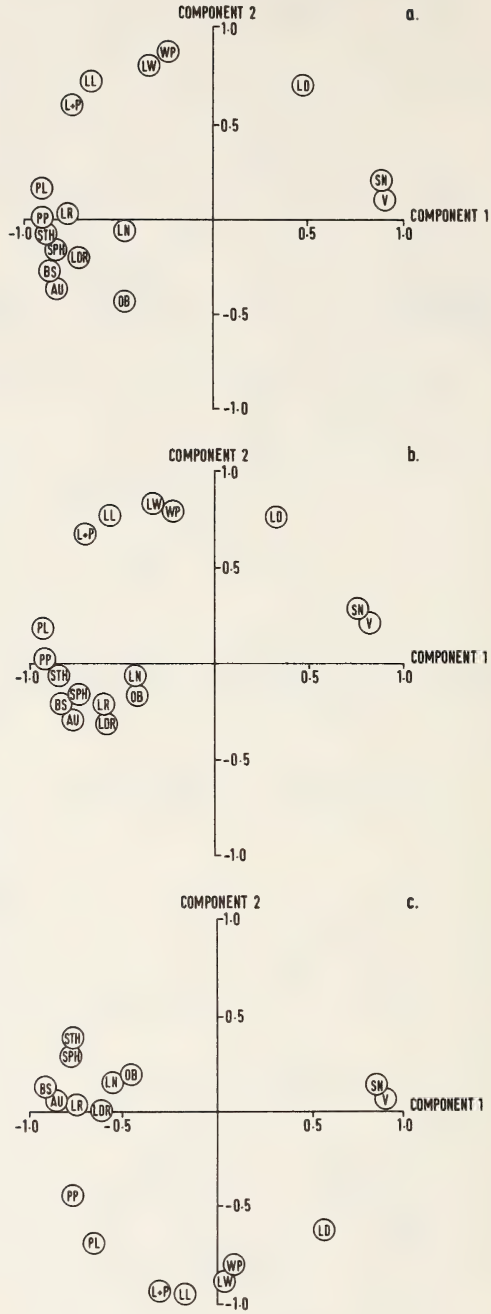

FIGURE 6. Vector loading diagrams for the first two components of the correlation matrix of three PCA: a. Populations R and P, b. Populations R, P and IR, c. Populations R, P and AP.

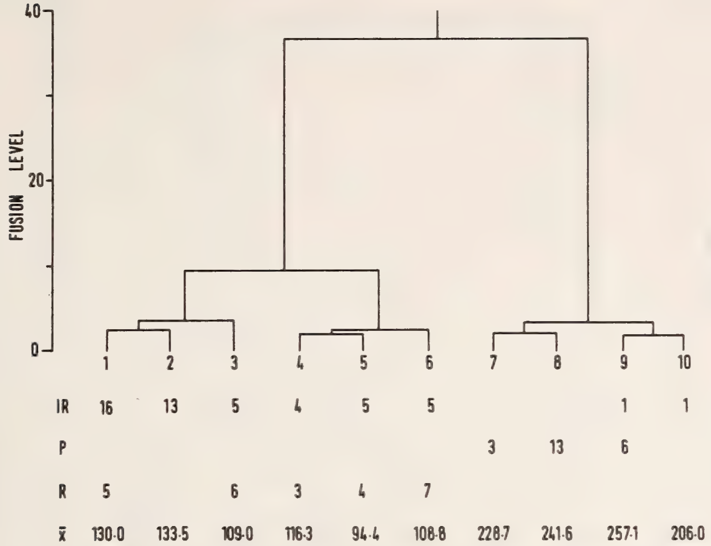

FIGURE 7. CA of the two reference *Quercus* populations, R and P, and population IR, using Ward's error sums of squares method. The membership of each cluster is shown together with the mean hybrid index (x̄) of each cluster.

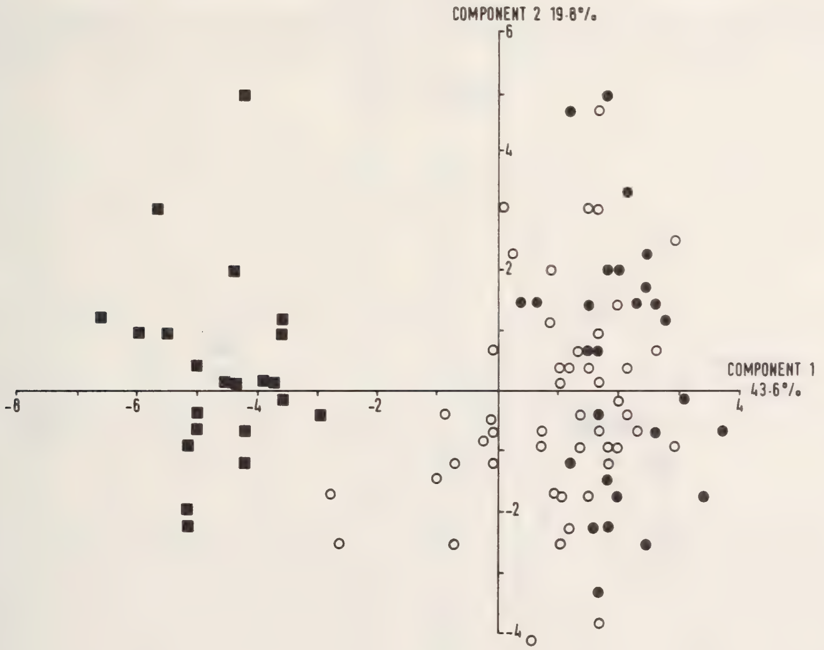

FIGURE 8. PCA of the two reference *Quercus* populations, R(●) and P(■), and population IR(○). The first two components of the correlation matrix are shown together with the percentage of the total variance accounted for by each component.

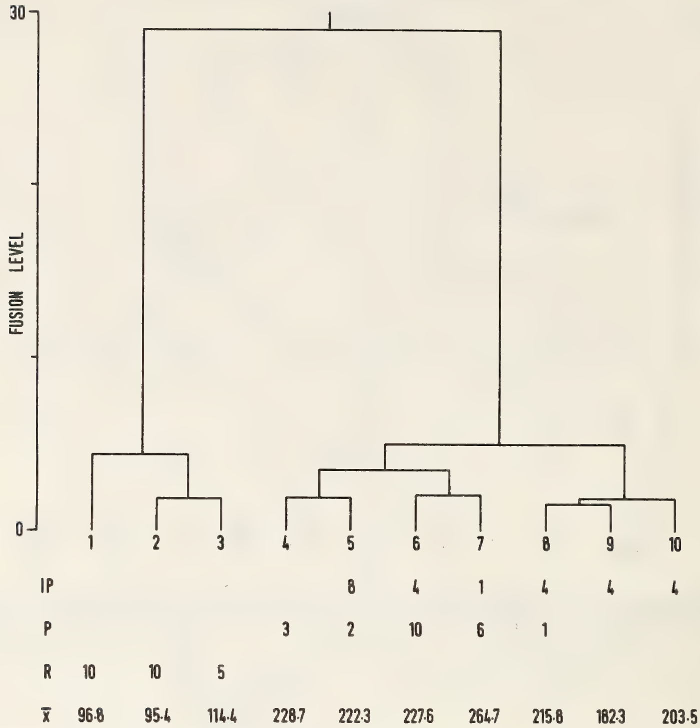

FIGURE 9. CA of the two reference *Quercus* populations, R and P, and population IP, using Ward's error sums of squares method. The membership of each cluster is shown together with the mean hybrid index (x̄) of each cluster.

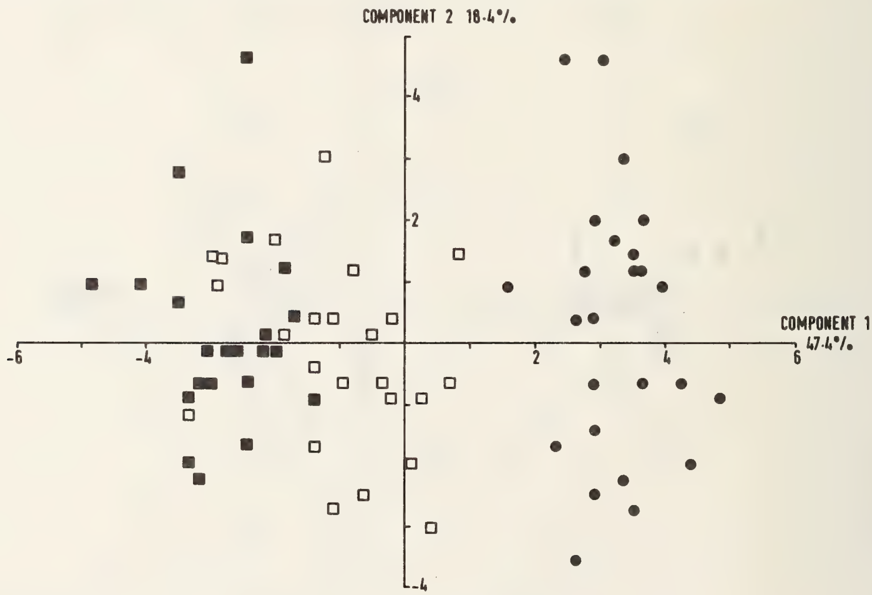

FIGURE 10. PCA of the two reference *Quercus* populations, R(●) and P(■) and population IP(□). The first two components of the correlation matrix are shown together with the percentage of the total variance accounted for by each component.

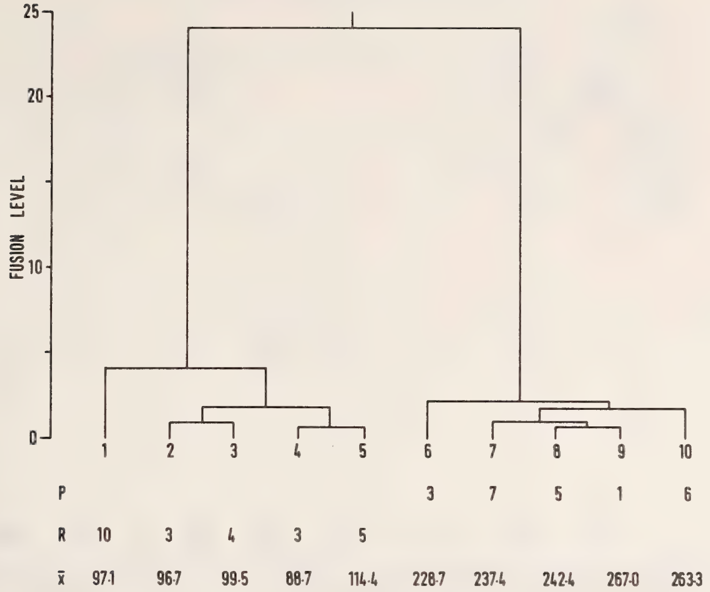

FIGURE 11. CA of the two reference *Quercus* populations, R and P, and population H, using Ward's error sums of squares method. The membership of each cluster is shown together with the mean hybrid index (x̄) of each cluster.

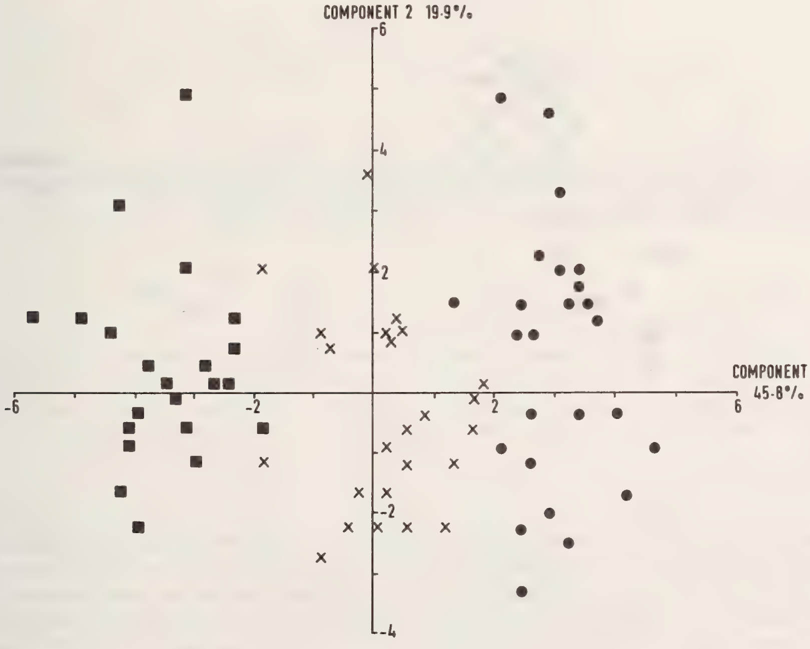

FIGURE 12. PCA of the two reference *Quercus* populations, R(●) and P(■) and population H(X). The first two components of the correlation matrix are shown together with the percentage of the total variance accounted for by each component.

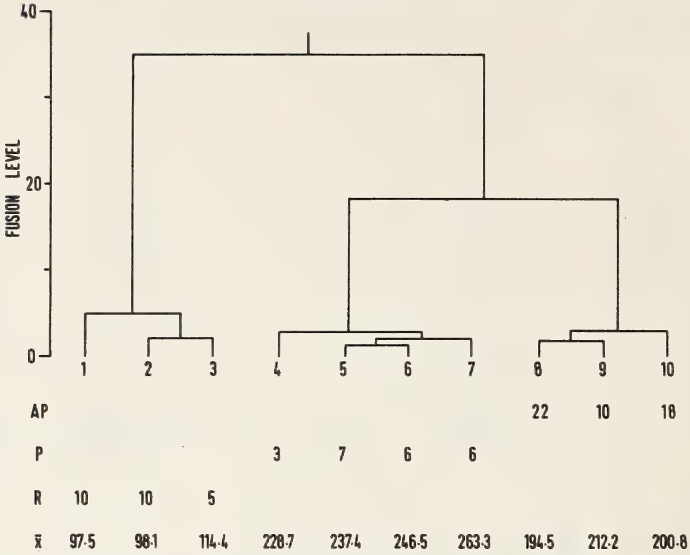

FIGURE 13. CA of the two reference *Quercus* populations, R and P, and population AP, using Ward's error sums of squares method. The membership of each cluster is shown together with the mean hybrid index (x̄) of each cluster.

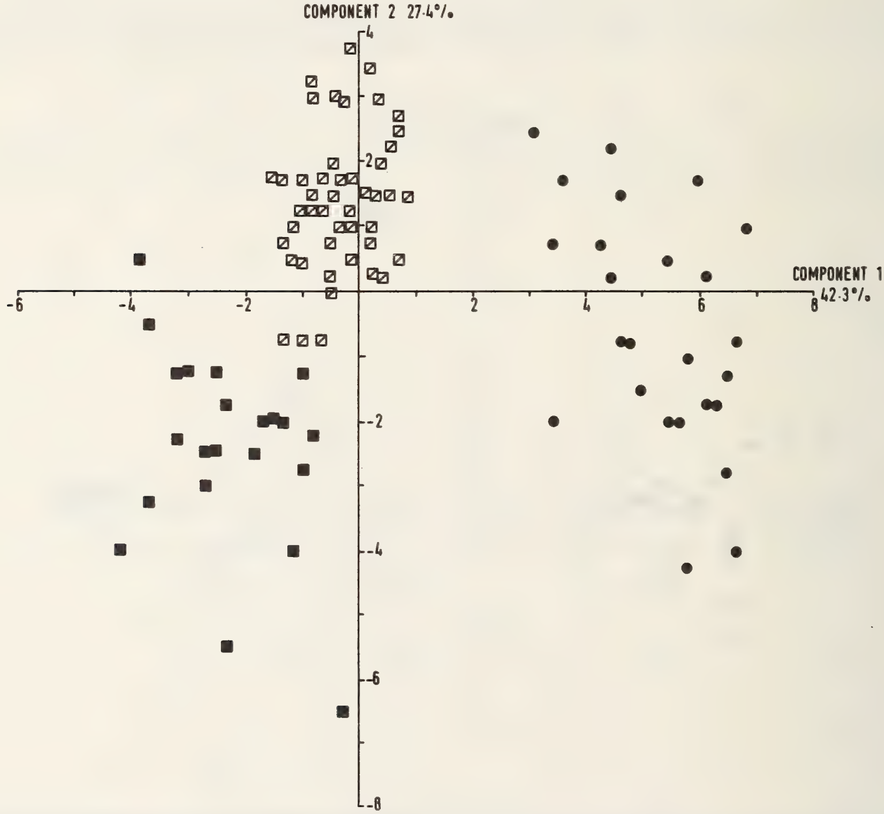

FIGURE 14. PCA of the two reference *Quercus* populations, R(●) and P(■) and population AP(☒). The first two components of the correlation matrix are shown together with the percentage of the total variance accounted for by each component.

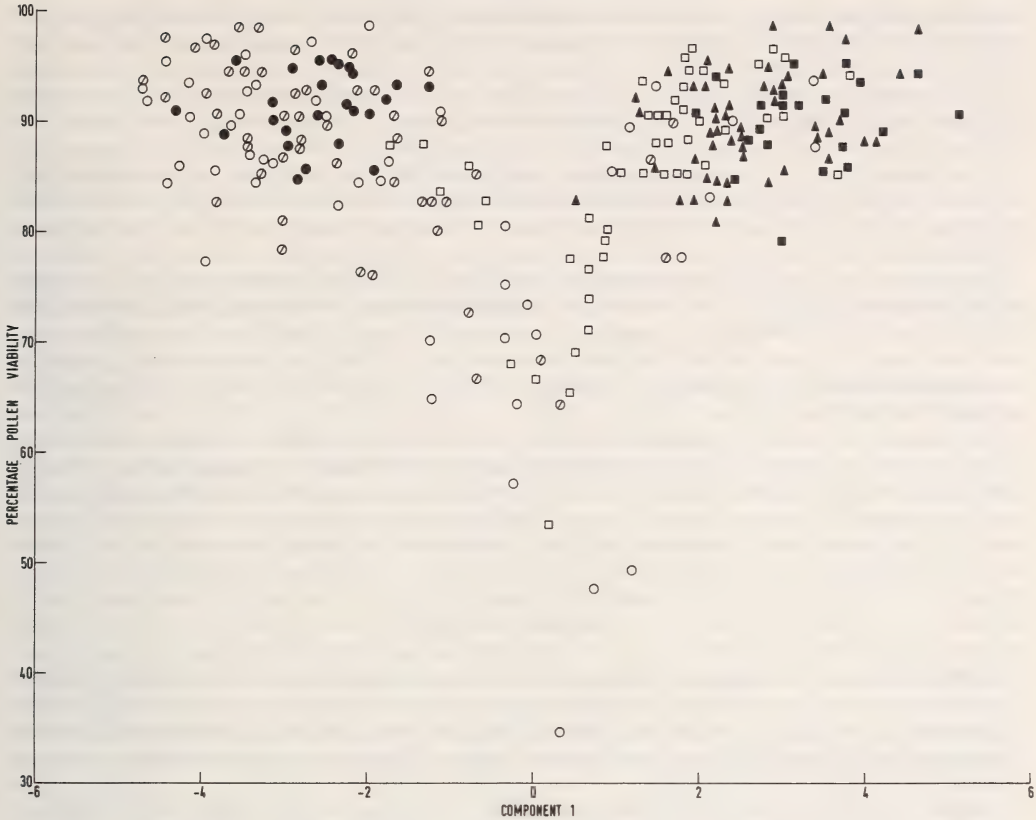

FIGURE 15. PCA of twenty *Quercus* populations. The first component of the correlation matrix is plotted against the corresponding percentage pollen viability for each individual tree. For clarity only six populations are shown. classified as: R-type population ●, IR-type populations ○ and ⊘. IP-type population □, P-type populations ■ and ▲.

the analysis with common information, each population was analysed with the two reference populations.

Both PCA and CA were completed on raw data matrices without transformation to hybrid indices.

RESULTS

In order to illustrate the different types of result obtained, four populations have been chosen to cover specific points. Fig. 3 shows the frequency histograms of hybrid indices for these four populations (Fig. 3b, c, d, f), together with the two reference populations, R and P (Fig. 3a, e). Initially, the two reference populations were subjected to PCA and CA without any other population. The results are shown in Figs. 4 and 5. PCA (Fig. 4) separated the two reference populations. There was no overlap of the two reference populations on the first Component which accounted for 54·5% of the total variance. The vector loadings for the first two Components are shown in Fig. 6a. All characters, with the exception of LW and WP, showed a high loading on the first Component, suggesting that all but these two characters were responsible for the separation of the two reference populations. Variation within the populations appeared to be associated with the second Component. As can be seen (Fig. 6a), the characters with the highest loadings on Component 2 are all those associated with leaf size, viz. L + P, WP, LL, OB, LD and LW.

CA of the same two populations (Fig. 5) showed that they clustered discretely. At the 10 cluster level (the lowest level shown in Fig. 5), each population had grouped into five clusters. The R population appeared to be slightly more heterogeneous than the P population, since the ten trees of Cluster 1 did not fuse with the other 15 trees of the population until level 4·30, whilst the clusters of population P had all fused at level 2·22. This greater heterogeneity in the R population can also be seen in the PCA, where the spread of the population over the second Component was much greater than that of the P population.

Both analyses separated the two pure populations. Since PCA is a multivariate technique, positional information alone is critical in evaluation of the component scatter. In the component space produced by a PCA, an individual located towards the intermediate zone between the two populations is positioned there by virtue of a consideration of all its characters. Thus, the position of an individual in component space may be thought of as an amalgam of the bivariate character axes and the metroglyph characters of the PSD.

The frequency histogram for population IR (Fig. 3b) showed a skewed distribution with several trees in the intermediate zone. CA of this population together with P and R is shown in Fig. 7. The R population formed five clusters (Clusters 1, 3, 4, 5 and 6), and the majority of the IR population (35 trees) also grouped with these clusters. 13 trees of the IR population formed a discrete cluster, Cluster 2, which did not contain trees from either the R or P population. The mean hybrid index of this cluster was 133·5, suggesting an intermediate morphology. Cluster 1, with a mean hybrid index of 130·0, contained 16 IR and five R trees; the mean hybrid index of the five R trees being 99·6 and that of the 16 IR trees 139·5. (This cluster was in fact formed by the agglomeration of the R and IR trees at the previous fusion cycle i.e. cluster level 11.) Two IR trees clustered with the P population, although one, with a hybrid index of 206, appeared discrete. PCA of the same populations is shown in Fig. 8. The two P-related trees can be clearly seen. Although the large majority of the IR population occurred at the end of Component 1, within the range of the R population, a proportion of the IR population occurred at the origin or just to the left of the origin. The membership of this latter group corresponded with the membership of Cluster 2 of the CA.

A similar result was obtained for population IP (Fig. 3d). CA yielded three clusters (Fig. 9, Clusters 1, 2 and 3) which consisted exclusively of the R population. 12 of the IP population (Clusters 8, 9 and 10) formed a relatively discrete group (only one alien tree from the P population), whilst the remaining 13 trees clustered with the P population (Clusters 5, 6 and 7). The mean hybrid indices of Clusters 8, 9 and 10 were considerably lower than those of Clusters 4, 5, 6 and 7. PCA (Fig. 10) produced a similar result to that of IR. Part of the IP population grouped with the P population, whilst the rest occupied an intermediate position.

Some populations were similar to the R or P population. For example, in PCA, such populations grouped with population R or P, but did not produce trees in the intermediate zone. Similarly, in CA, they clustered with the R or P population, but did not form discrete clusters like the IR and IP populations above. Such populations accounted for over 50% of the populations studied. A small number of populations proved to be mixed, but with no intermediates.

Two other population types were apparent. The first of these is illustrated in Fig. 3c. CA (Fig. 11) of this population (H) resulted in the population grouping into five clusters. Three of these, Clusters 5, 6 and 7, were discrete with mean hybrid indices of 176·6, 169·3 and 167·0 respectively. One tree fused with the P population (Cluster 9) and the remaining two trees with the R population (Cluster 4). Clusters 5, 6 and 7 finally fused with the clusters of population R, thus showing more affinities with them than with the P population. PCA (Fig. 12) emphasized the highly intermediate nature of this population; the majority of the trees were positioned between the two reference populations, although slightly shifted towards the R population. A small degree of overlap was apparent between population H on the one hand and populations R and P on the other on the first Component.

The final population type (AP) is shown in Fig. 3f. The range of hybrid indices, although marginally greater than the main body of the P population (Fig. 3e), was not sufficiently different to warrant undue attention. However, in CA and PCA, population AP behaved in a totally unexpected fashion. In CA (Fig. 13), the population formed three discrete, non-overlapping clusters (Clusters 8, 9 and 10). The mean hybrid indices of these were 194·5, 212·2 and 200·8 respectively. However, these did not fuse with the four population P clusters (Clusters 4, 5, 6 and 7) until the comparatively high fusion level of 18·37. This suggested that, although the hybrid indices were not very different from the P population (compare Fig. 3, e and f), the structure of the raw data was sufficiently different for CA to detect differences between the two populations. This difference was reflected in PCA (Fig. 14). Whilst population AP separated from population R on the first Component, it also separated from population P on the second Component. Although well separated from the R population, the centroid of the AP population is closer to the R population than is that of the P population.

The vector loadings diagram (Fig. 6) indicates that, whilst the loadings were substantially the same for PCA using populations R and P alone (Fig. 6a), and R and P together with populations such as IR (Fig. 6b), when using R and P together with AP (Fig. 6c) the vector loadings showed significant differences. The major differences, with the unimportant exception of orientation, was the very high negative loadings on Component 2 given to the leaf-size characters (LW, WP, LL, L + P and PL) and the ratio PP. Both PL and PP had very low loadings on Component 2 in the PCA of R, P and IR (Fig. 6b).

The use of CA and PCA clearly indicated that different population types could be recognised. However, these only have a basis in relation to the two reference populations used. Before generalisations can be made about the nature of these population types, the classification of populations into different types should be rigorous. This was completed by the choice of two further reference populations, and by analysing all the populations with these instead of the originals. The diagnosis of each population did not change significantly. Several further reference populations have been utilised, again with no significant change in the diagnosis of the individual populations.

POLLEN VIABILITY

Hybrid status has been inferred for morphologically intermediate trees, e.g. by Cousens (1963) and Carlisle & Brown (1965). Wigston (1974) has argued that the Theoretical Species Type analysis developed by Cousens (1963, 1965) is a powerful tool for assessment of populational variability. However, no matter how sophisticated the analysis, it relies solely on the original morphological data. Similar criticisms can be expressed about the discriminant function analysis used by Ledig *et al.* (1969) and Wigston (1971, 1974) and, indeed, PCA and CA used in this study. Only the relative ease of interpretation distinguishes the use of discriminant function analysis, PCA and CA from the more cumbersome PSD. Olsson (1975) has recognised the difficulties of interpretation of morphological data alone, and , following the criticisms of Gottlieb (1972), has resorted to the use of pollen stainability as supplementary to morphological data. This present study has used a similar approach.

For a range of populations, showing different morphological patterns, pollen viability was assessed during spring, followed by assessment of leaf morphology later in the year. Pollen viability was determined using nitro-blue tetrazolium (Hauser & Morrison 1964, Rushton 1974) with a minimum count of 200 pollen grains per tree. Twenty populations were assessed for pollen viability and leaf morphology, but, in order to retain clarity, only 6 populations are actually shown in Fig. 15. The total sample size was 960 trees. The morphological data for the 20 populations were subjected to a PCA. Fig. 15 shows the first Component of this analysis plotted against the corresponding percentage pollen viability for each tree. The trees showing morphological intermediacy, towards the centre of the first Component, showed a significant decrease in percentage pollen viability. This general pattern was repeated over 11 of the remaining 14 populations. There were three populations not conforming to this general result. A breakdown of the morphological composition of these three populations is given in Table 2. Despite having a range of intermediate forms, the pollen viabilities of all three populations was generally over 80%. Only six trees (See Table 2) had pollen viabilities below 80%. The status of these three populations is problematical.

INTERPRETATION

It is now generally accepted that low pollen viability is evidence towards the establishment of a case for hybridisation. Thus Woodell (1965) showed that plants regarded on morphological grounds as F_1 hybrids between *Primula veris* and *P. vulgaris* had a mean pollen viability of 43·5% and a range of 9–70%. Similarily, Bradshaw (1958) assigned plants morphologically intermediate between *Agrostis* *stolonifera* and *A. tenuis* to F_1 hybrid status on the basis of morphology and low pollen viability. Olsson (1975) has shown that in Sweden oaks intermediate in morphology between *Q. robur* and *Q. petraea* had an overall reduced pollen viability. He concluded that such trees were of hybrid status. However, the correlation established was not perfect. Some trees regarded on morphological grounds as being *Q. petraea* had pollen viabilities as low as 20–30%, some *Q. robur* trees as low as 40–50%, and some interspecific phenotypes had pollen viabilities as high as 90–100%. Jones (1959) has noted the occurrence of three oak trees (species unspecified) out of 25 that had a low pollen viability (50–75%) and a combination of characters of both species.

The results presented here parallel closely those of Olsson (1975), and the general interpretation of the PCA, CA and pollen viability results is that trees morphologically intermediate between *Q. robur* and *Q. petraea* are of hybrid origin. For those populations in which pollen viability was measured, trees regarded on the basis of PCA and CA as being pure types all had pollen viabilities greater than *c* 80%. All trees of the two initial reference populations, R and P (excluding the three non-conformist trees), had pollen viabilities above 85%. This contrasts with some of the results of Olsson (1975), since low pollen viability of morphologically pure types have not been recorded. The high pollen viabilities of some intermediate trees recognised by Olsson (1975) are similar to the results for the three populations detailed in Table 2. These trees may represent F_2 (or F_3 and back-cross) hybrid individuals with restored fertility. Doroszewska (1965) and Woodell (1965) provide comparable examples in other genera.

TABLE 2. DETAILS OF THREE OAK POPULATIONS SHOWING A RANGE OF INTERMEDIATE FORMS, WITH A LARGE MAJORITY OF THE TREES HAVING A HIGH % POLLEN VIABILITY

Classification of trees								Details of trees with <80% pollen viability	
Population code	Sample size	R-type	Inter-mediate	P-type	Mean hybrid index	Hybrid index range	No. trees with <80% pollen viability	Hybrid index	% Pollen viability
BY	50	31	16	3	131·8	69–262	0		
AAD	50	39	10	1	131·1	60–224	3	133	67
								128	74
								119	75
CCE	50	23	16	11	147·5	51–266	3	116	58
								199	63
								154	74

The nature of the hybridization between *Q. robur* and *Q. petraea* remains an open question, i.e. do the intermediate phenotypes represent only F_1 hybrids, or do they represent a full range of backcross individuals thus indicating introgressed populations? It would be expected that if the intermediates were only of F_1 hybrid status, a third discrete grouping should be apparent in the results of CA and PCA. Consideration of the results displayed in Figs. 8 and 10, typical of a large number of populations, showed a gradation of intermediates, with the majority shifted markedly to one side. The overall view of pollen viability results (Fig. 15) follows the same trend. No identifiable grouping can be seen in Fig. 15; the trees appear to form a complete gradation, from high pollen viability at the end of Component 1 to low pollen viabilities in the middle of the Component. Populations of the IR and IP type probably contain, therefore, not only F_1 hybrids but also a series of backcross hybrids, and may be regarded as introgressed populations.

The results of CA for a small number of populations (e.g. Fig. 11) would suggest a very specific grouping different from either R or P. However, as PCA shows (Fig. 12), the range of variation within this group is high and overlaps marginally the R and P reference populations. Only one population of this type was examined for pollen viability. The results indicated that the pollen viabilities of the intermediates were below 75%. It was concluded that populations of this type were composed of a large proportion of hybrids, many of which could be regarded as of F_1 status.

The sampling procedures used for the pollen viability investigation require closer scrutiny. Choice of individual trees for sampling within the populations was determined by a random walk. However, since only trees with catkins were chosen, the sample was non-random. Restriction of the sample to flowering trees only serves to decrease the estimate of hybridity. Comparison of the morphology of populations estimated from samples containing both flowering and non-flowering trees with that of the morphology of the same populations estimated from samples containing only flowering trees indicated that the two samples were not significantly different. Within-population morphological comparison of flowering and non-flowering trees showed no significant differences. It is concluded that, although the pollen viability samples were biased, restriction of the samples to flowering trees neither increased nor decreased the estimate of hybridity.

Six populations produced variation patterns similar to population AP (Figs. 13 & 14). Of these, four populations (including AP) clustered with the P population and two clustered with the R population. Arguments were advanced (Rushton 1974) that these populations might represent residual introgressed populations in which assimilation of the alien genes was nearly complete, allowing, therefore, only a minor shift in the populations' centroid along Component 1 in PCA. Inspection of the vector loadings for Component 2 (Fig. 6c) indicated that the leaves of the AP trees were on the whole smaller, both in length and width, than those of the corresponding reference populations. This was true for all the other five populations of the AP type. Unfortunately, no acorn or peduncle material was collected for these populations, nor were pollen viability studies conducted. Nevertheless, the leaf morphology is probably sufficiently different from the reference populations for the AP type populations to be considered for recognition of infraspecific taxa (Valentine 1975, Weimarck 1947a, b). It is interesting to note that no comparable populations were found in which the leaves were larger than those of the reference populations.

It is necessary to present the morphological limits of the parental species together with those of the hybrids. Examination of the results of 6673 trees analysed by PCA and CA, together with the pollen viability results from 960 trees, indicates that those trees within the hybrid index range 150 to 189 can be regarded with a high degree of certainty as being of hybrid origin. 515 trees (7·72% of the total sample) fell into this category. Excluding the three aberrant trees of the P population, the lowest hybrid index was 200 and the highest hybrid index of the R population was 134. Thus, a wider intermediate zone (149–199) might be justified. This would include 843 trees, or up to 12·63% of the total sample. However, extension of the hybrid zone to these limits would include trees with a significantly higher pollen viability (i.e. > 80%). A breakdown of the number of different population types contained in the 135 populations is given in Table 3.

TABLE 3. NUMBER OF POPULATIONS FOUND OF EACH TYPE AMONG THE 135 OAK POPULATIONS SAMPLED

Population type	Number of populations	% occurrence
Pure *Q. robur*	57	42·2
Pure *Q. robur* (but with smaller leaves)	2	1·5
Q. robur populations with a wide range of intermediates (introgressed)	22	16·3
H-type populations (i.e. substantially composed of intermediates)	8	5·9
Mixed populations containing both *Q. robur* and *Q. petraea*	7	5·2
Q. petraea populations with a wide range of intermediates (introgressed)	23	17·0
Pure *Q. petraea* (but with smaller leaves)	4	3·0
Pure *Q. petraea*	12	8·9

DISCUSSION

The levels of hybridization recorded here are substantially lower than those noted by Cousens (1963, 1965) and Carlisle & Brown (1965), but are in general accord with the conclusion of Jones (1959). He argued that, of populations where both species grew together, it was unusual to consider more than 5% of such populations to be hybrid. Cousens (1963, 1965), for the detailed analysis of his material, restricted his populations to those which contained sufficient fertile material for complete analysis. As argued earlier, such limitation would serve to underestimate the level of hybridization within the populations. Consideration of all the populations sampled by Cousens might therefore enlarge the differences between his results and the present survey. However, the data analyses are substantially different and the surveys completed on different areas.

Olsson (1975) has argued that the occurrence of a large number of hybrids between *Q. robur* and *Q. petraea* under natural conditions indicates that the specific status of these taxa should be questioned. This conclusion cannot be supported. The level of hybridization in oak populations is still a matter for debate, since few studies have used evidence other than morphology. Also there have been few large-scale population studies as compared with casual observation. However, it is important to note that all published accounts of variation in *Q. robur* and *Q. petraea* accept some level of hybridization. Nevertheless, the distinctly unsuccessful attempts to show anything other than minimal interfertility between the species (e.g. Dengler 1941, Rushton 1977) indicate that the interspecific isolating mechanisms are still intact. Until such time as the two morphological types, i.e. *Q. robur* and *Q. petraea*, are shown by crossing experiments to be relatively interfertile, the specific status of *Q. robur* and *Q. petraea* is best maintained.

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Tropical drift fruits and seeds on coasts in the British Isles and western Europe, 1. Irish beaches

E. C. NELSON

National Botanic Gardens, Glasnevin, Dublin 9, Eire

ABSTRACT

Seeds and fruits of tropical American plants capable of floating in sea-water for over one year can drift in the surface currents of the North Atlantic Ocean to the coasts of western Europe. Eight species of such disseminules ('drift seeds') washed ashore on Irish beaches are described. Several other seeds, not of American origin, also collected from Irish beaches are noted. The western and northern coasts of Ireland are the most likely to receive tropical drift; the surface currents in the vicinity of Ireland seem to deflect drift from the southern and eastern coasts.

INTRODUCTION

'It should be observed that scarcely any means of transport would carry seeds for very great distances; for seeds do not retain their vitality when exposed for great lengths of time to the action of sea-water . . . Ocean currents, from their course, would never bring seeds from North America to Britain, though they might and do bring seeds from the West Indies to our western shores, where if not killed by so long immersion in salt-water, they could not endure our climate.'

C. Darwin, *The Origin of Species* (1859)

As observed by Darwin (1859) and others (e.g. Sloane 1696, Guppy 1917), ocean currents in the North Atlantic carry seeds and fruits of tropical American plants to the coasts of north-western Europe. The disseminules (fruits and seeds) of many plants can float, though flotation time is variable (Guppy 1906, Praeger 1913); those capable of floating in salt-water for over one year could make the ocean voyage from the Americas to Europe.

The first record of tropical plant disseminules washed ashore on the coasts of the British Isles was published by L'Obel (1570). Records from the coasts of Great Britain will be reviewed in a later paper. The present paper discusses records from Irish beaches.

Sloane (1696) was the first to record 'drift seeds' on Irish beaches; he noted (Sloane 1696) that *Entada gigas* 'is cast upon the coast of Kerry in Ireland', and later (Sloane 1725) that *Caesalpinia bonduc* had been 'cast ashore on the north-west coast of Ireland'. A few other records were published in the nineteenth century. Brown (1818) noted that a seed of *C. bonduc* collected on an Irish beach had been successfully germinated. Other records noted by Blake (1823), Johnson (1897) and Tatlow (1899) were reviewed by Colgan (1919). Harvey (1846) noted that 'tropical woods and seeds are . . . frequently [stranded] and occur all along the west coast of Ireland'.

In his classic work, *Plants, seeds and currents in the West Indies and the Azores*, Guppy (1917) was unable to discuss Irish drift seed records because of lack of data. As Guppy's information from Ireland was meagre, Colgan (1919) assembled a list of eight species whose disseminules had been picked up on Irish beaches. Colgan (1919) surveyed the literature available to him, as well as noting museum specimens collected before that time. Since Colgan's review, little has been added to the Irish aspect of the topic; both Ridley (1930) and Praeger (1937) mentioned drift seeds but provided no new data. Gunn & Dennis (1976) published a guide to drift seeds which included discussion of Irish records but no details of recently collected specimens.

In the preparation of this paper, records subsequent to Colgan (1919), published and unpublished, were used. The sources included the collections and register of botanical specimens of the Irish National Herbarium (**DBN**), which was the register used in the Botany Section of the National Museum of Ireland, prior to the transfer of the museum's botanical collections to the National Botanic

Gardens in 1970. Unpublished records from the Ulster Museum, Belfast (**BEL**) were also used, as were data obtained from amateur naturalists and beachcombers throughout Ireland.

DRIFT SEEDS FROM IRISH BEACHES

Three categories of plant disseminules—commonly called 'drift seeds', though fruits are also found—can be washed ashore on any beach in western Europe that directly receives water from the North Atlantic currents. The first category—*local*—contains disseminules from plants that are growing in the environs of a beach, and includes fruits and seeds of locally-growing native and naturalized plants, as well as locally cultivated plants that might be of tropical or subtropical origin. The second category—*refuse*—consists of fruits and seeds discarded into the ocean by man, such as disseminules thrown or washed overboard from ships, washed into the sea from local urban refuse dumps, or discarded on beaches. The third category—*peregrine*—(true drift seeds)—comprises those disseminules that have travelled substantial distances in ocean currents, and it is of prime interest to phytogeographers. As all three categories can be encountered on any beach, each specimen must be carefully assessed in order to ascertain the category into which it should be placed. All the disseminules described below have been assessed; *local* and *refuse* disseminules have been included.

In the following section, each disseminule is described; collection localities are noted briefly according to vice-counties and are mapped in Fig. 1. Vernacular names and scientific synonyms are noted where relevant. A key to all the drift seeds recorded from European coasts will be included in the second paper.

1. *Amblygonocarpus andongensis* (Welw. ex Oliv.) Exell & Torre (Leguminosae: Mimosaceae). Vernacular name of the plant: banga-wanga. Drift category: refuse. 1 collection: *c* 1973, W. Galway, v.c. H16. Fruit woody, shining dark brown, slightly curved near peduncle, sides parallel, *c* 15cm long, *c* 2cm broad, tetragonal in cross-section. Seeds may rattle inside when mature.

The parent plant is a tree (*c* 15–20m tall) of the savannah and moist savannah woodlands in central, eastern and western Africa, from Mozambique to Ghana (Irvine 1961, Hutchinson & Dalziel 1958). Although the pod is capable of floating, it is very unlikely that it drifted in ocean currents from Africa. Logs of *A. andongensis* are imported into Europe, and the fruit most probably was washed off the deck of a timber-carrying ship. The species could not be cultivated out-of-doors in Ireland.

2. *Baillonella heckelii* (Pierre ex A. Chev.) Baehni (Sapotaceae) (syn. *Tieghemella heckelii* Pierre ex A. Chev., *Mimusops heckelii* (Pierre ex A. Chev.) Hutch. & Dalz.). Vernacular name of the plant: makoré. Drift category: refuse. 1 collection: 1965, W. Cork, v.c. H3. Seed light and dark brown, woody, one half boat-shaped, shining, light brown, other half rough, dull, dark brown or black, *c* 5cm long, *c* 3cm broad.

Like *Amblygonocarpus*, the parent plant is an African forest tree (*c* 36–40m tall) found from Sierra Leone to Zaire (Hutchinson & Dalziel 1963, Baehni 1965). The timber of *B. heckelii* (makoré) was imported into Ireland until recently. In western Africa the seeds are used for many purposes, including the extraction of oil (Irvine 1961) which can be used for cooking and making soap. It is probable that the seed was discarded from a ship, and thus it belongs in the refuse category. Gunn & Dennis (1976, p. 200) noted this record, but considered that the seed was incorrectly identified, and should be *Calocarpum mammosum* (L.) Cronquist. However, the specimen, originally determined by C. E. Hubbard (Royal Botanic Gardens, Kew), has been checked and is correctly identified (Gunn pers. comm. 1977).

3. *Caesalpinia bonduc* (L.) Roxb. (Leguminosae: Caesalpiniaceae) (syn. *Guilandina bonduc* L., *G. bonducella* L., *C. bonducella* (L.) Fleming). Vernacular names of seeds: nickar nut, grey nickar. Drift category: peregrine. 7 collections: *ante* 1725–1930 (Fig. 1). Seed light grey, shining to dull, hard, often with concentric hair-like cracks, *c* 2cm diameter, ovoid to spherical or subglobose, sometimes slightly flattened.

The seed of *C. bonduc* is light grey and about the size of an acorn. The parent plant is a thorny bush, widely distributed in the tropics, including the West Indies and Florida. Gunn & Dennis (1976) noted that the species is a native of south-eastern Asia but has now attained pantropical distribution

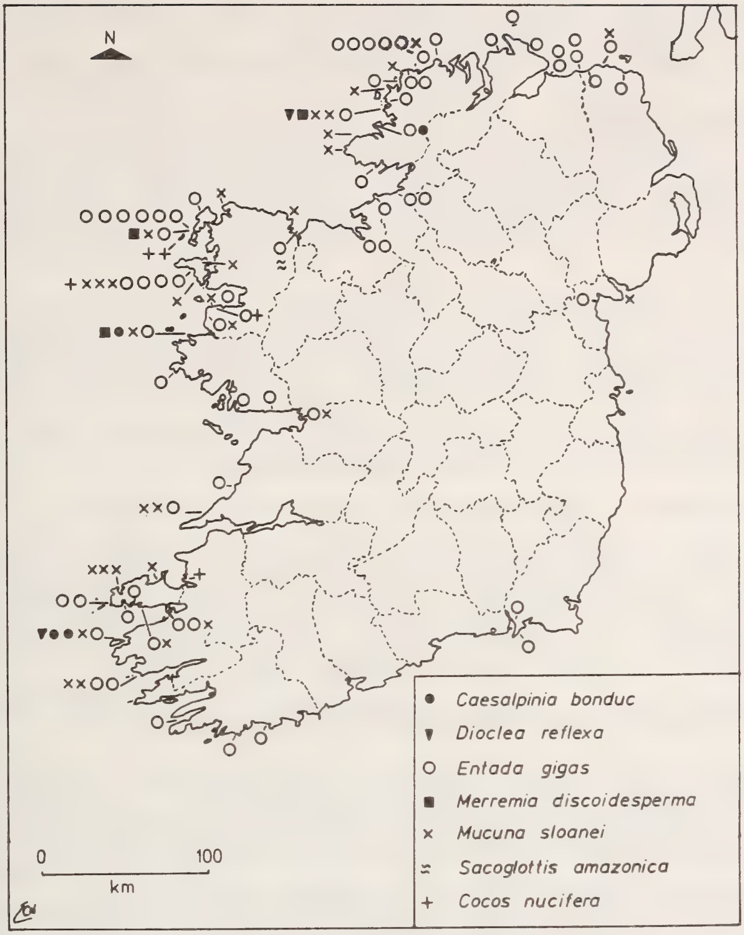

FIGURE 1. Recovery sites of peregrine drift fruits and seeds in Ireland; each symbol indicates a single specimen. A list of records is available from the author (vice-county boundaries indicated by dashed lines).

primarily by drifting in ocean currents. The shrubs often form thickets above the high-tide zone on tropical beaches.

This was one of the first drift seeds reported from Ireland (Sloane 1725). Robert Brown (1818) reported that a seed collected from an Irish beach had been germinated and a drawing of the seedling sent by the unnamed grower to Sir Joseph Banks; the drawing cannot be traced in Banks' correspondence (P. I. Edwards pers. comm. 1977, Colgan 1919). The most recent collection was made by Delap in 1930, when a seed apparently was 'fished' out of the sea near Valentia Island, S. Kerry, v.c. H1.

4. *Cocos nucifera* L. (Palmae). Vernacular name: coconut. Drift category: peregrine and refuse. 5 collections: 1974–1977 (Fig. 1). Fruit grey-brown to light brown, subglobose, *c* 30cm long, *c* 20cm broad, fibrous husk surrounding hard bony dark brown seed ('coconut').

Coconuts have been reported from European beaches for several centuries (see Guppy 1917). Most workers regard these records as refuse, believing that the specimens have been 'washed overboard' from passing ships. Guppy (1917) noted records from beaches in England, the Faroe Islands, Norway and the Lofoten Islands, but he dismissed them as having come with 'extreme probability' from wrecked or passing ships. Certainly some records, such as that of three coconuts on a beach in the Lofoten Islands (Flygaer 1765), must be considered refuse.

There are no records of stranded coconuts published in Irish scientific papers. A coconut stranded in W. Mayo, v.c. H27, was noted in a newspaper article (Viney 1977). The specimens examined by the author (Iniskea Is., W. Mayo, v.c. H27, coll. B. West; Barrow Strand, N. Kerry, v.c. H2, coll. L. O'Donnell & A. OhEadhra), which were whole fruits, obviously had been in the ocean for a long time. The N. Kerry specimen had barnacles and some marine algae attached to it when it was found. When the husk was removed a number of marine molluscs—*Psiloteredo megotera* (Forbes & Hanley), det. D. Minchin—were found to have bored into the fruit as far as the bony endocarp. Molluscs had also bored into the Iniskea specimen, but this was not dissected. Two of the other coconuts reported (Iniskea Is., W. Mayo, v.c. H27, coll. B. West; near Louisburgh, W. Mayo, coll. M. Viney) were whole fruits.

Coconuts are at present imported into Europe as whole fruits (with husk intact) and as 'prepared nuts' (information from Dept of Agriculture, Dublin), so that the possibility that these specimens were discarded cannot be ruled out. The clear indication on the Barrow Strand fruit of attached marine organisms tend to suggest that the specimen had been in an ocean for many months before being cast ashore, and that it might have drifted from the American region.

While a number, perhaps the majority, of records of coconuts must be assigned to the refuse category, it is likely that some floated across the North Atlantic.

5. *Dioclea reflexa* Hook. f. (Leguminosae: Papilionaceae). Vernacular name of seed: sea-purse. Drift category: peregrine. 2 collections: *c* 1870–1965 (Fig. 1). Seeds very variable; Irish specimens dark brown, ± circular to reniform in outline, may have one straight side, strongly to slightly compressed, *c* 3cm diameter, 1–2cm thick; hilum black, *c* 1·5mm broad, occupying $\frac{3}{4}$ of circumference.

This disseminule is variable in shape, size, colour and markings (Muir 1937, Gunn & Dennis 1976); spotted forms are known but are not recorded from Irish beaches (a photograph in Gunn & Dennis (1976) is misleading—the mottled seed shown was not collected in Ireland).

Dioclea reflexa is a woody vine with a pantropical distribution (Gunn 1968). The seeds may be mistaken for *Mucuna* spp. (see below) (Guppy 1917, Gunn & Dennis 1976).

6. *Entada gigas* (L.) Fawc. & Rendl. (Leguminosae: Mimosaceae) (syn. *E. scandens* L.). Vernacular names of seeds: sea-hearts, sea-beans, Molucca beans, sea-kidney, cocoon or cacoon, *sliogán bóileid, sceartaims* (? or *an scathain,* or *an cartain*). Drift category: peregrine. 73 collections: *ante* 1696–1977 (Fig. 1). Seed dull to shining, dark maroon-brown, hard, variable in size and shape, generally heart-shaped to ± circular in outline, flattened, *c* 5cm diameter, *c* 2cm thick.

This, the most commonly collected drift seed, was first reported from Irish beaches by Sloane (1696), and has been noted by Colgan (1919), Praeger (1937), Kertland (1956), Hamilton (1957), Hickin (1975) and Viney (1977). The frequent strandings of these seeds on Irish coasts has resulted in at least two vernacular Irish names, both of obscure origins and meanings (P. Ua Maoileoin pers. comm. 1977). *Sliogán bóileid*, recorded by Ua Maoileoin in the W. Kerry Gaeltacht, is derived from *sliogán* (= a mollusc), referring to the seed's hard testa and its shell-like appearance, and *bóileid,* which is not recognized by linguists but may be a corruption of *Boletus* and may mean 'fungus-like'. *Bóileid* is also encountered in the Irish name for a sea anemone—*siné bóileid* (=? fungus-like pap) (Ua Maoileoin pers. comm. 1977). *Sceartaims, an scathain* and *an cartain*, which may be renderings of the same Irish name, were reported by O'Sullivan from the W. Donegal Gaeltacht (Tory Island), but cannot be identified or translated.

Entada gigas is a woody vine that produces large pods over 1m long. The species occurs in central tropical Africa, central and southern tropical America and in the West Indies (Hutchinson & Dalziel 1958). The seeds have a tough impermeable testa; it is necessary to erode the testa substantially before moisture can be absorbed and germination proceed.

A seed of *E. gigas* collected in W. Donegal, v.c. H35 (coll. P. J. Haugh, *c* 1970), was germinated at the National Botanical Gardens, Glasnevin, and the plant is under cultivation. This is the first time that the species is known to have been germinated from seeds washed ashore on Irish beaches. Seeds of *Entada* sp. (probably *E. phaseoloides* (L.) Merrill) collected on Australian beaches (Twilight Cove, W. Australia, *ante* 1973; Moruya, New South Wales, 1974) were successfully germinated at the Australian National University, Canberra, by the author, and a second specimen, from Twilight Cove, has been germinated at Glasnevin.

Seeds of *E. gigas* washed ashore in Ireland have been made into snuff-boxes and used as play-objects for children (Colgan 1919), as well as being used as key-minders (D. J. O'Sullivan pers. comm. 1977) and as substitutes for padlocks (Miss A. Gallagher pers. comm. 1977). Superstitions are associated with these seeds in western Ireland.

7. *Mangifera indica* L. (Anacardiaceae). Vernacular name of plant: mango. Drift category: refuse. 2 collections: undated and unlocalized. Endocarp woody, dark brown to tan, surface may be slightly fibrous, *c* 5cm long, *c* 4cm broad (but variable), ellipsoidal, compressed with prominent basal scar.

These were certainly refuse, either thrown into the ocean from ships or washed into the sea from refuse dumps. They are capable of floating only for a few months and could not make a long ocean journey (Gunn & Dennis 1976, Muir 1937).

8. *Merremia discoidesperma* (Donn. Sm.) O'Donnell (Convolvulaceae) (syn. *Ipomoea discoidesperma* Donn. Sm.; often wrongly named *I. tuberosa* L. in literature, see Gunn 1977). Vernacular name of seed: Virgin Mary's bean. Drift category: peregrine. 3 collections: *c* 1823–1970 (Fig. 1). Seed black or dark brown, *c* 3cm diameter, *c* 2cm thick, ± circular in outline, flattened, hilum C-shaped on ventral surface, impressed cross-mark on dorsal surface.

This seed is recognized by the indented 'cross' on the dorsal surface and the conspicuous C-shaped hilum on the ventral surface. The species is discussed in detail by Gunn (1977). The parent plant is a high-climbing woody liana of wet mixed forests in central tropical America, Cuba and Hispaniola.

9. *Mucuna sloanei* Fawc. & Rendl. (Leguminosae: Papilionaceae). (Generally referred to as *M. urens* (L.) Medikus in drift literature; see Gunn & Dennis 1976). Vernacular name of seeds: (true) sea-bean, horse-eye bean. Drift category: peregrine. 33 collections: *c* 1823–1977 (Fig. 1). Seed dark brown, lustrous, with lighter band (greyish or reddish brown) around hilum, ± spherical or slightly compressed, *c* 2·5cm diameter, surface slightly rough (tuberculed); hilum black, 3–5cm broad, straight, occupying $\frac{3}{4}$ circumference.

As it is difficult to identify *Mucuna* seeds to species level (Muir 1937, Gunn & Dennis 1976), it is probable that more than one species of *Mucuna* is represented in material stranded on Irish beaches. Most of the seeds probably belong to *M. sloanei*, but *M. fawcettii* Urban and true *M. urens* are possibly represented (Gunn & Dennis 1976); the latter name has been most frequently applied in the drift literature. Colgan (1919) incorrectly referred some of the specimens he examined to *M. altissima* DC.

M. sloanei is a woody pantropical vine whose pods have stinging hairs on the surface (Gunn 1968). *M. fawcettii* and *M. urens* are similar.

A seed of *Mucuna* cf. *sloanei* collected in W. Donegal, v.c. H35 (coll. D. Griffith, 17. iv. 1976), has been germinated at the National Botanic Gardens, Glasnevin. It is hoped to be able to germinate further material in order to establish the specific identity of a range of seeds.

10. *Sacoglottis amazonica* Mart. (Humiriaceae). Drift category: peregrine. 1 report: *c* 1890 (Fig. 1). Endocarp 2–6cm long, 2–4cm in diameter, oblong, circular in cross-section, light to dark brown, surface dull with lumpy cysts, contains 2 seeds.

S. amazonica is a native of the Amazon and Orinoco estuaries. The woody endocarp of this tall forest tree contains a number of empty vesicles (Guppy 1917) which enables it to float in salt water for over two years (Gunn & Dennis 1976). The species is included in the Irish drift seed list on the basis of a description of the disseminule given by Miss Warren (Colgan 1919).

11. *Trachycarpus* sp. (Palmae). Drift category: local. 1 collection: 1960, W. Donegal, v.c. H35.

The single *Trachycarpus* specimen was identified by C. E. Hubbard (Royal Botanic Gardens, Kew). At least two species of *Trachycarpus* are grown out-of-doors in Ireland: *T. fortunei* (Hook.) H. Wendl. and *T. martianus* (Wall.) H. Wendl. (Morley 1975). It is probable that this disseminule came from a garden plant.

12. Native and naturalized species.

The fruits and seeds of certain native and naturalized plants are recorded from Irish beaches, including hazelnuts (*Corylus avellana* L.), beech fruits (*Fagus sylvatica* L.) and pine cones (*Pinus sylvestris* L., *Pinus* spp.) Other disseminules such as acorns (*Quercus* spp.) and horse-chestnuts (*Aesculus hippocastanum* L.) can occur.

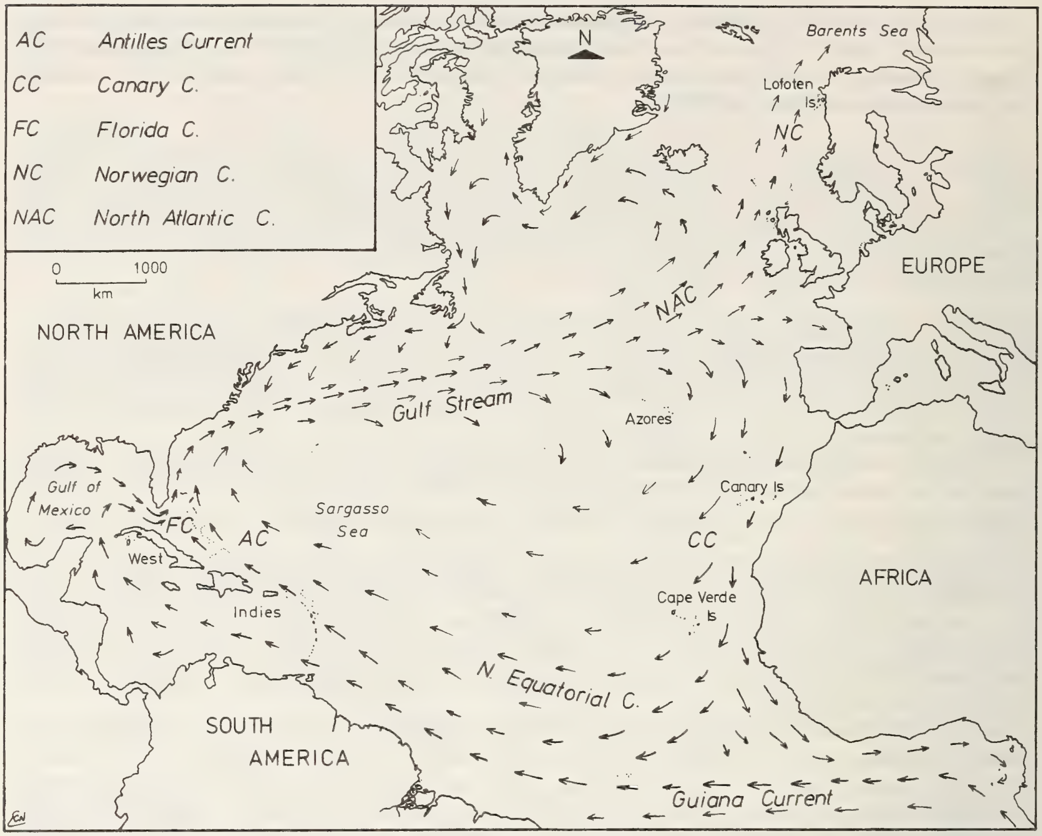

FIGURE 2. Surface currents in the North Atlantic Ocean, generalized.

OTHER BOTANICAL DRIFT

Fruits and seeds are the most frequently collected drift objects, but occasionally other pieces of plant debris are found on Irish beaches. Colgan (1919) did not list *Cocos nucifera* among his drift seeds, but quoted the following extract from a letter he received from Rev. W. Spotswood-Green (1. iii. 1917, Caherdaniel, Kerry): 'At various times I have picked up palm nuts of various species, fronds of palms and pieces of bamboo . . . I have moved house so often that such things as I collected were periodically abandoned.' The pieces of bamboo and palm fronds could have come from gardens in south-western Ireland which are renowned for the cultivation of subtropical plants, including palms and bamboos. However bamboo is common among debris on the beaches of Florida and possibly could float from America to Europe. The present author received a similar report from D. J. O'Sullivan (22. i. 1977, Lifford, Donegal), who wrote that: 'My first encounter with the beans (*Entada gigas*) was in Tory Island where the temporary lighthouse keeper . . . told me of "a stick of bamboo which was washed ashore with seeds in pods attached to it".' This seems to be a description of a piece of the *Entada* liana with intact pods attached. It is most unlikely to have been of local origin, if it was a piece of *E. gigas*, as this species could not survive in an Irish garden.

Logs, both with bark intact and prepared, are common on beaches on the west coast of Ireland, but are most likely to have come from ships. The most abundant plant debris on any beach is sea-weed, most of which is of local origin, but Sargassum weed (*Sargassum bacciferum* Ag.) has been reported from Valentia Island, S. Kerry, v.c. H1 (coll. Miss Delap; see Colgan (1919), p. 41). However, Harvey (1846) indicated that he had never seen this species from Irish beaches, and there are no recent Irish records of it (M. J. P. Scannell pers. comm. 1977).

FIGURE 3. Surface currents in the vicinity of Ireland; note the counter-rotating gyres north-west of Galway Bay (after Monahan (1977), see also Tulloch & Tait (1959)).

OCEAN CURRENTS

SURFACE CURRENTS IN THE NORTH ATLANTIC OCEAN

Seeds and fruits float on or near the water surface; the method by which buoyancy is achieved and maintained in each disseminule is discussed by Gunn & Dennis (1976). Their transport is determined by the surface currents in the oceans, which are caused primarily by the friction between the winds and surface waters. Other factors, such as differences in the salinity and temperature of ocean waters and the Coriolis effect also influence surface current patterns (King 1962, Neumann & Pierson 1966).

The major surface currents in the North Atlantic circulate in a basic clockwise direction (Fig. 2). In the region of the Tropic of Cancer, the surface water of the North Equatorial Current flows in a westerly direction, primarily under the influence of the trade winds. Part of this water flows into the Caribbean Sea and thence into the Gulf of Mexico, and part forms the Antilles Current which flows to the east of the West Indies. The water in the Gulf of Mexico then issues from the Florida Strait and, joining the Antilles Current, forms the Florida Current, which moves northwards along the south-eastern coast of North America past Florida to Cape Hatteras. Beyond Cape Hatteras, the surface water, now the Gulf Stream, is diverted eastwards into the North Atlantic. In the region of the Grand Banks (south-east of Nova Scotia) the Gulf Stream becomes more diffuse and tends to branch, part of it forming the North Atlantic Current (or Drift). North of the Azores, some of the surface water turns southwards between the Azores and the Iberian Peninsula forming the Canary Current and then completes the clock-wise circulation as it is diverted into the North Equatorial Current again. The other portion of the main drift moves north-eastwards and flows past Ireland, Scotland and Norway into the Barents Sea (King 1962, Neumann & Pierson 1966).

Thus any floating object cast adrift in the ocean between the Amazon estuary and south-eastern U.S.A. could reach western Europe. While not impossible, it is most unlikely that an object would float from central Africa to Europe by ocean currents.

The rate of travel of drift objects is determined by the surface currents. Guppy (1917, p. 80) noted that the average rate of drift of a bottle released in the northern part of the West Indies and recovered on a European beach was fourteen months; the time for an object to float from the Caribbean Sea or South America would be longer. The quickest recorded passage of a bottle was 337 days for a journey of 4140 miles (i.e. 20km/day) from Hispaniola to south-western Ireland (Guppy 1917).

OCEAN CURRENTS AROUND IRELAND AND RECOVERY LOCALITIES

The wind-induced North Atlantic surface currents in the vicinity of Ireland flow in an easterly direction (Fig. 3). Wind-induced currents in the northern hemisphere flow somewhat to the right of the direction toward which the wind is blowing; the prevailing wind in our latitudes blows towards the east-north-east. However, winds do not steadily blow in one direction, and local off-shore currents, not induced by the prevailing winds, can modify current patterns, especially near coasts. There is a coastwise current immediately off-shore which flows in a clockwise direction around Ireland (Fig. 3) (Monahan 1977).

DISCUSSION

From the plotted recovery sites of drift seeds (Fig. 1), it can be seen that they are most commonly found on the western and northern coasts of Ireland, and rarely on the eastern and southern coasts. There are sufficient records available for it to be argued that the pattern obtained does not indicate a dearth of beachcombers on the southern and eastern coasts.

Any floating object entering Irish coastal waters will tend to be deflected around the coast in a clockwise direction by the coastwise current. Thus, Atlantic drift will be deflected away from the coast east of Cape Clear (W. Cork), as is clearly demonstrated by recent oceanographic studies; drift cards released into the ocean south of Cork Harbour were recovered, not on the nearby beaches of the southern coast, but on the beaches between Mizen Head and Connemara (Monahan 1977). Similarly drift seeds will be carried away from the southern coast towards the western coast. The few seeds that have been obtained from southern beaches may have been washed ashore after storms had induced a strong northwards surface drift that overcame the coastwise current.

The records of drift seeds from the northern coast of Ireland can also be explained by the coastwise current; objects entering the in-shore waters will be carried along the north-western coast towards the northern coast, perhaps being washed ashore after northerly winds had modified the surface drift. The remarkable records of *Entada gigas* and *Mucuna* cf. *sloanei* from Louth, v.c. H31, on the eastern coast (Fig. 1) can only be explained by the seeds drifting in the coastwise current through the North Channel into the Irish Sea.

The best areas for collecting drift seeds are the western and northern coasts. The available records indicate that good beaches are those of the Dingle Peninsula (S. Kerry, v.c. H1), Achill Island (W. Mayo, v.c. H27), The Mullet (W. Mayo) and W. Donegal (v.c. H35) north of Glencolumbkille. However, the concentration of records in these areas may only reflect the distribution of keen beachcombers; the four areas named have observant resident beachcombers, or, in the case of the Mullet, a regular visitor.

Two areas on the western coast have produced few records, though they would be expected to have good beaches; these are Donegal Bay and Galway Bay. The Aran Islands may act as a barrier (or sieve) preventing drift from the open ocean entering Galway Bay in large quantities. It is interesting that there are no records of drift seeds from the Aran Islands, but the western shores of the islands are cliffed and therefore lack suitable beaches (Stephens 1969). The relative paucity of records from beaches between the Mullet and Glencolumbkille on Donegal Bay may be due to the possible presence of two counter-rotating currents (gyres) to the west of Donegal Bay (Tulloch & Tait 1959) (Fig. 3). Drift may be directed towards the Donegal coast north of Glencolumbkille by the northern clockwise gyre, little entering Donegal Bay.

CONCLUSION

Seeds and fruits of plants growing in the West Indies and central America set adrift in the ocean can, by floating in the surface currents, reach the shores of the British Isles. These disseminules must be capable of floating in salt water for over one year. The chance of an individual seed floating across the Atlantic, being washed ashore on Irish coasts, and being picked up by an inquisitive beachcomber is remote, and the chance of this seed coming to the attention of a scientific institute or research worker is even more remote. Superstitious people believe that good luck will attend the finder of a 'sea-bean'!

When disseminules which belong to the *local* and *refuse* categories are eliminated from the list of Irish records, Irish beaches have produced about eight species of *peregrine* drift disseminules of tropical American origin. These are *Caesalpinia bonduc, Cocos nucifera, Dioclea reflexa, Entada gigas, Merremia discoidesperma, Mucuna* spp. (probably *M. sloanei, M. fawcettii, M. urens*) and *Sacoglottis amazonica*. All these, except *Cocos nucifera*, were recorded by Colgan (1919), though sometimes under different names, and all are also recorded from Great Britain.

The peregrine drift seeds recorded from Irish beaches are mostly of West Indian origin; at least the parent plants are recorded from the West Indies. *Sacoglottis amazonica* is an exception (see above). The ocean currents that transport these fruits and seeds to Ireland do pass along part of the North American coast, but it is unlikely that seeds of plants from temperate areas of North America are transported to Europe by these currents. Some species of temperate North American plants are recorded in western Europe (e.g. *Sisyrinchium bermudiana* L., *Eriocaulon aquaticum* (Hill) Druce) but their disseminules could not have arrived in Europe by ocean currents in recent times. During periods of lower sea-levels which coincided with glacial maxima during the Quaternary, ocean currents did not circulate in the way observed today. During such epochs, long-distance transport of disseminules of temperate N. American plants to Europe might have taken place and produced some of the extant amphi-atlantic distribution patterns. However, only those plants with seeds or fruits capable of floating in salt water for a long time and remaining viable during such immersion could successfully cross the considerable ocean barrier.

Some of the seeds which arrive on Irish coasts from tropical America are capable of germinating; *Entada gigas, Mucuna* cf. *sloanei* and *Caesalpinia bonduc* seeds have been germinated. However, the seedlings cannot survive out-of-doors in Ireland. The seeds germinated at Glasnevin were scarified severely to stimulate germination, so they are unlikely to germinate on Irish beaches unless their very tough testas are broken.

Data available at present indicate that about 15 peregrine species have been collected from the beaches of the Outer Hebrides and other Scottish islands. The Irish coasts receive the same ocean currents, yet the numbers of species recorded from Irish beaches is only about half. One reason for this discrepency could be that no-one has collected in Ireland as intensively as collections were made in Scotland at the beginning of this century. According to Colgan (1919) there was a lack of interest in drift seeds in Ireland at the beginning of this century; an appeal made by the present author through provincial newspapers produced about a dozen records, suggesting that this disinterest continues. While lack of collections may be partly to blame for the low number of species, the coastwise current which seems to deflect drift from the southern coasts of Ireland may also deflect drift away from Ireland as a whole. However this seems unlikely; records show that more drift-bottle recoveries have been made in Ireland than elsewhere in western Europe (J. V. Dennis pers. comm. 1977).

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The *Juncus bufonius* L. aggregate in western Europe

T. A. COPE

Royal Botanic Gardens, Kew, Richmond, Surrey

and

C. A. STACE

Botanical Laboratories, University of Leicester

ABSTRACT

The history of the taxonomic treatment of the *Juncus bufonius* L. aggregate is surveyed. Five species within it are recognized in Europe: *J. foliosus* Desf., *J. bufonius* L., *J. ambiguus* Guss., *J. hybridus* Brot. and *J. sorrentinii* Parl. Each of these is described, and a list of synonyms and details of distribution and habitat preferences are provided for each. The first three of these five species occur in the British Isles.

INTRODUCTION

The genus *Juncus* L. comprises about 300 species varying from dwarf, ephemeral annuals to large tufted or rhizomatous perennials. Buchenau (1890, 1906) divided *Juncus* into eight subgenera, and his classification is still largely followed today. The only notable modifications are the three accepted by Krechetovich & Goncharov (1935) and Snogerup (1971a, 1971b, 1972) involving the division of subgenus *Poiophylli* Buchenau into subgenera *Poiophylli* (annuals) and *Pseudotenageia* Krech. & Gonch. (perennials); the division of subgenus *Graminifolii* Buchenau into *Graminifolii* (perennials) and *Juncinella* (Fourr.) Krech. & Gonch. (annuals); and the amalgamation of subgenus *Singulares* Buchenau with *Graminifolii sensu stricto*. Apart from *Poiophylli sensu stricto* and *Juncinella*, annual species are found only in subgenus *Septati* Buchenau (in this subgenus with perennials also). It should be mentioned that, if these nine subgenera are recognized instead as sections, the correct names are mostly different, largely dating from those of Kuntze (1903).

The *Juncus bufonius* L. aggregate belongs to subgenus *Poiophylli sensu stricto*, which consists of annual species with grass-like leaves and rather diffuse, leafy, terminal inflorescences. Apart from *J. bufonius* agg., the subgenus contains only two other species, both European: *J. tenageia* Ehrh. and *J. sphaerocarpus* Nees. These both differ from *J. bufonius* agg. in their possession of more or less spherical (not oblong) capsules.

J. bufonius agg. is morphologically extremely variable. It is a small, green, tufted annual up to 40cm high, with flattish, convolute or subterete leaves up to 15cm × 0·5–5mm. The flowers are in a compound, bracteate, dichasial cyme (often termed an anthela) and may be distantly spaced or partly or densely clustered. The outer tepals vary from acute to long-acuminate or cuspidate at the apex and are 4–9(–11)mm long. The inner tepals are acute or subacute to rounded or truncate at the apex and sometimes also emarginate and mucronate, and are shorter than the outer. The capsule is 3·5–5 × 1·2–2mm, oblong, acute to truncate at base and apex, and trilocular. The seeds are 0·3–0·5 × 0·2–0·3mm, frequently obliquely obovoid or sometimes ovoid to barrel-shaped, and without appendages.

J. bufonius agg. is distributed throughout the world, but is less frequent in tropical and polar regions. Being a weed of cultivation it is undoubtedly adventive in some localities (Good 1953). It is ubiquitous in Europe except for parts of the extreme north. It is also almost ubiquitous in Asia, occurring eastwards to temperate China, Japan and northern India. In Africa it is generally confined to the north and it is believed by Adamson (1950) to have been introduced to South Africa. It is found in Greenland, much of Canada and large parts of the United States and Central and South America. Although found throughout Australia and New Zealand, Cheeseman (1925) considered it to have been introduced to New Zealand with grass seed during the early days of colonization. It is found throughout the British Isles, being recorded from every vice-county (Perring & Walters 1962). It is clearly not possible to determine the native distribution of such a common and successful weed species; it is probably not native outside Eurasia, North Africa and perhaps eastern North America.

According to Laurent (1904), *J. bufonius* is cleistogamous or rarely chasmogamous, although Buchenau (1906) said that the converse was the case. Cleistogamy is unusual in *Juncus*, a genus believed by Cronquist (1968) to be a reduced anemophilous derivative of the entomophilous Commelinales. Only rarely in Britain have the flowers of *J. bufonius* agg. been seen to open before anthesis, but in the Mediterranean region, for which no data are at present available, the situation may be different. In Britain the flowering period ranges from about mid-June through to mid- or late-September, and the capsules are ripe about a month after flowering.

There is no normal dormancy in the seeds of *J. bufonius* agg., so that in mild, wet weather germination often takes place inside the dehisced capsules. Normally, however, soil temperatures are too low in autumn and winter for germination, which is therefore delayed until the following spring. Germination usually occurs in damp, exposed places and the species is a colonizer of bare ground. *J. bufonius* agg. cannot tolerate much shade or competition either from other species or from individuals of its own species. It prefers a high water-table and grows best when its roots are waterlogged. It is, however, generally intolerant of total submergence by salt-water and therefore is restricted in coastal habitats to those areas above the mean high-water mark. It is also intolerant of drought and seldom recovers after a prolonged dry spell. According to Good (1953), *J. bufonius* is the only species in the genus that is a weed of cultivated ground. However, *J. effusus* L. can also be so.

Proliferation, in which flowers are replaced by clusters of leaves and eventually new inflorescences, can easily be induced in some strains in cultivation by overcrowding, but proliferating specimens have not been seen in the wild or in herbarium material.

Dispersal of *J. bufonius* agg. may be brought about in several ways. On arable land it is most probably spread when the seeds adhere to mud that is transported on the wheels of vehicles and on the feet of man, cattle, horses or birds. The seeds become viscid when wet, an adaptation to dispersal by animals' feet common to many other species of *Juncus*. In waterside situations seeds and seedlings may be dispersed when stuck to the feet of waterfowl or by floating on moving water. As most seeds of *Juncus* are reported to sink in water almost at once (Ridley 1930), dispersal by floating seedlings seems to be more likely than by floating seeds, although flooding may deposit seeds, carried in silt, on to previously uncolonized ground. The seeds of *J. bufonius* agg., which weigh about 0·015mg (Porsild 1920), may possibly also be dispersed by wind (Löve 1963).

Historically, the taxonomy of *J. bufonius* agg. has been very confused. The present investigation was undertaken in an attempt to clarify the classification of the aggregate as represented in western Europe and the western Mediterranean region, and it involved anatomical, cytological, breeding behavioural, ecological, and experimental cultivation and hybridization studies in addition to orthodox taxonomic procedures. In this paper we describe the taxonomic history of the aggregate and set out the results of our investigation in the form of a brief, illustrated, systematic account. In it we recognize five species: *J. bufonius* L. *sensu stricto*, *J. foliosus* Desf., *J. ambiguus* Guss., *J. hybridus* Brot. and *J. sorrentinii* Parl. It should be emphasised that in western Asia there are further taxa not covered by us, although we believe there are no additional species in Europe. We intend to present more detailed reasons for adopting the above classification, and the results of cytological studies and hybridization experiments, in later papers.

THE HISTORY OF THE TAXONOMY OF THE *JUNCUS BUFONIUS* AGGREGATE

Linnaeus (1753) described *J. bufonius* as 'Juncus culmo dichotomo, foliis angulatis, floribus solitariis sessilibus', and he described five varieties of it, none of which, as far as can be ascertained, is synonymous with any subsequently published taxon. Since 1753 about 60 names applicable to *J. bufonius* agg. have been published, and clearly there are far more available than are necessary to account for the variation of the aggregate. There is inevitably some overlap in the limits and interpretations of the various taxa, as well as some nomenclatural synonymy. While it is not possible to review all of the relevant literature, most of the important Floras and monographs have been consulted, and the noteworthy ones are discussed below.

The first significant classification to appear after 1753 was that of Buchenau (1890, 1906). The single species *J. bufonius* was divided into seven varieties, of which only three, vars. *genuinus* Cout., *foliosus* (Desf.) Buch. (based on *J. foliosus* Desf.) and *halophilus* Fern. & Buch., are retained in any form today. The remainder, vars. *kochii* Buch., *leucanthus* Asch. & Graeb., *pumilio* Griseb. and *subauriculatus* Buch., are now generally disregarded, although the last was revived by Post (1933).

Husnot (1908) concerned himself with only European varieties, and to the three retained from Buchenau he added vars. *hybridus* (Brot.) Husnot (based on *J. hybridus* Brot.) and *sorrentinii* (Parl.) Husnot (based on *J. sorrentinii* Parl.). Var. *halophilus* he renamed var. *ambiguus* (Guss.) Husnot (based on *J. ambiguus* Guss.), listing *J. ranarius* Song. & Perr. as a synonym. Although Buchenau had reported that plants intermediate between var. *genuinus* and var. *halophilus* (which he said occurred in Canada, Germany and Sicily) were common in saline places and he mentioned *J. ranarius* as one of these, he mistakenly regarded *J. ambiguus* as a synonym of *J. tenageia*. Husnot, however, indicated in his synonymy a link between var. *halophilus*, *J. ambiguus* and *J. ranarius* that was to persist in many subsequent accounts. Buchenau did not think that *J. hybridus* was anything more than an unimportant form of var. *genuinus* with congested flowers, and var. *sorrentinii* did not appear in his account except in a note to the effect that var. *condensatus* Cout. (now an accepted synonym of it) was probably a good variety; the name *J. sorrentinii* appeared as a synonym of *J. pygmaeus* Rich., a synonymy that Husnot showed to be erroneous.

Shortly after the appearance of Husnot's paper, Briquet (1910) divided the aggregate into five varieties. These were taxonomically, although not nomenclaturally, the same as those of Husnot except that var. *ambiguus* was cited only as a variety of doubtful status.

Rouy's (1912) account in *Flore de France* included the same five taxa as Husnot, but each was treated as a species. The only significant nomenclatural change was to call *J. hybridus* by the later name *J. insulanus* Viv.; Rouy did not adopt the earlier name because he thought Brotero's type material of *J. hybridus* included two species, the second being *J. pygmaeus* Rich. Husnot, however, did not think that this was so and that, in any case, Brotero's description could not possibly have applied to *J. pygmaeus*, a member of subgenus *Septati*. Briquet (1910), too, was in some doubt about the status of *J. hybridus*, for he called his equivalent variety *congestus* Wahlb., and only included *J. hybridus* in the synonymy preceded by a question mark.

Fiori's (1923) account in *Nuova Flora analitica d'Italia* once more relegated all of the taxa to varieties of *J. bufonius*, but to the exclusion of *J. sorrentinii*, which did not appear anywhere in his *Flora*.

Krechetovich & Goncharov (1935) produced a very complex treatment for *Flora U.R.S.S.*, although this is not strictly concerned with our area of study. The subgenus *Tenageia* (Dumort.) O. Kuntze (= subgenus *Poiophylli*) was divided into three series and six species. The western and Mediterranean species *J. foliosus*, *J. hybridus* and *J. sorrentinii* were of course absent, while *J. bufonius* and *J. ambiguus* were joined by *J. minutulus* Krech. & Gonch. and three other new species. Each principal species was placed in its own series as follows: *J. bufonius* (along with the new species *J. nastanthus* Krech. & Gonch.) in series *Bufonii* Krech. & Gonch.; *J. ambiguus* (along with two further new species, *J. turkestanicus* Krech. & Gonch. and *J. juzepczukii* Krech. & Gonch.) in series *Ranarii* Krech. & Gonch.; and *J. minutulus* in series *Minutuli* Krech. & Gonch. The separation of species within each series was based on extremely critical characters, and the account in *Flora U.R.S.S.*, although potentially applicable to large parts of Europe and Asia, has not been generally adopted.

Another complex treatment of the aggregate is found in *Flore de l'Afrique du nord* (Maire 1957), in which *J. bufonius* has two subspecies, *eu-bufonius* Briq. and *foliosus* (Desf.) Maire & Weiller. Subsp. *eu-bufonius* contains five varieties: *laxus* Čelak. (= *J. bufonius sensu stricto*), *ambiguus*, *rhiphaenus* (Pau & Font-Quer) Maire & Weiller, *congestus* (= *J. hybridus*) and *mogadorensis* (H. Lindb.) Maire & Weiller. Two of these, vars. *mogadorensis* and *rhiphaenus*, are unknown from the European literature. The latter is remarkable, for among its synonyms is to be found *J. tenageia* subsp. *sphaerocarpus* (Nees) Trabut var. *rhiphaenus* (Pau & Font-Quer) Maire, a combination involving the names of two very different European species from outside the aggregate and a third, non-European, name from within it. To further confuse the situation, var. *rhiphaenus* is now known to be synonymous with *J. foliosus*, which Maire treated as his second subspecies.

Segal (1960) discussed the taxonomy of the aggregate and recognized seven species: *J. bufonius*, *J. foliosus*, *J. ambiguus*, *J. ranarius*, *J. mutabilis* Savi, *J. sorrentinii* and *J. sphaerocarpus*. He mentioned that the last six were generally regarded as varieties of *J. bufonius* but that he treated them as species for convenience. One of these, *J. sphaerocarpus*, is not considered by us to be a part of the *J. bufonius* aggregate. Another species, usually called *J. hybridus*, he called *J. mutabilis* Savi. While this name may be correctly applied to this species, it is a later homonym of *J. mutabilis* Lam. (Subgenus *Septati*) and therefore illegitimate. Segal discussed the suggestion of Fernald & Buchenau (1904) that *J. ambiguus* and *J. ranarius* should be separated, stating that, while they are often considered to be synonymous, they are not identical. He considered that North American plants (previously known as var. *halophilus*) and northern European plants both correspond to *J. ambiguus* (whose type locality, however, is in Sicily), but pointed out that numerous authorities had considered European specimens to represent *J. ranarius*, said by Fernald & Buchenau to be intermediate between *J. bufonius* and *J. ambiguus*.

Duvigneaud (1967), in an ecological account of the halophytic flora of eastern Lorraine (Dép. Moselle, north-eastern France) recognized the two segregates (*J. bufonius* and *J. ambiguus*) occurring there as distinct species.

Snogerup (1971a), in *Flora Iranica* (only of partial relevance to our area), recognized five species; *J. ambiguus, J. foliosus* and *J. sorrentinii* are absent from the area covered. *J. minutulus* was recognized by Snogerup although he cited Albert & Jahandiez as authorities. These authors clearly intended their taxon to be a forma of *J. bufonius*, a point which escaped Snogerup and, later, Van Loenhoud & Sterk (1976), who all cited it as a species. *J. turkestanicus* Krech. & Gonch. was also accepted by Snogerup, although he confessed that he was unable to distinguish readily all populations of it from *J. hybridus. J. rechingeri* Snogerup (a new, very distinct species), *J. bufonius* and *J. hybridus* were the other three species recognized.

Van Loenhoud & Sterk (1976) made a detailed study of the aggregate in the Netherlands and concluded that it was represented by three species. Apart from *J. bufonius*, they recognized, for the first time in that part of Europe, *J. minutulus*, but incorrectly cited (see above). The third species, which was recognized by Reichgelt (1964) in *Flora Neerlandica* as *J. bufonius* subsp. *ambiguus* (Guss.) Schinz & Thell., they called *J. ranarius* Song. & Perr. A synonym for *J. ranarius* which they mentioned was *J. bufonius* var. *halophilus*, a commonly accepted synonym for *J. ambiguus*. They gave no reason for using the name *ranarius* instead of *ambiguus*; if, as they implied, they considered the two as taxonomic synonyms their choice was incorrect, as *ambiguus* is the older name.

In an interesting paper concerning the Czechoslovakian flora, Holub (1976) added *J. minutulus* to that country's list. He was aware of Albert & Jahandiez's intention that *J. minutulus* should be considered subordinate to *J. bufonius*, but was in some doubt about the correct form of citation. He suspected that Prain *et al.* (1921) in *Index Kewensis*, Suppl. 5, made a new combination at specific rank based on forma *minutulus* Alb. & Jah., but it is much more likely that they intended to copy the citation directly from Albert & Jahandiez without making any judgement on its rank. Holub mentioned a remarkable work by Čerepanov (1973), who drew a taxonomic distinction between '*J. minutulus* Alb.& Jah.' and *J. minutulus* Krech. & Gonch.

A further point of interest in Holub's paper is the expansion of an idea, first mentioned by Segal (1960), that *J. ranarius* and *J. ambiguus* may not be conspecific. Indeed, Holub spoke of '*J. ranarius* Song. & Perr. *s.l.*', accepting this name for the aggregate in preference to *J. ambiguus*. He cited the latter as *J. ambiguus* auct., suggesting that the name is misapplied in the commonly accepted sense, but in his key to species he gave the name of the taxon in question as '*J. ranarius* Song. & Perr. *s.l.* (an *J. ambiguus* Guss.?)'. Included in the *J. ranarius* aggregate were four taxa: *J. ranarius* Song. & Perr. *s.s., J. ambiguus* auct., *J. juzepczukii* and *J. nastanthus*. The inclusion of the last of these is a little surprising for Krechetovich & Goncharov placed it in their series *Bufonii*, rather than in series *Ranarii*.

As far as the British Isles are concerned, only one species has usually been accepted, although the name var. *fasciculatus* Koch is sometimes found in local and national Floras (e.g. Colgan & Scully 1898, White 1912, Wolley-Dod 1937, Richards 1962). Druce (1911, 1912) is the only author to have seriously considered the possibility that *J. ranarius* (= *J. ambiguus*) might occur in Britain. He said (Druce 1911, p. 327) that this species (which he called *J. ranarius* Nees emend. Song. & Perr.) 'has either been confused with or called var. *fasciculatus* of *Juncus bufonius*'. The presence of *J. foliosus* in Britain was first indicated by Simpson & Walters (1959) and later by Allen (1969) and Benoit (1973). It was recorded by these authors from W. Cork and S. Kerry, from the Isle of Man and from Wales respectively. While discussing *J. bufonius* in *The flowering plants of the Isle of Man*, Allen (1969) said that 'populations approaching the "Lusitanian" race ssp. *foliosus* (Desf.) Maire & Weiller have recently been detected'. Although many field botanists are aware of their existence, *J. ambiguus* and *J. foliosus* have not hitherto been formally accepted as taxa for the British Isles.

In the recognition of five western European species within *J. bufonius* agg. our treatment agrees with those of Husnot (1908) and Rouy (1912).

MATERIALS

Material used in this study consisted of herbarium specimens and photographs from **BM**, **C**, **DBN/DUB**, **FI**, **K**, **L**, **LD**, **LISU**, **LTR**, **LIV**, **LY**, **MANCH** and **P**, and seed or living plants collected by us and numerous correspondents or obtained via seed exchange schemes. Altogether 85 samples were grown in cultivation, representing all five species recognized.

For the most part we have restricted our studies to material from western Europe and the western Mediterranean region (as far east as Germany, Italy and western Libya), with special emphasis on the British Isles. We feel this is a valid exercise, since the western Mediterranean is a centre of genetic diversity for the aggregate and it includes all the species we recognize in Europe.

The chromosome numbers given for each species refer to our own counts, of which details will be given in a later paper, but other counts (where different) are mentioned as well.

KEY TO SPECIES

1 Leaves bright green, more than 1·5mm wide; tepals usually with dark line on either side of midrib; anthers 1·2–5 times as long as filaments; seeds with 20–30 conspicuous longitudinal ridges (use × 20 hand-lens) .. .. 1. *J. foliosus*

1 Not with above combination of characters; leaves usually darker and seldom more than 1·5mm wide; seeds apparently smooth or with minutely reticulate surface

  2 Inflorescence partly (rarely wholly) contracted; inner tepals rounded, often emarginate and mucronate at tip; capsule truncate, as long as or longer than inner tepals .. .. 3. *J. ambiguus*

  2 Inflorescence variable; inner tepals acute to subacute; capsule acute to subacute, rarely truncate but then clearly shorter than inner tepals and these not rounded or emarginate-mucronate

    3 Inflorescence with widely spaced flowers, or if contracted then inner tepals and capsule acute and seeds obliquely obovoid .. .. 2. *J. bufonius*

    3 Inflorescence contracted; seeds barrel-shaped or ovoid

      4 Flowers fasciculate in open, fan-shaped clusters; outer tepals acute; inner tepals subacute, 3/4–4/5 as long as outer; capsule about 4/5 as long as inner tepals; lowest bract generally shorter than inflorescence .. .. .. 4. *J. hybridus*

      4 Flowers fasciculate in dense, fan-shaped clusters; outer tepals long acuminate to cuspidate; inner tepals acute to acuminate, up to 2/3 as long as outer; capsule about 1/2 as long as inner tepals; lowest bract often greatly exceeding inflorescence .. .. 5. *J. sorrentinii*

SYSTEMATIC ACCOUNTS

In the following accounts the synonymy is given as fully as we are able, although in a number of cases (indicated by ?) the identification is doubtful. We have seen and vetted the type specimens indicated. We do not formally recognize any infraspecific taxa, although some are discussed under *J. bufonius*.

1. J. FOLIOSUS Desf., *Fl. Atlant.*, **1**: 315, t. 92 (1798); (Fig. 1, Plates 1A and 2A)
   Type: 'Algeria in paludibus', *Desfontaines* (**P**, holotype).
   J. bufonius L. var. *major* Boiss., *Voy. Bot. Esp.*, **2**: 624 (1841), based on *J. foliosus* Desf.
   J. bufonius L. var. *foliosus* (Desf.) Buch. in Engl., *Pflanzenreich*, **25**: 105 (1906)
   J. rhiphaenus Pau & Font-Quer in Font-Quer, *Iter Maroc.* (Sched. 1929), No. 64 (1930) (**BM**, isotype)

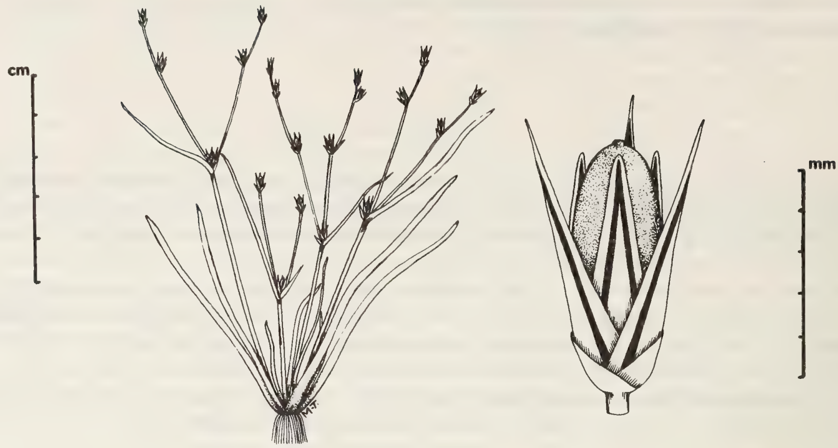


FIGURE 1. *Juncus foliosus* Desf. Whole plant and capsule.

FIGURE 2. *Juncus bufonius* L. Whole plant and capsule.

FIGURE 3. *Juncus ambiguus* Guss. Whole plant and capsule.

FIGURE 4. *Juncus hybridus* Brot. Whole plant and capsule.

FIGURE 5. *Juncus sorrentinii* Parl. Whole plant and capsule.

J. sphaerocarpus Nees var. *rhiphaenus* (Pau & Font-Quer) Maire in *Cavanillesia*, **4**: 97 (1931)

J. bufonius L. subsp. *eu-bufonius* Briq. ex Jah. & Maire var. *rhiphaenus* (Pau & Font-Quer) Maire & Weiller in Maire, *Fl. Afr. nord*, **4**: 264 (1957)

J. bufonius L. subsp. *foliosus* (Desf.) Maire & Weiller var. *major* ('Boiss') Maire, *Fl. Afr. nord*, **4**: 266 (1957), based on *J. foliosus* Desf.

J. bufonius L. subsp. *foliosus* (Desf.) Maire & Weiller var. *flaccidus* Maire, *Fl. Afr. nord*, **4**: 266 (1957)

J. tenageia Ehrh. subsp. *sphaerocarpus* (Nees) Trabut var. *rhiphaenus* (Pau & Font-Quer) Maire, *Fl. Afr. nord*, **4**: 264 (1957), *in synon.*

Annual or short-lived perennial; culms densely tufted, erect or ascending from slightly procumbent base, up to 35cm. Leaf-blades light green, 2–5mm wide; stomata 31–45μm. Inflorescence open; branches $\pm$ straight, often widely diverging or almost horizontal. Flowers 1–3(–5) per ultimate branch; tepals usually with pale brown to almost black line on either side of midrib; outer tepals acute, 4·6–6·8mm; inner tepals usually subacute, sometimes acute, 3·6–5·4mm; capsule usually subacute, sometimes obtuse, 3·7–5·3mm, about equalling inner tepals (0·8–1·25 times as long); anthers 1·2–5 times as long as filaments. Seeds obovoid, often truncate at one end and tapered at other, 430–600 $\times$ 270–400μm; interstices of testa large, *c* 60 $\times$ 20μm; longitudinal ridges pronounced, clearly visible through $\times$20 hand-lens as 20–30 ribs. $2n = 26$.

Habitat. This species occurs exclusively in freshwater habitats such as on the muddy margins of pools, ponds, lakes, streams and rivers, in wet fields and marshes, in roadside ditches and on waste land, in oceanic parts of western Europe.

Distribution (Figs. 6 and 10). Western and south-western Europe (northern Sardinia, southern Spain, Portugal, western France and British Isles); North Africa (Algeria, Morocco and Tunisia); Madeira. Britain (mainly in the south and west in vice-counties 1, 6, 10, 11, 14, 15, 17, 27, 45, 47, 48, 49, 52, 70, 71, 97, 103, 104); Ireland (widespread in vice-counties H1, 3, 6, 12, 16, 20, 21, 29, 34, 35);

Channel Isles (Sark). Allen (1969) considered it to be a member of the so-called Hiberno-Lusitanian element of the British flora.

J. foliosus is the most easily distinguished of the segregates. Its broad, bright-green leaves and striped tepals are very striking and the conspicuously ribbed seeds are diagnostic.

2. J. BUFONIUS L., *Sp. pl.,* p. 328 (1753); (Fig. 2, Plates 1B and 2B)
Type: Europe, *Van Royen* (**L**, sheet 904,145–433, lectotype; **L**, numerous paratypes).
J. divaricatus Gilib., *Exerc. phyt.*, **2**: 506 (1792)
J. prolifer H., B. & K., *Nov. gen. sp.*, **1**: 236 (1815)
J. bufonius L. var. *congestus* Wahlb. in Thunb., *Fl. Goth.*, p. 38 (1820)
J. bufonius L. var. *gracilis* St Amans, *Fl. Agen.*, p. 149 (1821)
J. inaequalis Willd. herb. in E. H. F. Meyer, *Syn. Luzul.*, p. 33 (1823)
J. bufonius L. var. *grandiflorus* Schult. & Schult, f., *Syst. veg.*, **7(1)**: 227 (1829)
J. bufonius L. var. *fasciculatus* Koch, *Syn. fl. Germ.*, p. 732 (1837)
J. dregeanus C.B. Presl, *Bot. Bemerck*., p. 117 (1844)
? *J. ranarius* Nees in *Linnaea*, **20**: 243 (1847), *nom. nud.*
J. bufonius L. var. *parvulus* Hartm., *Handb. Skand. fl.*, 7th ed., p. 241 (1858)
J. bufonius L. var. *longiflorus* Kit. in *Linnaea*, **32**: 333 (1863)
J. bufonius L. var. *alpinus* Schur, *Enum. pl. Transs.*, p. 688 (1866)
? *J. bufonius* L. var. *longifolius* Genn., *Fl. Sarda*, p. 31 (1867)
J. bufonius L. var. *compactus* Čelak., *Prodr. fl. Böhm.*, **1**: 83 (1869)
J. bufonius L. var. *laxus* Čelak., *Prodr. fl. Böhm.*, **1**: 83 (1869)
Tenageia bufonia (L.) Fourr. in *Annls Soc. linn. Lyon*, n.s., **17**: 172 (1869)
J. bufonius L. var. *jadarensis* Brym in *Bot. Notiser*, **1877**: 87 (1877)
J. bufonius L. var. *pumilio* Griseb. in *Abh. Ges. Wiss. Göttingen*, **24**: 316 (1879)
J. bufonius L. var. *genuinus* Cout. in *Bolm Soc. broteriana*, **8**: 102 (1890)
J. bufonum Bubani, *Fl. Pyren.*, **4**: 187 (1901)
J. bufonius L. var. *leucanthus* Asch. & Graeb., *Syn. mitteleur. Fl.*, **2(2)**: 422 (1904)
J. bufonius L. var. *subauriculatus* Buch. in Engl., *Pflanzenreich*, **25**: 107 (1906) (**K, MANCH**, isotypes)
J. bufonius L. forma *minutulus* Alb. & Jah., *Cat. vasc. pl. Var*, p. 501 (1908)
J. bufonius L. subsp. *eu-bufonius* Briq. ex Jah. & Maire, *Cat. pl. Maroc.*, **1**: 114 (1931)
? *J. nastanthus* Krech. & Gonch. in Kom., *Fl. U.R.S.S.*, **3**: 624 (1935)
J. minutulus Krech. & Gonch. in Kom., *Fl. U.R.S.S.*, **3**: 625 (1935)

Annual; culms tufted or solitary, erect or ascending from procumbent base, up to 35(–50)cm. Leaf-blades dark green, 0·5–1(–1·5)mm wide; stomata 29–47μm. Inflorescence open, rarely partly or wholly contracted; branches usually straight, diverging at less than 90°. Flowers 1–5 per ultimate branch; tepals usually without dark lines; outer tepals acute or shortly acuminate, 4·1–7·3mm; inner tepals usually acute, sometimes subacute, 3·4–5·8mm; capsule acute, subacute or rarely truncate, 3·1–4·9mm, usually shorter than inner tepals (0·7–1·1 times as long); anthers usually shorter than filaments, though occasionally much longer (0·3–1·1(–5) times as long). Seeds obliquely obovoid, rarely barrel-shaped or ovoid, 340–520 × 210–350μm; interstices of testa small, *c* 15 × 5μm, or outer integument sometimes lost and seeds perfectly smooth. $2n = 108$ (*c* 54, *c* 60, 70, *c* 72, 80, 104–110 also reported).

Habitat. *J. bufonius* is found in all kinds of habitat where the water-table is high, at least seasonally, and where competition is slight or absent. It occurs on the muddy, sandy or gravelly margins of ponds, lakes, streams and rivers, on marshes and, much less frequently, on acid bogs. It is also frequent in brackish situations such as estuarine mud- and sand-flats, dune-slacks in coastal dune-systems, and on the margins of saline or brackish lakes. Other situations occupied by *J. bufonius* are those associated with cultivation and it will grow in bare patches among crops, on and by paths and tracks, in wheel-ruts and drainage ditches and on waste ground.

Distribution. Cosmopolitan, but probably native only in Eurasia, North Africa and North America. Recorded from every vice-county in the British Isles (Perring & Walters 1962).

The extreme variability of *J. bufonius* has led to the creation of numerous infraspecific taxa, of which the following should be mentioned:

Var. *fasciculatus* Koch is a small variety with subfasciculate flowers described from the Rhine Valley and is often considered to be the same as *J. ambiguus*. No authentic material has been seen, but it seems that this combination could be reserved for those variants of *J. bufonius* that have subfasciculate flowers. There is no suggestion in the description that it differs from the type in any other way.

Var. *congestus* Wahlb. is a little more extreme than the previous variety and is usually regarded as having wholly fasciculate flowers. It is often considered to be synonymous with *J. hybridus*, but this is unlikely since it was described from Göteborg in Sweden, whereas *J. hybridus* is restricted to the Mediterranean region.

Var. *subauriculatus* Buch. differs from the type only in having the leaf-sheaths subobtuse instead of tapered at the top.

Forma *minutulus* Alb. & Jah. is a diminutive variant of *J. bufonius* first published in 1908 at forma level but subsequently accepted by other authors as a species and often mis-cited as *J. minutulus* Alb. & Jah. instead of *J. minutulus* Krech. & Gonch. The morphological limitations set by various authors for this taxon differ considerably and are summarized in Table 1.

TABLE 1. COMPARATIVE CHARACTERS FOR *J. BUFONIUS* AND *J. MINUTULUS* GIVEN BY VARIOUS AUTHORS

	Krechetovich & Goncharov 1935	Snogerup 1971a	Van Loenhoud & Sterk 1976	Extremes of all authors combined
J. bufonius				
Height, cm	10–50	5–50	—	5–50
Outer tepal, mm	6·5–7·5	(4·5–)6·0–8·0	—	4·5–8·0
Inner tepal, mm	5·0–6·0	4·0–6·5	—	4·0–6·5
Capsule, mm	4·0–4·5	(3·0–)3·5–5·0	3·0–4·0	3·0–5·0
Anthers	±1·0 × filaments	0·4–1·0 × filaments	0·35–0·67 × filaments	0·35–1·0 × filaments
Seed length, mm	0·30	0·40–0·55	0·41–0·49	0·30–0·55
Seed width, mm	—	—	0·24–0·30	0·24–0·30
J. minutulus				
Height, cm	0·8–5	0·5–5	—	0·5–5
Outer tepal, mm	2·5–3·5	4·0–6·5	—	2·5–6·5
Inner tepal, mm	2·0–3·0	3·0–4·5	—	2·0–4·5
Capsule, mm	1·5–2·5	2·5–3·0	2·7–3·7	1·5–3·7
Anthers	±0·67 × filaments	0·25–0·33 × filaments	0·4–1·25 × filaments	0·25–1·25 × filaments
Seed length, mm	0·30	0·35–0·40(–0·50)	0·36–0·42	0·30–0·50
Seed width, mm	—	—	0·23–0·27	0·23–0·27

Clearly there is much disagreement about the upper size limits of *J. minutulus*. In considering the total range of measurements given by the various authors for each characteristic of *J. bufonius* and *J. minutulus*, we find considerable overlap in all except height. Our own results, to be presented in a later paper, fail to show any bimodality in any feature of *J. bufonius* that would indicate the presence of two taxa in our sample. Both Snogerup and Van Loenhoud & Sterk support their recognition of *J. minutulus* with cytological data, both reporting that it is tetraploid ($2n = c\ 72$ and 70 respectively), rather than hexaploid. While this may be so, our own cultivation and cytological studies have shown that diminutive plants are not necessarily tetraploid and that tetraploids can be of the perfectly normal stature for *J. bufonius*. For these reasons we do not consider the recognition of *J. minutulus* at the species level to be practicable. Nor, since the two taxa are sympatric throughout the range of *J. minutulus*, do we think it worthy of the rank of subspecies.

3. J. AMBIGUUS Guss., *Fl. Sic. prodr.*, **1**: 435 (1827); (Fig. 3, Plates 1C and 2C)
   Type: Holotype not traced; the earliest known authentic specimen is from Sicily, Trapani, 1856, *Gussone* (**FI**, topotype).
   J. ranarius Song. & Perr. in Billot, *Annot.*, p. 192 (1859) (**P**, lectotype)
   Tenageia ranaria (Song. & Perr.) Fourr. in *Annls Soc. linn. Lyon*, n.s., **17**: 172 (1869)
   ? *J. bufonius* L. var. *major* Cand. in *Bull. Soc. bot. Fr.*, sér. 4, **3**: 373 (1897), *non* Boiss. (1841)
   J. bufonius L. var. *halophilus* Fern. & Buch. in *Rhodora*, **6**: 39 (1904) (**K**, isotype)
   ? *J. bufonius* L. var. *kochii* Buch. in Engl., *Pflanzenreich*, **25**: 107 (1906)
   J. bufonius L. var. *ambiguus* (Guss.) Husnot in *Bull. Soc. bot. Fr.*, **55**: 49 (1908)
   J. bufonius L. subsp. *ambiguus* (Guss.) Schinz & Thell., *Fl. Schweiz*, **1**: 126 (1923)
   J. bufonius L. subsp. *ranarius* (Song. & Perr.) Hiit., *Enum. pl. vasc. Fenn. or.*, p. 22 (1934)
   J. juzepczukii Krech. & Gonch. in Kom., *Fl. U.R.S.S.*, **3**: 625 (1935)
   ? *J. turkestanicus* Krech. & Gonch. in Kom., *Fl. U.R.S.S.*, **3**: 625 (1935)

Annual; culms densely tufted or solitary, erect or ascending from procumbent base, up to 17cm. Leaf-blades dark green, 0·5–1mm wide; stomata 24–36μm. Inflorescence open; branches scorpioid with ultimate 2 or 3 flowers on each close together. Flowers 2–4(–5) per ultimate branch; tepals without dark lines; outer tepals acute, 4·0–6·8mm; inner tepals obtuse or rounded, often emarginate and mucronate, 3·3–5·3mm; capsule truncate, 3·3–5·3mm, equalling or slightly shorter than inner tepals or sometimes longer and equalling outer tepals (0·9–1·1 times as long); anthers usually shorter than filaments (0·5–1·0 times as long). Seeds ovoid or barrel-shaped, 330–440 × 250–350μm; interstices of testa small, *c* 15 × 5μm, or outer integument sometimes lost. $2n = 34$ (30, 32, 60 also reported).

Habitat. *J. ambiguus* is typically a halophyte, occurring on the coast on mud- and sand-flats above the high-water mark and on the margins of saline and brackish lakes. It is also found on bare mud and waste-ground associated with inland salt-flashes and salt-workings and on the highly basic substrate provided by lime-waste tips.

Distribution (Figs 7 and 11). Europe (in suitable habitats over much of the continent, seen by us from Au, Bl, Br, Co, Da, Ga, Ge, Gr, Hb, He, Hs, Hu, Is, It, No, Po, Sa, Si, Su and reliably recorded also from Cz, Ho and Rs); parts of North Africa, Asia and North America (distribution incompletely known). Britain (around most of the coast and in inland saline areas, especially in Cheshire, Staffs. and Worcs., in vice-counties 1, 2, 4, 6, 9, 10, 11, 13, 14, 15, 21, 27, 28, 29, 37, 38, 39, 45, 48, 49, 51, 52, 54, 58, 59, 68, 69, 82, 85, 88, 94, 103, 104, 111); Ireland (around much of the coast, in vice-counties H1, 3, 5, 6, 12, 21, 23, 38, 40); Channel Isles (Guernsey).

This species is frequently known as *J. ranarius* Song. & Perr. and there has been much argument over the correct name for it. Segal (1960) thought that *J. ambiguus* and *J. ranarius* might not be conspecific (see above), and that North American material corresponds to *J. ambiguus* while European material is *J. ranarius*. Fernald & Buchenau (1904), in discussing their var. *halophilus*, cited not only North American material under this name, but German and Sicilian specimens as well. Furthermore, the type locality of *J. ambiguus* is in Sicily. Having seen type material of *J. ambiguus*, *J. ranarius* and *J. bufonius* var. *halophilus* we feel certain that they are conspecific.

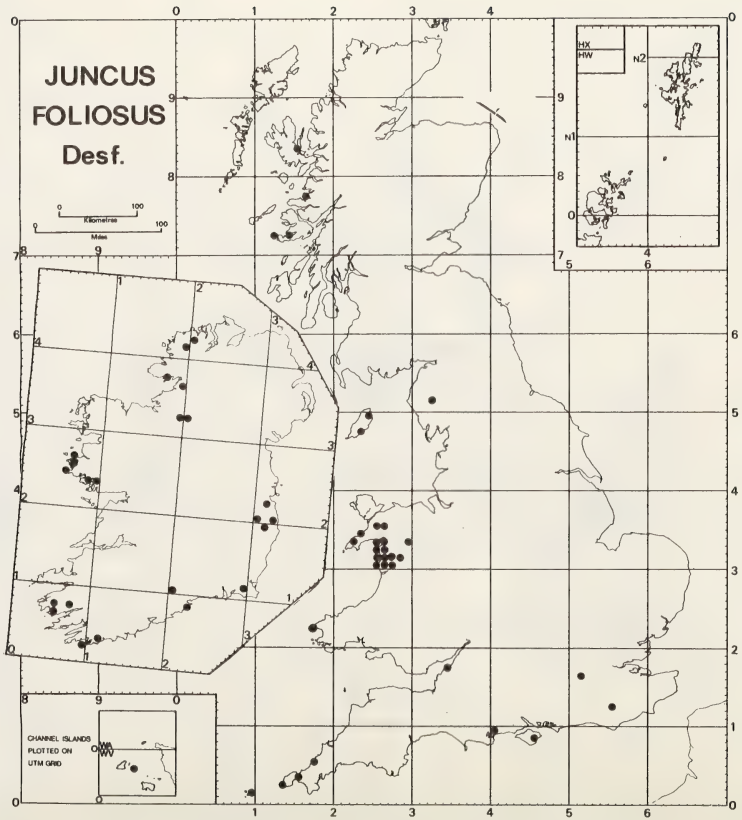
4. J. HYBRIDUS Brot., *Fl. Lusit.*, **1**: 513 (1804); (Fig. 4, Plates ID and 2D)
   Type: 'Circa Conimbricam et alibi in Beira'. Holotype not traced; according to Professor A. Fernandes (pers. comm. 1974) Brotero's herbarium was probably lost at the time of the Napoleonic Peninsular Wars.
   J. mutabilis Savi, *Fl. Pisana*, **1**: 364 (1798), *non* Lam. (1789)
   J. pygmaeus Savi, *Bot. Etrusc.*, **2**: 69 (1815), *non* Rich. (1799)
   J. congestus Schousb. in E. H. F. Meyer, *Syn. Junc.*, p. 40 (1822)
   J. insulanus Viv., *Fl. Cors.*, p. 5 (1824)
   J. fasciculatus Bertol., *Fl. Ital.*, **4**: 190 (1839), *non* Schousb. (1865)
   J. bufonius L. var *fasciculiflorus* Boiss., *Voy. bot. Esp.*, **2**: 624 (1841)
   J. querrioides Pourr. herb. *teste* Willk. & Lange, *Prodr. fl. Hisp.*, **1**: 181 (1861), *nom. nud.*
   J. bufonius L. var. *hybridus* (Brot.) Husnot in *Bull. Soc. bot. Fr.*, **55**: 50 (1908)
   J. bufonius L. subsp. *insulanus* (Viv.) Briq. ex Jah. & Maire, *Cat. pl. Maroc.*, p. 114 (1931)
   ? *J. bufonius* L. subsp. *mogadorensis* H. Lindb. in *Acta Soc. Sci. Fenn.*, n.s., **B1(2)**: 31, t. 11 (1932)

FIGURE 6. Distribution of *Juncus foliosus* Desf., compiled from herbarium material and certain published records.

FIGURE 7. Distribution of *Juncus ambiguus* Guss. (excluding America and Greenland), compiled from herbarium material and certain published records.

FIGURE 8. Distribution of *Juncus hybridus* Brot., compiled from herbarium material and certain published records.

FIGURE 9. Distribution of *Juncus sorrentinii* Parl., compiled from herbarium material and certain published records.



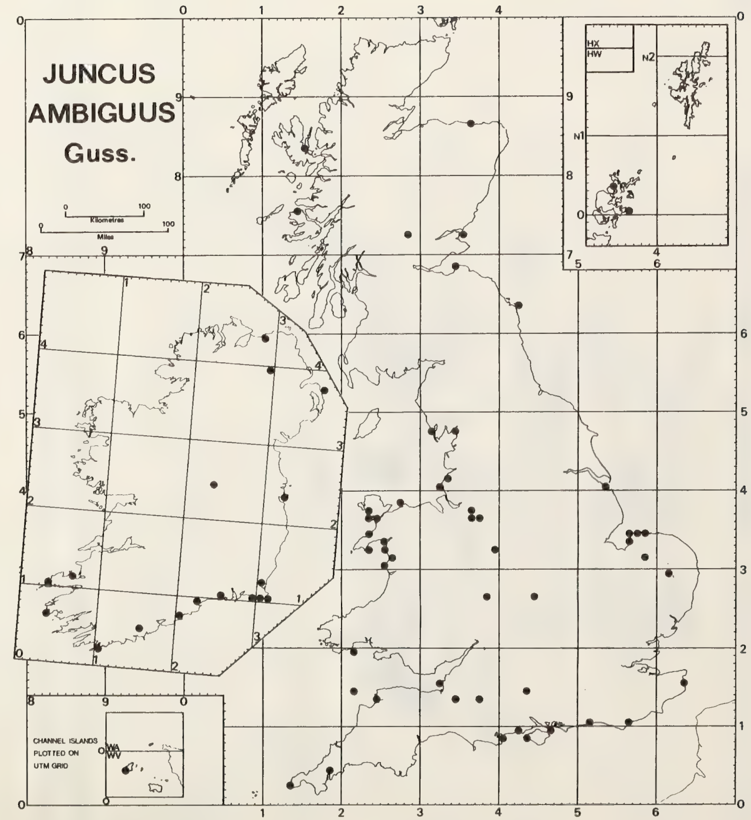


FIGURE 10. Distribution in the British Isles of *Juncus foliosus* Desf., compiled by the Biological Records Centre from data supplied by the authors.

FIGURE 11. Distribution in the British Isles of *Juncus ambiguus* Guss., compiled by the Biological Records Centre from data supplied by the authors.

J. bufonius L. subsp. *eu-bufonius* Briq. ex Jah. & Maire var. *congestus* Maire & Weiller in Maire, *Fl. Afr. nord*, **4**: 265 (1957), *non* Wahlb.

?*J. bufonius* L. subsp. *eu-bufonius* Briq. ex Jah. & Maire var. *mogadorensis* (H. Lindb.) Maire & Weiller in Maire, *Fl. Afr. nord*, **4**: 265 (1957)

J. bicephalus auct. *non* Viv. (1879)

Annual; culms fasciculate, rarely solitary, erect or ascending from slightly procumbent base, up to 31cm. Leaf-blades dark green, 0·5–1mm wide; stomata 25–39μm. Inflorescence contracted, with flowers disposed in open fan-shaped clusters. Flowers 3–6 per ultimate branch and 2–4 branches per cluster; tepals usually without dark lines; outer tepals acute to slightly acuminate, 4·9–7·3mm; inner tepals subacute, very rarely acute or obtuse, 4·0–5·8mm; capsule subacute, very rarely acute or truncate, 3·3–4·9mm, somewhat shorter than inner tepals (0·7–0·9 times as long); anthers longer or shorter than filaments (0·25–2·0 times as long). Seeds ovoid, occasionally barrel-shaped, 280–410 × 190–310μm; interstices of testa small, *c* 15 × 5μm, or outer integument sometimes lost. $2n = 34$.

Habitat. *J. hybridus* is found in similar habitats to *J. bufonius* and *J. ambiguus*.

Distribution (Fig. 8). Circum-Mediterranean; Canary Islands; Azores; Atlantic coast of Europe north to Sables d'Olonne, Vendée, France, Recorded in the British Isles as a casual on two occasions towards the end of last century, once in S. Kerry, v.c. H1, and once in N. Devon, v.c. 4. Also introduced in parts of North America and Australia.

Trimen (*fide* Husnot 1908) suggested that Brotero had mixed two species in his type collection and was describing both *J. hybridus* and *J. pygmaeus* Rich., but his long description, following his diagnosis, does not support this suggestion. Husnot considered that the citation for *J. bicephalus* in the synonymy should read *J. bicephalus sensu* Gren., *non* Viv., as *J. bicephalus* Viv. is conspecific with *J. pygmaeus* Rich. (with which we agree judging from the description of *J. bicephalus* and a sheet at **K** collected and named as such by Viviani). Since we have not been able to trace this interpretation by Grenier, we have cited *J. bicephalus* auct., *non* Viv.

5. J. SORRENTINII Parl., *Fl. Ital.*, **2**: 356 (1857); (Fig. 5, Plates 1E and 2E)

Type: Sicily, Alcamo, Aug. 1853, *Duca da Sorrento* (**FI**, lectotype); Corsica, Portovecchio, May 18-- (date illegible), *Requien* (**FI**, lectoparatype).

J. bufonius L. var. *condensatus* Cout. in *Bolm Soc. broteriana*, **8**: 102 (1890)

J. bufonius L. var. *sorrentinii* (Parl.) Husnot in *Bull. Soc. bot. Fr.*, **55**: 50 (1908)

Annual; culms fasciculate, rarely solitary, erect or ascending from slightly procumbent base, up to 20cm. Leaf-blades dark green, 0·5–1mm wide; stomata 29–42μm. Inflorescence strongly contracted, with flowers disposed in dense fan-shaped heads. Flowers 3–6 per ultimate branch and 4–6 branches per head; tepals without or rarely with weak dark lines; outer tepals acute to long-acuminate or cuspidate, 5·8–8·2mm; inner tepals acute, sometimes subacute, 4·3–6·0mm; capsule variable in shape, 2·9–4·6mm, much shorter than inner tepals (0·65–0·8 times as long); anthers usually shorter than filaments, rarely longer (0·28–1·7 times as long). Seeds ovoid, 320–420 × 220–480μm; interstices of testa small, *c* 15 × 5μm, or outer integument sometimes lost $2n = 28$.

Habitat. In similar situations to *J. hybridus*.

Distribution (Fig. 9). Southern Europe (Corsica, southern Spain, Portugal, Sardinia and Sicily eastward to Greece); North Africa (Morocco); Madeira.

J. sorrentinii is either rare or under-collected and relatively little is known about it. Of the wealth of names to be found in the literature, only Coutinho's var. *condensatus* can be ascribed to the synonymy with any certainty.

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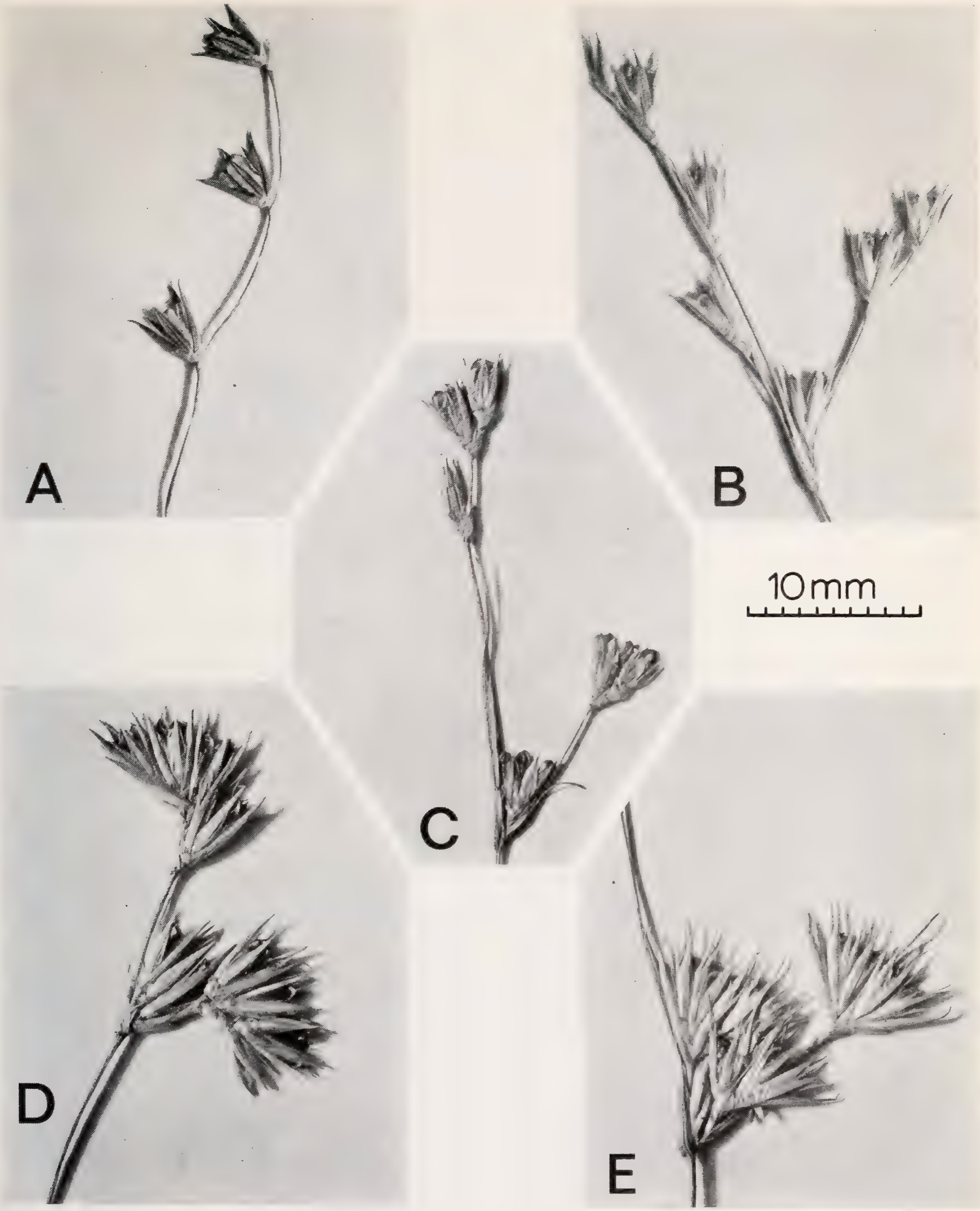

PLATE 1. Portions of inflorescences of A. *Juncus foliosus* Desf., B. *J. bufonius* L., C. *J. ambiguus* Guss., D. *J. hybridus* Brot., E. *J. sorrentinii* Parl.

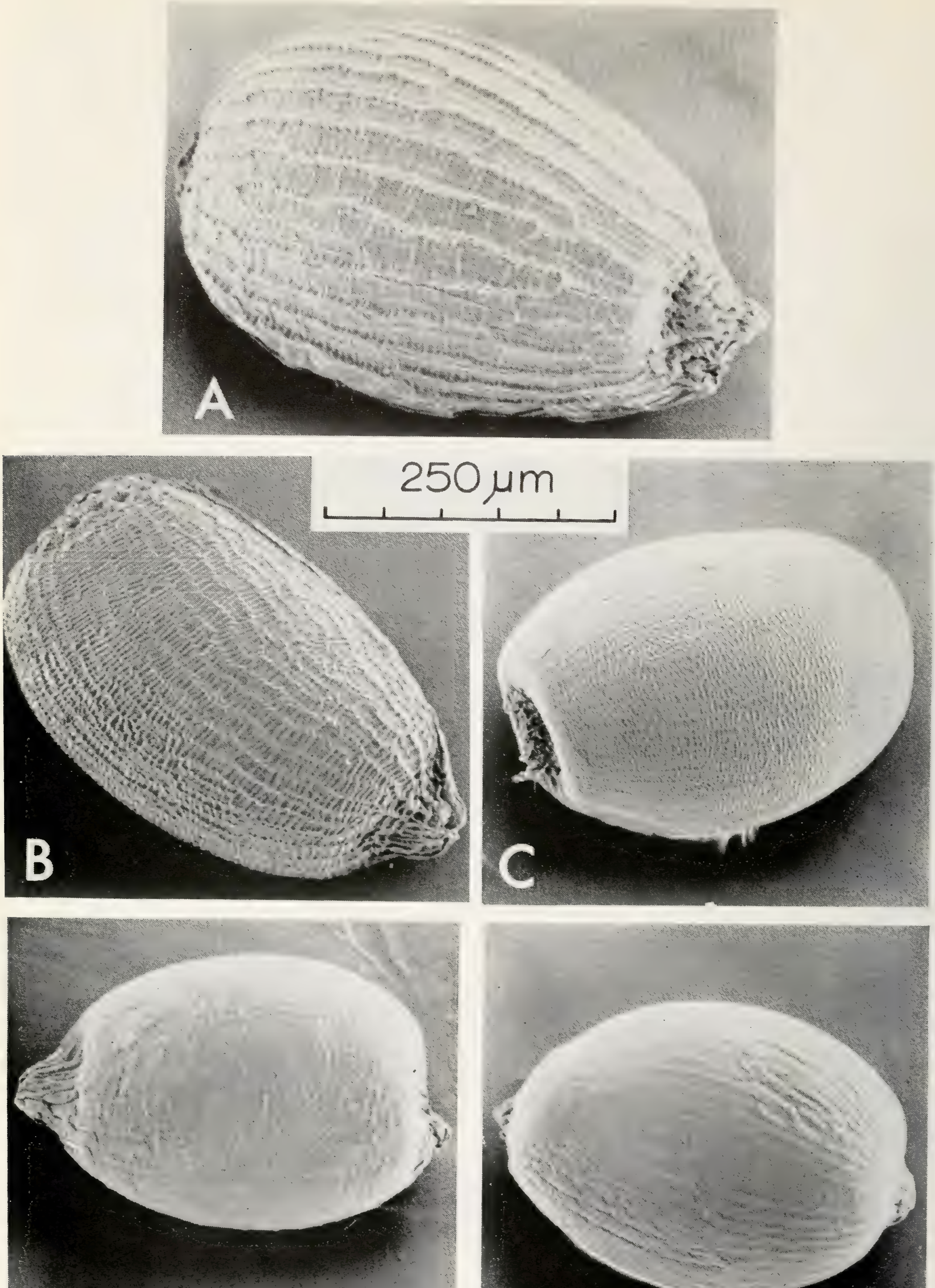

PLATE 2. Scanning electron micrographs of seeds of A. *Juncus foliosus* Desf., B. *J. bufonius* L. C. *J. ambiguus* Guss., D. *J. hybridus* Brot., E. *J. sorrentinii* Parl.

Watsonia, **12**, 129–132 (1978).

Veronica crista-galli Stev. in the British Isles

R. G. B. ROE

Seafin, Charlton Adam, Somerton, Somerset

ABSTRACT

Recent records of *Veronica crista-galli* Stev. in Britain and Ireland are summarized and their possible modes of origin discussed.

INTRODUCTION

Veronica crista-galli Stev. (Fig. 1) is a native of south-western Asia. Its claim to a place in the list of British plants as a naturalized alien (Warburg 1962) rests on its persistence until recently near Henfield, W. Sussex, v.c. 13, since May, 1888, when it was first collected there by T. Hilton (**BM**). It was apparently unknown elsewhere in Europe, and when the site was destroyed by road-works about 1971 it was generally thought to be extinct in Britain (Walters & Webb 1972). The refinding of the plant at Batheaston, N. Somerset, v.c. 6, in 1977 prompted enquiries which have shown, however, that it is established in at least three other areas in the British Isles.

IRISH RECORDS

In May, 1904, R. A. Phillips found the plant in a graveyard near Cork city, Mid Cork, v.c. H4 (**BM**), and in 1906 he reported it as escaped from the Cork Botanic Gardens and naturalized near the city. A second specimen from a roadside near Cork, collected by him and dated 19th May, 1907, is also in **BM**. These records seem to have been lost sight of until 1970 when T. O'Mahony, while checking the distribution of the annual Veronicas in Mid and E. Cork, came across colonies of the plant in two localities near Cork city and one near Dripsey, 12 miles away. The following year he found it near Kinsale, again in Mid Cork, 18 miles from Cork city (O'Mahony & Scannell 1977), and in succeeding years in five more localities, all in Mid Cork, and within a 5 mile radius of the city. In March, 1977, he found a small, apparently recently naturalized, colony on a grassy roadside near Glanmire, E. Cork, v.c. H5. He cannot find any in the remains of the old Botanic Garden which is now within the bounds of a cemetery, possibly the one referred to by Phillips. In May, 1977, Dr H. Heine, on a tour with the International Dendrology Society, saw the plant in abundance near the Kenmare estuary, S. Kerry, v.c. H1. T. O'Mahony (pers. comm. 1977) says the plant is spreading in its Cork city localities, and the latest find indicates that it may already be quite widespread in south-western Ireland.

BRITISH RECORDS

The first record for *Veronica crista-galli* from a hedgebank at Batheaston, N. Somerset, v.c. 6, was made by Lester-Garland (1926) and specimens dated 5th May, and 5th June, 1926, are in **K**. Nine years later Brenan (1935) found a patch about 2 miles away near Bathford, N. Somerset. In 1941, Miss A. E. White, who lived near Bath and made several notable botanical records in the area, entered in her notebook the finding of an unknown Speedwell near Batheaston. On 8th June, 1942, she showed a fresh specimen of *Veronica crista-galli* to R. P. Scase, who was then botanical recorder for the Bath Natural History Society, and said she was sending it to Kew for identification. Her specimen of that date is in **K**, and another collected about the same time in **NMW**, but the record was never published. The plant does not seem to have been noticed again until the 4th May, 1977, when R. D. Randall visited a lane at

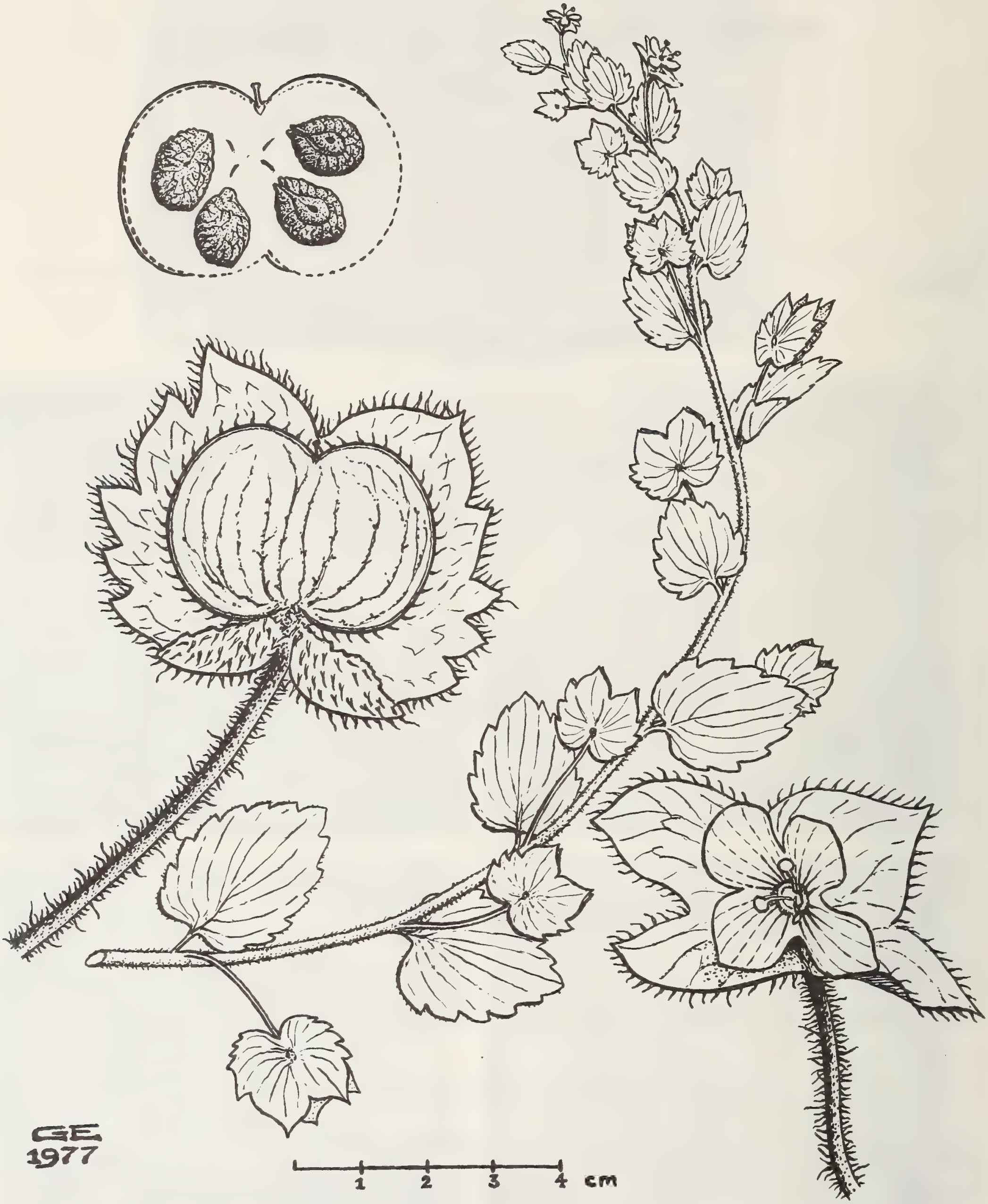

FIGURE 1. Drawing of a specimen of *Veronica crista-galli* Stev. from Batheaston, N. Somerset.

Batheaston to photograph some other alien species there and found the *Veronica* well established on both banks. He later found it in an adjoining lane and in a third about half a mile away. At the suggestion of R. P. Scase I searched a footpath connecting the two sites and found it on both sides in considerable quantity. This footpath skirts the grounds of a large house and it seems very likely that the plant originally escaped from there.

Veronica crista-galli was also found in May, 1975, by Miss M. H. Bigwood on an old rubbish dump near Aberystwyth, Cards., v.c. 46 (**NMW**), and was still thriving there in 1977.

MODE OF INTRODUCTION

Veronica crista-galli is an annual, not altogether unlike *V. persica* Poir. or *V. hederifolia* L. Flowering starts in early spring. The small flowers are evanescent and the capsules and distinctive large calyces, with four segments united in pairs, quickly develop as the stems lengthen. By August the plants have completely died back. In some of the Cork localities a second flowering has been seen in September but, at Batheaston, although abundant young plants had sprung up by November, 1977, none had reached the flowering stage. The typical habitats are banks and verges by roads and pathways, and, in Ireland, woodland margins; only in Kerry has it been reported from cultivated land. The plant seems remarkably persistent in the British Isles once it has established itself. The plentifully produced seeds are well wrapped up in the capsules and persistent calyces so are more adapted to the species consolidating its hold on territory already occupied than to rapid dispersal to new ground. It is hard to explain why it escaped notice for the last 35 years at Batheaston, but it may well have been there in smaller quantity than at present for most of the time. In southern England other annual species have been exceptionally abundant in 1977, presumably due to the hot dry summer of 1976, followed by the copious rain in the autumn.

How the plant became established in these places is a matter of conjecture, but escape from cultivation seems the answer in most instances. It was grown in the Botanic Garden at Cambridge from 1813. A specimen from Cambridge collected in 1863 by C. B. Clarke is in **K**, but there is no evidence to suggest that the plant ever established itself in the wild there. The original Henfield site bordered William Borrer's (1781–1862) garden and it has been presumed that the colony originated from there. That Borrer was particularly interested in the annual Veronicas is evident from his contributing the descriptions of *V. agrestis* L. and *V. persica* Poir. to the supplement to *English Botany* and from remarks by Hooker (1835). However, there is no specimen of *Veronica crista-galli* in Borrer's herbarium at **K**. The Irish populations almost certainly came from the old Cork Botanic Garden. Praeger (1934) commented on the number of introduced plants which have run wild about the city. The house at Batheaston mentioned above was once the home of C. E. Broome (1812–1886), who is perhaps better known as a mycologist but was also a botanist who contributed many records to Babington's supplement to his *Flora Bathoniensis* (1839). It is tempting to suppose that he was responsible for introducing the plant to the area, but it could have been some later occupant of the house. The plants at Aberystwyth may have come in with shoddy in mattress-packing dumped on the tip; in this case it is difficult to think of any other origin and, if this is right, it may appear in other places as a casual. Although apparently extinct at Henfield, the plant may survive somewhere in the area. Seeds from this colony have been cultivated successfully in E. B. Harris's garden at Steyning, Sussex.

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Amendments to the British *Rubus* list

E. S. EDEES

23 Dartmouth Avenue, Newcastle, Staffs.

and

A. NEWTON

11 Kensington Gardens, Hale, Cheshire

ABSTRACT

The revision of the British *Rubus* list requires the publishing of three new combinations (**R. pliocenicus** (W. C. R. Wats.) Edees & Newton, **R. plymensis** (Focke) Edees & Newton and **R. cantianus** (W. C. R. Wats.) Edees & Newton), two new names (**R. curvispinosus** and **R. trelleckensis**) and eight new species (**R. leucandriformis, R. pervalidus, R. brevistaminosus, R. lanaticaulis, R. infestisepalus, R. obscuriflorus, R. angloserpens** and **R. erythrops**).

1. **Rubus leucandriformis** Edees & Newton, **sp. nov.**

R. leucandrus sensu W. R. C. Wats., Handb. Rubi Gt Brit. & Ireland, 70, f. 12 (1958), non Focke in Alpers, Verz. Gefässpfl. Landdr. Stade, 27 (1875)

Frutex robustus, eglandulosus. Turio angulatus subglaber, aculeis nonnullis e basi lata rectis vel declinatis armatus. Folia 5–nata magna viridia imbricata, supra glabra, infra pilosa; foliolum terminale late ovatum, plicatum, basi $\pm$ cordatum, late acuminatum, aequaliter et haud profunde crenatum vel dentatum. Inflorescentia laxa subpyramidata, apice subcorymbosa; ramuli infimi longi acute adscendentes. Rachis pilosa aculeis curvatis numerosis instructa. Sepala reflexa viridia pilosa albomarginata. Flores magni. Petala alba, elliptica vel obovata. Carpella $\pm$ glabra.

HOLOTYPUS: Hengistbury Head, GR 40/16.90, S. Hants., v.c. 11, 26/7/1972, *A. Newton* (**herb. A.N.**)

2. **Rubus pliocenicus** (W. C. R. Wats.) Edees & Newton, **comb. et stat. nov.**

R. egregius var. *pliocenicus* W. C. R. Wats., Lond. Nat., **31**, Suppl.: 98 (1952)

3. **Rubus pervalidus** Edees & Newton, **sp. nov.**

R. atrocaulis sensu W. C. R. Wats., Handb. Rubi Gt Brit. & Ireland, 85 (1958), non P. J. Muell., Pollichia, **16–17**: 163 (1859)

Turio angulatus rufescens, leviter pilosus, glabrescens, aculeis numerosis longis validis patentibus armatus. Folia digitata, foliolis supra subglabris, subtus canescenti-tomentosis, $\pm$ aequaliter serratis; foliolum terminale suborbiculare, breviter acuminatum, basi subcordatum; petiolus aculeis curvatis munitus. Ramus florifer pilosus, aculeis multis longis validis patentibus vel parum declinatis vel curvatis armatus, foliola illis caulis pilosiora ad basin cuneata ferens. Inflorescentia variabilis, nunc apicem versus lata ramulis inferioribus longis, nunc cylindrata pedunculis subaequalibus instructa. Sepala reflexa. Petala obovata, *c* 12×8 mm, rosea. Stamina dilute rosea stylos pallidos vel ad basin rufescentes parum superantia.

HOLOTYPUS: Broad Strood, Epping Forest, GR 51/4.9, S. Essex, v.c. 18, 7/8/1937, *W. C. R. Watson* as *R. atrocaulis* P. J. Muell. (**herb. E. S. Edees** 13095)

4. **Rubus curvispinosus** Edees & Newton, **nom. nov.**

R. curvispinis W. R. C. Wats., Rep. botl Soc. Exch. Club Br. Isl., **9**: 261 (1931), non Foerster, Fl. excurs. Aachen, 96 (1878)

LECTOTYPUS: Christchurch, S. Hants., v.c. 11, 6/8/1893, *E. F. Linton* as *R. dumnoniensis* Bab., Set of British Rubi no. 27 (**CGE**)

5. **Rubus brevistaminosus** Edees & Newton, **sp. nov.**

R. braeuckeri sensu W. C. R. Wats., Handb. Rubi Gt Brit. & Ireland, 105 (1958), non G. Braun, Herb. Rub. Germ. no. 85 (1877)

Turio sulcatus, pilis brevibus sparsim vestitus, pruinosus, glandulis breviter stipitatis rarioribus vel rarissimis munitus, aculeis numerosis declinatis vel curvatis armatus. Folia quinata, foliolis undique viridibus et leviter pilosis, supra glabrescentibus, ±aequaliter serratis; foliolum terminale obovato-oblongum, cuspidato-acuminatum, basi emarginatum vel truncatum; petiolus aculeis multis falcatis munitus. Ramus florifer aculeis valde declinatis curvatis armatus. Inflorescentia laxe pyramidata, inferne ramulis adscendentibus axillaribus aucta, superne e pedunculis pedicellisque patulis composita. Sepala aculeolata, reflexa. Petala obovata, rosea, *c* 8 × 4 mm. Stamina stylis breviora. Carpella tenuiter pilosa. Fructus parvi.

HOLOTYPUS: Between Fairthorn and Kenward, Pembury, GR 51/61.43, W. Kent, v.c. 16, 24/7/1969, *E. S. Edees* 20413 (**herb. E.S.E.**)

6. **Rubus lanaticaulis** Edees & Newton, **sp. nov.**

R. hebecaulis sensu W. C. R. Wats., Handb. Rubi Gt Brit. & Ireland, 112, f. 25 (1958), non Sudre, Bull. Assoc. Fr. Bot., **3**: 101 (1900)

Turio purpuratus pilosus eglandulosus obtusangulus striatus, aculeis moderatis haud numerosis plerumque declinatis armatus. Folia 3–5–nata subpedata, foliolis haud imbricatis, supra strigosis, infra pilosis, ad nervos praesertim pectinatis; foliolum terminale cuspidatum, ellipticum vel obovatum, basi emarginatum, haud profunde serratum. Inflorescentia magna longa thyrsoidea pyramidata; ramuli infimi paniculati multiflori, medii subpatentes cymosi. Rachis vix flexuosa, supra dense villosa tomentosa, glandulis paucis brevibus aculeis declinatis vel curvatis numerosis instructa. Sepala griseoviridia tomentosa, villosa, longe attenuata, fructum laxe amplectentia. Petala rosea, elliptica vel obovata, pilosa. Stamina stylos vix superantia. Carpella leviter pubescentia.

HOLOTYPUS: Banks of River Ogwen, near Bethesda, Caerns., v.c. 49, 27/9/1895, *C. Bailey* (**MANCH**)

7. **Rubus plymensis** (Focke) Edees & Newton, **comb. et stat. nov.**

R. egregius var. *plymensis* Focke, Bibl. Bot., **83**: 183 (1914)

LECTOTYPUS: near Plymouth, Devon, v.c. 3, 1872, *T. R. A. Briggs* no. 60 as *R. borreri* Bell Salt. forma (**BREM**). Isotypus in **CGE**

8. **Rubus infestisepalus** Edees & Newton, **sp. nov.**

R. macrothyrsus sensu W. C. R. Wats., Handb. Rubi Gt Brit. & Ireland, 119 (1958), non Lange, Icon. Pl. Fl. Dan., **48**: 6 (1870)

Turio angulatus purpurascens, pilis brevibus dense vestitus, aciculis glandulisque stipitatis brevibus sparsim praeditus, aculeis numerosis, e basi lata rectis vel declinatis, nonnunquam diametro caulis longioribus armatus. Folia digitata, foliolis supra subglabris, subtus albotomentosis ad nervos pilosis, inaequaliter serratis; foliolum terminale parvum, *c* 5 × 4 cm, obovato-suborbiculare, cuspidatum, basi subintegrum; petiolus aculeis curvatis munitus. Inflorescentia late elongata; ramus florifer et ramuli villosi, glandulis stipitatis paucis vel interdum multis pilos aequantibus vel eis brevioribus muniti, aculeis numerosis longis curvatis purpureis armati. Sepala patentia, conspicue aculeolata. Petala lata, *c* 12 × 9 mm, incurva rosea. Stamina stylos vix superantia. Carpella pilosa.

HOLOTYPUS: Chislehurst Common, GR 51/44.70, W. Kent, v.c. 16, 12/7/1964, *E. S. Edees* 18670 (**herb. E.S.E.**)

9. **Rubus trelleckensis** Edees & Newton, **nom. nov.**

R. orthocladus A. Ley, J. Bot., Lond., **34**: 159 (1896), non Boulay, Ronces Vosg., 242 (1869)

LECTOTYPUS: Beacon Hill, Monmouth, v.c. 35, 4/7/1893, *A. Ley* as *R. myricae* var. *virescens* G. Braun, Set of British Rubi no. 60 (**MANCH**)

10. **Rubus cantianus** (W. C. R. Wats.) Edees & Newton, **comb. et stat. nov.**

R. radula var. *cantiana* W. R. C. Wats., Rep. botl Soc. Exch. Club Br. Isl., **9**: 768 (1932)

LECTOTYPUS: Barnet Wood Lane, Hayes, W. Kent, v.c. 16, 3/9/1928, *W. C. R. Watson* as *R. prionodontus* Muell. & Lefèv. (**K**)

11. **Rubus obscuriflorus** Edees & Newton, **sp. nov.**

R. minutiflorus sensu W. M. Rogers, Handb. Brit. Rubi, 89 (1900), ex parte, non P. J. Muell., Pollichia, **16-17**: 235 (1859)

Turio obtuse angulatus, rufescens, pruinosus, pilis simplicibus, 1–2 mm longis, aciculis glandulisque stipitatis, 0·5–2 mm longis, copiose instructus, aculeis numerosis brevibus gracilibus declinatis armatus. Folia digitata ampla, foliolis undique sparsim pilosis, supra glabrescentibus, $\pm$aequaliter sed haud profunde serratis; foliolum terminale oblongum, *c* 13 × 8 cm, acuminatum, basi emarginatum; petiolus aculeis tenuibus, patentibus vel paulo declinatis armatus. Ramus florifer rufescens, turioni similiter vestitus armatusque. Inflorescentia subracemosa vel corymbosa, e ramulis inferioribus axillaribus paucifloris superioribus plerumque unifloris nonnunquam 2–3–floris composita. Sepala aculeolata, dense glandulosa, longe attenuata, patentia vel erecta. Petala parva, elliptica, alba. Stamina stylos vix superantia.

HOLOTYPUS: Seckley Wood, GR 32/76.77, Staffs., v.c. 39, 26/7/1954, *E. S. Edees* 10975 (**herb. E.S.E.**)

12. **Rubus angloserpens** Edees & Newton, **sp. nov.**

R. curtiglandulosus sensu W. C. R. Wats., Handb. Rubi Gt Brit. & Ireland, 152 (1958), non Sudre, Bull. Assoc. Fr. Bot., **4**: ? (1901) & Excurs. Batol. Pyr., 173 (1901)

Turio obtuse angulatus vel teretiusculus, pruinosus, pilis brevibus parce vestitus, aciculis glandulisque stipitatis brevibus dense obsitus, aculeis numerosis e basi lata subulatis brevibus armatus. Folia ternata vel interdum quinata, foliolis undique viridibus et sparsim pilosis, grosse biserratis; foliolum terminale ovatum, *c* 12–15 × 6–8 cm, sensim acuminatum, basi subcordatum, petiolulo proprio quadruplo vel quintuplo longius; petiolus aculeis multis brevibus tenuibus $\pm$ patentibus munitus. Ramus florifer dense pilosus aciculis glandulisque breviter stipitatis copiose praeditus, turioni similiter armatus. Inflorescentia diffusa foliosa, e ramulis inferioribus racemoso-paucifloris superioribus plerumque unifloris composita, pedicellis summis usque ad 3 cm longis patulis. Sepala aculeolata glandulosa albomarginata, longe attenuata, patentia vel amplectentia. Petala parva, elliptica, alba. Stamina stylos vix superantia.

HOLOTYPUS: Stanford-on-Teme, GR 32/69.65, Worcs., v.c. 37, 31/7/1964, *E. S. Edees* 18596 (**herb. E.S.E.**)

13. **Rubus erythrops** Edees & Newton, **sp. nov.**

R. rosaceus sensu W. C. R. Wats., Rep. botl Soc. Exch. Club Br. Isl., **8**: 862 et fig. (1929), Handb. Rubi Gt Brit. & Ireland, 178 (1958), non Weihe & Nees in Bluff & Fingerh., Comp. Fl. Germ., **1**: 685 (1825)

R. viridis sensu W. M. Rogers, Handb. Brit. Rubi, 85 (1900), non C. Presl ex Ortmann in Flora (Regensb.), **18**: 488 (1835), nec Kaltenb., Fl. Aachen. Beck., **2**: 284 (1845)

R. leptadenes var. *calliphylloides* (Sudre) Sudre, Rubi Eur., 220 (1913), quoad loc. angl.

Turio atrorufescens vel purpurascens, obtusangulus, leviter pilosus, glandulis stipitatis subaequalibus numerosis, aciculis tenuibus numerosis, nonnullis glanduliferis, aculeis brevibus tenuibus declinatis vel falcatis armatus. Folia 3–5–nata pedata, foliolis ± imbricatis, supra strigosis, infra leviter pilosis; foliolum terminale anguste vel late rotundo-obovatum, basi subcordatum, aequaliter serratum. Inflorescentia longa pyramidata apice congesta; ramuli infimi subracemosi vel paniculati, multiflori subpatentes, medii et supremi subcymosi patuli, breviter pedunculati, brevissime pedicellati. Rachis flexuosa, supra dense pilosa glandulis brevibus numerosis, aciculis tenuibus, aculeis tenuibus brevibus rectis declinatis vel curvatis instructa. Sepala attenuata, griseotomentosa, pallide marginata, pilosa, glandulifera, aciculis tenuissimis praedita, primo reflexa denique fructum amplectentia. Flores medii. Petala pallide rosea. Stamina vix stylos pallide roseos superantia. Carpella pilosa.

HOLOTYPUS: Witley, Surrey, v.c. 17, 17/8/1892, *E. F. Linton* as *R. viridis* Kalt., Set of British Rubi no. 23 (**MANCH**)

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Watsonia, **12**, 137–143 (1978).

Change and stability of clines in *Spergula arvensis* L. (corn spurrey) after 20 years

J. K. NEW

Department of Biology, Cambridgeshire College of Arts and Technology, Cambridge

ABSTRACT

Work in the mid-1950s established that there are genetically distinct morphs of *Spergula arvensis* L. which show clines in their distribution in the British Isles. The morphs differ in the nature of the seedcoat (presence or absence of papillae) and in the glandular hairiness of the stems and leaves. Recent work has been undertaken to determine whether the clines are stable. After 20 years the distribution of the seedcoat morphs is generally the same, though there are four local changes. The cline of the hairiness morphs has, however, shown a general and significant change in position to the S.S.E.. Possible explanations are discussed.

INTRODUCTION

There have been very few long-term studies of the distribution of polymorphisms in plant species. Ellis, Keymer & Jones (1977) have, however, shown that a maritime population of *Lotus corniculatus* L. possesses a cline which has been stable for 16 years.

My earlier work (New 1958, 1959) demonstrated that there are genetically different morphs of *Spergula arvensis* L. which show north-north-west to south-south-east clines in their geographical distribution. *S. arvensis* is a largely self-fertilized annual weed of arable land, of widespread occurrence except on soils of a high pH (New 1961). The different morphs have (1a) a large number of papillae on the seedcoat—more common in the south and east, (1b) no papillae on the seedcoat—more common in the north and west, (2a) stems and leaves with rather few glandular hairs—more common in the south and east, and (2b) stems and leaves with dense glandular hairs—more common in the north and west. There is no genetic linkage between the seedcoat character and the hairiness character. Though the characters may be experimentally modified by extreme environments during growth, this fact in no way explains the clines, rather the reverse (at high temperatures there is a small *reduction* in the number of papillae on genetically papillate seeds and under low light intensities and low temperatures hairiness is *reduced*). Plants with a small number of papillae on their seedcoats are found occasionally and are known to be heterozygotes. Experiments showed that temperature during germination and growth affect the morphs differently, but that these are not the only selective factors (New 1958).

The seeds of *S. arvensis* are capable of surviving for 50 years in undisturbed soil (Chippindale & Milton 1934). Even in regularly cultivated soil there is a considerable reservoir of seeds (see Discussion for estimates) which will have survived for varying numbers of years. For this reason differences between two successive years in the relative frequencies of the morphs may not be readily detectable, whereas cumulative changes over many years may be. The main aim of the present work has been to establish whether the clines were stable or evolving after 20 years.

METHODS

Sampling and scoring techniques were the same as for the former survey (New 1958). Wherever possible, several fields in each locality were sampled by examining single plants with a hand-lens at 5 m intervals round the edges of fields and scoring them for seedcoat and hairiness characters. Plants were scored as papillate if they had all seeds with greater than 120 papillae per seed, non-papillate if they had no papillae on any seed, and intermediate if they had a small and variable number (0–80) of papillae on

TABLE 1. COMPARISONS OF THE 1955/56 AND 1975/76 LOCALITY TOTALS OF PAPILLATE AND NON-PAPILLATE SEEDCOAT MORPHS

Vice-County[4]	Altitude (m)	Numbers of plants[3] 1955/56 pap.	1955/56 non-pap.	1975/76 pap.	1975/76 non-pap.	Proportion of papillate genes 1955/56	1975/76
17, Surrey	150	172	272	42·5	59·5	0·38	0·42
3, S. Devon	300	15	1	14	6	0·94	0·70
4, N. Devon	60	201	27	136·5	13·5	0·88	0·91
36, Hereford	200	39	150	15·5	58·5	0·21	0·21
40, Salop (a)	180	36	156	17·5	40·5	0·19	0·30
40, Salop (b)	400	23·5	217·5	8·5	126·5	0·10	0·06
57, Derbys. (a)	260	43	29	37	44	0·60	0·46
57, Derbys. (b)	300	37	62	18	91	0·37	0·17[1]
48, Merioneth	130	65	178	4	26	0·27	0·13
58, Cheshire	30	131·5	420·5	29	170	0·24	0·15[1]
69, Westmorland	200	40·5	179·5	0	226	0·18	0[1]
73, Kirkcudbright (a)	20	11	104	9	77	0·10	0·11
73, Kirkcudbright (b)	150	11	117	10	110	0·09	0·08
74, Wigtown	15	32·5	187·5	10	43	0·15	0·19
88, Mid Perth	60	49·5	119·5	53·5	45·5	0·29	0·54[2]
90, Forfar	10	1	65	2	46	0·02	0·04
107, E. Sutherland	10	0	78	0	83	0	0
109, Caithness	10	2	203	0	157	0·01	0

[1] Difference between 1955/56 and 1975 significant at the $p=0·05$ level
[2] Significant at the $p=0·01$ level
[3] Intermediate phenotypes were classed as 0·5 papillate and 0·5 non-papillate as they are known to be heterozygous—there was a total of 11 intermediates in 1975/76
[4] Localities are in order of increasing distance north-north-east from Dover (E. Kent)

different seeds of the same plant. Plants were scored as densely hairy if they had more than 20 hairs per 1·5 cm as seen in silhouette on the lowest stem internode, and medium hairy if they had less. Most plants have about 40 or about 5 hairs per 1·5 cm (New 1959).

The same localities (except those in Northern Ireland) and the same fields were revisited. Where fields were now grass rather than arable, adjacent or nearest fields were sampled. Except for North and South Devon, which were visited in 1976, the sampling was done in 1975 and was therefore not influenced by the exceptionally hot dry summer of 1976.

RESULTS

The investigation was concerned with relative frequencies of the morphs rather than population sizes. However, it might be mentioned that there was some decrease in the abundance of the species after 20 years, presumably due to changes in farming practice such as raising the soil pH and the use of weedkillers. No individuals could be found in the Essex locality. In Merioneth the sample was small because of the very much reduced arable farming in this area. In many localities the species was still abundant. The data for the two altitudes in Salop and in Derbys. presented in Tables 1 and 2 have been added in Figs. 1 and 2.

i) Seedcoat morphs

There has been no general change in the distribution of the seedcoat morphs (Table 1, Fig. 1), though there has been a significant decrease in the proportion of papillate-seeded plants in three localities, Cheshire, Derbys. (b) and Westmorland (t-test on angularly transformed proportions for several fields

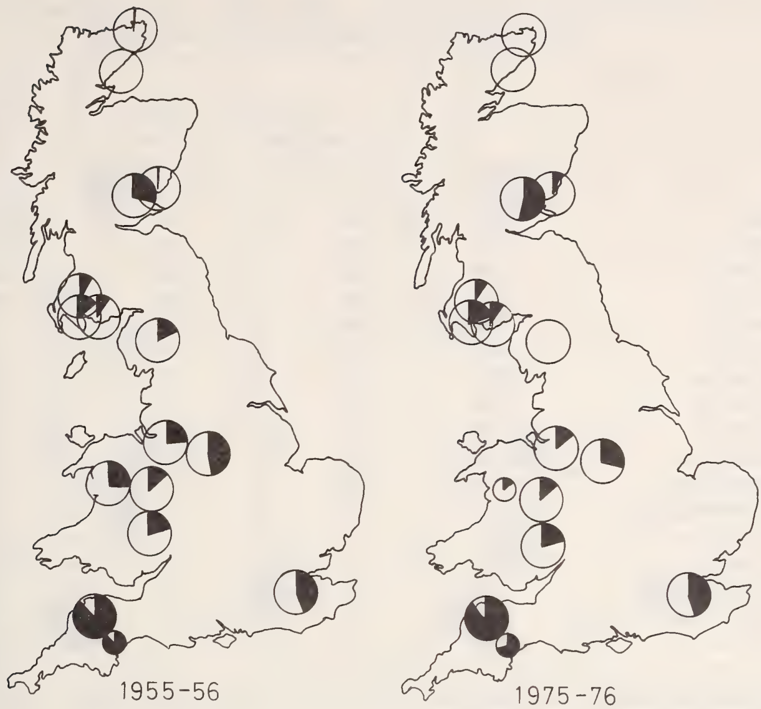

FIGURE 1. Maps showing the proportions of papillate and non-papillate seedcoat morphs in 1955/56 and 1975/76. Black segments = proportion of papillate; white segments = proportion of non-papillate; large circles = 50 or more plants; small circles = 16 to 49 plants.

in a locality, $p<0{\cdot}05$ in each of the three localities), and an increase in one locality, Mid Perth ($p<0{\cdot}001$).

The inheritance of the seedcoat character is known to be determined by a single major gene without dominance (New 1959). The phenotype frequencies may therefore be directly converted to gene frequencies, as in the last column of Table 1.

ii) Hairiness morphs

In contrast to the results for the seedcoat morphs, there has been a general and significant change ($p<0{\cdot}01$, paired t-test on transformed locality proportions) in the distribution of the hairiness morphs (Table 2, Fig. 2). There has been a general increase in the relative frequency of densely-hairy plants (in 14 out of 17 localities) and a south-south-east shift in the cline of 60 km in the north and 150 km in the south (determined from the horizontal distance between regression lines, Fig. 3). None of the three local decreases in the relative frequency of dense-hairiness (Cheshire, Derbys. and Caithness) are statistically significant (t-test on angularly transformed proportions for several fields in a locality).

The results for the Mid Perth locality are exceptional in both surveys, although they were included in the calculation of the regression lines.

The earlier studies of the inheritance of hairiness showed that the cline in phenotype frequencies is closely paralleled by a cline in gene frequencies (New 1959), though it cannot be converted to gene frequencies by a simple procedure.

DISCUSSION

The fact that the general distribution of the seedcoat morphs is the same after 20 years indicates that there has been no general change in the selection forces which determine the distribution. Local changes in relative frequencies may be due to a) local changes in selection forces, though it would be

TABLE 2. COMPARISONS OF THE 1955/56 AND THE 1975/76 LOCALITY TOTALS OF MEDIUM AND DENSELY HAIRY MORPHS

Vice-County	Altitude (m)	Numbers of plants 1955/56 medium	1955/56 dense	1975/76 medium	1975/76 dense	Proportion of densely-hairy plants 1955/56	1975/76
17, Surrey	150	236	4	96	6	0·02	0·06
3, S. Devon	300	16	0	18	2	0	0·10
4, N. Devon	60	222	6	140	10	0·03	0·06
36, Hereford	200	136	13	61	13	0·09	0·18
40, Salop (a)	180	190	0	53	5	0	0·09
40, Salop (b)	400	223	18	43	92	0·07	0·68
57, Derbys. (a)	260	51	21	47	34	0·29	0·42
57, Derbys. (b)	300	43	38	59	50	0·47	0·46
48, Merioneth	130	107	136	6	24	0·56	0·80
58, Cheshire	30	394	136	162	37	0·26	0·19
69, Westmorland	200	162	38	7	219	0·19	0·97
73, Kirkcudbright (a)	20	24	91	4	82	0·79	0·95
73, Kirkcudbright (b)	150	12	106	2	118	0·90	0·98
74, Wigtown	15	53	124	10	43	0·70	0·81
88, Mid Perth	60	254	5	63	36	0·02	0·36
107, E. Sutherland	10	0	35	0	83	1·00	1·00
109, Caithness	10	3	199	3	154	0·99	0·98

Note. No data for hairiness had been collected for the Forfar locality in 1955/56 and therefore this locality is omitted from Table 2 and Fig. 2.

difficult to find evidence for these; or b) the local spread of modifier genes or gene combinations which affect the relative fitness of the forms (Clarke 1966). It is unlikely that the local changes are due to random drift, since the severe reductions in population size necessary will rarely occur because of the large reservoirs of buried seed. Various estimates of the size of populations of buried seed are: (a) in arable soil—$4{\cdot}9 \times 10^6 ha^{-1}$ (my recent estimate), $3{\cdot}8 \times 10^6 ha^{-1}$ (Champness & Morris 1948), $22{\cdot}69 \times 10^6 ha^{-1}$ (Roberts 1958); (b) soil under a 1-yr-old grass ley—$19{\cdot}8 \times 10^6 ha^{-1}$ (New 1957); (c) soil under a 10-yr-old grass ley—$1{\cdot}2 \times 10^6 ha^{-1}$ (New 1957).

There are two main possible explanations of the change in distribution of the hairiness character: migration (of either major genes or modifiers) and changes in selection agents. Short-distance migration of seeds occurs in the mud on farm implements mainly between fields on one farm, and can be neglected. Short-distance movement of pollen in this largely self-fertilized species may also be neglected. Long-distance migration occurs when *S. arvensis* seeds are contaminants of agricultural seed and also via the mud on birds' feet. Using published figures on the occurrence of *S. arvensis* in cereal seed (Tonkin 1968, Tonkin & Phillipson 1973) it can be estimated that contaminants could account for up to 3·5 immigrants $ha^{-1}yr^{-1}$. I know of no data for the numbers of seeds carried on birds feet but the numbers are likely to be very low, perhaps of the same order. Therefore, immigrants as a proportion of the population already occupying the area (as buried seed) are estimated as 10^{-5} to 10^{-6}, of the same order of mutation and totally inadequate to account for the observed changes. This leaves selection to be considered.

Over the past 20 years there has been a great increase in the agricultural use of weedkillers and it is possible that dense glandular hairs might give some protection against weedkillers. However, observations on two fields treated with weedkiller (with very small and yellowing *S. arvensis* plants) showed that medium and densely hairy plants were equally affected.

Protection against insect attack is a possible role of the glandular hairs (Levin 1973). Several insect enemies of *S. arvensis* are known but whether these differentiate between the morphs has not yet been determined. In general, the increased use of insecticides might have been expected to reduce selection pressures from insects rather than increase them.

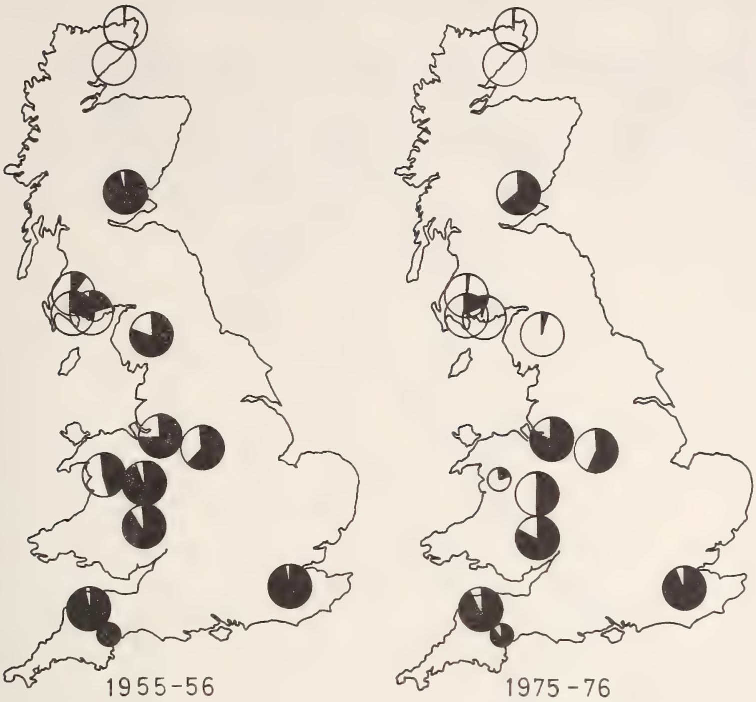

FIGURE 2. Maps showing the proportion of medium-hairy and densely-hairy morphs in 1955/56 and 1975/76. Black segments = proportion of medium-hairy; white segments = proportion of densely-hairy; large circles = 50 or more plants; small circles = 16 to 49 plants.

Perhaps the most plausible explanation of the distribution shift is that of climate change. Some effect of summer temperature on the fertility of *S. arvensis* plants was established in earlier experiments (New 1958). Over the past 20 years the general North Atlantic climate is known to have cooled by 0·6°C (Lamb 1974). Manley (1974) has published detailed figures for central England showing that summer temperature (10-year running means) declined 0·5°C between 1956 and 1973. Such a change leads to a shift of summer temperature isotherms of the order of 100 km to the south-south-east and would seem to offer an explanation of the change in the hairiness cline. Ford (1977) states that there has been a general southward contraction of the ranges of many animal species since the 1940s and that the cooling trend has also resulted in the return of some northern species to the British Isles. No such information is available for plant species.

It was seen in Fig. 3 that the Mid Perth results do not fall on the cline; it is therefore of interest that this region has a climate with exceptionally warm summers for its latitude. The fact that the distribution of the hairiness morphs has moved south whereas the distribution of the seedcoat morphs has not could be explained on the basis that the former character is more sensitive to small temperature changes.

ACKNOWLEDGMENTS

I am very grateful to Dr R. J. Adams, Dr M. J. Ford, Mr R. J. Hartley and Dr C. E. Quartley for their specialist help and comments.

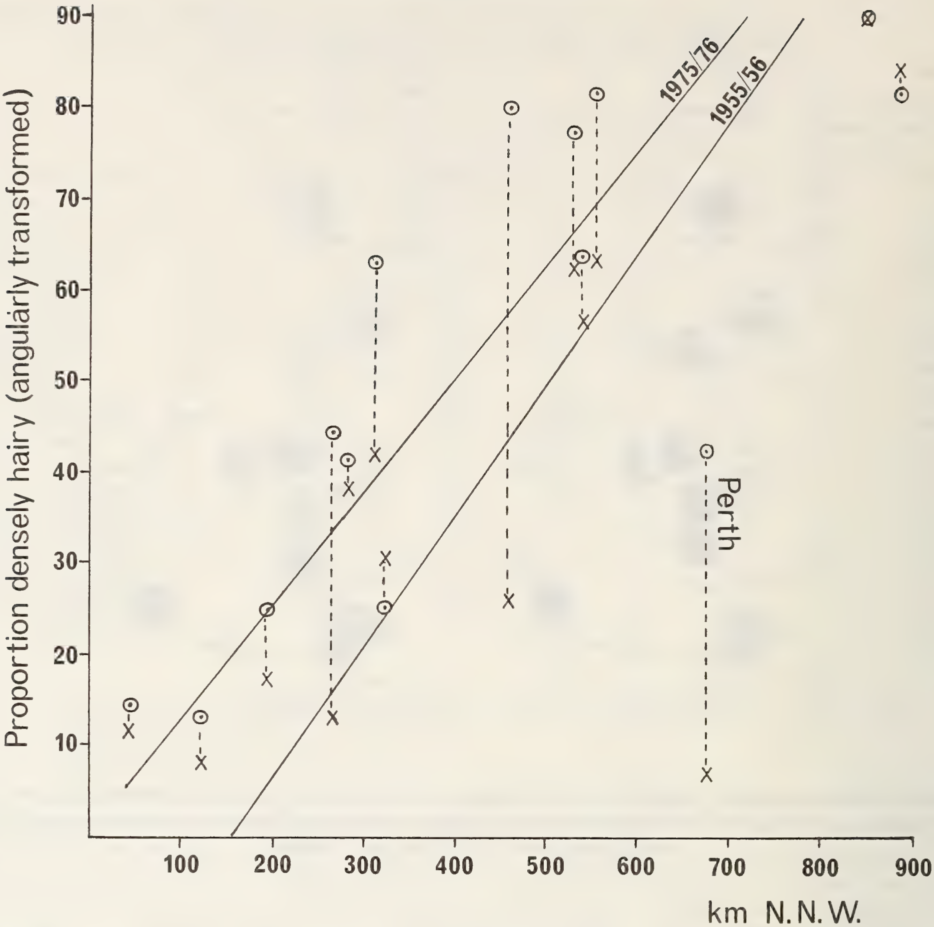

FIGURE 3. Proportions (angularly transformed, 90° = 1) of densely hairy morphs plotted against distance north-north-west from Dover, E. Kent. X = 1955/56 survey; ⊙ = 1975/76 survey; the unbroken lines are calculated regression lines (X on Y); broken lines join 1955/56 and 1975/76 observations for a locality.

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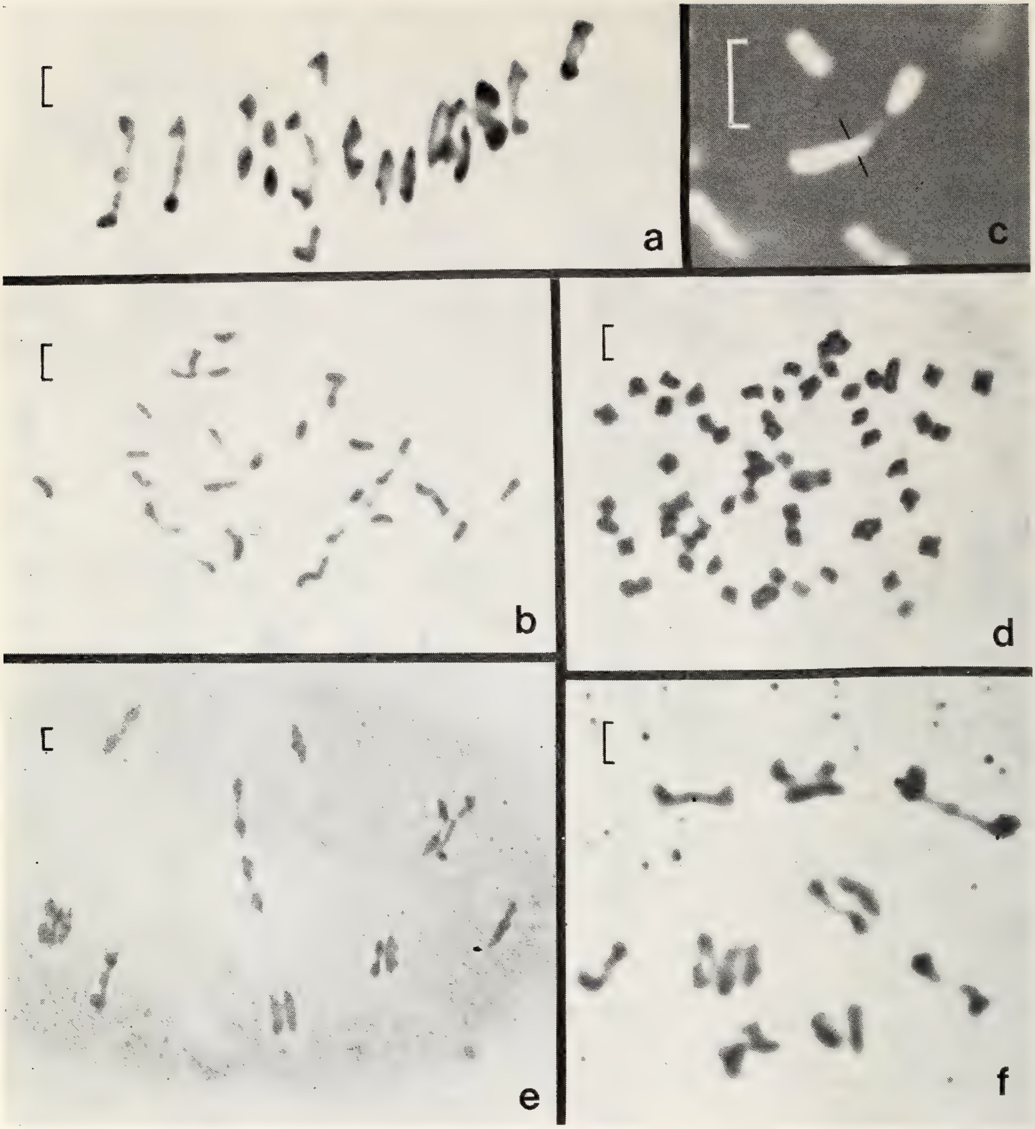

PLATE 3. Photographs of chromosomes of *Ononis* spp. (a) *O. spinosa*, $n = 15$ at metaphase I of meiosis in PMC of plant 0-3-3. (b) *O. spinosa*, $2n = 30$ in root tips of plant 0-184-3 (see interpretative drawing in Fig. 1A). (c) One L-chromosome from central part of Plate 3b, showing faint-staining secondary constriction; compare sizes of satellite and small metacentric chromosome nearby; dark lines show position of centromere (anoptral phase contrast). (d) *O. repens*, $2n = 60$ in root tips of plant 0-10-6 (see interpretative drawing in Fig. 2A). (e) *O. arvensis*, $n = 15$ at metaphase I of meiosis in PMC of plant 0-43-6. (f) *O. masquillieri*, $n = 15$ in plant 0-142. In (e) and (f), some bivalents show sticky associations. Scales = 2μm.

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Chromosome numbers in *Ononis* L. series *Vulgares* Širj.

P. MORISSET

Département de biologie, Université Laval, Québec, Canada

ABSTRACT

Chromosome numbers have been counted in root tips and pollen mother cells of 43 plants of *Ononis spinosa* L. subsp. *spinosa* (from Britain, France, Sweden and Czechoslovakia), 21 of *O. repens* L. (from Britain, Ireland, Sweden and E. Germany), six of *O. arvensis* L. (from Hungary, Poland and Latvia), and one of *O. masquillieri* Bertol. (from Italy). *O. spinosa, O. arvensis*, and *O. masquillieri* were all diploid with $2n = 30$,, whereas *O. repens* was tetraploid with $2n = 60$. There was probably some aneuploidy in *O. repens* ($2n$ = *c*59, *c*61, *c*64). *O. spinosa* has one pair of large chromosomes with a long, proximal secondary constriction isolating a large satellite; confusion of the latter with whole chromosomes would account for the published records of $2n=32$ for this species. Similar confusions have also occurred for *O. repens* and, probably, *O. arvensis*. The basic number in *Ononis* series *Vulgares* is believed to be $x = 15$.

INTRODUCTION

Four species are included in *Ononis* L. series *Vulgares* Širj. (Leguminosae): *O. spinosa* L., *O. repens* L., *O. arvensis* L. (*O. hircina* Jacq.), and the Italian endemic *O. masquillieri* Bertol. (Širjaev 1932). *O. spinosa* has been subdivided by Širjaev (1932, 1940) into four, mostly allopatric, subspecies: subsp.

TABLE 1. PREVIOUSLY PUBLISHED CHROMOSOME NUMBERS IN *ONONIS* SERIES *VULGARES*

	n	$2n$	References
O. spinosa		20	Strid (1971)
		30	Gadella & Kliphuis (1968, 1970, 1971), Gadella *et al.*(1970)
		32 (30)	Tschechow (1933)
		32	Morton (1956), Palková (1959), Endtmann (1964), Morisset (1964), Gadella & Kliphuis (1966, 1968)
		60	Sañudo *et al.* (1976)
		64	Fernandes & Santos (1971, 1975)
O. repens		30	Larsen (1956)
	16		Reese (1952)
		32	Weimarck (1963), Sañudo *et al.* (1976)
	30		Lepper (1970)
		60	Larsen (1956), Weimarck (1963), Gadella & Kliphuis (1967, 1970), Lepper (1970)
		64	Morton (1956), Morisset (1964), Sañudo *et al.* (1976)
O. arvensis		24	Chuxanova (1967)
		30	Gadella *et al.* (1970)
		32 (30)	Tschechow (1933)
		32	Kuzmanov & Markova (1973)
	16		Llane (1969)
	30		Senn (1938)

TABLE 2. CHROMOSOME NUMBERS OF *ONONIS* SERIES *VULGARES* DETERMINED IN THE PRESENT STUDY

Locality, map-reference and collector[1]	Code numbers	n	$2n$[2]
O. spinosa			
Abandoned chalk pit, Toot Hill, Orwell, Cambs., v.c. 29, 52/364.506 (s)	0–1–16, 0–3–3, 0–3–7, 0–3–8	15	
Idem (c)	0–140–2, 0–140–6	15	
Idem (c)	0–140–1, 0–184–3		30
Idem (s)	0–1–13		30
Idem (s)	0–1–3, 0–1–15, 0–3–2		$2x$
Idem, C. D. Pigott (s)	0–9		30
Idem, J. W. Wilson (s)	0–34–3		30
Idem, J. W. Wilson (s)	0–34–2, 0–34–5, 0–34–6		$2x$
Fox Hill, Orwell, Cambs., 52/366.513 to 367.514 (s)	0–22–2, 0–27–2, 0–27–4		$2x$
Quy Fen, Stow cum Quy, Cambs., 52/515.627 (s)	0–17–7, 0–18–7	15	
Idem (s)	0–17–1, 0–18–2, 0–18–9		$2x$
Idem (c)	0–37–5	15	
Idem (c)	0–37–4, 0–37–10		30
Idem (c)	0–37–11		$2x$
Chippenham Fen, Chippenham, Cambs., 52/646.698 (c)	0–41A–1, 0–41B–1		30
Idem (c)	0–41C–1		$2x$
Idem, 52/644.697 (c)	0–42C–2	15	
Idem (c)	0–42B–3		30
East of Abingdon, Berks., v.c. 22, 41/512.980 (c)	0–62–1		45
Marsden, Durham, v.c. 66, 45/397.656 (f)	0–187–1, 0–187–10	15	
Near Nantes, Loire Inférieure, France (e)	0–47–9		30
Idem (e)	0–47–1, 0–47–6		$2x$
Baskemölle, Gladsax, Skåne, Sweden (s)	0–104–6		30
Tustaberga, Trolle-Ljungby, Skåne, Sweden (s)	0–107		30
Pikovice nad Sázavou, Central Bohemia, Czechoslovakia, M. Kovanda (s)	0–130		30
O. repens			
Clunch Pit, Harlton, Cambs. (s)	0–4–1		$4x$
Toot Hill, Orwell, Cambs., 52/364.506, C. D. Pigott (s)	0–10–5	30	
Idem (s)	0–10–6		60
Idem (s)	0–10–7		c59
West Wratting, Cambs., 52/557.544 (s)	0–15–2		c61
Idem (s)	0–15–6		$4x$
Fleam Dyke, Cambs., S. M. Walters (c)	0–52		$4x$
Chippenham Fen, Chippenham, Cambs., 52/646.698 (f)	0–186		$4x$
Holme dunes, Holme, W. Norfolk, v.c. 28, 53/694.437 (c)	0–53–1		$4x$
Marsden, Durham, 45/406.644 (f)	0–187–14	30	
Blackhall Rocks, Blackhall, Durham, 45/473.388 (f)	0–188–4	30	
Brighouse Bay, near Kirkcudbright, v.c. 73, D. Ockendon 65/GB–12 (f)	0–159	30	
Killiney, Dublin, v.c. H21 (s)	0–29–7, 0–30–10		60
Raheny Quarry, Dublin (s)	0–32–3		60
Near Buberow, District of Gransee, E. Germany (e)	0–49–1		60
Lassau, District of Wolgast, E. Germany (e)	0–116		$4x$
Near Sjöbo, Skåne, Sweden (s)	0–84–2		c64
Limhamn, Skåne, Sweden (s)	0–91–1		$4x$
Near Krankesjön, Skåne, Sweden (s)	0–103–1		c60
Idem (s)	0–103–3		c59

TABLE 2.—*continued*

Locality, map-reference and collector[1]	Code numbers	n	$2n$[2]
O. arvensis			
Hungary (e)	0–43–3, 0–43–6	15	
Idem (e)	0–43–1, 0–43–5		30
Tyniec, near Kraków, Poland (f)	0–161–4	15	
Latvia, U.S.S.R. (e)	0–150–4		30
O. masquillieri			
Calanchi di Paderno, near Bologna, Italy, F. Corbetta (c)	0–142	15	30

[1] Collections by P. Morisset, unless otherwise stated. (s), material grown from wild-collected seed. (c), material grown from wild-collected cuttings. (f), material fixed in the field. (e), seed obtained through exchange, unspecified collector.

[2] $2x$ and $4x$ indicate that, although the ploidy level could be ascertained, it was not possible to discriminate safely between, respectively, $2n=30$ and 32, and $2n=60$ and 64.

spinosa, subsp. *antiquorum* (L.) Arcang., subsp. *austriaca* (Beck) Gams, and subsp. *leiosperma* (Boiss.) Širj. These taxa are very variable, and their overall taxonomic structure is still poorly understood. Their close relationship is evident from the fact that many authors, *e.g.* Rouy (1897) and Gams (1923), have considered them as a single, very polymorphic, species. On the other hand, all four subspecies of *O. spinosa* have been considered as distinct species by some authors, although most modern Floras, including *Flora Europaea* (Ivimey-Cook 1968), follow Širjaev's treatment with four species and a (variable) number of infraspecific taxa. Clearly, one might hope that cytological data would help elucidate relationships and limits within this complex. However, there are conflicting reports in the literature (Table 1) concerning the chromosome numbers of *O. spinosa, O. repens* and *O. arvensis*, both in basic number ($x = 8$ or 15) and in ploidy level. This study was undertaken in order to clarify the situation with respect to *O. spinosa* and *O. repens*, but some plants belonging to *O. arvensis* and *O. masquillieri* were also studied.

MATERIALS AND METHODS

Plants were brought into cultivation from wild-collected seed and cuttings. Seeds do not exhibit any dormancy and readily germinate after the seed coat has been partly chipped away to allow penetration of water. They were germinated on moist filter paper in Petri dishes, and the young seedlings were potted in John Innes No. 1 soil.

Somatic chromosomes were studied from root tips pretreated in a saturated aqueous solution of 1-bromonaphthalene for 2 hours at room temperature and fixed in acetic-alcohol (1:3) for 30 min to 12 hours. The fixative was washed out with 70% ethanol and replaced with a 1:1 mixture of ether and concentrated HCl for 10–15 min at room temperature in order to clear the cytoplasm (K. Jones pers. comm. 1965). Maceration was done in 1N HCl at 60°C (6–7 min), and the material was then stained in bulk in alcoholic HCl-carmine for 12–24 hours at 60°C (Snow 1963). The stain was washed out with 70% ethanol and single meristems were dissected and squashed on a slide in 45% acetic acid. *Ononis* somatic chromosomes seem extremely difficult to process, stain and spread sufficiently. The method described above gave but mildly satisfying results but was far superior to standard aceto-orcein or aceto-carmine squashes, and to many other techniques which were tried.

Many chromosome counts were also made during meiosis in pollen mother cells from both cultivated and wild-growing plants. Young flower buds were fixed in acetic-alcohol and stained in alcoholic HCl-carmine according to Snow's (1963) method. Individual anthers were then dissected out and gently heated in a drop of 45% acetic acid on a slide before applying the coverslip and squashing.

Voucher specimens have been deposited in **CGE**, and microscopical preparations are kept in the author's laboratory at Laval University, Québec.

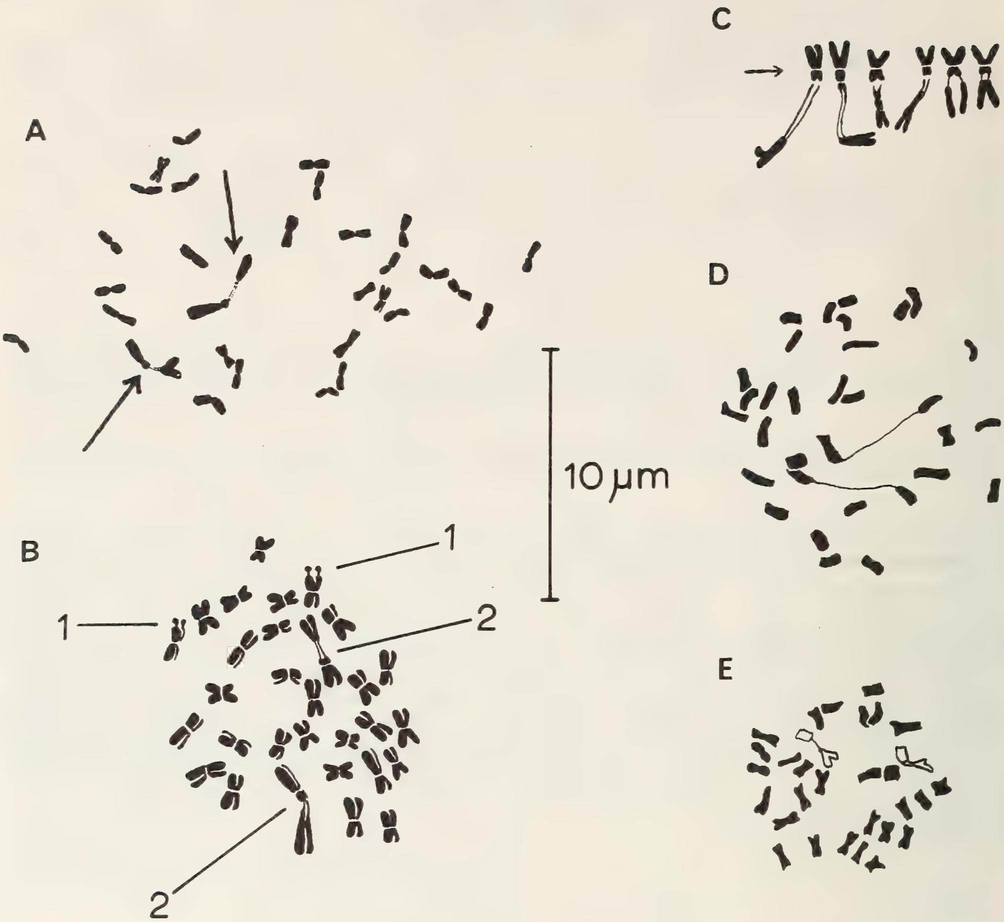

FIGURE 1. Camera lucida drawings of somatic chromosomes of *Ononis spinosa*. A, $2n=30$ in plant 0–184–3 (interpretive drawing of photograph presented in Plate 3b; arrows point to the two large (L-) chromosomes with long proximal secondary constrictions). B, $2n = 30$ in plant 0–41B–1 (1, pair of short metacentric chromosomes with subterminal secondary constrictions; 2, pair of L-chromosomes). C. One L-chromosome from 6 different cells at metaphase in plant 0–184–3 (arrow points to centromeres). D, $2n = 30$ in plant 0–1–13 (note very long secondary constrictions in L-chromosomes). E, $2n=30$ in plant 0–34–3 (L-chromosomes outlined).

RESULTS AND DISCUSSION

Table 2 lists the chromosome numbers determined. Many counts are approximate in the sense that individual chromosomes could not be observed clearly enough to discriminate *safely* between, for instance, $2n=30$ and $2n=32$, although the ploidy level could be easily ascertained. Such counts are entered in Table as $2x$ and $4x$, meaning repectively $2n=c30$ and $2n=c60$. Unfortunately, the chromosomes were too poorly spread and flattened to allow an accurate description of karyotypes. The main practical problem encountered was the general occurrence of a heavy 'stickiness', similar to that found by Seabrook & Dionne (1976) in *Apios* and which they attributed to 'intertelomeric chromosomal fibres'. In *Ononis*, this stickiness partially disappeared with a longer hydrolysis in HC1, but the chromosomes were then too faintly stained to be accurately studied and counted.

FIGURE 2. Camera lucida drawing of somatic chromosomes of *Ononis repens* (A–C) and *O. arvensis* (D, E). A, $2n=60$ in plant 0–10–6 (interpretative drawing of photograph shown in Plate 3d; L-chromosomes (outlined) show no sign of a secondary constriction). B, $2n=60$ in plant 0–30–10 (L-chromosomes (outlined) with long proximal secondary constrictions). C, $2n=60$ in plant 0–49–1 (note L-chromosomes (outlined) without secondary constrictions and the 4 pairs with minute satellites). D, $2n=30$ in plant 0–43–1. E, $2n=30$ in plant 0–150–4 (1, pair with subterminal secondary constriction; 2, pair with secondary constriction in the middle part of the long arm; 3, pair of subtelocentrics). Both scales = 10μm.

Ononis spinosa

43 plants belonging to subsp. *spinosa* were studied. 42 were diploid, the precise number of $2n=30$ or $n=15$ being counted in 26 individuals (Plates 3a & 3b, Figs. 1A, 1B 1D, 1E). The other plant (No. 0–62–1) was triploid with $2n=45$; this plant belonged to an otherwise normal diploid population and was most probably autotriploid.

O. spinosa has 14 pairs of metacentric or submetacentric chromosomes measuring about 1–1·5μm in length after the 1-bromonaphthalene pretreatment, and one pair of longer chromosomes, referred to here as L-chromosomes. One of the small metacentric pairs has a subterminal secondary constriction isolating a minute satellite. Due to their small size, these satellites were not always apparent but they could be clearly seen in some cells of a few individuals (Fig. 1B). They were also observed by Tschechow (1933). The L-chromosomes have a secondary constriction of variable length and measure *c*3μm excluding the constriction. The latter is proximal, rather close to the centromere, and isolates a large satellite about 1·5μm long (Plate 3c, Figs. 1A, 1B & 1C).

Many authors have failed to notice the proximal secondary constriction of the L-chromosome because of its length, its usually very faint staining, its sensitivity to breakage during squashing, and the large size of the satellite which can easily be mistaken for a whole chromosome. However, it could be observed in some slides with the help of phase-contrast optics (Plate 3c). Sometimes it could not be identified in somatic chromosomes, which thus appeared to number 32, but those plants always had 15 bivalents at metaphase I of meiosis. Presumably, the secondary constriction had in those cases been broken during squashing, as was observed by Markarian & Schultz-Schaeffer (1958) in *Anthoxanthum, Secale* and *Alopecurus*.

As shown in Fig. 1C, the secondary constriction sometimes varied in length from cell to cell in the same root tip. There was also some evidence that it was consistently longer in some individuals than in others. Two extreme cases are illustrated in Figs. 1D and 1E, where the secondary constriction measured respectively 4 and 0·5μm. Such differences might be natural, as found for instance by Jones (1964) in *Anthoxanthum*. However, most variation within plants was probably an artefact, partly due to differences in stretching during squashing, and partly to differences between cells in the general shortening of chromosomes caused by 1-bromonaphthalene.

Confusion of the large satellites with whole chromosomes almost certainly accounts for previous records of $2n=32$ for *O. spinosa* (Table 1). This interpretation was originally put forward by Morisset (1967), and was the basis for similar statements by Ivimey-Cook (1968) and Morton (1975). It has also been checked by Gadella & Kliphuis (1970) for their own *O. spinosa* material from the Netherlands. In the few metaphase plates where Tschechow (1933) counted $2n=30$ rather than 32, it is probable that the constriction was much shortened, as seen in Fig. 1C. His own interpretation involved the fusion of two pairs of chromosomes into one pair.

All chromosome numbers so far determined in *O. spinosa* are diploid ($2n=30$), with four exceptions. Strid's (1971) number of $2n = 20$ in *O. spinosa* subsp. *austriaca* from Albania is clearly puzzling, although this same number has been found by Sañudo *et al.* (1976) in *O. cossoniana* Boiss. & Reut., a quite unrelated annual from south-western Spain. The three other exceptions are tetraploid counts by Fernandes & Santos (1971, 1975) from Portugal ($2n=64$) and by Sañudo *et al.* (1976) from Spain ($2n=60$). It seems likely that Fernandes & Santos considered four satellites as distinct chromosomes. Nevertheless, these three counts show that there are tetraploids in southern populations of *O. spinosa*.

Ononis repens

Few precise counts could be made from *O. repens* because the higher number of chromosomes greatly increased the difficulty of making good root tip preparations. Furthermore, the almost constant stickiness of chromosomes at meiosis was a serious hindrance to meiotic counts. 21 plants were studied and a precise number could be determined in nine, all of which had $2n=60$ or $n=30$ (Plate 3d, Figs. 2A, 2B & 2C). The other plants were also tetraploid, although some from England and Sweden appeared aneuploid with $2n$ = *c*59, *c*61 and *c*64. Aneuploidy would certainly be promoted by the unequal segregation of chromosomes that was observed in 64% of pollen mother cells at first meiotic anaphase in plant No. 0–10–5 (Morisset 1967).

The chromosomes were all metacentric to submetacentric. 28 pairs measured *c*1–2μm; the other two pairs were about twice as long and were therefore equivalent to the L-chromosomes of *O. spinosa*. Up to four pairs of small metacentric chromosomes had a subterminal secondary constriction isolating minute satellites (Fig. 2C), but these were not always visible. In most individuals the two pairs of L-chromosomes had a proximal secondary constriction measuring 0·5–1μm (Fig. 2B). In other individuals L-chromosomes showed no secondary constriction (Figs. 2A, 2C), especially in material from the Continent. The drawings published by Larsen (1956) for two French plants showed numbers of $2n=30$ and $2n=60$ without any evidence of proximal secondary constrictions. Furthermore, he found a uniform chromosome size in both individuals, and so his material appeared to lack L-chromosomes altogether. There certainly is infraspecific variation in chromosome morphology in *O. repens*, but the data are still too scarce to provide a meaningful picture.

Morisset's (1964) published counts of $2n=64$ are erroneous, four large satellites having been mistaken for four chromosomes. Morton's (1956) counts of $2n=64$ are incorrect for the same reason (Morton 1975). Lövqvist (in Weimarck 1963, and pers. comm. 1964) counted $2n=32$ in an individual from Trolle-Ljungby (Skåne, Sweden). I saw this individual growing in the botanical garden of the Botanical Museum in Lund and it undoubtedly belonged to *O. spinosa*, not to *O. repens*. Sañudo *et al.* (1976) published numbers of $2n=32$ (var. *maritima* Gren. & Godr. and var. *repens*) and $2n=64$ (var. *maritima*) for Spanish plants and it would not be unreasonable to doubt the accuracy of these counts until confirmed by a study of meiotic chromosomes, where confusion of satellites with chromosomes would not occur. The accuracy of Reese's (1952) count of $n=16$ is also doubtful, as the author himself stressed. This plant, from Kiel (northern W. Germany), one individual studied by Larsen (1956) from Biscarosse (south-western France), and five plants from Spain (Sañudo *et al.* 1976) are the only diploid counts that exist so far for *O. repens*. All other counts (from the British Isles, Netherlands, Germany, Sweden, France and Spain) are tetraploid, and $2n=60$ would appear to be the correct number apart from, possibly, occasional aneuploid plants. The ploidy level of more populations of this species on the Continent needs to be determined before a pattern, if any, can be disclosed in the distribution of diploids and tetraploids.

Ononis arvensis

The plants of this species studied, from Hungary, Poland, and Latvia (U.S.S.R.), were all diploid with $2n=30$ or $n=15$ (Plate 3e, Figs. 2D & 2E). In the Hungarian plants the chromosomes were 1–2μm long, with no outstandingly large chromosomes, although one pair had a secondary constriction of variable length in the middle of one arm (Fig. 2D). The chromosomes of the Latvian individual were twice as large, 2–4μm (Fig. 2E), and also differed from other *Ononis* plants studied in having one pair of subtelocentric chromosomes (arm ratio *c*1:4). The other pairs were submetacentric or metacentric, and two had short secondary constrictions respectively in the middle and at the distal third of one arm. The satellites were therefore rather large but distinctly shorter than those found in *O. spinosa*.

The chromosome number of *O. arvensis* was first reported by Tschechow (1933) as $2n=32$, and more rarely $2n=30$ in some cells. It seems likely that Tschechow considered satellites of the type found in plant No. 0–43–1 (Fig. 2D) as whole chromosomes, and his rarer counts of 30 can be explained by shortened secondary constrictions. Kuzmanov & Markova (1973) found $2n = 32$ in a plant from Bulgaria; it is quite possible that this count was incorrect for the same reason. Also the drawing published by Llane (1969) for his count of $n=16$ is not at all convincing.

Tschechow (1933), Gadella *et al.* (1970), Kuzmanov & Markova (1973) and the present study have shown *O. arvensis* to be diploid. Senn (1938) has published a tetraploid count for this species, but his material came from the Brooklyn Botanical Gardens, and no tetraploid numbers have so far been found in wild populations of *O. arvensis*. Chuxanova's (1967) count of $2n=24$ is puzzling and, in the light of present evidence, cannot be explained.

Ononis masquillieri

The single available specimen of this species, which is closely related to *O. spinosa*, had $2n=30$. The somatic chromosomes measured *c*1–2μm long and a pair of larger chromosomes was present but did not show any secondary constriction. Plate 3f shows the 15 meiotic bivalents of this plant. The chromosome number given by Ivimey-Cook (1968) was based on this count; there appear to be no previous counts.

CONCLUSIONS

The first conclusion to be drawn from the data presented above is that there is much variation in chromosome morphology within the series *Vulgares*. Thus, L-chromosomes are present in *O. spinosa*, *O. masquillieri* and *O. repens*, but not in *O. arvensis*. Long secondary constrictions and large satellites have been found in *O. spinosa* and *O. arvensis*, but not in *O. masquillieri*; in *O. repens* they are present in most British plants but have not been found on the Continent (except, perhaps, in Spain). Within *O. arvensis*, there appears to be important variation not only in the morphology but also in the size of the chromosomes. Such variation might turn out to be taxonomically significant after further studies.

There is no doubt that the basic number in *Ononis* series *Vulgares* is $x=15$. Numbers based on $x=8$ were due to confusion of large satellites with whole chromosomes, and there is no need to invoke 'fusion of chromosomes' (Tschechow 1933) or the possible occurrence of B-chromosomes to explain discrepancies in published counts of these species. A similar confusion may have occurred in three other *Ononis* species. *O. alopecuroides* L. was studied by Tschechow (1933), who found $2n=32$, but later Senn (1938) and Sañudo *et al.* (1976) counted $n=15$ for the same species. In *O. fruticosa* L., Tschechow (1933) counted $2n=32$, but Sañudo *et al.* (1976) $n=15$. For *O. reclinata* L., the following numbers have been published: $n=15$ and $2n=32$ (Sañudo *et al.* 1976), $2n=46$ (Fernandes & Santos 1971), $n=30$ (Senn 1938), $2n=60$ (Dahlgren *et al.* 1971) and $2n=64$ (Tschechow 1933). In these three species, somatic counts based on $x = 8$ have not been confirmed by meiotic counts, and confusions of large satellites with whole chromosomes in somatic preparations appear quite probable. Fernandes & Santos' count of $2n=46$ could therefore be of a $2n=45$ triploid, presumably hybrid with one large satellite coming from the diploid parent. This is admittedly very hypothetical but the possibility of such errors is worth raising if one remembers the similar confusions that have occurred in *O. spinosa* and *O. repens*. The importance of meiotic counts should be stressed, as studies by Senn (1938), Sañudo *et al.* (1976) and myself have revealed meiotic numbers based on $x=15$ in six species whose previously published somatic numbers were based on $x=8$.

That there are, however, two basic numbers ($x = 8$, 15) in the genus *Ononis* is shown by the occurrence of $2n=16$ in two species: *O. atlantica* (Quézel 1957) and *O. adenotricha* (Kuzmanov & Markova 1973), and of $n=16$ in five species (*O. crotalarioides* Cosson, *O. filicaulis* Salzm., *O. laxiflora* Desf., *O. natrix* L. and *O. pinnata* Brot.) studied at meiosis by Sañudo *et al.* (1976). Therefore, $x=15$ is probably a secondary, derived base number and species with $2n=30$ could be considered as 'hypotetraploids' as suggested by Fernandes & Santos (1971) about *O. mitissima*.

It should be stressed that if relationships between the taxa of *Ononis* series *Vulgares* are to be clarified, cytotaxonomic and biosystematic work will have to be done on the circum-Mediterranean and eastern European populations of these taxa, especially in those areas where Širjaev (1932) identified many so-called transitional forms between different species and subspecies, and where more than one subspecies of *O. spinosa* appear to occur sympatrically (Širjaev 1940). In central Europe, the relationships of *O. spinosa* subsp. *austriaca* (*O. foetens* All.) with the partly sympatric *O. repens*, *O. arvensis* and *O. spinosa* subsp. *spinosa* should be investigated. Chromosome numbers alone might not be very useful but, coupled with a study of chromosome morphology and meiotic behaviour in hybrids (Morisset 1967, and in prep.), they should throw some light on the nature of this complex of closely related taxa.

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Short Notes

SENECIO SQUALIDUS L. × *S. VULGARIS* L. IN CAMBRIDGESHIRE

On 9th July, 1977, we found a single plant of the hybrid *Senecio squalidus* L. × *S. vulgaris* L. on sandy ground on the top of a disused railway embankment between Toft and Bourn, Cambs., v.c. 29, GR 52/338.558; specimens are in **herb. A. C. Leslie** and **CGE**. A description of the plant follows:

Plant 47cm; stock 1·5cm, short, thick; stems numerous, erect, much branched. Lower leaves all shrivelled or eaten by larvae of cinnabar moth (*Callimorpha jacobaeae*) at time of gathering; upper leaves narrowly lanceolate, shallowly lobed or toothed, auriculate. Capitula numerous, ± cylindrical or narrowly ovoid, *c* 9–12mm diameter; rays 7–9 (–13 in cultivation), 3–4mm long, eventually reflexed and coiled. Anthers with 14% stainable pollen grains. Elongated stigmatic papillae fewer and more variable in length than in *S. squalidus*. Achenes pale and shrivelled. Chromosome no. $2n = 30$ (counts from six cells).

This is the first record of this hybrid in Cambridgeshire and only the third cytologically confirmed British record. Stace (1977) reported two counts (one from Manchester, the other from Leicester), both from plants in long-established mixed populations of the parents. *Senecio cambrensis* Rosser is thought to have arisen from such a hybrid by chromosome doubling. The sterile triploid is the plant Druce called *S.* × *baxteri*, the correct citation for which is as follows:

Senecio squalidus × *S. vulgaris* = *S.* × *baxteri* Druce in *Rep. botl Exch. Club Brit. Isles,* **2**: 228 (1907) (Lectotype: Cardiff Docks, Glamorgan, v.c. 41, June 1905, H. J. Riddelsdell plant B (**OXF**)); *S.* × *baxteri* Druce in *Rep. botl Exch. Club Brit. Isles,* **1**: 374 (1893), nom. nud.

In his original publication of the hybrid name *S.* × *baxteri* in 1893, Druce gave no description, but in 1907, when discussing some Senecios collected by Riddelsdell at Cardiff Docks, he said: 'but I should be inclined to consider them hybrids of *vulgaris* × *squalidus* (= × *baxteri* Druce).' He went on to say how these plants differed from the parents, thus validating the hybrid name. Three different gatherings, labelled A, B and C, are involved and these specimens are to be found in his herbarium (**OXF**).

They were also distributed through the Botanical Exchange Club and duplicates are to be found in other herbaria. Specimen B is chosen as the lectotype. It has larger heads than have most *S. vulgaris* plants and smaller ligules than in *S. squalidus*. The elongated stigmatic papillae are more abundant than in *S. vulgaris*. The achenes, as stated by Druce himself, are mostly undeveloped. This specimen seems to be good *S. squalidus* × *S. vulgaris*. Specimens A and C are hardly distinguishable from rayed forms of *S. vulgaris,* but at least some of the plants have undeveloped achenes. All three specimens had been labelled, in an unknown hand, '*S. nebrodensis*', which is a glandular hairy plant, quite unlike *S.* × *baxteri*.

The Cambridgeshire plant was conspicuous on account of its size and number of capitula, which became nodding after flowering as the apex of the pedicel withered. It was growing with both parents, though *S. squalidus* was in small quantity, together with *S. viscosus* L. and a number of plants of *S. squalidus* × *S. viscosus*. There was no *S. vulgaris* var. *hibernicus* Syme. The railway line has been disused since 1969 and it is probable that these three species colonized the area shortly after.

Cuttings from this plant (from which root-tip chromosome counts were made) were grown in the University Botanic Garden, Cambridge. Under these conditions the leaf form showed considerable plasticity. Those leaves produced soon after rooting were broadly lanceolate and only shallowly toothed, whereas the later leaves were deeply lobed. Comparisons with *S. vulgaris* var. *hibernicus* collected in the Botanic Garden revealed that the hybrid often has a broader area of disc florets and broader, sometimes more numerous, rays, which may overlap, unlike those in the majority of rayed groundsels. Moreover, var. *hibernicus* (like var. *vulgaris*) has few or no elongated stigmatic papillae. The hybrid differed from *S. squalidus* in its habit, capitulum size and shape, leaf dissection and stigmatic papillae.

Stace (1977) suggested that var. *hibernicus* may have arisen by mutation, rather than having a complex origin involving hybridization and introgression of the ray gene from *S. squalidus*. He drew parallels with several other intraspecific rayed and rayless pairs within the Asteraceae (e.g. in *Aster* *tripolium*). The morphological characters of *S. squalidus* × *S. vulgaris* differ greatly from those of var. *hibernicus*, in which nothing but the ray florets separate it from normal *S. vulgaris*. Indeed, as Stace pointed out, even the rays of var. *hibernicus* differ significantly from those of *S. squalidus*. The rarity and sterility of *S. squalidus* × *S. vulgaris* in Cambridgeshire would suggest that the derivation of var. *hibernicus* through the triploid hybrid is at most a very rare event. This does not preclude the possibility of hybridization involving unreduced gametes of *S. squalidus*, but if this were the case, one might expect the resultant plants to have some other *S. squalidus* characters. *S. squalidus* was certainly in cultivation at the University Botanic Garden before the end of the nineteenth century and rayed *S. vulgaris* was unknown there until 1901, when it was first recorded as *S. squalidus* × *S. vulgaris*; this sort of evidence cannot, however, really provide unequivocal support to either hypothesis. It seems sensible to concur with Stace's conclusion that an origin through mutation is at least as plausible an hypothesis as one via hybridization.

ACKNOWLEDGMENTS

We should like to thank the curator of the Druce-Fielding Herbarium, Oxford (**OXF**), for the loan of the relevant specimens and Mr P. D. Sell for supplying the notes on the nomenclature.

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R. I. S. BRETTELL & A. C. LESLIE

HEATHERS WITH PARTS IN FIVES OR SIXES

The discovery early in 1977 of more examples of *Erica tetralix* with five or six leaves in a whorl (cf. McClintock 1976) prompted a wider search for such plants in this and other species too, and thoughts on its value taxonomically or otherwise.

The five-leaved state was briefly ('feuilles quinées') described as var. *quinaria* by Guffroy (1927, p. 29). Senay (1928), unaware at the time of Guffroy's name, came across the plant independently (also in Brittany) and wrote a longer account, including a description of one plant with leaves in sixes. He recorded its presence in seven French départements, all in the north-west, and found a specimen that had been collected in 1858 by de Brébisson. Van Ooststroom & Reichgelt (1961) reported: 'Bladen in kranzen van 4 (of 6).'

Withering (1796) noted that *Erica tetralix* has 'leaves sometimes five in a whirl (sic).' Nothing more seems to have been noticed in Britain until P. Rawlinson found it in 1974 near Dolgelly, Merioneth, v.c. 48, and the next year it was sent from Co. Galway by Col. A. Morris. These were shown at the B.S.B.I. Exhibition Meeting in 1975 (McClintock 1976).

In 1977, one of us (P. R. B.) found it to be plentiful on Silchester Common and Bartley Heath, N. Hants., v.c. 12, and here too some of the whorls were in sixes. Further search by him showed that plants with leaves in fives or sixes are common on many other heaths in Hampshire, including the New Forest, and also in Surrey. This was followed by Col. Morris sending specimens of *E.* × *praegeri* with leaves in fives from Connemara. To his shame, the other author (D. McC.) found in his herbarium that he had collected *E. tetralix* in 1975 in the same locality with leaves in fives, and had not noticed it. Further search showed that this form of pleiomery occurs also in *E. mackaiana*, both in Connemara and Donegal (specimens in **herb. D. McClintock**, 1975), and in at least one named cultivar ('Whitehouse'). In extenuation, it may be pleaded that few people even look for this, nor is it easy to notice. Indeed, a search through **BM** showed specimens of *E. tetralix* with leaves in fives (apparently unnoticed) to be frequent, with one specimen dating back to 1855.

Further studies of these variants of *E. tetralix* have proved very interesting. The most obvious finding is that plants with leaves in fives are common, at least locally (up to one plant in three in some areas). On these plants, the number of shoots with leaves in fives or sixes is variable, but we have not found any plants where all the shoots are affected. Ecological observations show conclusively that plants with leaves in fives are much more common on the borders of waterlogged areas than in the less wet parts. Also, the number of affected shoots on each plant is much higher in the wetter areas. Plants with leaves in sixes have only been found so far in the very wet areas, where there is much surface water, and they are not uncommon there. All such plants have at least some shoots with leaves in fives; one specimen was found with a shoot on which the numbers of leaves in each whorl alternated between five and six. Another common finding is for the leaves to lose their arrangement in whorls and to take on a spiral pattern. The number of sepals on all these plants also seems to vary between four and six, but this number does not necessarily correlate with the number of leaves on a shoot. On the other hand, there may be wholly pentamerous flowers (Hagerup 1928) and Miss M. J. P. Scannell has noticed that occasionally such plants also have leaves in fives.

Senay (1928) wrote: 'nos *Erica tetralix* ne présentent pas de stades intermediaires entre les verticilles tetramères et les verticilles quinées: la transition est completement brusque'. Our studies have shown the exact opposite. Indeed, it may be more appropriate to include all these states under plain *Erica tetralix* L., describing its leaves as whorls of 4 (–6) and flowers tetramerous (–pentamerous). The inconstancy of its appearance seems to reduce its taxonomic, if not its physiological, value. More study is needed, however, if a name is required for this variant under *E. mackaiana* and *E.* × *praegeri*, in neither of which it has previously been noted.

Finally, there is a subform of *Calluna vulgaris* with 'flowers often with a pentamerous, sometimes hexamerous perianth', to which is added 'the packets of bracts are as a rule more or less twisted' (Beijerinck 1940, p. 133). This is the subf. *pentamera* of f. *multibracteata*, in which the number of bracts exceeds 12 and which is the normal state in late-flowering varieties. Both these taxa were described by J. Janssen in 1935.

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P. R. Brough & D. McClintock

TRAGOPOGON × *MIRABILIS* ROUY IN WEST KENT, V.C. 16

On 31st May, 1976, we found a single plant of the hybrid *Tragopogon porrifolius* L. × *T. pratensis* L. (= *T.* × *mirabilis* Rouy) at a field border between Cuxton Great Wood and the M2 motorway near Rochester, W. Kent, v.c. 16. Dr F. H. Perring has confirmed that this is the first record for W. Kent. A flowering stem which was taken from the plant was confirmed by Dr C. A. Stace and is now in **MANCH**.

The plant was growing within a few metres of both parents and was about 1m high. Its capitula were purple with a yellow centre, and it resembled *T. pratensis* rather than *T. porrifolius* in its leaf-base and thickness of peduncle.

Fresh pollen grains were stained and measured; they varied between 24μm and 60μm, and 46% of them became stained in acetocarmine. The average size of stained grains was 48μm and that of unstained (presumably infertile) grains 36μm. Achenes produced appeared normal but none of those sown proved to be viable. When dissected they were found to be hollow, containing only shrivelled contents.

The site was revisited in 1977 but no hybrid plants were found.

B. & J. Burrow

PHALARIS ARUNDINACEA L. IN BARVAS

In my report of the 1975 field meeting at Stornoway, Outer Hebrides, v.c. 110 (Copping 1977), I mentioned that 'we passed two fields at Barvas containing *Phalaris arundinacea* apparently being grown as a crop.' A correspondent of Mr B. W. Ribbons of the Botany Department, University of Glasgow, expressed surprise and interest in this observation and as a result of enquiries Mr Ribbons received the following reply from the Area Agricultural Adviser for Lewis and Harris:

'Reed-grass (*Phalaris arundinacea*) is a common plant of marshy ground in the Islands. For example it occurs also in Tobson, Bernera and Strond, Harris, where it is encroaching into adjacent croft land due to a combination of impeded drainage and severe overgrazing in spring. It also occurs in the river valley at Horgabost in Harris.

The grass is a weed which is not cultivated, but has been allowed to spread. As I mentioned, most inbye areas [enclosures near a dwelling house] are overgrazed with sheep, especially in spring, which reduces the vigour of grass and its ability to compete with this weed. Lack of maintenance of drainage ditches encourages a higher water-table and waterlogging of land, resulting in a suitable environment for the plant.

I believe that in the past, when the 'black house' [humble dwelling built largely of turf] was occupied by the majority of the Islanders, this grass was used for thatching.'

So, evidently, I was mistaken, but I had never seen *Phalaris arundinacea* so dominant over such an extensive area before. Curiously enough, I discovered a similar situation in July, 1977, on a damp part of Mellis Common, E. Suffolk, v.c. 25, where the grass has grown rampantly to the virtual exclusion of other species. Had I seen this colony earlier I should probably not have been misled in Lewis.

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A. Copping

THE DISTRIBUTION OF *CAREX ELONGATA* L. IN THE BRITISH ISLES

Carex elongata L. is scattered in central and northern Europe, where it reaches Arctic Norway, and extends into Siberia. Its existence in Britain is precarious, for the habitats that can provide its very specific requirements have been much reduced as a result both of natural causes and of human intervention.

This sedge demands abundant moisture and minimum competition, but cannot tolerate continuous swamp conditions or colonize newly exposed mud. A characteristic habitat is a carr of decaying alder or willow, where the plant is often epiphytic upon fallen boughs that raise it above flood level but allow its roots ready access to water. It also favours stagnant ditches in water-meadows, and canals where the ancient wooden camp-sheathing provides the kind of pedestal that it enjoys. Such situations are fast disappearing in England. The Mersey marshes, which supplied the earlier herbaria with so many robust specimens, have been wholly reclaimed for agriculture or for building. Those of Loddon, Wey and Medway have been domesticated, and there the sedge, if not entirely gone, is much reduced. Wayside and woodland pits have been filled in or taken over as rubbish tips. The rehabilitation of waterways for recreation has been at the expense of *Carex elongata*. The wash of powered 'long-boats' erodes the banks and necessitates their strengthening with metal sheathing that not only destroys the growing sedge but creates a rigid verge that denies it a footing for regeneration. Only in the north, and in Ireland, can the plant be said to flourish, and here its known position has been much strengthened by the very recent finding of three large colonies by Loch Lomond and its rediscovery, after 100 years, in more than one spot by Lough Neagh. Even so it is disconcerting to learn that the colony at Askham Bog, Mid-W. Yorks, v.c. 64, probably the largest and most floriferous in England, seldom sets viable seed.

Nevertheless regeneration can and does occur, and a constant look-out should be kept in suitable habitats for this very distinctive sedge. The inflorescence, with its rigidly angled zig-zag spikes, is like no other, and even in the vegetative state the bright yellow-green leaves that arch rather stiffly outwards from the strong, compact crowns can be recognized from many yards away.

A list of British stations follows, with grid references. All that can be traced have been surveyed since 1970, and the size of the population when last seen is indicated by the symbols $A^1 = 1$ to 9, $A^2 = 10$ to 20, B = 21 to 100, C = over 100. Where the plant has not been refound the date of its last sighting and the authority for this are given, with the location of authentic specimens seen in herbaria.

Dorset, v.c. 9: 41/0.0, Trickett's Cross, 1939, **BM, E, K, OXF**. Destroyed in the 1960s by building.

N. Hants., v.c. 12: 41/7.6, between Jouldern's and Thatcher's Fords, 1899, **OXF**.

W. Sussex, v.c. 13: 51/0.2, Billingshurst (A^1).

E. Sussex, v.c. 14: 51/3.2, Danehill (A^2); 51/5.3 (?), Tunbridge Wells, 1881, **BM, LIV** (Wolley-Dod 1937); 51/9.2, Rye, 1933 (Wolley-Dod 1937), pond filled, *c*1960.

E. Kent, v.c. 15: 51/9.3, Ashford, 3 places (A^1, A^1, A^2).

W. Kent, v.c. 16: 51/5.4, Penshurst, 1948, **E, K**; Tonbridge (F. Rose *in litt.* 1970); 51/6.4, Tonbridge (A^1); Yalding (A^2).

Surrey, v.c. 17: 41/8.5, Frimley, 1894, **BM, LIV**; North Camp, 1888, **BIRM, BM, CGE, E, LIV, MANCH**; 51/0.5, Ripley (A^1); Wisley, 1943 (Lousley 1976); 51/0.6, Horsell, 1943 (Lousley 1976); Ham Moor, 1892, **E**; Weybridge, 1904, **BIRM, BM, E, GL, K, LIV, MANCH**.

N. Essex, v.c. 19: 52/8.2, Markshall, 2 places, 1849, **BM, CGE, K, LIV**.

Berks., v.c. 22: 41/6.6, Padworth, 1959 (Bowen 1968), no specimen traced; 41/7.6, Jouldern's Ford, extinct (Bowen 1968); 41/7.7, Coleman's Moor, 1890, **BIRM, BM, LIV, MANCH, OXF**; 41/8.6, Sandhurst (A^2).

Bucks., v.c. 24: 41/9.8, Slough, 1940 (Davies 1951). A specimen from near Henley (41/7.8), 1976, is *C. paniculata* L.

E. Suffolk, v.c. 25: 62/4.7, Reydon Wood, 1917, **BM** (utricles only but determination correct); 62/5.8, Benacre, 1917, no specimen traced (F. W. Simpson *in litt.* 1977).

E. Norfolk, v.c. 27: unlocalized (Bennett *et al.* (1930) on basis of a specimen not traced). Specimen from Beccles, 1919, **RDG**, is *C. disticha* Huds. (H. J. M. Bowen *in litt.* 1977).

Cambs., v.c. 29: 53/4.2, 'washes on the Nene', 1883 (doubted by Perring *et al.* (1964)).

Worcs., v.c. 37: 32/8.7, Hartlebury, 1852 (Lees 1867). Lees' specimen in **WOS** is immature but in my judgement can only belong to *C. elongata.*

Warks., v.c. 38: 42/0.7, Earlswood (A^2); 42/1.7, Earlswood, 2 places (A^1, A^1); Dickens Heath (A^2), extinct in a second locality *c* 1965; 42/2.8, Hampton-in-Arden, 1876, **BM, E, MANCH, OXF**.

Staffs., v.c. 39: 33/7.2, Loynton (C); 33/7.5, Balterley (C).

Salop, v.c. 40: 33/4.3, Ellesmere, 1893, **BM, CGE, GL, K**; Colemere (A^1); 33/5.3, Brickwalls, 1968 (A^1), extinct 1977.

Denbigh, v.c. 50: 33/2.3, Chirk (A^1).

N. Lincs., v.c. 54: 43/8.9, Laughton, 1882, **BM**; 44/9.0, Manton, 1920 (Gibbons 1975), no specimen traced.

Cheshire, v.c. 59: 33/3.8, Bebington (de Tabley 1899); 33/5.4, Steer, 1972 (A^1), extinct 1976; 33/6.4, Wrenbury (A^2); 33/6.6, Over, 1827, **E, GL**; 33/7.7, Peover, 2 places, 1865, **BM**; de Tabley, 1867, **BM, OXF**; 33/7.8, Rostherne, 1868, **BIRM, BM, CGE, K, MANCH, OXF**; 33/7.9, near Irlam, 1885, **OXF**; 33/9.9, Staley Great Wood, 1851 (de Tabley 1899). Unconfirmed records from 33/2.8, West Wirral, 1958, 33/5.7 and 33/6.7, unlocalized, 1938, 33/7.5, Wybunbury, 1952, and 33/8.8, Lindow, 1955, are regarded as errors (A. Newton *in litt.* 1977).

S. Lancs., v.c. 59: 33/4.8, Hale (Savidge 1963); 33/6.8, Warrington, 3 places, 1841–1899, **BM, CGE, E, GL, K, OXF**; 33/6.9, Tyldesley, Town Lane Bridge, 1842, **BM**; 33/7.9, Irlam, 1880, **GL, MANCH**; 33/8.9, Eccles (Savidge 1963); Chorlton, 1854, **BM, CGE, E, GL, K, LIV, MANCH, OXF**; Stretford, 1866, **BM, LIV, MANCH, OXF**; Withington, 1842, **LIV, MANCH**.

E. Yorks., v.c. 61: 44/6.4, Langwith, 1874, **BM, E, LIV, MANCH**, extinct by 1902 (Sledge 1936).

S. W. Yorks., v.c. 63: 43/4.9, Aldwarke, **BM**, extinct 1874–1876 (Sledge 1936); 43/5.0, Doncaster, 1847, **OXF**; Fishlake, 1946, **K**, extinct by 1970.

Mid-W. Yorks., v.c. 64: 44/5.4, Askham Bog (C).

Westmorland, v.c. 69: 34/3.8, Roudsea Wood (B); 34/3.9, Esthwaite (B); 35/3.0, Pull Wyke (A^2); Ambleside (B).

Cumberland, v.c. 70: 25/9.0, Snellings Mire, extinct by 1882 (Hodgson 1898); 35/2.2, Ullock (Sledge 1944) was an error; Friar's Crag (A^1).

Dumfries, v.c. 72: 25/8.9 (?), Anchenessnane, 1893 (Scott-Elliot 1896), **BM** 'Dumfriesshire'.

Kirkcudbright, v.c. 73: 25/3.7, Wood of Cree (B); 25/6.7, Kenmure (A^2).

Stirling, v.c. 86: 26/4.8, Loch Lomond (C).

Dunbarton, v.c. 99: 26/3.8, Loch Lomond, 2 places (B, C).

Leitrim, v.c. H29: 23/1.1, Corduff Lake (B) (Faris 1974).

Cavan, v.c. H30: 23/2.1, Ballyconnell (B); Togher Lough (A^1) and Clonty Lough (A^2) (Faris 1974).

Fermanagh, v.c. H33: 23/3.2, Crom, 2 places (A^2, C); 23/4.3, Kilmacbrack (A^2).

Tyrone, v.c. H36: 23/8.6, Tamnamore (A^2), and 23/9.7, Killywoolaghan, 2 places (A^1, A^2) (Harron 1974).

Antrim, v.c. H39: 33/0.6, Selshan, 1856, **BM, CGE, E, GL, K, OXF**; 33/0.8, Farr's Bay, 2 places (B, B) (Harron 1974); 33/1.8, Antrim (A^2) (Harron 1974).

Londonderry, v.c. H40: 23/9.8, near Toome (A^1) (Harron 1974).

Faris's and Harron's colonies not seen by R. W. D.

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R. W. David

VERBASCUM SPECIOSUM SCHRADER × *V. THAPSUS* L. NEW TO BRITAIN

In connection with his work on an 'Alien Flora' of Britain, Mr David McClintock was told about a population of *Verbascum speciosum* Schrader and *V. thapsus* L. growing with hybrids near Didlington, W. Norfolk, v.c. 28, by Miss V. M. Leather of Didlington, Norfolk. In July, 1976, together with A. Wilson, he collected a specimen which is now in **K**. This appears to be the first record of this hybrid occurring in Britain. For ease of comparison the details of this hybrid are given in the format of *Hybridization and the flora of the British Isles* (Ferguson 1975).

6 × 1. *V. speciosum* Schrader *V. thapsus* L.

a. *V.* × *duernsteinense* Teyber.

b. This hybrid is intermediate between its parents in most characters. The leaves are less decurrent than those of *V. thapsus* and those on the upper part of the stem are somewhat undulate as in *V. speciosum*. The inflorescence is weakly branched, being simple in the upper part. The anthers of the lower stamens are decurrent on the filaments, as in *V. thapsus*. Hybrids appear to be highly sterile; most of the pollen grains have no cell contents and capsules with ripe seeds are rarely formed.

FIGURE 1. The distribution of *Sesleria caerulea* (×) and *S. albicans* (•).

F

c. Hybrids have been found only near Didlington, W. Norfolk, v.c. 28, where they grew in 1976 together with the two parents on open ground by a roadside, and in Austria.
d. None.
e. *V. thapsus* ($2n = 34, 36$).
f. Ferguson, I. K. (1975). *Verbascum*, in Stace, C. A., ed. *Hybridization and the flora of the British Isles*, pp. 359–365. London.
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I. K. Ferguson

ECOLOGY OF *SESLERIA ALBICANS* KIT. EX SCHULT.

Sesleria caerulea (L.) Ard. *sensu lato* includes at least two ecologically distinct and allopatric demes. Pouzar (1961) demonstrated that *S. caerulea* (L.) Ard. is the correct name for the taxon of 'Habitat in Europeae pascuis uliginosis' described by Linnaeus, and that *S. albicans* Kit. ex Schult. should be applied to the 'alkalophilic' taxon of rocky habitats, which includes all *Sesleria* in the British Isles. The distribution of these two species is shown in Fig. 1, which was compiled from all available sources. *S. caerulea* has, for this purpose, been regarded provisionally as including *S. heufleriana* Schur and *S. uliginosa* Opiz of Deyl's (1946) review of the genus, in which *S. albicans* was recognized as *S. calcaria* Opiz.

Characteristic phenodemes of *S. albicans* occur in particular habitats. The commonest growth-form of *S. albicans* is an *erect tussock form* with tillers arising at all angles to the vertical; this is characteristic of screes and other little-grazed areas. A *hanging form* occurs on vertical rocks, with the leafy tillers pendant on long (up to 30cm) rhizomes; the thin branching rhizomes are recognizable when bared by decay and disintegration, in both tussocks and hanging plants, of the sheathing proximal leaf-bases. A *sward form* occurs as mats or centrifugal rings of procumbent tillers, and is produced by heavy grazing by farm animals. Enclosure experiments show that this growth-form grows out to form tussocks which may soon dominate grassland released from grazing pressure. Such tussocks may persist for a quarter of a century or more. A *shade form*, with narrower, thinner, longer leaves, more open tussocks and few or no inflorescences, has been found in conifer plantations developing over *Sesleria* populations.

S. albicans is described by Schubert (1963) as a species with aspect preferences. However, it occurs on hillsides of all aspects in the British Isles, although not always on all sides of a single hill.

Morphological clines may occur in *S. albicans*: for example, a decrease in spikelet number per inflorescence from the south-east to the north-west of its world distribution.

A record by Rotheray (1900) of *S. albicans* in a millstone grit area has now been explained through examination of soil samples. Gritstone ledges high above the River Wharfe (GR 44/063.565) bore calcareous soil (pH 7·8, extractable calcium 80mg $100g^{-1}$), evidently deposited during spates, with tussocks of *S. albicans*, in 1977.

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D. J. Hambler & J. M. Dixon

A SEVEN YEAR STUDY OF A COLONY OF BEE ORCHIDS (*OPHRYS APIFERA* HUDSON)

During the years 1971–77 I conducted a study of two colonies of *Ophrys apifera* Hudson. Colony A was discovered in 1971 and Colony B in 1972. Both colonies are situated at Frampton Pools, W. Gloucs., v.c. 34, a set of now disused and flooded gravel workings about a mile from the River Severn. The

TABLE 1. NUMBER OF PLANTS AND NUMBER OF FLOWERS PER INFLORESCENCE EACH YEAR IN THE TWO COLONIES OF *OPHRYS APIFERA*

		No. of flowers per inflorescence										
Year	Colony	1	2	3	4	5	6	7	BR	DP	BP	Total plants
1971	A		5	10	3	4					3	25
1972	A		6	21	3			1	5			31
	B		3	6	3	1			1			13
1973	A		4	5	7				8	1	1	18
	B		4	1					8			5
1974	A		6	21	10	3			12		3	43
	B		8	10	1	3						22
1975	A		4	1	1				1			6
	B	1	5	5	3							14
1976	A		2	6							1	9
	B		11	5		2	1				1	20
1977	A		1	1	1	1						4
	B	3	13	10	2	2			79	3		33
Totals		4	68	105	35	16	1	1	114	4	9	243

BR – Basal rosette only
DP – Destroyed inflorescence
BP – Broken inflorescence

orchids occur on the edge of one of the pools, a sandy gravelly area dominated by sallow and birch scrub, around which vegetation clusters, thinning out to clearings and pathways. The water-table and humidity is high, and after rain the area is often flooded. In two important ways, therefore (the amount of water present and the density of competing vegetation), these two sites are unusual ones for *Ophrys apifera*.

I have been particularly concerned with numbers of plants and numbers of flowers per inflorescence, for, as Summerhayes (1951, p. 309) said:

> 'One of the most striking features of the bee orchid is the uncertainty of its appearance in any given spot. Most people know at least some places where a few specimens may be found almost every year, but usually the number of plants fluctuates in an amazing manner. . . .'

This is borne out by the results given in Table 1. The number of flowering plants in Colony A varies from 4 to 43, and in Colony B from 5 to 33, and there is no consistent pattern of numbers.

Summerhayes (1951, p. 307) also stated:

> 'the flower-spike contains two to seven (rarely as many as eleven) rather widely spaced flowers.'

As can be seen from Table 1, all the specimens had between 1 and 7 flowers per inflorescence, with 2–5 being most frequent; 2 (29·5% of the 7 year total) and 3 (45·6% of the 7 year total) were by far the commonest numbers.

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D. A. HILL

OENOTHERAS IN BRITAIN

Dr K. Rostański of Katowice, Poland, an authority on the typical subgenus of *Oenothera*, visited Britain for the first time in September, 1977. During this visit he examined all specimens of this subgenus in **BM, BRIST, CGE, JSY, K, LINN, LIV, MNE, NMW, OXF, RDG** and **STP**, went to the dunes in S. Wales, and also saw Oenotheras growing at Cambridge and Oxford. He will be writing up his findings with a key and full details at a later date. Meanwhile, thanks to his diligence and skill, the following taxa, all of them biennial, have been identified by him for Britain:

O. biennis L. Quite generally distributed; perhaps less frequent than formerly and apparently not in Wales.

O. cambrica Rost. This new species (Rostański 1977) was shown to the B.S.B.I. at the 1975 Exhibition Meeting (McClintock 1976). It is rather like *O. erythrosepala*, but smaller and with always green sepals and with pink veins on at least the lower leaves. Plants thus named seem to be clearly the third most frequent species in Britain and the solution of some nagging identification problems. The most usual name it has gone under has been *O. parviflora*.

It has proved to be most plentiful along the coast of S. Wales, and I have been in touch with Dr Rostański about it there since 1969. It is also the plant recorded under changing names from the dunes across the estuary at Burnham and Berrow, N. Somerset and was collected at Portishead, N. Somerset, in 1941 and Sharpness, W. Gloucs., in 1956. Further afield, there are specimens from Jersey (nine dates from 1867 to 1973), W. Cornwall (Penzance), E. Cornwall (Rock, 1930), N. Devon (Braunton Burrows, 1917 and 1958), S. Hants. (Hayling Island, 1960: Southampton, 1958), W. Kent (Stone, 1974), Surrey (Peckham Fields, 1840), Oxon. (Oxford, 1972–77), Caerns. (Portmadoc, 1957), Denbigh (Llangollen), N. E. Yorks. (Redcar, 1958) and Edinburgh (Fushiebridge, 1962, 1964 and 1966).

O. erythrosepala Borb. (*O. lamarckiana* auctt., non Ser.). The largest flowered and probably our commonest species.

O. × *fallax* Renner em. Rost. (*O. biennis* × *O. erythrosepala*). Specimens attributable to the cross in which *O. erythrosepala* is the female parent (syns.O. × *fallax* sensu stricto, *O.* × *cantabrigiana* Davis, *O.* × *velutirubata* Renner) usually have the smaller flowers of *O. biennis*, but the red-striped sepals and at least some red-based hairs of *O. erythrosepala*, and have been seen from S. Lancs. (Aintree, 1942; Freshfield, 1956, 1961; Ince Moss, Wigan, 1969) and in the Oxford Botanic Garden, under various names, but the earliest record is from Guernsey in 1941/42, under *O.* × *velutirubata* (McClintock 1975). The reverse of this cross (syn. *O.* × *albivelutina* Renner), which is apparently more variable, was detected from N. Essex (Colchester, 1881), Oxon. (Banbury, 1972), Northants. (Northampton, 1875), Notts. (Nottingham, 1963), S. Lancs. (Birkdale, 1913), W. Lancs. (St Anne's, 1907), and Guernsey, 1941–42 (under *O.* × *albivelutina*) (McClintock 1975). In addition, this hybrid has been recorded from Jersey in 1881 and Somerset in 1833 (Davis 1926), and from Cheshire and S. Lancs. (Stace 1975).

O. muricata L. (*O. rubricaulis* Klebahn). In **LINN** Dr Rostanski found a specimen of Linnaeus' long disputed *O. muricata*, which proves its identity. This species was collected at Berrow, N. Somerset, in 1951 and at Lytham, W. Lancs., in 1965. It differs from the next species in its somewhat larger flowers, 10–25 mm, but with a hypanthium up to only 25 mm, and in its erect sepal-tips.

O. parviflora L. This has very small petals, up to 10 mm, but a long hypanthium, exceeding 25 mm, and spreading sepal-tips. Specimens have been seen only from Glamorgan (Port Talbot, 1905; Aberdare, before 1917).

O.perangusta Gates. This is like *O. muricata*, but has narrower, less toothed leaves, hairs with thick, red bases and fruits specially hairy on the angles. There are seven records: Cheshire (Hoole Bank, 1968), Glamorgan (Nantgarw, 1935; Abercym, 1961), N. Devon (Saunton, 1972), Surrey (Hurst Park, 1963), W. Kent (Stone, 1974), E. Suffolk (Ipswich, 1975–77).

O. renneri Scholz. Distinctive in its rosette of imbricating spathulate leaves, and stems which are grey with soft hairs. Known for certain only since the early 1960s from Borthwick Bank, Edinburgh.

O. salicifolia Desf. ex Don (*O. depressa* Greene, *O. hungarica* Borb., incl. *O. multiflora* Gates). A tall mostly unbranched plant with small red bases to the hairs and flowers often cleistogamous or falling in bud, with petals usually under 20 mm and fruits greyish with appressed hairs. There are two records—Baildon, Mid-W. Yorks., 1962 (under *O. multiflora*) and Bristol, before 1918. Compare also Gates (1914, p. 387).

O. victorini Gates & Catches. A distinctive species with almost entire leaves with a pink midrib recorded only from Cofton, S. Devon, in 1915 and later.

The only other species of *Oenothera* found wild in Britain is *O. stricta* Ledeb. ex Link, which belongs to subgenus *Raimannia*.

Despite previous determinations, no specimens seen were attributable to *O. ammophila, O. chicaginensis, O. grandiflora, O. nuda* or *O. suaveolens*, which should disappear from our lists in the absence of verification.

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D. McClintock

VARIATION IN TERMINAL LEAFLET SHAPE OF *ONONIS REPENS* L. IN THE BRITISH ISLES

Wild colonies of *Ononis repens* L. growing in various localities in the British Isles were sampled between the months of June and August from 1954 to 1956; in almost all localities, the exhaustive sampling method was employed except where some of the plants were inaccessible or the population was too

TABLE 1. MEAN TERMINAL LEAFLET INDICES OF *O. REPENS* IN THE BRITISH ISLES

Localities sampled	Sample size	Mean leaflet index	Standard error ±
1. Sands of Luce, Wigtown, v.c. 74	33	1·64	0·03
2. Oxwich Burrows, Glam., v.c. 41	33	1·66	0·05
3. Hartlepool Dunes, Durham, v.c. 66	137	1·67	0·02
4. Boxhill, Surrey, v.c. 17	100	1·70	0·03
5. Whitburn Coast, Durham, v.c. 66	149	1·73	0·02
6. Edinburgh, v.c. 83	34	1·78	0·04
7. Holy Island Dunes, Cheviot, v.c. 68	50	1·80	0·03
8. Lay-town, W. Meath, v.c. H23	34	1·81	0·03
9. Courtown Harbour, Wexford, v.c. H12	32	1·86	0·05
10. Slapton Sands, S. Devon, v.c. 3	66	1·87	0·04
11. Beachy Head, E. Sussex, v.c. 14	144	1·88	0·03
12. Corbridge, S. Northumb., v.c. 67	76	1·92	0·04
13. Tunstall, E. Suffolk, v.c. 25	111	1·93	0·03
14. Newmarket, W. Suffolk, v.c. 26	50	1·94	0·04
15. Berwick, Cheviot, v.c. 68	43	1·94	0·04
16. Oxwich mainroad, Glam., v.c. 41	34	1·95	0·04
17. Stroud Road (East), E. Gloucs., v.c. 33	33	1·95	0·03
18. Drigg Dunes, Cumberland, v.c. 70	51	1·95	0·04
19. Rodborough Common, W. Gloucs., v.c. 34	50	1·96	0·04
20. Quarrington, S. Lincs., v.c. 53	128	1·98	0·03
21. Albury, Surrey, v.c. 17	50	2·20	0·05
22. Stroud Road (West), E. Gloucs., v.c. 33	65	2·02	0·03
23. Newark/Sleaford Road, S. Lincs., v.c. 53	54	2·08	0·04
24. Clonakilty Bay, W. Cork, v.c. H3	38	2·35	0·04

large. With each plant sampled, the length and the greatest breadth of the terminal leaflet were measured; a leaflet index was then computed as the ratio of the former to the latter.

Table 1 shows the extent of inter-population variation in the leaf indices of the localities sampled. The data suggest that in the British Isles *Ononis repens* colonies show a continuous variation in their terminal leaflet indices. However, when some of these colonies are compared, they show significant differences in their terminal leaflet length, width, and index (i.e. leaflet shape). It also appears that most coastal colonies have lower leaf indices, and therefore broader terminal leaflets, than the inland colonies.

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C. E. Stephens
(Department of Botany, University of Cape Coast, Cape Coast, Ghana)

Plant Records

Records for publication must be submitted in the form shown below to the appropriate vice-county Recorder (*List of members* (1976)), and *not* to the Editors.

Records are arranged in the order given in the *List of British vascular plants* by J. E. Dandy (1958) and his subsequent revision (*Watsonia*, **7**: 157–178 (1969)), but *Taraxacum* is arranged according to A. J. Richards (*Watsonia*, **9**, Suppl. (1972)). With the exception of collectors' initials, herbarium abbreviations are those used in *British Herbaria* by D. H. Kent (1958).

The following signs are used:

* before the record: to indicate a new vice-county record.
† before the species number: to indicate that the plant is not a native species of the British Isles.
† before the record: to indicate a species which, though native in some parts of the British Isles, is not so in the locality recorded.
[] enclosing a previously published record: to indicate that the record should be deleted.

1/3. Lycopodium annotinum L. ***93**, N. Aberdeen: Bennachie, GR 38/68.23. Moorland at 1400 ft. A. H. Somerville, 1964, **ABD**.

1/5. Lycopodium alpinum L. **93**, N. Aberdeen: Buck of Cabrach, GR 38/41.23. 2200 ft. D. Welch, 1977, **ABD**. 1st post-1930 record.

2/1. Selaginella selaginoides (L.) Link ***47**, Montgomery: Lake Vyrnwy, GR 23/9.2. P. M. Benoit & M. O. Hill, 1975, field record. (*Nature Wales*, **16**: 64 (1978)).

3/1. Isoetes lacustris L. **74**, Wigtown: Black Loch, Castle Kennedy, GR 25/11.61. C.S.S.F. Field Meeting, 1977, field record. 1st post-1930 record. **85**, Fife: Dow and Lurg Loch, Cleish Hills, GR 36/09.96. G. H. Ballantyne, 1975, field record. 1st record since 1821.

3/2. Isoetes echinospora Durieu ***73**, Kirkcudbright: Lochenkit Loch, GR 25/80.75. O. M. Stewart, 1977, **BM**, det. A. C. Jermy.

4/4. Equisetum variegatum Schleich. ex Weber & Mohr ***1**, W. Cornwall: Penhale Sands, GR 10/77.57. Dune-slack. B.S.B.I. Field Meeting, 1977. **BM**, det. A. C. Jermy. Upton Towans, Hayle, GR 10/57.39. L. J. Margetts, 1977, **CAMB**. 1st and 2nd records.

4/8. Equisetum pratense Ehrh. **85**, Fife: Bishop Hill, GR 37/18.04. G. H. Ballantyne, 1975, field record, det. C. N. Page. 1st record since 1857.

4/9 × 5. Equisetum arvense L. × E. fluviatile L. **45**, Pembs.: near St. David's, GR 12/74.27. Moorland, P. M. Benoit, 1976, field record. 2nd record. (*Nature Wales*, **16**: 62 (1978)). ***85**, Fife: Cockairney gravel pit, Cleish, GR 36/09.98. G. H. Ballantyne, 1975, **herb. G.H.B.**, det. C. N. Page. 1st definite record. ***89**, E. Perth: Killiecrankie, GR 27/91.61. M. McC. Webster, 1976, **E**, conf. C. N. Page.

5/1. Osmunda regalis L. **73**, Kirkcudbright: near Newton, GR 25/55.53. H. J. B. & H. H. Birks, 1975, field record. Only known native habitat.

7/1. Hymenophyllum tunbrigense (L.) Sm. **72**, Dumfries: Auchenhessnane, Scaur Water, GR 25/80.96. H. J. B. Birks, 1976, field record. 2nd record.

9/1. Cryptogramma crispa (L.) R. Br. ex Hook. **93**, N. Aberdeen: Hill of Foudland, GR 38/60.33. D. Welch, 1976, field record. 1st post-1930 record.

15/1c. Asplenium cuneifolium Viv. ***88**, Mid Perth: Corrycharmaig, Glen Lochay, GR

27/52.35. P. Ewing, 1909, **GL**, det. R. H. Roberts & A. McG. Stirling. Corrycharmaig, Glen Lochay, GR 27/52.35. A. McG. Stirling, 1973, **E**. $2n = 72$.

15/2. Asplenium billotii F. W. Schultz ***47**, Montgomery: Machynlleth, GR 23/7.0. Roadside bank. P. M. Benoit, 1976, **NMW**. (*Nature Wales*, **16**: 64 (1978)).

15/6. Asplenium viride Huds. ***93**, N. Aberdeen: Hill of Towanreef, GR 38/46.24. Serpentine rocks. D. Welch, 1977, **ABD**.

†17/1. Matteuccia struthiopteris (L.) Tod. ***85**, Fife: Balbitnie, Markinch, GR 37/29.02. G. H. Ballantyne, 1974, field record.

21/2. Dryopteris pseudomas (Wollaston) Holub & Pouzar ***29**, Cambs.: Chippenham, GR 52/67.69. O. Vaughan, 1964, **CGE**, det. H. V. Corley, conf. A. C. Jermy. Wicken Fen, GR 52/5.7. A. C. Leslie, 1976, **CGE**, conf. A. C. Jermy. 1st and 2nd records.

21/3. Dryopteris abbreviata (DC.) Newm. **73**, Kirkcudbright: station at Gatehouse of Fleet, GR 25/54.62. C.S.S.F. Field Meeting, 1977, field record. 2nd record. ***74**, Wigtown: near Dirnow, GR 25/28.66. C.S.S.F. Field Meeting, 1977, **herb. A. J. Silverside**.

21/6 × 7. Dryopteris carthusiana (Vill.) H. P. Fuchs × D. dilatata (Hoffm.) A. Gray ***90**, Forfar: Drumore Loch, Blacklunans, GR 37/16.60. C.S.S.F. Field Meeting, 1977, **herb. U. K. Duncan**, det. A. J. Silverside.

22/1. Polystichum setiferum (Forsk.) Woynar **74**, Wigtown: by Beoch Burn, GR 25/09.65. C.S.S.F. Field Meeting, 1977, field record. 1st post-1930 record.

22/2 × 1. Polystichum aculeatum (L.) Roth × P. setiferum (Forsk.) Woynar ***48**, Merioneth: Ceunant Llenyrch, GR 23/6.3. P. M. Benoit, 1977, **NMW**, conf. A. C. Jermy.

24/4. Thelypteris dryopteris (L.) Slosson **93**, N. Aberdeen: Laithers, GR 38/67.47. Woodland. D. Welch, 1977, **ABD**. 1st post-1930 record.

25/1/2. Polypodium australe Fée ***57**, Derbys.: Hagg Rock, Matlock Bath, GR 43/2.5. 1860, in herb. collection of J. Whittacker, **DBY**, conf. A. C. Jermy, J. M. Mullin & J. A. Crabbe.

26/1. Pilularia globulifera L. **70**, Cumberland: Strands, Wasdale, GR 35/12.02. R. Stokoe, 1977, **herb. R.S.** Only extant locality.

46/22c. Ranunculus penicillatus (Dumort.) Bab. ***47**, Montgomery: River Vyrnwy, Llansantffraid, GR 33/2.1. F. H. Perring, 1976, field record. (*Nature Wales*, **16**: 64 (1978)).

56/1 × 2. Nuphar lutea (L.) Sm. × N. pumila (Timm) DC. **99**, Dunbarton: Rossdhu Woods, Luss, GR 26/35.87. A. McG. Stirling, 1976, field record. 2nd record.

58/1. Papaver rhoeas L. **73**, Kirkcudbright: Carsluith, GR 25/48.54. Among rocks near shore. O. M. Stewart, 1977, field record. 1st post-1930 record.

66/6b. Fumaria muralis Sond. ex Koch subsp. boraei (Jord.) Pugsl. ***93**, N. Aberdeen: Little Millbrex, GR 38/81.44. Roadside. D. Welch, 1976, field record.

66/7. Fumaria micrantha Lag. **80**, Roxburgh: Laretburn, St Boswells, GR 36/59.30. Roadside verge. R. W. M. Corner, 1976, **herb. R.W.M.C.** 1st post-1930 record.

67/4. Brassica nigra (L.) Koch ***74**, Wigtown: Wigtown, GR 25/46.59. C.S.S.F. Field Meeting, 1977, field record.

†69/3. Rhynchosinapis cheiranthos (Vill.) Dandy ***57**, Derbys.: Shirebrook North railway station, GR 43/52.68. J. G. Hodgson, 1977, field record.

74/2. Raphanus maritimus Sm. ***72**, Dumfries: Powfoot, GR 35/14.65. J. D. S. Martin, 1977, field record.

†79/p. Lepidium perfoliatum L. ***57**, Derbys.: Matlock Bank, GR 43/30.60. Road-verge. J. G. Hodgson, 1977, field record.

80/1. Coronopus squamatus (Forsk.) Aschers. **85**, Fife: Anstruther, GR 36/56.03. On tarmac near shore. G. H. Ballantyne, 1977, field record. 1st record since 1905.

85/1. Teesdalia nudicaulis (L.) R. Br. **79**, Selkirk: Blakehope Hill, Caddonfoot, GR 36/45.35. J. G. Roger, 1976, field record. 1st post-1930 record.

95/1. Erophila verna (L.) Chevall. ***93**, N. Aberdeen: Brae of Scurdargue, GR 38/47.28. D. Welch, 1977, **ABD**.

95/2. Erophila spathulata Láng ***73**, Kirkcudbright: Brighouse Bay, GR 25/63.45. A. McG. Stirling, 1960, field record.

†98/4. Barbarea verna (Mill.) Aschers. **80**, Roxburgh: Whitlaw, Hawick, GR 36/50.12. Railway embankment. R. W. M. Corner, 1976, **BM**. 1st definite post-1930 record. ***89**, E. Perth: Killiecrankie, GR 27/91.62. M. McC. Webster, 1976, **E**.

102/3. Rorippa sylvestris (L.) Bess. **73**, Kirkcudbright: near Buittle Farm, GR 25/82.62. O. M. Stewart, 1972, field record. 1st post-1930 record.

†104/1. Hesperis matronalis L. **73**, Kirkcudbright: N. W. of Dumfries, GR 25/97.76. M. E. R. Martin, 1973, field record. 1st post-1930 record.

113/5 × 4. Viola reichenbachiana Jord. ex Bor. × V. riviniana Reichb. **49**, Caerns.: Treborth, Bangor, GR 23/55.71. R. H. Roberts, 1976, field record. 2nd record. (*Nature Wales,* **16**: 65 (1978)).

113/11. Viola lutea Huds. ***93**, N. Aberdeen: Brae of Scurdargue, GR 38/47.28. D. Welch, 1977, **ABD**.

†115/2. Hypericum inodorum Miller ***27**, E. Norfolk: Corpusty, GR 63/12.30. Conifer plantation. M. A. Brewster, 1977, field record, conf. E. L. Swann.

115/6 × 5. Hypericum maculatum Crantz × H. perforatum L. **29**, Cambs.: Longstowe, GR 52/31.55. Meadow. A.C. Leslie, 1975, **herb. A.C.L.**, conf. N. K. B. Robson. 1st post-1930 record.

122/1. Elatine hexandra (Lapierre) DC. **70**, Cumberland: W. of Carlisle, GR 35/0.1. R. Stokoe, 1977, **herb. R.S.** Confirmation of pre-1930 locality and one of two extant localities. **74**, Wigtown: White Loch, Castle Kennedy, GR 25/11.60. C.S.S.F. Field Meeting, 1977, field record. 1st post-1930 record.

127/8. Dianthus deltoides L. **66**, Durham: Edmundbyers, GR 45/01.50. G. H. Ballantyne, 1977, **SUN**. Only extant locality.

131/10. Cerastium diffusum Pers. ***77**, Derbys.: Temple Normanton, GR 43/43.67. Railway track ballast. J. Hodgson & S. Band, 1972, field record. Morley, GR 43/38.39. J. Hodgson & A. Willmot, 1977, field record. 1st and 2nd records.

133/6. Stellaria palustris Retz. **45**, Pembs.: near Castle Morris, GR 12/90.31. Flood-plain mire. K. Pearce & S. K. Saggitt, 1977, **NMW**, det. S. B. Evans. 2nd record. (*Nature Wales,* **16**: 62 (1978)).

135/1. Moenchia erecta (L.) Gaertn., Mey. & Scherb. **48**, Merioneth: near Tywyn, GR 23/5.0. P. M. Benoit, 1977, **NMW**. 1st record since 1927.

136/1. Sagina apetala Ard. ***89**, E. Perth: Pitlochry station yard, GR 27/93.58. A. McG. Stirling, 1971, field record. 1st definite record.

136/3. Sagina maritima Don **44**, Carms.: Taf estuary, Llanstephan, GR 22/3.0 I. M. Vaughan, 1977, field record. 2nd record. (*Nature Wales,* **16**: 60 (1978)).

136/7. Sagina normaniana Lagerh. **89**, E. Perth: Glen Tarf, Atholl, GR 27/93.79. & 27/90.83. N. A. Sanderson, 1975, field records. 1st post-1930 records.

145/1. Corrigiola litoralis L. **†61**, S. E. Yorks.: Hull, GR 54/05.29. Disused railway sidings. F. E. Crackles, 1977, **herb. F.E.C.** 2nd record.

154/2. Chenopodium polyspermum L. *51, Flint: Connah's Quay, GR 33/30.69. Tip. V. Gordon, 1975, field record. *73, Kirkcudbright: Gatehouse of Fleet railway station, GR 25/54.62. C.S.S.F. Field Meeting, 1977, field record. *74, Wigtown: Castle Kennedy estate, GR 25/11.61. C.S.S.F. Field Meeting, 1977, field record.

†154/c. Chenopodium carinatum R. Br. *29, Cambs.: Kennett, GR 52/69.68. Filled gravel-pit tip. G. M. S. Easy, 1969, **herb. G.M.S.E.**

156/l. Atriplex longipes Drej. *69, Westmorland: Arnside, GR 34/46.78. Muddy foreshore. M. Baecker, 1977, **LANC**, det. P. M. Taschereau.

156/p. Atriplex praecox Hulphers *73, Kirkcudbright: near Borgue, GR 25/6.4. O. M. Stewart, 1977, **E**, det. P. Taschereau. *99, Dunbarton: Lochside, Garelochhead, GR 26/23.91. A. McG. Stirling, 1977, **E**, det. P. M. Taschereau.

157/1. Halimione portulacoides (L.) Aellen 74, Wigtown: Portdown Bay, GR 25/09.33. H. A. Lang, 1977, field record. 1st definite post-1930 record.

168/12. Geranium rotundifolium L. †*48, Merioneth: near Aberdovey railway station, GR 22/6.9. K. M. Stevens, 1975, **NMW**, det. P. M. Benoit.

168/14. Geranium pusillum L. †48, Merioneth: Aberdovey, GR 22/6.9. K. M. Stevens, 1977, **NMW**, conf. P. M. Benoit. 1st record since 1927.

169/3 × 4. Erodium cicutarium (L.) L'Hérit. × E. glutinosum Dumort. *49, Caerns.: near Warren Farm, Morfa Dinlle, GR 23/43.59. Sandy pasture. R. H. Roberts, 1961, field record. (*Nature Wales*, **16**: 65 (1978)).

180/1. Frangula alnus Mill. 73, Kirkcudbright: Bargaly Farm, Palnure, GR 25/45.65. A. McG. Stirling, 1960, field record. 2nd record.

†185/h. Genista hispanica L. subsp. occidentalis Rouy *46, Cards.: Constitution Hill, Aberystwyth, GR 22/58.82. A. O. Chater, 1977, **NMW**. Naturalised here since 1927. (*Nature Wales*, **16**: 63 (1978)).

†188/s. Cytisus striatus (Hill) Rothm. *46, Cards.: between Aberystwyth and Penparcau, GR 22/58.80. A. O. Chater, 1977, **NMW**, det. B. E. Smythies. 1st planted *c* 1970 and spreading. (*Nature Wales*, **16**: 63 (1978)).

190/1. Medicago falcata L. †85, Fife: near Ladybank, GR 37/29.11. Railway bank. G. H. Ballantyne, 1976, field record. 2nd record and 1st since 1889.

†191/2. Melilotus officinalis (L.) Pall. 73, Kirkcudbright: Kirkbean, GR 25/97.59. O. M. Stewart, 1977, **E**. 1st post-1930 record.

192/24. Trifolium micranthum Viv. *69b, Furness: Grange-over-Sands, GR 34/41.78. Lawn by station. S. M. Coles, 1977, **LANC**. 1st definite record.

200/2. Astragalus alpinus L. 89, E. Perth: Glen Shee, GR 37/1.7. Grassland on limestone. N. A. Sanderson, 1975, field record. 1st post-1930 record.

206/17. Vicia bithynica (L.) L. 51, Flint: 2 miles S. E. of Rhuddlan, GR 33/04.76. D. Stephenson, 1976, field record. 1st post-1930 record.

211/1. Rubus chamaemorus L. 73, Kirkcudbright: Alwhat, GR 26/61.99. H. A. Lang, 1974, field record. 2nd record. *85, Fife: Mellock Hill, Ochil Hills, GR 37/02.06. G. H. Ballantyne, 1975, field record.

211/9 × 6. Rubus caesius L. × R. idaeus L. *68, Cheviot: Shawdon Burn, GR 46/08.15. G. G. Graham, 1963, **herb. G.G.G.**

211/11/18. Rubus latifolius Bab. *80, Roxburgh: between Hawick and Appletreehall, GR 36/5.1. C. W. Muirhead, 1972, **E**. 89, E. Perth: Pitlochry, GR 27/9.5. M. McC. Webster, 1966, **E**. 2nd record.

211/11/21. Rubus balfourianus Bloxam ex Bab. **29**, Cambs.: White Wood, Gamlingay, GR 52/21.51. A. C. Leslie, 1977, **herb. A.C.L.**, conf. A. Newton. 1st definite record.

211/11/129. Rubus ulmifolius Schott ***80**, Roxburgh: Stobs railway station, GR 36/50.09. R. W. M. Corner, 1976, **herb. R.W.M.C.**, det. A. Newton.

211/11/a. Rubus anglocandicans A. Newton ***29**, Cambs.: Gamlingay, GR 52/23.52. A. C. Leslie, 1977, **herb. A.C.L.**, det. A. Newton.

211/11/w. Rubus wirralensis A. Newton ***73**, Kirkcudbright: Burn Foot, GR 25/74.44. C.S.S.F. Field Meeting, 1977, **herb. O. M. Stewart**, det. A. Newton.

218/2. Agrimonia odorata (Gouan) Mill. ***79**, Selkirk: Singliehill End, Ettrick, GR 36/36.21. Roadside verge. R. W. M. Corner, 1977, **herb. R.W.M.C.** 1st localized record.

223/1. Poterium sanguisorba L. **85**, Fife: Angle park, Ladybank, GR 37/29.11. Side of railway. G. H. Ballantyne, 1976, field record. 1st record since 1919.

225/9c × 14. Rosa coriifolia Fr. × R. rubiginosa L. ***90**, Forfar: Letham Grange railway station, 4½ miles N. of Arbroath, GR 37/63.45. U. K. Duncan, 1977, **K**, det. R. Melville.

225/17. Rosa agrestis Savi ***27**, E. Norfolk: Donkey Lane, Eaton, GR 63/20.06. E. T. Daniels, 1976, field record, conf. R. Melville.

225/17 × 8. Rosa agrestis Savi × R. canina L. ***27**, E. Norfolk: Donkey Lane, Eaton, GR 63/20.06. Chalk-pit. M. J. Wigginton, 1975, field record, det. R. Melville. 1976 material **herb. G. G. Graham**.

†227/2. Cotoneaster simonsii Bak. **73**, Kirkcudbright: Grey Mare's Tail, GR 25/49.72. About ten plants. C.S.S.F. Field Meeting, 1977, field record. 2nd record.

235/1. Sedum rosea (L.) Scop. **44**, Carms.: Carreg Cennen Castle, GR 22/66.19. Wall. Sir J. Holland, 1977, field record. 2nd record. (*Nature Wales*, **16**: 61 (1978)).

235/10. Sedum forsteranum Sm. †***85**, Fife: Kirkforthar, 1 mile S. of Freuchie, GR 37/28.04. Side of railway, well naturalized. G. H. Ballantyne, 1977, field record.

235/12. Sedum villosum L. **93**, N. Aberdeen: Buck of Cabrach, GR 38/42.24. D. Welch, 1968, field record. 1st post-1930 record.

239/2. Saxifraga stellaris L. ***93**, N. Aberdeen: Buck of Cabrach, GR 38/41.23. D. Welch, 1977, **ABD.**

242/1. Chrysoplenium oppositifolium L. ***29**, Cambs.: Woodbury, Beds., GR 52/2.5. J. G. & C. M. Dony, 1977, field record.

254/3 × 5. Epilobium montanum L. × E. roseum Schreb. ***29**, Cambs.: Bateman St, Cambridge, GR 52/45.57. Both parents present. A. C. Leslie, 1977, **herb. A.C.L.**

†254/6. Epilobium adenocaulon Hausskn. ***78**, Selkirk: Ettrick Water, Selkirk, GR 36/46.28. C. W. Muirhead, 1975, **herb. C.W.M.**

†254/6 × 3. Epilobium adenocaulon Hausskn. × E. montanum L. **29**, Cambs.: Hayley Wood, GR 52/29.53. Old railway track. A. C. Leslie & R. I. S. Brettell, 1977, **herb. A.C.L.** 2nd record. ***73**, Kirkcudbright: Grey Mare's Tail, GR 25/49.72. With both parents. C.S.S.F. Field Meeting, 1977, **E**.

254/7. Epilobium adnatum Griseb. ***99**, Dunbarton: Linns, Cove, GR 26/22.82. Garden weed. A. McG. Stirling, 1977, field record.

254/9 × 5. Epilobium obscurum Schreb. × E. roseum Schreb. ***62**, N. E. Yorks.: Robin Hood's Bay, GR 45/95.05. E. Chicken, 1975, **herb. E.C.**, det. T. D. Pennington.

262/3. Callitriche obtusangula Le Gall ***69**, Westmorland: Helton Tarn, Winster valley, GR 34/41.84. R. Stokoe, 1977, **herb. R.S.**, det. P. M. Benoit. ***70**, Cumberland: Monkhill, GR

35/33.58. Longtown, GR 35/36.68. 2nd record. Both records R. S. Stokoe, 1977, **herb. R.S.**, det. P. M. Benoit. New northern limit in Europe.

262/5. Callitriche hermaphroditica L. *70, Cumberland: Moorthwaite Lough, Wigton, GR 35/29.48. G. Halliday, 1976, **LANC**. 1st definite record. Thurstonfield Lough, GR 35/32.56. R. Stokoe, 1977, **LANC**, det. P. M. Benoit. 2nd record.

267/1. Chamaepericlymenum suecicum (L.) Aschers. & Graebn. ***93**, N. Aberdeen: Buck of Cabrach, GR 38/41.24. D. Welch, 1977, **ABD**.

285/1. Apium graveolens L. **67**, S. Northumb.: N. bank of R. Tyne near Heddon, Gr 45/14.65. G. A. Swan, 1977, **herb. G.A.S.** 1st record since 1911. **68**, Cheviot: Long Nanny near Tughall Mill, GR 46/22.27. G. A. & M. Swan, 1959, field record. 1st record since 1914.

285/2. Apium nodiflorum (L.) Lag. **85**, Fife: Clatto Reservoir, GR 37/36.07. G. H. Ballantyne, 1972, field record. 1st record for 100 years.

285/4. Apium inundatum (L.) Reichb. f. **85**, Fife: Culross Moor, GR 36/96.87. G. H. Ballantyne, 1972, field record. 1st record for 100 years.

288/1. Cicuta virosa L. **85**, Fife: Otterston Loch, Aberdour, GR 36/16.85. G. H. Ballantyne, 1969, field record. 1st record since 1903.

291/1. Carum verticillatum (L.) Koch **43**, Radnor: between Llanyre and Cross Gates, GR 32/06.64. R. G. Woods, 1977, field record. 2nd record. (*Nature Wales,* **16**: 59 (1978)).

300/1. Oenanthe fistulosa L. **85**, Fife: Newburgh, GR 37/22.18. Near shore of Firth of Tay. G. H. Ballantyne, 1976, field record. 1st localized record for 200 years.

304/1. Meum athamanticum Jacq. **85**, Fife: Gallandarea, 4 miles W. of Milnathort, GR 37/05.04. Pasture-land. G. H. Ballantyne, 1975, field record. 1st record since 1876.

†319/15. Euphorbia esula L. ***99**, Dunbarton: Duchess Woods, Helensburgh, GR 26/28.83. A. Rutherford, 1977, field record.

320/11. Polygonum nodosum Pers. ***73**, Kirkcudbright: Balmae, GR 25/68.44. C.S.S.F. Field Meeting, 1977, field record.

320/14. Polygonum minus Huds. ***99**, Dunbarton: shore of Loch Lomond near Tarbet, GR 27/3.0. J. H. Penson, 1966, field record. Shore of Loch Lomond near Ross Priory, GR 26/41.87. A. McG. Stirling, 1977, **E**. 1st and 2nd records.

†320/20. Polygonum sachalinense F. Schmidt ***67**, S. Northumb.: How Dene, near Wylam, GR 45/10.65. G. A. & M. Swan, 1977, **herb. G.A.S.** ***74**, Wigtown: Castle Kennedy estate, GR 25/11.60. C.S.S.F. Field Meeting, 1977, field record. ***79**, Selkirk: Glenkinnon Burn, below Peel Hospital, GR 36/43.34. Well established colony. R. W. M. Corner, 1977, field record. ***80**, Roxburgh: east end of policies of Monteviot House, GR 36/65.24. Well established colony. C.S.S.F. Field Meeting, 1977, field record.

†320/21. Polygonum polystachyum Wall. ex Meisn. ***74**, Wigtown: Newton Stewart, GR 25/41.65. Builder's yard. Castle Kennedy, GR 25/11.60. Woodland edge. 2nd record. Both records C.S.S.F. Field Meeting, 1977, field record.

†320/22. Polygonum campanulatum Hook. f. ***49**, Caerns.: Belan, Morfa Dinlle, GR 23/44.58. Hedgerow. L. J. Larsen, 1977, **NMW**. (*Nature Wales,* **16**: 65 (1978)). **73**, Kirkcudbright: Shambellie, GR 25/96.66. Well naturalized, known for over 25 years. O. M. Stewart, 1976, field record. 2nd record.

325/8. Rumex longifolius DC. ***79**, Selkirk: Tweedside above Gala Foot, GR 36/50.34. Riverside. C.S.S.F. Field Meeting, 1977, **herb. R. W. M. Corner**. 1st localized record.

343/13 × 16. Salix aurita L. × S. repens L. **106**, E. Ross: near Garbat, by Garve, GR 28/41.67. U. K. Duncan, 1977, **herb. U.K.D.**, det. R. D. Meikle. 1st record since 1890.

343/20. Salix myrsinites L. *99, Dunbarton: Creag an Leinibh, Glen Luss, GR 26/31.92. Rock ledge on calcareous schist. A. McG. Stirling, 1977, **E**. 1st definite record.

343/21. Salix herbacea L. **93**, N. Aberdeen: Buck of Cabrach, GR 38/41.23. Dwarfed Callunetum at 2300 ft. D. Welch, 1977. **ABD**. 1st record since 1860; from the only locality.

346/1. Loiseleuria procumbens (L.) Desv. **99**, Dunbarton: near Stob na Coinnich Bhacain, N. E. of Ben Vorlich, GR 27/30.15. A. McG. Stirling, 1977, field record. 2nd record.

350/1. Andromeda polifolia L. **44**, Carms.: Llanllwch, GR 23/36.18. Peat bog. S. B. Evans & M. J. Dunn, 1977, field record. 2nd localized record. (*Nature Wales*, **16**: 61 (1978)).

354/1. Arctostaphylos uva-ursi (L.) Spreng. ***93**, N. Aberdeen: Turf Hill, GR 38/45.26. Heather moor. D. Welch, 1977, **ABD**. ***99**, Dunbarton: ½ mile S. E. of Lochan Beinn Damhain, near Ardlui, GR 27/29.16. A. McG. Stirling, 1976, **E**.

358/1. Vaccinium vitis-idaea L. ***93**, N. Aberdeen: Turf Hill, GR 38/45.26. Heather moor. D. Welch, 1977, **ABD**.

364/2. Empetrum hermaphroditum Hagerup ***93**, N. Aberdeen: Buck of Cabrach, GR 38/41.23. Among rocks at 2350 ft. D. Welch, 1977, **ABD**.

370/3. Lysimachia vulgaris L. ***80**, Roxburgh: Bewlie Moss, 2 miles E. of Lilliesleaf, GR 36/56.25. Fen. M. E. Braithwaite, 1976, **herb. R. W. M. Corner**. 1st localized record. †***93**, N. Aberdeen: West Crichie, GR 38/97.43. Roadside. D. Welch, 1976, **ABD**.

372/4. Anagallis minima (L.) E. H. L. Krause **73**, Kirkcudbright: Gatehouse of Fleet station, GR 25/54.62. C.S.S.F. Field Meeting, 1977, field record. 2nd record. **74**, Wigtown: White Loch, Castle Kennedy, GR 25/10.60. C.S.S.F. Field Meeting, 1977, field record. 1st post-1930 record. **99**, Dunbarton: south side of Carman Muir, Cardross, GR 26/36.78. A. McG. Stirling, 1976, field record. 2nd record.

†392/2. Symphytum asperum Lepech. ***28**, W. Norfolk: Hargham, GR 52/02.91. Churchyard. P. G. Lawson, 1974, field record, conf. E. L. Swann.

†395/1. Pentaglottis sempervirens (L.) Tausch ***93**, Aberdeen: Brae of Scurdargue, GR 38/47.28. D. Welch, 1977, **ABD**.

399/1. Pulmonaria longifolia (Bast.) Bor. †***85**, Fife: Balbirnie Estate, Markinch, GR 37/29.02. Copse. G. H. Ballantyne, 1977, field record. Well naturalized.

405/1. Convolvulus arvensis L. **74**, Wigtown: White Loch, Castle Kennedy, GR 25/10.61. Roadside. C.S.S.F. Field Meeting, 1977, field record. 1st post-1930 record.

†406/3. Calystegia silvatica (Kit.) Griseb. **74**, Wigtown: White Loch, Castle Kennedy, GR 25/10.61. C.S.S.F. Field Meeting, 1977, field record. 1st post-1930 record.

406/4. Calystegia soldanella (L.) R. Br. ***68**, Cheviot: near Scremerston, GR 46/02.48. A. T. Blair & M. Tulloh, 1975, **herb. G. A. Swan.** Near Warkworth, GR 46/26.05. W. A. Clark, 1977, **herb. G.A.S.** 2nd record.

416/4 × 1. Verbascum lychnitis L. × V. thapsus L. †***46**, Cards.: Felin-y-mor, 1 km S. of Aberystwyth, GR 22/58.80. Disused railway line. A. O. Chater, 1977, **NMW**, det. I. K. Ferguson. (*Nature Wales*, **16**: 63 (1978)).

†420/2. Linaria purpurea (L.) Mill. **74**, Wigtown: Castle Kennedy, GR 25/11.60. Old walls. C.S.S.F. Field Meeting, 1977, field record. 1st post-1930 record. ***89**, E. Perth: Pitlochry station yard, GR 27/93.58. A. McG. Stirling, 1971, field record.

420/3. Linaria repens (L.) Mill. ***74**, Wigtown: Barsalloch Point, Monreith, Machars Peninsula, GR 25/34.41. Shingle by sea. P. F. Yeo, 1974, **CGE**.

†425/1 × 2. Mimulus guttatus DC. × M. luteus L. ***99**, Dunbarton: near Gavinburn Farm, Old Kilpatrick, GR 26/45.73. A. McG. Stirling, 1972, field record.

427/1. Sibthorpia europaea L. **46**, Cards.: Bangor Teifi, GR 22/3.3. A. O. Chater, 1977, **NMW**. 1st post-1930 record. (*Nature Wales*, **16**: 63 (1978)).

†428/1. Erinus alpinus L. ***74**, Wigtown: Castle Kennedy, GR 25/11.60. Old walls. C.S.S.F. Field Meeting, 1977, field record.

430/6. Veronica montana L. **93**, N. Aberdeen: Den of Auchmedden, GR 38/85.65. J. G. Roger, 1954, **ABD**. 1st post-1930 record.

†430/14. Veronica peregrina L. ***74**, Wigtown: Douglas Ewart School, Newton Stewart, GR 25/40.65. Garden. C.S.S.F. Field Meeting, 1977, field record, conf. A. J. Silverside.

†430/24. Veronica filiformis Sm. ***93**, N. Aberdeen: Laithers, GR 38/67.47. D. Welch, 1977, **ABD**.

435/1/1. Euphrasia micrantha Reichb. ***85**, Fife: by Stronachie Reservoir, 4 miles N.W. of Milnathort, GR 37/06.08. G. H. Ballantyne, 1974, **herb. G.H.B.**, det. P. F. Yeo.

435/1/2. Euphrasia scottica Wettst. ***74**, Wigtown: 2½ miles S. of Newton Stewart, GR 25/39.60. P. F. Yeo, 1974, **herb. P.F.Y.**

435/1/4. Euphrasia frigida Pugsl. ***99**, Dunbarton: Ben Vorlich, GR 27/2.1. R. Mackechnie, 1957, field record.

435/1/13. Euphrasia nemorosa (Pers.) Wallr. **74**, Wigtown: Barvennan Moss, S. W. of Newton Stewart, GR 25/38.60. P. F. Yeo, 1974, **herb. P.F.Y.** 1st post-1930 record.

439/1. Lathraea squamaria L. ***48**, Merioneth: Carrog, near Corwen, GR 33/1.4. P. M. Benoit, 1977, field record. 1st record of native occurrence.

440/2. Orobanche purpurea Jacq. ***12**, N. Hants.: Stoke, near St Mary Bourne, GR 41/40.51. Paddock. P. J. Chandler, 1976, **herb. A. Brewis**, det. S. A. Brewis.

440/8. Orobanche minor Sm. ***99**, Dunbarton: between Old Kilpatrick and Bowling, GR 26/45.73. Disused railway track. J. H. Penson, 1964, **E**.

480/2. Lobelia dortmanna L. **85**, Fife: Dow and Lurg Lochs, Cleish Hills, GR 36/09.96. G. H. Ballantyne, 1975, field record. 1st record since 1905.

485/2. Galium boreale L. **85**, Fife: Bishop Hill, GR 37/18.04. G. H. Ballantyne, 1972, field record. 1st record since 1872.

485/3 × 4. Galium mollugo L. × G. verum L. ***67**, S. Northumb.: near the Eals, N. Tyne, GR 35/75.85. G. A. & M. Swan, 1963, **herb. G.A.S.**, det. F. H. Perring. ***74**, Wigtown: near Spittal, GR 25/37.57. C.S.S.F. Field Meeting, 1977, **E.**

†492/1. Leycesteria formosa Wall. ***46**, Cardigan: between Moriah and Nanteos, GR 22/62.78. Scrub. A. O. Chater, 1976, field record. (*Nature Wales*, **16**: 63 (1978)).

†502/3. Bidens frondosa L. **35**, Mon.: Pontnewydd near Cwmbran, GR 31/2.9. Canal bank. D. Moore, 1977, **NMW**, det. A. E. Wade. 2nd record. (*Nature Wales*, **16**: 57 (1978)).

506/2 × 1. Senecio aquaticus Hill × S. jacobaea L. **29**, Cambs.: Cambridge, GR 52/44.57. Ditchbank by R. Cam. A. C. Leslie & A. M. Smith, 1977, **herb. A.C.L.**, conf. P. D. Sell. 2nd record.

†506/4 × 8. Senecio squalidus L. × S. vulgaris L. ***29**, Cambs.: Bourn, GR 52/33.55. Old railway track. R. I. S. Brettell & A. C. Leslie, 1977, **CGE**. $2n = 30$. 1st natural occurrence of the hybrid.

†506/18 × 1. Senecio cineraria DC. × S. jacobaea L. ***48**, Merioneth: Cambrian Road, Tywyn, GR 23/5.0. D. E. M. Paish & K. M. Stevens, 1975, field record, conf. P. M. Benoit. Llwyngwril, GR 23/5.0. K. M. Stevens, 1975, **NMW**, conf. P. M. Benoit. 1st and 2nd records.

509/1. Petasites hybridus (L.) Gaertn., Mey. & Scherb. **89**, E. Perth: S. bank of R. Dean, GR 37/30.45. R. B. Robb, 1975, field record. 1st record of female plant.

†509/3. PETASITES JAPONICUS (Sieb. & Zucc.) F. Schmidt *85, Fife: Pitcarlie Estate, 2 miles S. of Newburgh, GR 37/23.15. Parkland, well established. G. H. Ballantyne, 1976, field record.

515/1. GNAPHALIUM SYLVATICUM L. *45, Pembs.: Poppit sands, St Dogmaels, GR 22/15.48. V. Gordon, 1955, field record, 1st localized record. (*Nature Wales*, **16**: 62 (1978)).

535/7. ARTEMISIA MARITIMA L. **85**, Fife: Fife Ness, GR 36/63.09. G. H. Ballantyne, 1976, field record. 1st record since 1905.

540/8. CIRSIUM DISSECTUM (L.) Hill **57**, Derbys.: Willington Junction, GR 43/30.29. A. Willmot, 1977, **DBY**. 1st post-1930 record.

540/8 × 3. CIRSIUM DISSECTUM (L.) Hill × C. PALUSTRE (L.) Scop. **29**, Cambs.: Wicken Fen, GR 52/55.70. A. C. Leslie & R. I. S. Brettell, 1977, field record. 2nd record and 1st since 1840.

†541/1. SILYBUM MARIANUM (L.) Gaertn. **73**, Kirkcudbright: Creetown, GR 25/47.58. C.S.S.F. Field Meeting, 1977, field record. Rediscovered at site of 1st and only record (1905).

544/3. CENTAUREA CYANUS L. **74**, Wigtown: Cruggleton, GR 25/48.43. Cliff-top field. H. A. Lang, 1977, field record. 1st post-1930 record.

544/8. CENTAUREA ASPERA L. †***44**, Carms.: Pembrey Country Park, GR 22/39.00. Grassy bank on old dunes. Mr & Mrs S. Powell, 1977, **NMW**. (*Nature Wales*, **16**: 61 (1978)).

†547/2. LAPSANA INTERMEDIA Bieb. ***49**, Caerns.: Gt Orme's Head, GR 23/76.82. Limestone grassland. R. J. Pankhurst, 1977, **BM**, det. P. D. Sell. (*Nature Wales*, **16**: 65 (1978)).

555/1. MYCELIS MURALIS (L.) Dumort. ***79**, Selkirk: Eldinhope Linn, Yarrow, GR 36/30.23. Rocky bank. R. W. M. Corner, 1976, field record.

552/1b. TRAGOPOGON PRATENSIS L. subsp. MINOR (Mill.) Wahlenb. **73**, Kirkcudbright: S. of Castle Douglas, GR 25/77.60. O. M. Stewart, 1977, field record. 2nd record. ***74**, Wigtown: Monreith Bay, GR 25/35.41. C.S.S.F. Field Meeting, 1977, field record.

558/1/94. HIERACIUM DURICEPS F. J. Hanb. ***85**, Kinross: Warroch area, 3 miles N. of Crook of Devon, GR 37/04.05. G. H. Ballantyne, 1974, **herb. G.H.B.**, det. A. McG. Stirling.

558/1/139. HIERACIUM RUBIGINOSUM F. J. Hanb. ***54**, N. Lincs.: Broughton, Humberside, GR 44/96.10. Limestone quarry. B. N. K. Davis, 1976, **herb. Monks Wood Exptl St.**, det. P. D. Sell.

558/1/140. HIERACIUM DECOLOR (W. R. Linton) A. Ley ***66**, Durham: Wynch Bridge, Teesdale, GR 35/90.27. G. G. Graham, 1976, **SUN**, det. J. N. Mills.

588/1/156. HIERACIUM RECTULUM A. Ley ***46**, Cards.: Allt Pantygourych, 1·5 km N.E. of Llangeitho, GR 22/62.61. Rocks in oakwood. A. O. Chater, 1977, **NMW**, det. P. D. Sell. (*Nature Wales*, **16**: 63 (1978)).

558/1/162. HIERACIUM CHERIENSE Jord. ex Bor. †***29**, Cambs.: Cambridge University Botanic Garden, GR 52/45.57. P. D. Sell, 1950, **CGE**.

†558/2/8. HIERACIUM BRUNNEOCROCEUM Pugsl. ***74**, Wigtown: Wigtown, GR 25/43.55. Old railway. P. Adam, 1974, **herb. P.A.**, det. P. D. Sell.

559/4. CREPIS MOLLIS (Jacq.) Aschers. **90**, Forfar: Caenlochan Glen, GR 37/18.77. J. M. Mullin & R. J. Pankhurst, 1977, **BM**, det. J. B. Marshall. 1st record since 1850.

560/3. TARAXACUM LACISTOPHYLLUM (Dahlst.) Raunk. ***48**, Merioneth ***91**, Kincardine

560/4. TARAXACUM RUBICUNDUM (Dahlst.) Dahlst. ***61**, S.E. Yorks.

560/15. TARAXACUM FULVUM Raunk. ***91**, Kincardine

560/20. TARAXACUM PROXIMUM (Dahlst.) Dahlst. ***17**, Surrey

560/21. TARAXACUM SIMILE Raunk. ***91**, Kincardine

560/25. TARAXACUM POLYODON Dahlst. ***91**, Kincardine

560/33. TARAXACUM UNGUILOBUM Dahlst. ***91**, Kincardine

560/36. TARAXACUM FAEROENSE (Dahlst.) Dahlst. ***91**, Kincardine

560/37. TARAXACUM SPECTABILE Dahlst. ***48**, Merioneth

560/42. TARAXACUM EURYPHYLLUM (Dahlst.) M. P. Chr. ***91**, Kincardine

560/44. TARAXACUM PRAESTANS H. Lindb. f. ***61**, S.E. Yorks.

560/46. TARAXACUM NAEVOSIFORME Dahlst. ***72**, Dumfries ***91**, Kincardine

560/50. TARAXACUM NAEVOSUM Dahlst. ***91**, Kincardine

560/64. TARAXACUM ADAMII Claire ***48**, Merioneth

560/67. TARAXACUM SUBCYANOLEPIS M. P. Chr. ***17**, Surrey ***91**, Kincardine

560/69. TARAXACUM SELLANDII Dahlst. ***91**, Kincardine

560/71. TARAXACUM SUBLACINIOSUM Dahlst. & H. Lindb. f. ***46**, Cards. ***70**, Cumberland

560/75. TARAXACUM PANNUCIUM Dahlst. ***17**, Surrey ***46**, Cards. ***91**, Kincardine

560/77. TARAXACUM PALLESCENS Dahlst. ***12**, N. Hants.

560/84. TARAXACUM INSIGNE Raunk. ***91**, Kincardine

560/86. TARAXACUM SUBLAETICOLOR Dahlst. ***12**, N. Hants.

560/90. TARAXACUM SPILOPHYLLUM Dahlst. ***61**, S.E. Yorks. ***70**, Cumberland

560/92. TARAXACUM CHERWELLENSE A. J. Richards ***12**, N. Hants.

†560/98. TARAXACUM PECTINATIFORME H. Lindb. f. ***12**, N. Hants.

560/112. TARAXACUM CHRISTIANSENII Hagl. ***70**, Cumberland

560/113. TARAXACUM BRACTEATUM Dahlst. ***12**, N. Hants.

560/114. TARAXACUM HAMATUM Raunk. ***48**, Merioneth ***70**, Cumberland ***91**, Kincardine

560/115. TARAXACUM HAMATIFORME Dahlst. ***91**, Kincardine

560/116. TARAXACUM MARKLUNDII Palmgr. ***46**, Cards.

560/117. TARAXACUM LATISECTUM H. Lindb. f. ***17**, Surrey

560/121. TARAXACUM RAUNKIAERI Wiinst. ***91**, Kincardine

570/3. ELODEA NUTTALLII (Planch.) St John ***57**, Derbys.: River Hipper, Somersall Park, Chesterfield, GR 43/35.70. J. G. Hodgson, 1976, field record. Melbourne pool, GR 43/38.24. A. Wilmot, 1977, field record. 2nd record. ***69**, Westmorland: S.E. side of Coniston Water, GR 34/29.91. C. D. Pigott, 1976, **LANC**. Brothers Water, GR 35/40.12. R. Stokoe, 1977, **herb. R.S.** 2nd of several records. ***70**, Cumberland: N. end of Derwentwater, Keswick, GR 35/25.23. S. end of Bassenthwaite Lake, GR 35/22.27. 2nd record. Both records R. Stokoe, 1977, **herb. R.S.**

576/1. ZOSTERA MARINA L. ***74**, Wigtown: S.E. end of Loch Ryan, GR 25/08.61. C.S.S.F. Field Meeting, 1977, field record, det. T. G. Tutin.

576/2. ZOSTERA ANGUSTIFOLIA (Hornem.) Reichb. ***61**, S.E. Yorks.: Spurn, GR 54/4.1. B. Pashby, 1977, **herb. F. E. Crackles**.

577/5. POTAMOGETON LUCENS L. ***99**, Dunbarton: Forth and Clyde Canal, Old Kilpatrick, GR 26/45.73. A. McG. Stirling, 1970, field record. Forth and Clyde Canal, Bowling, GR 26/45.73. C.J. Raymond, 1976, **E**, det. A. J. Silverside & A. C. Jermy. 2nd record.

577/7 × 19. POTAMOGETON ALPINUS Balb. × P. CRISPUS L. *79, Selkirk: N. bank of R. Tweed at Holylee, Inner Leithen, GR 36/39.37. N. T. H. Holmes, 1971, **BM**, det. J. E. Dandy.

577/11. POTAMOGETON FRIESII Rupr. **73**, Kirkcudbright: Loch Milton, GR 25/83.71. R. C. L. Howitt, 1977, **E**. 2nd record. ***99**, Dunbarton: Forth and Clyde Canal between Clydebank and Dalmuir, GR 26/49.70. A. J. Silverside, 1975, field record.

577/16. POTAMOGETON TRICHOIDES Cham. & Schlecht. ***99**, Dunbarton: Forth and Clyde Canal at Temple Bridge, Glasgow, GR 26/54.69. C. J. Raymond & A. Aird, 1976, **E**, det. A. J. Silverside & A. C. Jermy.

577/19 × 16. POTAMOGETON CRISPUS L. × P. TRICHOIDES Cham. & Schlecht. ***99**, Dunbarton: Forth and Clyde Canal, Garscadden, Glasgow, GR 26/52.69. C. J. Raymond, 1976, **E**, det. A. J. Silverside & A. C. Jermy.

577/20. POTAMOGETON FILIFORMIS Pers. ***80**, Roxburgh: Essenside Loch, Ashkirk, GR 36/45.20. R. W. M. Corner, 1976, **BM**, det. A. C. Jermy.

†593/1. LILIUM MARTAGON L. ***47**, Montgomery: Lower Garth near Guilsfield, GR 33/21.10. Naturalized in wood. V. J. Macnair, 1950's, field record.

†593/2. LILIUM PYRENAICUM Gouan ***47**, Montgomery: near Llyn Mawr, Caersws, GR 33/0.9. Ditch. V. J. Macnair, 1950's, field record. Near Llangynew, GR 33/12.09. Hedgebank. V. J. Macnair, 1950's, field record. 1st and 2nd records.

605/26. JUNCUS TRIGLUMIS L. ***85**, Fife: Carmodle, Ochil Hills, GR 37/03.05. G. H. Ballantyne, 1974, field record. 1st definite record.

605/f. JUNCUS FOLIOSUS Desf. ***2**, E. Cornwall: Pentire Peninsula, GR 10/93.79. L. J. Margetts, 1977, **herb. L.J.M.**

†606/4. LUZULA LUZULOIDES (Lam.) Dandy & Wilmott ***79**, Selkirk: near upper loch, Bowhill, Selkirk, GR 36/43.27. Sides of path in woodland. C.S.S.F. Field Meeting, 1977, **herb. R. W. M. Corner**. ***80**, Roxburgh: Perch Pond Wood, 2 miles N. E. of Ancrum, GR 36/64.26. Oak forest. C. S. S. F. Field Meeting, 1977, **herb. R. W. M. Corner.**

607/5. ALLIUM VINEALE L. **89**, E. Perth: Pitlochry station yard, GR 27/93.58. A. McG. Stirling, 1971, field record. 2nd record.

†607/9b. ALLIUM ROSEUM L. subsp. BULBIFERUM (DC.) E. F. Warb. ***46**, Cards.: Henfynyw Churchyard, GR 22/44.61. Naturalized in abundance. A. O. Chater, 1977, **NMW**. (*Nature Wales*, **16**: 64 (1978)).

611/2. LEUCOJUM AESTIVUM L. †***86**, Stirling: near confluence of Burn of Mar and R. Endrick, GR 26/43.88. J. Mitchell, 1977, **E**.

625/1. EPIPACTIS PALUSTRIS (L). Crantz **51**, Flint: Connah's Quay, GR 33/29.69. Waste ground. V. Gordon, 1975, field record. 1st post-1930 record.

631/1. HAMMARBYA PALUDOSA (L.) Kuntze ***46**, Cardigan: Cwm Ystwyth, GR 22/8.7. A. O. Chater, 1977, field record. (*Nature Wales*, **16**: 64 (1978)).

643/1 × 7. DACTYLORHIZA FUCHSII (Druce) Soó × D. TRAUNSTEINERI (Sauter) Soó ***49**, Caerns.: near Edern, GR 23/28.39. With both parents in a base-rich fen. R. H. Roberts & S. D. Ward, 1976, field record. (*Nature Wales*, **16**: 66 (1978)).

643/2 × 636/1. DACTYLORHIZA MACULATA (L.) Soó × GYMNADENIA CONOPSEA (L.) R. Br. ***73**, Kirkcudbright: Dromore, GR 25/54.63. With both parents. C.S.S.F. Field Meeting, 1977, **E**.

643/3b. DACTYLORHIZA INCARNATA (L.) Soó subsp. PULCHELLA (Druce) Soó ***2**, E. Cornwall: Retire Common, GR 20/0.6. Heathland. L. J. Margetts, 1977, field record, det. R. H. Roberts.

643/6c. DACTYLORHIZA MAJALIS (Reichb.) Hunt & Summerhayes subsp. CAMBRENSIS R. H.

Roberts. **52**, Anglesey: Cob Pool, Malltraeth, GR 23/41.68. Base-rich marsh. R. Arthur, 1976, field record, det. R. H. Roberts. 2nd record. (*Nature Wales,* **16**: 68 (1978)).

645/1. ANACAMPTIS PYRAMIDALIS (L.) Rich. **73**, Kirkcudbright: Abbey Burn Foot, GR 25/74.44. C.S.S.F. Field Meeting, 1977, field record. 1st record since 1882.

†646/1. ACORUS CALAMUS L. ***69b**, Furness: Esthwaite Water, GR 34/35.96. R. Stokoe, 1977, **herb. R.S.** ***70**, Cumberland: Brigham, Cockermouth, GR 35/08.31. J. D. Hinde, 1949. field record. 1977 specimen **herb. R. Stokoe**. Hutton-in-the-Forest, GR 35/46.35. R. Stokoe, 1977, **herb. R.S.** 2nd record. ***74**, Wigtown: Ardwell, GR 25/10.45. C.S.S.F. Field Meeting, 1977, field record.

649/2. ARUM ITALICUM Mill. †***48**, Merioneth: Minfford near Portmadoc, GR 23/59.38. R. H. Roberts, 1976, field record.

652/4. SPARGANIUM MINIMUM Wallr. **80**, Roxburgh: Kippielaw Moss, Hawick, GR 36/49.15. R. W. M. Corner, 1977, **herb. R.W.M.C.** 2nd record.

654/2. ERIOPHORUM GRACILE Roth ***41**, Glam.: near Swansea, GR 21/6.9. A. Lees, 1977, **NMW**. (*Nature Wales,* **16**: 58 (1978)).

662/1. KOBRESIA SIMPLICIUSCULA (Wahlenb.) Mackenzie **89**, E. Perth: near Ben Vuirich, GR 27/9.7. and 27/9.8. Calcareous flushes. B. S. Brookes & R. A. H. Smith, 1975, **herb. B.S.B.**, det. R. Mackechnie. 2nd record, 2 localities.

663/1. CAREX LAEVIGATA Sm. **43**, Radnor: Llananno, GR 32/04.77. Boggy moorland. A. C. Powell, 1977, field record. Llandegley Rocks, GR 32/12.61. R. G. Woods, 1977, field record. 2nd and 3rd records. (*Nature Wales,* **16**: 59 (1978)).

663/3. CAREX PUNCTATA Gaudin ***46,** Cards.: Cardigan, GR 22/18.45. Alder carr. T. A. W. Davis, 1970, **NMW**, det. A. O. Chater & R. W. David. (*Nature Wales,* **16**: 64 (1978)).

663/4 × 7. CAREX HOSTIANA DC. × C. LEPIDOCARPA Tausch ***67**, S. Northumb.: Beldon Cleugh, GR 35/91.50. G. A. & M. Swan, 1972, **herb. G.A.S.**, det. A. C. Jermy. Caw Burn, GR 35/73.68. C. M. Wilson, 1977, **herb. G.A.S.**, conf, A.C.J. 2nd record.

663/23. CAREX STRIGOSA Huds. ***47**, Montgomery: near Abermule, GR 32/1.9. Wooded roadside. P. M. Benoit, 1977, **NMW**. (*Nature Wales,* **16**: 64 (1978)). ***60**, W. Lancs.: Broad Meadow Wood, Aighton, Bailey and Chaigley, GR 34/69.41. By stream. T. Blockeel, 1970, **LIV**. N. W. of Galgate, Lancaster, GR 34/47.55. In oakwood. G. Halliday, 1974, **LANC**. 2nd record.

663/28. CAREX LIMOSA L. **41**, Glam.: near Swansea, GR 21/6.9. Fen. A. Lees, 1977, **NMW**, conf. A. O. Chater. 1st record since 1804. (*Nature Wales,* **16**: 58 (1978)).

663/33. CAREX LASIOCARPA Ehrh. ***99**, Dunbarton: Geal Loch, Inverarnan, GR 27/31.16. A. McG. Stirling, 1976, **E**.

663/48. CAREX AQUATILIS Wahlenb. ***67**, S. Northumb.: River Irthing near Paddaburn, GR 35/65.76. G. A. & M. Swan, 1977, **herb. G.A.S.**, cont. A. C. Jermy.

663/52. CAREX BIGELOWII Torr. ex Schwein. **66**, Durham: Burnhope Seat, Burnhope Moor, GR 35/78.37. 2400 ft. R. W. M. Corner, 1977, field record. 2nd record.

663/54 × 71. CAREX PANICULATA L. × C. REMOTA L. ***57**, Derbys.: by Shirley Brook, GR 43/21.41. K. M. Hollick, 1977, **DBY**.

663/68/b. CAREX MURICATA L. subsp. PAIRAEI (F. W. Schultz) Čelak. ***82**, Haddington: North Berwick Law, GR 36/55.84. I. R. Bonner, 1974, field record, det. R. W. David.

663/69. CAREX ELONGATA L. **73**, Kirkcudbright: near Kenmure Castle, New Galloway, GR 25/63.76. J. Mitchell, 1976, **E**. 1st post-1930 record, rediscovered at original locality. Near Wood of Cree, Newton Stewart, GR 25/37.71. D.A. Ratcliffe, 1977, field record. 2nd record. ***86**, Stirling: near confluence of Burn of Mar and River Endrick, GR 26/43.88. J. Mitchell, 1977, **E**.

663/81. Carex dioica L. *41, Glam.: near Swansea, GR 21/6.9. Fen. A. Lees, 1977, **NMW**, conf. A. O. Chater. 1st post-1930 record. (*Nature Wales*, **16**: 58 (1978)).

669/1 × 2. Glyceria fluitans (L.) R. Br. × G. plicata Fr. *93, N. Aberdeen: West Crichie, GR 38/97.43. D. Welch, 1976, **ABD**.

669/3. Glyceria declinata Bréb. *93, N. Aberdeen: Leslie, GR 38/60.24. D. Welch, 1976, **ABD**.

670/3 × 671/1. Festuca gigantea (L.) Vill. × Lolium perenne L. *48, Merioneth: near Pennal, GR 22/7.9. P. M. Benoit, 1973, **NMW**, conf. C. E. Hubbard.

670/4. Festuca altissima All. 47, Montgomery: between Machynlleth and Glandyfi, GR 22/7.9. Wooded glen. P. M. Benoit, 1974, field record. 1st post-1930 record. (*Nature Wales*, **16**: 64 (1978)). 73, Kirkcudbright: Glenlee Burn, Dalry, GR 25/60.81. A. McG. Stirling, 1960, field record. 1st post-1930 record.

670/6 × 672/3. Festuca rubra L. × Vulpia myuros (L.) C. C. Gmel. *28, W. Norfolk: Snettisham, GR 53/65.33. R. P. Libbey, 1974, **herb. R.P.L.**, det. C. A. Stace.

670/11. Festuca longifolia Thuill. *57, Derbys: Taddington by-pass, GR 43/13.71. J. G. Hodgson & S. R. Band, 1973, **K**, conf. C. E. Hubbard. Alport, GR 43/21.64. Roadside. J. G. Hodgson & S. R. Band, 1974, **K**, conf. C. E. Hubbard. 2nd record.

†671/2 × 1. Lolium multiflorum Lam. × L. perenne L. *29, Cambs.: Swaffham Prior, GR 52/56.63. New by-pass verge. A. C. Leslie, 1977, field record.

673/2. Puccinellia distans (L.) Parl. *74, Wigtown: Grange of Cree, GR 25/46.60. C.S.S.F. Field Meeting, 1977, field record.

676/7. Poa glauca Vahl 87, W. Perth: Am Caisteal, Glen Falloch, GR 27/37.19. Rock ledge. H. McAllister, 1969, field record. 1st post-1930 record.

676/9. Poa compressa L. 47, Montgomery: Dovey Junction, GR 22/6.9. Railway line. P. M. Benoit, 1975, field record. 2nd record.

676/12. Poa subcaerulea Sm. 29, Cambs.: Gamlingay, GR 52/22.51. Damp meadow. A. C. Leslie, 1977, **herb. A.C.L.** Only extant locality.

677/1. Catabrosa aquatica (L). Beauv. *80, Roxburgh: Cavers, Hawick, GR 36/53.14. C. O. Badenoch & D. Wells, 1977, **herb. R. W. M. Corner.** 1st localized record.

†683/9. Bromus tectorum L. *57, Derbys.: Ashbourne, by the Clifton Road, GR 43/17.46. Reseeded old railway land. K. Hollick, 1977, **DBY**, det. C. E. Hubbard.

683/10. × 13. Bromus hordeaceus L. × B. lepidus Holmberg *57, Derbys.: Whitwell, GR 43/53.76. Raper Lodge near Alport, GR 43/21.65. 2nd record. Both records J. G. Hodgson, 1976, field record, conf. C. E. Hubbard. *74, Wigtown: near Dirnow, GR 25/29.65. C.S.S.F. Field Meeting, 1977, **herb. A. J. Silverside.**

683/p. Bromus pseudosecalinus P. Smith *57, Derbys.: Wye Farm near Rowsley, GR 43/24.65. S. Band, Mrs Carr & J. G. Hodgson, 1974, field record, det. C. E. Hubbard. Near Hathersage, GR 43/21.81. S. Band & J. G. Hodgson, 1974, field record, det. C. E. Hubbard. 2nd record.

†687/j. Hordeum jubatum L. *74, Wigtown: Grange of Cree, GR 25/46.60. Reclaimed salt-marsh. C.S.S.F. Field Meeting, 1977, **herb.J. Martin**, det, H. J. M. Bowen.

693/1. Helictotrichon pratense (L.) Pilg. *93, N. Aberdeen: Hill of Towanreef, GR 38/46.14. Serpentine rocks. D. Welch, 1976, **ABD**. [*93, N. Aberdeen: *Proc. Bot. Soc. Br. Isl.*, **5**: 143 (1963) locality is actually in v.c. 94]

693/2. Helictotrichon pubescens (Huds.) Pilg. *43, Radnor: Llanbadarn Fynydd, GR 32/09.78. Roadside bank and old hay meadows. Stanner rocks, GR 32/26.58. Grassland. Both records R. G. Woods, 1977, field record. 1st and 2nd records. (*Nature Wales*, **16**: 60 (1978)).

697/3. AIRA CARYOPHYLLEA L. subsp. MULTICULMIS (Dumort.) Aschers. & Graebn. ***1**, W. Cornwall: Truro, GR 10/82.43. Old railway track. R. J. Pankhurst & J. M. Mullin, 1976, **BM**, det. A. Melderis. Portreath, GR 10/64.45. Cliff-top. L. J. Margetts, 1976, **herb. L.J.M.**, det. C. E. Hubbard. 2nd record. ***89**, E. Perth: Killiecrankie, GR 27/91.62. M. McC. Webster, 1976, **E.**, conf. C. E. Hubbard.

700/1. CALAMAGROSTIS EPIGEJOS (L.) Roth ***48**, Merioneth: Llangelynin, GR 23/5.0. P. M. Benoit, 1976, **NMW**. [***48**, Merioneth: *Watsonia*, **8**: 311 (1971) and *Watsonia*, **9**: 391 (1973) have been redetermined as *C. canescens*.]

700/2. CALAMAGROSTIS CANESCENS (Weber) Roth **57**, Derbys.: Whitwell Wood, GR 43/51.78. J. G. Hodgson, 1976, field record, conf. C. E. Hubbard. 1st record since 1901.

702/2. APERA INTERRUPTA (L.) Beauv. **57**, Derbys.: Shirebrook North Railway Station, GR 43/52.68. Disused railway siding. J. G. Hodgson, 1977, field record. 2nd record.

707/3. PHLEUM ALPINUM L. ***89**, E. Perth: Glen Tarf, Atholl, GR 27/91.82. Wet flush. N. A. Sanderson, 1975, field record.

708/4. ALOPECURUS AEQUALIS Sobol. ***47**, Montgomery: near Llansantffraid, GR 33/2.—. F. H. Perring, 1976, field record. (*Nature Wales*, **15**: 149 (1977)).

708/4 × 3. ALOPECURUS AEQUALIS Sobol. × A. GENICULATUS L. ***48**, Merioneth: Mochras, Llanbedr, GR 23/5.2. P. M. Benoit, 1972, **NMW**.

714/1. PARAPHOLIS STRIGOSA (Dumort.) C. E. Hubbard ***74**, Wigtown: Cree estuary, GR 25/4.5. and 25/46.60. C.S.S.F. Field Meeting, 1977, field records. 1st two definite records.

716/a. SPARTINA ANGLICA C. E. Hubbard ***70**, Cumberland: Ravenglass, GR 34/08.96. T. G. Tutin, 1975, field record. ***74**, Wigtown: Baldoon Sands, Cree estuary, GR 25/44.52. P. Hopkins, 1977, field record.

Book Reviews

Flore du Sahara. P. Ozenda. 2nd edition. Pp. 622, with 16 black & white plates and 177 figures. C.N.R.S., Paris. 1977. Price NF 140.

The original edition of Prof. Ozenda's pioneering *Flore du Sahara septentrional et central* was published in 1958. It is a synthesis of the floristic and taxonomic knowledge of the region in North Africa bordered by the Atlas Mountains in the north-west, the Fezzan in the north-east, Mauritania in the south-west and Tchad in the south-east.

This second edition is rather unusual in that the first 463 pages, 'Introduction à la botanique saharienne' and 'Flore analytique', are merely a reprint of the first edition. Corrections and updatings of the main body of text are made in 155 completely new pages added to the end of the book, in a new 'Complements' section and a revised 'Appendices et tables'. When it is necessary to consult the 'Complements' section for any new information, a small 'c' has been included in the margin on the relevant page in the old text. For example, a new account of the Plumbaginaceae can be found on page 566 under the heading 'C–363–Plombaginacées (nouvelle redaction)' i.e. referring to page 363 in the original account. This is an incredibly cumbersome system for the user, especially where those descriptions have undergone drastic changes. Especially mystifying are those new accounts which were absent from the original text. For example a 'c' next to the key of *Orobanche* in the 'Flore analytique' on page 390 in fact refers to a new account of Acanthaceae in the 'Complements'. Thus, to identify a plant which happens to be a member of the Acanthaceae, one would first proceed through the family key on page 116, which would then refer to 'c116' on page 523, i.e. the amended key, which, in turn would eventually refer to another complement, 'c390' on page 575, a new account for the family.

The 'Introduction' is extremely useful and gives a very good general background to the deserts of the world and the desert environment of the Sahara in particular. Historical and climatic factors are considered in some detail, and the phytogeographical section gives emphasis to the endemic plants and their modes of adaptation to desert conditions. The 'Flore analytique' is very much within the French tradition of Flora-writing, an unusual combination of an extended determinator and a diagnostic Flora. The keys to the species embody specific descriptions, but the keys to the genera are quite separate from their comparatively long descriptions. On the whole the keys work well and provide easy access to the identity of the species of this rather impoverished flora.

The 'Complements' to the Flora are very useful and refer the reader to most of the recent taxonomic changes regarding North African plants. However, much remains to be done for the flora of the Maghreb, and changes included in the work are only those which have already been published. The fact that *Gymnosporia senegalensis* (Lam.) Loesener has been replaced by *Maytenus senegalensis* (Lam.). Exell provides us with a good modern example; but there still remain many 'skeletons in the cupboard' which could easily have been exposed to view. One of the worst problems is that many of the generic concepts are out of date. The genus *Chrysanthemum* L., for example, contains many diverse elements, some of which have already been placed in distinct genera in other Floras. *C. fuscatum* Desf. is now *Heteromera fuscata* (Desf.) Pomel, a segregate of the *Leucanthemum* group. Similarly, *C. macrocarpum* Coss. & Kral. and *C. trifurcatum* Desf. belong to as yet undescribed genera; and it seems odd that *C. gayanum* Coss. & Dur. and *C. maresii* Coss. have not been included in *Leucanthemum* when they had already been transferred to that genus by Maire. *C. coronarium* L., the type species of *Chrysanthemum*, is the only member of this genus in the desert flora, where it occurs as a weed. An even more obvious example is the case of *Battandiera* Maire. Although supposedly a monotypic genus of the Liliaceae with a distinct fruit and close to *Ornithogalum, B. amoena* (Batt.) Maire is in fact a good species of *Ornithogalum*. The genus is based entirely on a fruit of *Dipcadi*, perhaps *D. serotinum* (L.) Medik., a quite unrelated member of the same family.

In conclusion, for those who already possess the first edition it is unlikely that this work will be of any real use, except for the updated bibliography and Professor Ozenda's interpretations of literature published on the Sahara over the last 18 years. By contrast, for those who do not possess the work at all it is an excellent, and in fact the only readily available, Flora of this extensive desert region. At only 140 NF, a price made possible by publication subsidy from the Centre de la Recherche Scientifique, it provides excellent value for the first-time buyers.

C. J. Humphries

Cytotaxonomical atlas of the Pteridophyta. Áskell Löve, Doris Löve and R. E. G. Pichi Sermoli. Pp. xviii +398. J. Cramer, Vaduz. 1977. Price DM 150·00.

This book is an index to the chromosome numbers of Pteridophyta with reference to the authors and papers where such counts have been published. This in itself is a tremendous undertaking and the responsibility of Áskell and Doris Löve. Nothing, one may think, could be more useful to cytotaxonomists; and that would be true, if the authors had listed the species in alphabetical order and not cluttered the text with synonyms and blank entries. The book is not, however, arranged in this way but systematically, according to the system of Pichi Sermoli, which I understand will be elaborated (and further enlarged?) in a pending issue of *Webbia*. Pteridologists will look forward to that; it suffices here to say that Pichi Sermoli has some 458 genera in 65 families and, as in all systems which attempt to display a three-dimensional arrangement on the printed page, that it is a matter of personal choice in which order the branches of the system are presented; the arrangement on these branches, with a few controversional exceptions, is generally agreed by most, even if the total number of genera and families is not.

It is of the contribution that Löve and Löve have made to this book that I find myself being critical. The authors have quoted supposed basic chromosome numbers under each genus heading and have, it seems, manipulated the arithmetic in order to justify some of the proposed generic splits. Thus *Woodwardia* is based on '$x=17$' and *Lorinseria* and *Anchistea* on '$x=7$, (35)'. In fact all the *Woodwardia* species counted have $x=34$, and both numbers are within the range seen in *Blechnum*. Similarly in *Botrychium lanuginosum*, four counts by five authors giving $x=45$ are ignored in favour of one count by Löve and Löve of '$x=23$ (46)', which supports its inclusion in the segregate genus *Botrypus*. Again, two very closely related (possibly conspecific) taxa, *Lycopodium meridionale* ($2n=138$) and *L. carolinianum* ($2n=78$), are placed in *Lycopodium* ('$x=17$') and *Lycopodiella* ('$x=13$') respectively.

The chromosome numbers reported are given as sporophytic (2n) numbers regardless of the stage at which they were recorded by the author quoted, a procedure that involves an entirely false assumption as many ferns are apogamous and have the same chromosome number in both stages of the life-cycle. No indication is given as to whether the species is apogamous or sexual. A definitive number (i.e. one 'that the compilers of the Atlas have concluded is correct') precedes each species entry and, if a choice is to be had, this is naturally that of Löve and Löve, e.g. in *Woodsia ilvensis*, where $2n=78$ (a Löve count) is preferred to $2n=82$ found by eight other authors!

Where a species complex has been shown to include diploids and tetraploids, Áskell Löve prefers to give each cytotype specific rank. He automatically gives the diploid taxon the earlier name and creates a new name for the tetraploid, regardless of what the type specimen proves to be on morphological grounds; e.g. *Polypodium virginianum* L. is applied to the diploid and the tetraploid is named *P. vinlandicum* Löve & Löve. I further doubt if Löve has looked at the type of *Asplenium melanocaulon* Willd.; but here again he assumes it to be the diploid cytotype and thus applies the name *A. trichomanes* L. to the tetraploid, in spite of numerous publications where the opposite concept is put forward with good morphological, historical and geographical reasons. This leads solely to confusion; but it allows for further name combinations, a criterion, I feel, which weighs heavily in Löve's philosophy of taxonomy. He is apparently not aware of Lovis's count of a diploid *A. septentrionale* (L.) Hoffm. from the Caucasus, and perhaps this is just as well.

The book also contains many misquotations and misleading statements. For instance the quotation in Jermy, Jones & Colden (*J. Linn. Soc. (Bot.)*, **60**: 150 (1967)) that *Selaginella platybasis* Bak. has $2n=36$–40 is misinterpreted as '$2n=c.\ 36$', and *S. stenophylla* A.Br. ($2n=50$–60) is quoted as '$2n=c.\ 50$', the 'correct number' being given as '$2n=?48$'!

The publication of this book in this form cannot do compilers, publishers or users any good. It was obviously begun as a worthwhile venture; and possibly many of these data in the right editorial hands could be remoulded into a useful book if it were arranged alphabetically with accurate quotations of authors' reports. I would suggest also giving the geographical location of the counted material. Löve, Löve & Pichi Sermoli have failed to produce what we were all hoping for. Perhaps the publisher too may learn something from this exercise; a qualified referee, at the manuscript stage, could have prevented this catastrophe. It should certainly not have been published as it is. More serious is the fact that the unsuspecting user can come rapidly to grief.

A. C. JERMY

The physiology of the garden pea. Edited by J. F. Sutcliffe and J. S. Pate. Pp. xii + 500, with frontispiece and 137 figures. Experimental Botany, Vol. 12. Academic Press, London. 1977. Price £18·50.

Experimental evidence for the processes of plant physiology comes from a variety of species, and usually in textbooks these systems are treated as if applicable to plants in general. In *The physiology of the garden pea* the approach is different. One species has been chosen, and sixteen authors with specialized knowledge contribute their own experience and summarize previous work on every aspect of its physiology. The book begins with a historical review emphasizing the importance and special suitability of *Pisum sativum* L. as experimental material; next follows a summary of its classification and genetics; then the bulk of the volume deals with physiological processes in a natural sequence from germination to seed maturation. With a wealth of information to impart, each writer treats his subject lightly, and this is balanced by long reference-lists at the end of every chapter. The editors are to be congratulated on the pleasant, standardized format, the clear diagrams and the cross-references between different chapters which consolidate the whole. The book succeeds in synthesizing present knowledge of one of the best-known species, and shows where gaps remain for future workers to fill.

F. K. KUPICHA

Wild flowers of Britain. R. Phillips. Pp. 192, with numerous coloured photographs. Ward Locke, London. 1977. Price (hard cover) £6·50, (soft cover–Pan Books) £3·95.

The first impression on opening this book (of the same size as the original 'Keble Martin' or the enlarged *Wild flowers* by Fitter, Fitter & Blamey) is how attractive it is and how unusual. I do not doubt that, before this review ever gets to the printers, countless copies will have been sold to countless kindly Aunt Jemimas; and indeed it could help to name plants. The non-botanical author had the assiduous and invaluable assistance of Dr Martyn Rix, who managed to keep him nearly free from error.

The book is subtitled 'over a thousand species by photographic identification', which method the author considers better for the newcomer to botany than our 'fine tradition of botanical drawing'. The thousand include no grasses or sedges, a solitary horsetail among all the Pteridophyta, several extremely rare plants, one extinct one, several of borderline wildness and even two species of *Nothofagus*; and some much commoner plants are omitted. The blurb claims 'comprehensive descriptions', but they are nothing of the sort, providing woefully inadequate help in difficult cases; and some of the statements are questionable.

Rather under 100 plants are depicted by other people's normal colour transparencies—normal alas, too, in the way too many are reproduced, i.e. like grimy porridge. All the rest are on plates dated to the day and month and chronologically arranged. They are photographed as picked, and have a certain unreal, eerie effect as though they were frozen or in china, despite the fact that most are beautifully clear. But the inevitable objection to this novel style is precisely that they are blatantly, and confessedly, picked (a few, such as *Leucojum vernum*, *Gagea lutea* and *Omphalodes verna*, roots and all), thus setting a particularly deplorable example when the whole current emphasis is on not picking. Admittedly, in an unexceptionable paragraph in his introduction the author dutifully sets out the protected plants; under the picture of *Veronica spicata* he even repeats the law which impliedly he has flouted!

All these plants were photographed in one season, a remarkable achievement; the skill exhibited is considerable and the result like nothing else I know. But the picking aspect nags and leaves a bad taste, not only in my mouth.

D. MCCLINTOCK

The wild flowers of Britain and northern Europe. Marjorie Blamey, Richard Fitter and Alistair Fitter. Pp. 82, with 126 coloured plates. Collins, London. 1977. Price £5·95.

This is an enlarged edition of the book, by the same authors and with the same title, which was first published in 1974. The earlier version was reviewed in *Watsonia*, **10**: 315–316 (1975). The new large edition is not quite identical with it, however, as the identification keys, descriptions of additional species, and the ecological notes have been left out. The plates benefit considerably from being some 60% larger, and from improved printing techniques, and are of good quality as botanical illustrations. In spite of this, the new book is inadequate for serious botanists because of the lack of any keys, and because of the omission of all ferns, grasses, sedges, rushes and pondweeds. Unless it is bought simply as a 'coffee-table' book, one will need to supplement it with some other reference work, such as the *Excursion Flora*.

Readers should compare this book with *Wild flowers of Britain* by Phillips, which is also reviewed in this issue. The advantages of proper botanical illustrations over photography, however expert, are made clear. Prospective purchasers of this kind of book should also consider *The concise British Flora in colour* by Keble Martin, who does include all the grasses, sedges, rushes and pondweeds. Keble Martin's drawings are renowned for their quality, but the quality of the printing is distinctly lower, for this price level, since his work was first published over ten years ago.

R. J. Pankhurst

The vegetation of Mediterranean France: a review. L. W. Wright & P. J. Wanstall. Pp. 44, with 8 coloured photographs & 8 text-figures. Occasional Papers No. 9. Department of Geography, Queen Mary College, University of London, London. 1977. Price not indicated.

The vegetation of Mediterranean France is described, following the descriptive methods of Flahault and Braun-Blanquet and emphasizing the interactions between the vegetation, the climate and the soil. The history of the vegetation from the late Tertiary period is also considered, whilst the final section examines the role played by man in modifying the natural vegetation.

C. T. Prime

Pennine flowers. Joan E. Duncan and R. W. Robson. Pp. 96, with 11 monochrome photographs, 8 line drawings and 3 maps. Dalesman Publishing Co. Ltd, Clapham. 1977. Price (soft cover) £1·20.

The Pennines contain some of the best known and best loved botanical country in the British Isles. Such sites as Ingleborough, Malham, Widdybank and High Cup combine spectacular scenery and relative ease of access with a galaxy of rare and interesting plants that is only partly diminished at the present. It is also an area about which many people have written; for instance at least four of the semi-popular 'New Naturalist' series have sections concerning the Pennine flora. Thus my initial reaction to this little book was to wonder whether it fulfilled a need, and my first impressions were not improved by a quick glance through the centrally placed plates, which are unattractively presented and poorly reproduced.

I was delighted, however, to find on closer inspection a book of real worth, with a wealth of well presented information compressed into a small space. A short introductory chapter is followed by sections on geology and palaeobotany, identification and field work. Concise pen-portraits of 40 typical Pennine flowering plants are followed by short chapters on orchids and pteridophytes, critical groups, sedges and grasses. There follows a rather lengthy section on 'plant lore', which is in fact a distillation of plant uses past and present, little of which is original, but which I nevertheless found fascinating. A guide to well known localities is followed by lists of books, topographical and botanical, which strangely have no discernible order of author, title or date, and a useful and fairly comprehensive plant list. The authors quite clearly have a very thorough knowledge of the Pennine flora: I could detect very few errors, and many delightful passages rang an instant bell with my own experiences. Above all, the balance of the book is just right, and the authors are to be congratulated on mastering that very difficult art of balancing the tight-rope between botanists and the uninformed. Indeed this would be an excellent book to give to a complete novice to show the sort of way botanists think, and why.

A few minor criticisms: I doubt if *Anagallis tenella* is ever found in *Sphagnum* bogs, and *Trollius* is by no means confined to limestone. It seems unlikely that Ring Ousels deliberately decorate their nests with *Oxalis*, and the statistics on the number of genera and species in the Orchidaceae are grossly understated. There is a strange emphasis, especially in the chapter on orchids, on altitudinal records, and 'rachis' (sic) is misspelt throughout. This apart, I was able to detect only four misprints. I had always thought that *sanguisorba* meant a 'bloody orb' (which is quite descriptive) rather than 'stopping the flow of blood'. High Cup Nick refers to the ravine made by the High Cup Burn, and not to the whole of that massive amphitheatre, and I very much doubt if 'Meadow Rue' (*Thalictrum flavum?*) grows in the latter (High Cup), although both *T. minus* and *T. alpinum* most certainly do. Incidentally, the 'few places not far from the summit of Cross Fell worth searching for plants' include one of the best montane sites in England, which the authors may well not know about.

The nomenclature is rather uneven. Although the names are said to be recommended by the B. S. B. I. in *English names of wild flowers* (Dony, Rob & Perring), it is strange to find such anachronisms as *Potentilla sibbaldi*, *Cerastium holosteoides* and *Potentilla 'alpina'* (? *alpestris* = *crantzii*) hobnobbing with such novitiates as *Juncus subuliflorus*. Is *Cochlearia alpina* now 'agreed' to be the taxon in the Pennines? I hope not.

But this is a work full of interest. I for one had not noticed the interesting polymorphism in *Minuartia verna*, nor the brown form of *Viola lutea*, and I certainly did not know that juniper berries used in gin come from Hungary (Why *Hungary*?). And did anybody outside a coven know that ointment from *Potentilla* is used to help witches fly? British Airways and Upper Teesdale look out!

A. J. RICHARDS

Biological nomenclature. Charles Jeffrey. 2nd edition. Pp. viii + 72. Edward Arnold, London. 1977. Price £4·75 (boards), £1·95 (paper).

Since its first appearance in 1973 (cf. *Watsonia*, **10**: 201 (1974)), this little book has proved to be a very useful guide to the intricacies of the rules governing the naming of organisms, as they are inscribed in the three nomenclatural Codes (Botanical, Zoological and Bacteriological). This Second Edition, in which the text has been modified to take account of recent changes in these Codes, will therefore be welcomed by all those who wish to be correct and up-to-date in their usage of biological nomenclature.

For those who turn to it for enlightenment on how the Codes work, this new edition contains several alterations which make their intentions clearer. For example § 5.11, entitled 'Legitimacy' in the first edition, has been amplified under a more explicit title: 'Names excluded from consideration for the purposes of priority when the name by which a taxon should properly be known is being decided'. Such amendments and additions in the interests of clarity have been made in several places; but one or two of the printers' original errors are still present. Moreover, § 7.2, on the use of 'in' and 'ex', still does not make it clear that 'in' is part of the bibliographical citation, not of the authority, and therefore should be omitted when citing the name only.

These minor criticisms do not prevent my giving a warm welcome to this second edition of *Biological nomenclature*, which should be on the desk or reference shelf of every biologist, professional or amateur.

N. K. B. ROBSON

Henslow of Hitcham. Russell-Gebbett, J. Pp. 139, with 32 black & white illustrations. Terence Dalton, Lavenham, Suffolk. 1977. Price £4·40.

It is a pleasure to welcome a new biography of John Stevens Henslow, Professor of Botany at Cambridge University from 1825 to 1860. Henslow's main claim to fame is that he persuaded the young Charles Darwin to take biology seriously at Cambridge; but his influence as a teacher of botany was quite remarkably wide, ranging from the poor of his parish of Hitcham up to the Prince Consort and the royal children. Miss Russell-Gebbett has assembled together much material previously inaccessible in museums and libraries, and her book effectively complements the rather formal 'Memoir' written by Henslow's brother-in-law, Leonard Jenyns, in 1862.

We may not find it easy today to appreciate the difficulties experienced by Henslow in persuading University authorities, school governors and educationalists generally of the need to take seriously the natural sciences. In many ways, not least in popular education, Henslow was far ahead of his time, a liberal Christian who enjoyed field and laboratory studies as revealing the extraordinary interest and variety of God's created world, and wished to share his pleasure with others. All this emerges clearly from Miss Russell-Gebbett's book. Yet the reader is left with a feeling that some aspects of Henslow's character remain enigmatic. As Babington, later to succeed him as Professor, complained in 1846, they had 'a non-resident Professor, who only comes here five weeks'. Did this inability to help to build the natural sciences in Cambridge, as many obviously hoped he would, never seriously worry Henslow? Perhaps he was a man of such wide talents and interests that he could be satisfied, and make a significant contribution, wherever he found himself. We do not find the answer, or any hint, in this biography. Henslow is clearly a figure who cannot easily be contained within a small book, and there is room for a more complete study.

The numerous illustrations, of rather variable quality, contain some very welcome things. As one who has seen with sorrow the famous inscription on the wall of Corpus Christi College fade over the years since the early 1950s, I particularly welcome the photographic record in Plate ix. It would, indeed, be difficult to beat the 'School Botany Pamphlet', the subject of Plate xiv, for both general and specialist interest—one wonders, for example, how many village children spelt 'Thalamifloral' correctly, and so proceeded to the Third Class of Botany! But why must both Plate xxviii and Appendix II be devoted to what is essentially the same 'List of Honorary Members of the Ipswich Museum'? In general, one feels that more careful checking to prevent repetition would have improved the book. Yet, in spite of minor inadequacies and infelicities of style and arrangement, this is an attractive, useful study of a remarkable and seriously underestimated Victorian scientist.

S. M. Walters

Watsonia, **12**, 187–190 (1978).

Obituaries

JOHN NORTON MILLS
(1914—1977)

His friends were shocked to hear of the death, in December 1977, at the age of 63, of John Mills in a climbing accident in North Wales.

John Mills was educated at Winchester and Oxford. He became an animal physiologist, and held lectureships at both Oxford and Cambridge. He joined Manchester University as a lecturer in 1950, and was appointed to the Brackenbury Chair of Physiology in 1965. He had a distinguished professional career and was particularly known for his studies of circadian rhythms.

Among John Mills' hobbies were climbing and botanizing, and he often managed to bring the two together in his special interest, which was the study of hawkweeds. His interest in *Hieracium* was aroused by Dr Cyril West and, over the last 15 years, in collaboration with his wife, he spent a large amount of his spare time collecting species of *Hieracium* in the British Isles, and studying and identifying them. He grew a number in his own garden and, in collaboration with Dr C. A. Stace, counted the chromosomes of some 20 species. He also discovered and named a new species in Derbyshire (*H. naviense*). He amassed a sizeable herbarium, which he has left in his will to **MANCH**, and it is hoped to maintain in cultivation in Manchester some of his living material.

During this period, John Mills' expertise became widely known, and he was called on by many botanists for help in identifying hawkweeds. This help was always gladly and fully given. Thus he contributed determinations to A. R. Clapham's *Flora of Derbyshire* (1969) and A. Newton's *Flora of Cheshire* (1971) and recently he was in touch with writers of other local Floras. He had also begun to take up the study of *Taraxacum*.

John Mills was a charming and courteous person, liked and respected by all who came into contact with him. His botanical work, though only a hobby, was carried out with scientific rigour and attention to detail. He personified the tradition—long may it continue—of the gifted and devoted amateur specialist, of whom so many have made important contributions to British botany. Our sympathy goes to his wife and family. We shall miss him very much.

PUBLICATIONS ON HAWKWEEDS

Mills, J. N. (1968). A new species of *Hieracium* in Derbyshire. *Watsonia,* **7**: 40–42.

Mills, J. N. & Mills, J. R. J. (1970). Two *Hieracia* Sect. Alpestria from the British mainland. *Watsonia,* **8**: 48–49.

Mills, J. N. & Stace, C. A. (1974). Chromosome numbers of British plants, 3. *Watsonia,* **10**: 167–168.

Edmondson, T. & Mills, J. N. (1975). Notes on *Hieracium* from Flint and eastern Denbigh. *Watsonia,* **10**: 286–287.

D. H. Valentine

MARY ALICE ELEANOR RICHARDS
(1885–1977)

For an active life in field botany to span six reigns is indeed a remarkable achievement, but for such a life to start afresh in Africa at the age of 65 and to end up with something over 27,000 herbarium specimens from Africa to its credit is clearly unique! Such a person was Mrs Mary Alice Eleanor Richards, who was born in 1885 and died in 1977 at the great age of 92.

Mary was the only daughter of Mr & Mrs Frederick Stokes of Knowlhurst, Lichfield, where most of her childhood was spent and where her love of nature was stimulated by her German governess, with whom she explored the Staffordshire countryside. But Mary frequently visited her grandmother's home, Dolserau near Dolgellau, where in fact she was born. Her ambition in those far-off days was to study botany at a University, but her parents did not consider a scientific career to be a fitting one for their daughter. She did, however, manage to attend part-time classes in botany under Professor Hillhouse of Mason College (later the University of Birmingham), thereby acquiring knowledge which stood her in good stead when, in later life, she began to study the African flora, so different from that of her beloved Wales.

In 1907 Mary Stokes married her cousin, Major Henry Richards, O.B.E., D.L., J.P., of Caerynwch near Dolgellau, just up the valley from the house where she was born. At this stage in her life, Mary's world-wide travels began. In her younger days she had got to know several European countries; now she set off with her husband on a leisurely journey round the world, visiting India, Malaya, China, Japan and some Pacific Islands, and ending up in Canada and the United States, studying the flora wherever she went.

Throughout her married life, in spite of her undertaking many voluntary public duties, playing a full part in the life of her local Brithdir Church, and bringing up her family of one son and two daughters, she continued her interest in natural history, especially botany. She got to know the country around Caerynwch very well, including the whole of the Cader Idris massif, much of which fell within the family estate.

During the First World War she turned her home into a Red Cross hospital for other ranks, and took a major part in running it. For her outstanding work with the Red Cross, Mary was invested with the Royal Red Cross Medal, a highly cherished award. The War over, she became active in local administration, and was a Councillor on the Merioneth County Council for many years, taking a particular interest in housing, in the fight against tuberculosis, and in the establishment of maternity and child welfare clinics. She also took an active interest in the Nursing Association, the Girl Guide movement and the local schools.

In the early twenties, with her home returned to normal, Mary found more time for her main hobby, field botany, and in 1921 she found what was reported to be a blue-flowered form of *Phyteuma spicata* in a pasture near Dolgellau, which discovery brought her into contact with a friend of her parents, Dr G. Claridge Druce, the leading field botanist of the day and Secretary of the Botanical Society and Exchange Club of the British Isles. Druce persuaded her to become a life member of the B. E. C. (by which abbreviation our Society was then generally known), and her name appears in the list of new members for 1922 (in *Rep. B.E.C.*, **6**:597 (1923)), together with such well-known names as Capt. A. W. Hill (later Sir Arthur, Director of Kew), Dr Otto Stapf (Keeper of the Kew Herbarium), H. K. Airy Shaw (Compiler and editor of the seventh edition of Willis's Dictionary) and N. D. Simpson, to mention just a few of the notable intake of that year.

Mary continued her public work and work for the Red Cross throughout the Second World War, but she soon reverted to her botanical studies after peace was declared. I first met her on the B. S. B. I. field meeting in the Manifold Valley, Derbyshire in 1947. A year later she led a B. S. B. I. field meeting based on Dolgellau, and the members attending had a splendid introduction to the various habitats and the botanical richness of the Merioneth countryside, from the dune slacks of Mochras to the rugged cliffs and screes of Cader Idris. Mary's energy and endurance were amply demonstrated, whether she was plunging into bogs, negotiating tricky saltings or following precipitous mountain tracks, as if she were one of the feral white goats of Moelfre which she proudly showed to visitors when conducting them on one of her favourite walks up the Roman Steps. The account of this very successful 'excursion' appears in *B.S.B.I. Yearbook*, **1950**: 44–51 (1950), written by Mary Richards herself, with a list of finds by our mutual friend Peter Taylor.

Field botany was her main interest, and her studies concentrated mainly on the flowering plants of her home county, culminating in 1961 in 'A contribution to a Flora of Merioneth', which she compiled jointly with her friend, Peter Benoit, and which appeared in parts in *Nature in Wales*, **7**. Two years later a revised edition appeared as a 69-page booklet. Peter Benoit tells me that one of her earliest specimens, collected near Dolgellau in 1904, is *Stellaria nemorum* subsp. *glochidisperma*. It is cited as very rare, from one locality only, in the above-mentioned publication!

In 1964 the University of Wales honoured Mary Richards with the degree of *Magister in Scientia, honoris causa*. The following words are quoted from the address of Professor Lily Newton when she presented Mary Richards to the Vice-Chancellor at the degree ceremony at the University College of North Wales, Bangor, which I was very glad to have attended. 'Mrs Richards belongs to the generation which, from country homes and country parsonages, made an outstanding contribution to the study of Natural History in Britain. They heard the "tune the enchantress plays" and responded to it. By their efforts plants were located, named, and recorded—their results are the basis on which further studies of increasing complexity have been built. To them the magic was in the living organism in its own environment. They pursued knowledge for its own sake; for future generations they have built a rich and lasting heritage'. Richly did Mary deserve this glowing tribute from the University of Wales.

In 1949, four years after the death of Major Richards and with her family all married and independent, Mary moved to a delightful cottage, Tynllidiart, on the Caerynwch estate, while the old home was let as a hotel. Here, with splendid views of her beloved Merioneth hills on all sides, and with the help of her devoted Karl Keiderer (a German ex-prisoner-of-war who had settled in the district), she created a very charming garden with many choice shrubs, a bog garden and a fine rock garden, blue with *Gentiana sino-ornata* when I visited her one year. Her new home became an open house for fellow gardeners and naturalists, for Mary's hospitality was on a par with her enthusiasm and energy.

It was from Tynllidiart that, in 1950, Mary went for a holiday to stay with old friends, the Misses Gamwell, who had settled years ago in Abercorn (later Mbala), Northern Rhodesia (now Zambia). When I saw her before departing, I asked her to do some collecting for Kew while she was at Abercorn, but she flatly refused, saying she was going there 'on holiday'! However it was not long after she arrived in Africa that I had a letter from her asking for collecting equipment, as she found the flora so fascinating. Thus, at the age of 65, she started a botanical collecting career which has placed her name high on the list of famous botanical collectors. This is not the place to dwell on her outstanding exploits in Africa, but I must mention that, in appreciation of her work on the flora of Zambia, she was appointed in the 1969 New Year's Honours a Member of the Order of the British Empire, I believe on the personal recommendation of President Kenneth Kaunda himself! After a few annual visits to Abercorn, each one lasting many months, Mary finally decided to settle there. She let Tynllidiart in 1955, unfortunately to a very unsatisfactory tenant, who allowed the cottage to fall into disrepair and the beautiful garden to become a wilderness. She carried on in Africa until 1973, having moved from Zambia to Tanzania, when her failing eyesight forced her reluctantly to return home. She had developed a strong association with her friend, the naturalist Desmond Vesey-Fitzgerald, a member of the staff of the International Red Locust Control Service, Abercorn, and later Warden of the Arusha National Park, Tanzania. It was here that Mary spent the latter part of her African life. She was greatly shocked and saddened on finally arriving in England to learn of Vesey's sudden death in Nairobi the day before.

Besides her activity in field botany, Mary contributed widely to the natural history and nature conservation movements. With the late E. Price Evans she convened on 21st March 1953 the first meeting of the Merioneth Branch of the West Wales Field Society, later to become a branch of the West Wales Naturalists' Trust and today, following a further nomenclatural change, The North Wales N. T. She eventually became President of this Merioneth Branch. In Africa, when not collecting plants, she would lend a hand with the collection of insects, especially butterflies, but I am unable to say where her entomological collections are at present located.

On her return to Wales, Mary regained possession of Tynllidiart, and started once more to make the neglected and overgrown garden into something approaching its former beauty; this, at the age of 89 and without the help of Karl, was no mean achievement. She was still living on her own, but her son, now retired by the navy, and his wife and family were back in the old home, Caerynwch (which ceased to be a hotel in 1962), and able to keep an eye on her. I stayed with her for a short while in 1974, and was astonished by her energy. We were prevented from undertaking much active gardening owing to the very wet weather, but Mary and I went for a five-mile walk, much of it across rough country, at the end of which she seemed as fresh as when she started!

When I first knew Mary, I was greatly impressed by her keen eyesight. Well do I remember the occasion when, walking fairly briskly over coastal turf in Cardiganshire, she suddenly stopped and exclaimed 'Here's allseed'. Sure enough there was a nice little colony of *Radiola linoides* growing in the short rabbit-grazed turf, a minute plant usually discovered by the finder only when on hands and knees! She had a strong voice and knew how to use it. She would hold conversations from her kitchen window with Karl working many yards away. She was well known and greatly respected by the local people for miles around. One day I was botanising with her some ten miles or more from her home and we were crossing a meadow about 300 yards from a farm, when out came the farmer's daughter shouting and swearing at us, trespassers. Mary let her come to within about 100 yards, then she turned towards her and shouted 'I am Mrs Richards of Caerynwch'. The girl wilted and returned to the farmhouse, speechless, while we continued on our way!

Mary Richards' herbarium, mainly of Welsh plants, is now in the National Museum of Wales. As one of her botanical friends, I feel greatly saddened by her departure, yet glad to have known so well such a remarkable Victorian lady.

E. Milne-Redhead

Reports

EXHIBITION MEETING, 1977

The Annual Exhibition Meeting was held in the Department of Botany, British Museum (Natural History), London, on Saturday, 26th November, 1977, from 12.00 to 17.30 hours.

SOME GEMS FROM THE DRUCE ARCHIVES

George Claridge Druce (1850–1932) was the sole officer of the Society for almost thirty years. On his death his papers, library and herbarium were bequeathed to Oxford University. Druce was an assiduous preserver of letters and other ephemera acquired during his long, busy and varied life. Among Druce's personal papers is, in effect, the official archive of the Society for the period of his secretaryship, and for a few years after that. Each year's correspondence from members is collected into a separate and labelled bundle. Exhibited were photocopies of various items, including a printed statement circulated to members of the Society by C. E. Moss in 1915, which was the culmination of a controversy which arose over Druce's increasingly autocratic methods of running the Society. The papers relating to this were mostly contained in a special, small, red box-file labelled in Druce's handwriting as the 'The Row'. Until recently the organization of an anti-Druce movement was not suspected.

D. E. ALLEN

CYTISUS STRIATUS (HILL) ROTHM.

Cytisus striatus (Hill) Rothm., a native of Portugal and western Spain, is now abundantly established and increasing along *c* 400m of a reconstructed slope above a main road south of Aberystwyth, Cards., v.c. 46, where it was planted, mixed with *C. scoparius* (L.) Link, *c* 1970. The two are difficult to distinguish in flower, but the densely white-hairy pods of *C. striatus* remain on the bushes throughout most of the winter, and distinguish it from *C. scoparius* which has usually lost its more or less glabrous pods by early Autumn. *C. striatus* mixed with *C. scoparius* has also been recently planted along reconstructed slopes by the A470 road between Llanwrthwl and Newbridge-on-Wye, Radnor, v.c. 43. Self-sown plants have appeared here in 1977 for the first time.

A. O. CHATER

GENISTA HISPANICA L. NATURALIZED FOR 50 YEARS IN V.C. 46

In 1927 a specimen of *Genista hispanica* L. was collected from Constitution Hill, Aberystwyth, Cards., v.c. 46. It has been seen there for at least the last 25 years, and over the last 10 years has increased considerably. In full flower in late May, the clear, yellow patches it forms amongst the richer yellow of *Ulex europaeus* L. can be seen with the naked eye from two miles away. The Aberystwyth plants belong to subsp. *occidentalis* Rouy, originating from the W. Pyrenees and N. Spain, with smaller standard and more patent indumentum on the shoots than the type. There are now several hundreds of plants in an area *c* 150 × 50m. The largest bushes form cushions *c* 3m in diameter and *c* 70cm tall.

A. O. CHATER

PUBLICATIONS OF THE BRITISH MUSEUM (NATURAL HISTORY)

The exhibit consisted of recent and forthcoming publications from the Department of Botany, British Museum (Natural History), including; page proofs and illustrations for the *Island of Mull*, the artist's original drawings for the third series of Ecological Wallcharts, and *Seaweeds of the British Isles*, Vol. 1 (i). Some recent parts of the *Bulletin of the British Museum* (*Natural History*), Botany Series, were displayed, with specimen pages of *Atlas of ferns of the British Isles* – a joint publication of the B.S.B.I. and the British Pteridological Society.

DEPARTMENT OF BOTANY, BRITISH MUSEUM (NATURAL HISTORY)

ERICA TETRALIX L. VAR. *QUINARIA* GUFFROY

Specimens and photographs of heathers with parts in fives or sixes were exhibited (see Short Notes, pp. 156–157).

P. R. BROUGH & D. MCCLINTOCK

ATLAS OF THE FLORA OF CÁDIZ, MÁLAGA AND GRANADA

The six volumes of the Atlas were exhibited. A total of 73 UTM squares were examined in 1977. Most of the squares of the three provinces have now been searched and the Atlas is at a point where statements about the distribution of various species may be made. A special feature was of some recent maps with drawings and herbarium sheets. Few of the local rarities, including orchids, appear to be in any danger. Quite a few of the species have the same boundaries as they did a century ago, despite considerable development of the area by man. The preparation of a book on the subject (*A botanical adventure in Andalucia*) was announced.

J. W. CARR

MORE ABOUT ALIEN POLYGONUMS

Specimens and photographs of five of the alien species of *Polygonum* and *Reynoutria* naturalized in Britain were exhibited, illustrating some recently observed taxonomic characters. They included morphological features of the inflorescence in 'male' and 'female' plants of both *R. sachalinensis* and *R. japonica*, and details of leaf-hair and leaf-epidermal characters. These latter appear to be specifically constant even in specimens of unusual form, and also in the dwarf var. *compacta* of *R. japonica*. Also exhibited were recently discovered plants of *R. japonica* showing the polygamous condition (as in *R. sachalinensis*), *Polygonum polystachyum* (both long- and short-styled) and its hairy-stemmed variant, and the characters distinguishing the latter from *P. molle*.

A. CONNOLLY

CAREX DIGITATA L. AND *C. ELONGATA* L. IN BRITAIN

Illustrations of the distribution, habitats and habits of *Carex digitata* L. and *C. elongata* L. were exhibited. A full account of *C. digitata* is given in *Watsonia,* **12**: 47–49, and of *C. elongata* in Short Notes, pp. 158–160.

R. W. DAVID

SOME PLANTS FROM THE CONSERVATION SECTION OF THE UNIVERSITY BOTANIC GARDEN, CAMBRIDGE

The Eastern England Rare Plant Project, begun in 1974 under contract from the Nature Conservancy Council, is now taking more permanent shape in the new Conservation Section of the Cambridge University Botanic Garden. Appropriate reserve stocks of nationally and regionally rare species in the Cambridge area will be grown. The exhibit used live plants from the Conservation Section to illustrate the variety of case-histories which such rare species show.

D. DONALD & S. M. WALTERS

PLANTS OF NEWPORT RUBBISH TIP AND DOCKS

Pressed plants mainly collected at the B.S.B.I. meeting, 24th September, 1977, at Newport, Mon., v.c. 35, were displayed. Adventives such as *Sorghum halepense, Guizotia abyssinica, Achillea ligustica* and *Trifolium resupinatum* have persisted at Newport for many years. *Scirpus holoschoenus, Carex divisa, Centaurium pulchellum, Geranium rotundifolium* and *G. pyrenaicum* were among the many native plants that occur in few other places in v.c. 35. Many grasses are buried under mounds of rubbish but reappear in succeeding years. The prostrate *Amaranthus standleyanus* (Argentina) and *Lythrum junceum* (S. Europe) were recorded for the first time at the meeting. One card was of *Ambrosia artemisiifolia* from Avonmouth Docks, W. Gloucs., v.c. 34, with drawings illustrating the peculiar method of dehiscence of the united anthers in male flowers.

T. G. Evans

THE ORIGINAL DETAIL PAINTINGS FOR *TREES AND BUSHES OF EUROPE*

Original paintings, all from live material and mainly obtained from Kew Gardens, were displayed, being the illustrations for *Trees and bushes of Europe* by O. Polunin, Oxford, 1976.

B. Everard

MONITORING RARE PLANTS

Using the maps in the *Atlas of the British flora*, rare species, defined as occurring in 15 or fewer 10km squares, were selected for detailed study. Data on the 310 rare species in the British Isles have been collected over the past 5 years and are now published in the Red Data Book. *Orchis militaris* was used as an example, and a model showing a coordinate method of recording each individual plant was shown, as was the computer map produced from these data.

L. Farrell & F. H. Perring

A HYBRID *VERBASCUM* NEW TO BRITAIN

For a full report on this exhibit see Short Notes, pp. 160–162.

I. K. Ferguson

RECENT RECORDS OF *POLYGONUM MARITIMUM* L. IN THE BRITISH ISLES

Polygonum maritimum L. is a largely Mediterranean species with its northern limit of distribution in the British Isles. There appear to be only four post-1960 records for this species. These are: Herm, Channel Islands; Tramore, Waterford, v.c. H6; Lantic Bay, near Polruan, W. Cornwall, v.c. 1; and Gunwalloe Church Cove, W. Cornwall, v.c. 1. There is evidence that the species is persisting at Herm and Lantic Bay. It is very rare and sporadic at Tramore and there is need for confirmation of the occurrence at Gunwalloe Church Cove.

I. K. Ferguson

ECOLOGY OF *SESLERIA ALBICANS* KIT. EX. SCHULT.

For a full account of this exhibition see Short Notes, pp 161–162.

D. J. Hambler

BIRD-SEED ADVENTIVES, 1976–77

Cage-bird food mixtures contain many kinds of imported seed, mainly from the Mediterranean region but also from the U.S.A., Argentina and Ethiopia. Sowing the mixture and extracting unknown seeds for cultivation in sterilized soil at Ware has led to the remarkable score of 246 definite bird-seed aliens since the experiment commenced in 1969. The specimens on display were raised during 1976 and 1977, and included two live bird-seed grasses from Ethiopia.

C. G. Hanson

THE BEHAVIOUR OF INSECT VISITORS IN POLYMORPHIC POPULATIONS OF THE WILD RADISH, *RAPHANUS RAPHANISTRUM* L.

The exhibit consisted of descriptions and photographs of the behaviour of pollinators visiting *R. raphanistrum* L., with reflectance spectra of the petals and distribution maps of the yellow-flowered (insect-purple) and white-flowered (insect-white) morphs in Britain. In four populations with frequencies of the yellow-flowered morph ranging from 7·3% to 60·8%, flower-visiting *Pieris brassicae, P. napi* and *P. rapae* (cabbage-white butterflies), and *Eristalis arbustorum* and *E. tenax* (syrphid flies) were observed to show strong preferences for this morph. Honey-bees, bumble-bees and some other syrphids discriminated less strongly or not at all, although *Bombus pascuorum* showed a fairly consistent preference for the white-flowered morph. Discrimination by pollinators is probably important both in determining the balance of the morphs and in maintaining the polymorphism.

Q. O. N. Kay

SOME FLOWERS OF THE YORKSHIRE DALES

A selection of water-colour paintings made during the last ten years in the Yorkshire Dales was exhibited. Some were of single species, some grouped according to habitat.

H. Lefevre

RANUNCULUS AURICOMUS L. IN CAMBRIDGESHIRE

Local distribution maps and representative leaf sequences of 13 taxa distinguished for the first time in Cambs., v.c. 29, were shown, together with some herbarium specimens. The exhibit demonstrated the abundance of the collective species on the boulder clay and the great variability not only in vegetative characters but in petal number and receptacle hairiness.

A. C. Leslie

A SECOND CAMBRIDGE MISCELLANY

The exhibit comprised a varied selection of new or interesting records from Cambs., v.c. 29. Herbarium specimens of *Cirsium* × *forsteri* (*C. dissectum* × *C. palustre*), *Hypericum* × *desetangsii* (*H. perforatum* × *H. maculatum*) and *Senecio* × *baxteri* (*S. squalidus* × *S. vulgaris*) were shown, together with photographs and living plants, representing the first or only modern records for these combinations in Cambridgeshire. New records for 1977 from the Gamlingay greensand included herbarium specimens of *Rubus balfourianus* (first confirmed record for v.c. 29), *Sagina ciliata, Poa subcaerulea* and *Trifolium subterraneum*.

A. C. Leslie

PHOTOGRAPHING BRITISH GRASSES

The photographs displayed were first attempts to work out a suitable technique for photographing grasses. When the technique has been developed it is intended to take photographs showing the habitat, the overall morphology, the flowering head and a magnified view of the spikelet or single flower of most grass species in Britain. Photographs will be taken to illustrate differences between similar species, and important discriminatory features will be recorded.

M. J. Liddle

OENOTHERAS IN BRITAIN

Specimens were exhibited in support of all taxa named by Dr K. Rostański and enumerated in Short Notes, pp. 164–165.

D. McClintock

DIGITALIS × *PURPURASCENS* ROTH.

Digitalis lutea L. × *D. purpurea* L. has persisted for many years in rough grass by a drive at Platt, W. Kent, v.c. 16. There is usually at least one plant, but there have been up to three, aided no doubt by being a short-lived perennial. *D. lutea* has grown self-seeding in a flower-bed 50 yards away for even longer. *D. purpurea* is abundant. The hybrid is completely sterile, which makes its persistence remarkable.

D. McClintock

THREE VARIEGATED PLANTS

The following species all appeared spontaneously with variegated foliage in the contributor's garden in Platt, W. Kent, v.c. 16, in 1977:

1. *Oenothera stricta* Ledeb. ex Link, with leaves either longitudinally striped or wholly yellow.
2. *Setaria lutescens* (Weigel) Hubbard with leaves similar to the above.
3. *Teucrium scorodonia* L. with all its leaves blotched yellow.

All these variegations have persisted throughout the season. The latter could make a valuable plant for shady places.

D. McClintock

A NEW FORM OF BROOM

A new variant of *Cytisus scoparius* (L.) Link was found in Brittany in 1962 and has proved to come true from seed. It flowers not only in the normal May and June, but until winter sets in. It has been named f. *indefessus* McClintock in *The Garden*, **103**: 37–38 (1978).

D. McClintock

SOME CHAROPHYTE DISTRIBUTION MAPS

Recent 10km square records of Charophyta sent to, or collected by, the author since 1972 have been plotted, and distinct patterns have emerged. *Chareae* are prominent in a strip of sites crossing the country, mainly in chalk and limestone areas, including v.c. 23, 24, 27–30, 33–35 and 41. There are fewer sites for *Nitelleae*, with small concentrations particularly in v.c. 11, 27, 29 and 33. Many Charophytes take up lime to encrust the thallus and the map reflects this affinity. However, the pattern is also one of the distribution of collectors! It is important to establish a wider distribution of enthusiasts whose collections will assist this project, since many counties are devoid of recent records.

J. A. Moore

PHILATELY—A HOBBY FOR BOTANISTS

An album of botanical stamps can become a useful book of botanical illustrations. The exhibit set out some of the themes used to begin a collection—the flora of one country, a genus or species collection, medicinal plants, economic plants, horticultural plants, gardens, art, etc.

Y. L. Moscati

A NEW RECORD FOR *LAPSANA COMMUNIS* L. SUBSP. *INTERMEDIA* (BIEB.) HAYEK

Lapsana communis L. subsp. *intermedia* (Bieb.) Hayek differs from the common subsp. *communis* in its larger capitula of 2·5–3cm diameter (instead of 1·5–2cm), longer involucre of 8–9mm (6–8mm) and shorter achenes. The upper stem-leaves are usually narrower and subentire. Subsp. *intermedia* was first found at Totternhoe, Beds., v.c. 30, on chalk, in the 1940s. There is an unpublished record from Cilcain, Flint, v.c. 51, on limestone, but this may have been a deliberate introduction. A new colony was found on the Great Orme, Caerns., v.c. 49, in July 1977, in semi-natural limestone grassland corresponding to the native habitat of the plant in other parts of Europe. At a casual glance luxuriant forms of this plant could be mistaken by its capitula for species of *Crepis*, and may have been overlooked elsewhere in Britain.

R. J. PANKHURST

COMPUTER IDENTIFICATION

A visual-display computer terminal was linked by telephone to the computer of the British Museum (Natural History) and a programme was shown which helped to identify specimens of plants by question-and-answer, using characters given by the operator. The identification of British species of *Euphrasia* and *Taraxacum* was demonstrated.

R. J. PANKHURST

LACTUCA SERRIOLA L. ON M5 MOTORWAY VERGES—1976 AND 1977

The M5 Motorway passes through the limit of common occurrence of *L. serriola* L. near Exeter and again near Birmingham; between these points, for 150 miles, the motorway coincides approximately with the limit of distribution of *L. serriola*. The verges are no longer mowed and this extensive ruderal habitat provides an unusual opportunity to study the behaviour of the plant at its distribution limit. Summer surveys of 1976 and 1977 were exhibited. The maps showed the frequency of *L. serriola* to vary considerably, colonies being more common below 50m altitude and near to conurbations. This suggests that *L. serriola* has spread on to motorway verges from extant colonies, rather than by migration along the motorway. A gradual decline in early colonists such as *L. serriola* was expected as the verge-vegetation became established; in fact the plant increased considerably in 1976 and 1977. The hot, dry summer of 1976 is the probable cause, emphasizing the continentality of *L. serriola*.

S. D. PRINCE

VERONICA CRISTA-GALLI STEV. IN THE BRITISH ISLES

The Caucasian species *Veronica crista-galli* Stev. has possibly gone from its *locus classicus* near Henfield, W. Sussex, v.c. 13, but it survives from local seed in a garden near-by. Many thought this to be its only locality, but in 1977 it was seen in five other vice-counties. Details are given in the paper, pp. 129–132.

R. ROE & D. MCCLINTOCK

THE GUERNSEY BAILIWICK, 1977

Among the species found in 1977 new to one of the islands, or refound after many years, are:

GUERNSEY: *Geranium pyrenaicum* refound after 46 years in its original locality; *Galium debile*, new to the Grande Mare and the second record since 1906; *Silybum marianum*, fourth year recorded, first for 33 years; *Echinochloa muricata* var. *microstachys*, apparently new to the British Isles.

ALDERNEY: *Senecio bicolor* subsp. *cineraria*; *Eupatorium cannabinum*; *Echinochloa crus-galli*; *Panicum miliaceum*—all new to the island.

SARK: *Daphne laureola*; *Halimione portulacoides*; *Carex pendula*—all new to the island.

HERM: *Cynosurus echinatus*—a surprising absentee hitherto.

P. RYAN

CHECK LIST OF THE FLOWERING PLANTS AND FERNS OF SARK

A revised check list has been prepared by members of the Botanical Section of La Société Serquiaise. It contains very numerous alterations from the 1962 list. It will be obtainable early in 1978 from Le Jardin du Milieu, Sark, Channel Islands. Visitors are welcome to help refind old records and find new ones.

P. RYAN

TWO VARIANTS OF *CLADIUM MARISCUS* (L.) POHL

Near Carna, W. Galway, v.c. H16, two sorts of *Cladium mariscus* (L.) Pohl have been found about ½ mile apart—one green, graceful and scarcely serrate, the other glaucous, robust and stongly serrate. The two were also observed near Lough Coura, Offaly, v.c. H18. In cultivation '*C. germanicum*' is found, *ex* nursery stock, and matches the graceful plant.

M. J. P. SCANNELL

THE WARBURG MEMORIAL FUND—ICELAND 1976

The exhibit presented an account of a three-man expedition (of 18- and 19-year olds) to northern Iceland. The expedition examined the stages involved in the formation of a climax community by analysing the plant communities on the sequence of moraines behind a retreating glacier. Further expeditions of this nature for young people are planned, the next to Thailand in 1979. The report of the Icelandic Expedition is available (price 20p to cover postage) from the contributor at Coombe Head, Bunch Lane, Haslemere, Surrey.

C. SHACKLETON

OPERATION ORCHID

This project on the bee orchid, *Ophrys apifera* Huds., commenced in March 1975 and has been continued by consecutive forms of twelve year-old girls. Discoveries to date include:

1. Leaf-cutter bees remove labellums for nesting material.
2. The new shoots of plants which bloomed the previous June grew within the old, dead stem until well above the ground.
3. Only flowering plants showed marked fluctuations in numbers.
4. Wind and lack of rain at the end of May causes plants coming into bud to blacken and fail.
5. Some plants have bloomed (to date) for five consecutive years.
6. Bisected tubers have been replanted, and each half produced a full rosette which bloomed for three consecutive years.
7. Clumps around large rosettes are derived from very young tubers.

ST CHRISTOPHER'S SCHOOL,
BURNHAM-ON-SEA

SOME LEICESTERSHIRE ELMS

Specimens and photographs of representatives of the main taxa of *Ulmus* to be found in Leicestershire, v.c. 55, were displayed. *U. glabra* Hudson, *U. procera* Salisbury and *U. minor* Miller agg. are all common. Within the last, the segregates known as *U. plotii* Druce and *U. coritana* Melville are also common. Intermediates (putative hybrids) between the two latter taxa and *U. glabra*, and between *U. plotii* and *U. coritana*, are very widespread and variable, and in parts of Leicestershire form the bulk of the elm population. *U. procera* usually remains quite distinct, but intermediates between it and *U. coritana* are frequent in parts of southern Leicestershire where *U. coritana* is common. In Leicestershire *U. plotii* and *U. coritana* are to a considerable degree vicarious.

C. A. STACE

PLANT DRAWINGS

A drawing of *Ranunculus gramineus* taken from a book of rare species in the British Isles of 1853 was exhibited. The plant is included in W. J. Hooker's *British Flora*, 2nd ed. (1831), and was recorded from N. Wales, although the exact locality is unknown. The exhibit also showed new records from v.c. 73 & 74, including *Salix nigricans* and hybrid willows. Miscellaneous flower paintings included *Atriplex praecox*, new to v.c. 73, and the new hybrid *A. littoralis* × *A. patula*.

O. M. STEWART

ATRIPLEX LITTORALIS L. × *A. PROSTRATA* BOUCHER EX DC.—A NATIVE HYBRID NEW TO SCIENCE

Plants collected in Norfolk in 1976 and exhibited at the 1976 Exhibition meeting were provisionally identified as *Atriplex littoralis* × *A. prostrata*. Seeds from these specimens were sown in the Manchester University Botanic Garden. Plants from these seeds segregated back to the parental types: *A. littoralis* L. and *A. prostrata* Boucher ex DC. Both species and the hybrid progeny are diploid ($2n=18$). Pollen fertility varied independently of morphological segregation from *c*50% to 90% stainable grains. Field observation has shown that both F_1 hybrid plants and F_2 segregants occur widely in Britain where both parents are present in disturbed estuarine and coastal habitats. Some intermediate segregants have a leaf morphology identical with exaggerated serrate plants of *A. littoralis*. In other segregants the leaf form is indistinguishable from that of the tetraploid *A. patula* L. ($2n=36$).

P. M. TASCHEREAU

ATRIPLEX LITTORALIS L. × *A. PATULA* L.—NEW TO THE BRITISH ISLES

Atriplex littoralis L. × *A. patula* L., a semi-sterile triploid hybrid, was artificially synthesized at Manchester in 1976. The natural hybrid, previously known from Sweden, was collected in 1977 from disturbed waste ground by the coast at Leith Docks, Edinburgh, v.c. 83. Herbarium specimens of the hybrid plants and their progeny were exhibited together with a map showing their distribution.

P. M. TASCHEREAU

VARIATION IN STYLE LENGTH WITHIN WILD POPULATIONS OF *MYOSOTIS SYLVATICA* HOFFM.

The exhibit illustrated the variation in style length found among individuals of *Myosotis sylvatica* Hoffm. within populations from western Derbys., v.c 57. In each of five populations the ratio of style length to corolla tube length ranged from 0·5 to 1·33. Photographs of developing flower-buds showed that the difference between long- and short-styled plants is apparent at an early stage. The possible biological significance has been investigated by hand-pollination experiments.

E. THORPE

SOUTH SWALE LOCAL NATURE RESERVE, E. KENT. V.C. 15

During 1977 the Department of Botany, British Museum (Natural History), organized a survey of the vegetation at the reserve owned by the Kent Trust for Nature Conservation on the River Swale. The survey produced a check list of plants and description of their communities, and involved some of the younger staff in field work. The site exhibits a range of communities which include saltmarsh, grazing meadow, *Zostera* beds and cryptogamic plants on a sea-wall. The flora has proved to be surprisingly rich, containing a number of maritime species uncommon in south-eastern England.

I. TITTLEY & G. C. S. CLARKE

The following also exhibited:

H. J. M. BOWEN. *Verbascum*.
B. S. BROOKES. A *Schoenus ferrugineus* file.
E. J. CLEMENT. More adventive news.
A. RUTHERFORD & H. A. MCALLISTER. Further researches in the genus *Hedera*.

In the lecture hall the following members gave short talks illustrated by colour slides:

F. N. Hepper. Portraits of *Flora Europaea* botanists.
J. L. Mason. Plants of the western U.S.A.
E. Milne-Redhead. The Fox Fritillary field, Framsden, Suffolk.
J. Pope. Flowers and insects.
C. Shackleton. Iceland, 1976.

At the Conversazione Dr & Mrs J. G. Dony presented an exhibit:
B.S.B.I.—past and present.

COMMITTEE FOR THE STUDY OF THE SCOTTISH FLORA EXHIBITION MEETING, 1977

An Exhibition Meeting was held at the Royal Botanic Garden, Edinburgh, on Saturday, 5th November, 1977, at 14.00 hours. The following exhibits were shown.

G. H. Ballantyne. (a) Recent records from Fife.
(b) Wild flowers of Kinross.
E. Blake. European and South African Ericaceae.
B. Burbridge. The Botanical Society of Edinburgh.
J. W. Clarke. *Carex flacca* × *C. nigra*?
R. W. M. Corner. Plant records from Selkirk and Roxburgh.
J. Dickson. Roman army rations?
U. K. Duncan. Six hybrids.
C. Edmans. The Holyrood Park study.
A. G. Kenneth. Plants from Argyll and Kintyre.
Macaulay Institute for Soil Research. Soil Survey of Scotland.
C. W. Murray. New and interesting plants from the Isle of Skye.
F. H. Perring & L. Farrell. Monitoring rare plants.
A. Rutherford & H. McAllister. Further researches in the genus *Hedera*.
A. J. Silverside. Macrophytes of the Forth and Clyde Canal.
O. M. Stewart. Herbarium specimens and drawings.
A. McG. Stirling. (a) New noteworthy plants from western Scotland.
(b) *Ranunculus reptans* in Argyll?
P. M. Taschereau. *Atriplex praecox* and *A. longipes*.
M. McC. Webster. Scottish plant records.

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's *British Herbaria*. Line drawings should be in Indian ink, preferably on good quality white card, but blue-lined graph paper or tracing paper are acceptable. 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 Lettraset 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 only be accepted in exceptional cases.

Contributors are strongly advised to consult the editors before submission in any cases of doubt. Manuscripts will be scrutinized by the editors and a referee and a decision communicated as soon as possible. Authors receive a galley proof for checking, but only errors of typography or fact may be made. 25 offprints are given free to authors of papers. Further copies, and copies of Short Notes, 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 C. A. Stace, Botanical Laboratories, Adrian Building, University Road, Leicester, LE1 7RH. Books for review should be sent to Dr N. K. B. Robson, Dept. of Botany, British Museum (Natural History), Cromwell Road, London, SW7 5BD. Plant records should be sent to the appropriate vice-county recorders.

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Botanical Society of the British Isles

Patron: Her Majesty Queen Elizabeth the Queen Mother

Applications for membership should be addressed to the Hon. General Secretary, c/o Department of Botany, British Museum (Natural History), Cromwell Road, London, SW7 5BD, from whom copies of the Society's Prospectus may be obtained.

Officers for 1978-79

Elected at the Annual General Meeting, 6th May 1978

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Recent issues (Vol. 11 part 3 onwards) are available from the Hon. Treasurer of the B.S.B.I., 68 Outwoods Road, Loughborough, Leicestershire.

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Presidential Address, 1978

EXPERIMENTAL WORK ON THE BRITISH FLORA

D. H. VALENTINE

INTRODUCTION

I should like to begin my address by thanking the Society for the honour it has done me by electing me to the office of President. The title I have chosen for the address is, I hope, an appropriate one, representing as it does my own interests in relation to those of the Society as a whole. Indeed, I can ask the question 'how has experimental work become involved with the aims and activities of the Society?' In order to answer this question I shall have to look briefly at past history.

In its earlier years the Society functioned largely as an Exchange Club for amateurs, many of whom built up extensive and critical herbaria often in consultation with professional botanists both at home and abroad, and the standard of the material collected and of the notes published was high. An interest in geographical distribution dating from the days of H. C. Watson was strong, and this culminated in 1932 with the publication by G. C. Druce of *The comital flora of the British Isles*. However, interest in ecology and habitat was less intense, and by 1932 the much younger Ecological Society had become a flourishing and independent organization, aware of the B.S.B.I. and with some common membership, but not often in close co-operation.

In the 1930s the impact of what was then called experimental taxonomy (which included genecology) began to be felt by field botanists. This new approach was well exemplified by the work of W. B. Turrill at Kew, and by his concepts of *alpha* and *omega* taxonomy. His idea was that experimental studies of plants would furnish new data which could be incorporated into classical (*alpha*) taxonomy, and produce a new improved *omega* version. This view was well summed up in his book *British plant life* in the New Naturalist series published in 1948. During the period 1930 to 1950 while the mainstream activities of the B.S.B.I. continued, professionals in the Universities, Kew and the Natural History Museum began to take more interest in it.

This new activity was brought to the fore by the Society in its Conferences. The first of these, under the prophetic title *British flowering plants and modern systematic methods*, was organized by A. J. Wilmott in 1948. This Conference and its successors provided an admirable meeting-place in which all those interested in the systematics, old and new, of the British flora could discuss their work. It is notable that one of the leading amateurs, Edward Lousley, was responsible for organizing several of the Conferences of the 1950s. One of the most influential of these Conferences was that of 1950 on *The study of the distribution of British plants*, for this led eventually to the publication by Perring and Walters (1962) of the now famous *Atlas of the British flora*.

This geographical bias has been reflected in many of the local Floras subsequently produced. At the same time the interest in variation below the level of the species and in the naming of taxa at the level of variety and form has tended to decrease in the writing of Floras. This line of approach has been taken over by the professionals with their newer techniques and modes of analysis. If I were to guess the main interests of the Society at the present time I would say that systematics and geographical distribution certainly take a high place, but in addition and rightly a good deal of attention is being given to Nature Conservation. Also there are many who are interested in studying the introduction and naturalization of alien plants — a subject of increasing importance.

The old interest in infraspecific variation, which can be seen so strongly in the work of such men as G. C. Druce, and which was continued in many local Floras such as those of Bristol (White 1912), Gloucester (Riddelsdell *et al.* 1948) and Devon (Martin & Fraser 1939), is now not so strong as it was. Allen (1966) drew attention to this in his valuable paper on infraspecific taxa which had been tested in cultivation. The point was recently brought home to me by a study I have made of *Centaurea scabiosa* L. and its maritime populations. I should like to say something about this here as it will allow me to illustrate the approach and method of the older naturalists and to see their point of view. The work is largely descriptive; it may have a genetical element, but the ecological element is usually weak. The story is quite a long one, but I shall make it as short as I can.

CENTAUREA SCABIOSA L.

E. S. Marshall, a clergyman by profession, was an eminent amateur botanist in the period 1885–1919 and an active member of the Botanical Exchange Club. In 1897, with his friend W. A. Shoolbred (a medical doctor and also a good amateur botanist), he explored the north coast of Scotland (Marshall & Shoolbred 1898) and discovered some plants with undivided leaves in populations of *C. scabiosa* growing 'among the sandhills' in the region of the Kyle of Tongue. After a second excursion (Marshall 1901) he gave the plant a varietal name (var. *succisifolia*) and showed that it kept quite distinct in cultivation and reproduced itself from seed. In 1906 H. J. Riddelsdell, a friend of Marshall and like him both a clergyman and an excellent field botanist, discovered plants with similar undivided leaves on limestone cliffs in the Gower peninsula near Swansea. He showed them to Marshall and they agreed that these plants were sufficiently like the Scottish ones to be given the same name. Both men prepared and distributed herbarium specimens (Riddelsdell 1906). A little earlier than this Williams (1901), in his now little-known *Prodromus Florae Britannicae*, commented on Marshall's variety. He compared Marshall's plants with Continental specimens which also had undivided leaves (though none was maritime) and concluded that the British plants were closely similar to some, notably to var. *gelmii* Briquet collected in Austria in the south Tyrol.

Apart from a few references to var. *succisifolia* in local Floras and in *Welsh flowering plants* (Hyde & Wade 1934), nothing has been heard of the variety in recent years, but because the findings of Marshall and Riddelsdell were so well reported they are still valid and valuable and can be discussed in terms of modern concepts such as the ecotype. As it happened, I rediscovered Riddelsdell's plants while on holiday in the Gower peninsula and started some simple cultivation and breeding experiments on them before finding the Williams (1901) reference.

The first observation which I made was that on the exposed cliff and rock-ledge habitats to which the species was largely confined, the plants of *C. scabiosa*, irrespective of their leaf-form, were dwarf—a character not emphasized by Riddelsdell. Although such plants, when brought into cultivation, increased somewhat in size, they remained smaller than plants from inland populations not so directly exposed to wind. I also found that seeds taken from wild dwarf plants bred more or less true to the dwarf character. A second set of observations was concerned with leaf-shape. Most plants from the limestone cliffs in the Gower peninsula had the divided leaves of typical *C. scabiosa*, but a small proportion, varying in small local populations from 3 to 18%, had undivided leaves and so corresponded to var. *succisaefolia*. Further, I found that some of the dwarf plants were heterozygous for the genes controlling leaf-shape. In two experiments the seed of a plant with pinnatifid leaves collected in the field showed quite sharp segregation into plants with pinnatifid and plants with undivided leaves, the latter being in a minority.

Unfortunately, I have not yet cultivated or even seen living plants of the Scottish var. *succisifolia*, and friends who have visited the region have not been able to find Marshall's plants or even extensive populations of the species itself. However, we now have sufficient data to enable us to interpret the position on the Gower peninsula. First, in this region the species has been able to adapt itself both physiologically and morphologically to a rather xerophytic maritime habitat. The characters of the plants, with their dwarf habit and rather coriaceous leaves, can be regarded as adaptive and the populations can be considered as ecotypic variants. Second, the populations are polymorphic in leaf-shape. The polymorphism is under typical genetic control, the sharp segregation indicating that few genes are involved.

We can now see very well how the point of view has changed since the time of Marshall and Riddelsdell. We are still unable to explain with any certainty the factors which cause the leaf polymorphism, but we now instinctively look at the *population*, whereas Marshall's interest was concentrated on the *individual*. He picked out the aberrant plants with undivided leaves and gave them a name. Not that there was anything wrong with this, and indeed it had the advantage in the long run of keeping the knowledge in circulation, but the evolutionary viewpoint was lacking. The brief observations of Riddelsdell (1906) raised points of both ecological and genetical interest. He noted that plants of the variety grew on the cliff-face in full exposure and had rather thick, succulent leaves. He also noted that 'there are signs of transition between the forms, possibly owing to the action of hybridization', but neither of these points was developed any further.

ECOTYPIC AND POLYMORPHIC VARIATION

A small but useful amount of work has been done in the last 30 or 40 years on both ecotypic and polymorphic variation of the kind I have just described. I shall not attempt to review it here and indeed I have recently published (Valentine 1978) an account of ecological criteria in taxonomy. There are, however, two or three matters concerning these kinds of infraspecific variation to which I should like to refer here.

The first is the extent to which other widespread species, besides *Centaurea scabiosa*, have become adapted to maritime habitats. G. Turesson, the Swedish botanist who was the founder of genecology, pointed out that there were certain rather demanding habitats, such as the alpine, the woodland and the maritime, which had, as it were, 'attracted' widespread species, which then produced ecological races or ecotypes often showing parallel adaptations. Some information about maritime races in the British flora is available in the literature, e.g. in Perring & Sell (1968), but so far as I know this information has not been put together or analysed as a whole. A preliminary survey which I have made shows that at least 40 species of the British flora have maritime races which can be recognized taxonomically, and these are usually classified as subspecies or varieties. In many of these the genotypic basis of at least some of the distinctive features has been proved, for example in the broom, *Cytisus scoparius* (L.) Link. This species may occur on shingle or rocks by the sea and sometimes adopts a prostrate habit. Transplant and breeding experiments by Gill & Walker (1971) have shown that this habit character is sometimes genetically fixed and sometimes not.

In other examples, although the appearance of the plant in the field strongly suggests that the distinguishing character (e.g. the small size or the prostrate habit) is genetically fixed, there is no evidence either from cultivation or breeding experiments that this is so. Two common shrubs which have decumbent or prostrate maritime variants are *Prunus spinosa* L. and *Ligustrum vulgare* L. I have observed both of these on cliffs in Glamorgan and Pembrokeshire (and the *Prunus* in Brittany) and they are mentioned in a number of local Floras (e.g. Martin & Fraser 1939, Salter 1935) but so far as I know they have never been described or named. These are cases in which names at the level of variety or even form would possibly be valuable, as they would draw attention to the variants and bring them into a field of study. I have now started some cultivation experiments with *Ligustrum* and hope to extend these to *Prunus*.

I have also made an analysis of 32 of these maritime races, selecting those which are probably of ecotypic status. The most striking point which has emerged is that although the parent species have a wide and fairly general distribution, the maritime races show a strong geographical bias to the south and west of Britain, with relatively few in the east and in Ireland. There are several possible explanations for this. There may have been more botanical exploration on the west coast than on the east, or the milder climatic conditions in the west may be more favourable to the development and establishment of new variants. Some of the variants may represent survivals from an earlier, warmer period which have survived in western refuges, an historical explanation. Whatever the reason there is a need for more work, both in the critical evaluation of the variants and in the careful recording of their habitat and geographical distribution. The notes by Perring & Sell (1967) represent a first contribution in this direction.

Another point I should like to make concerns physiological adaptation. Ecotypic variants are commonly marked by morphological characters, especially of size, but this is not always the case. For example, Wilkins (1960) showed experimentally that plants of *Festuca ovina* L., which morphologically could not be told apart, sometimes showed wide and heritable differences in their tolerance of high lead concentration in the soil (of the order of 1000 ppm). He further found that these differences were correlated with habitat, the tolerant plants favouring lead-rich soils. Variants of this kind, adapted physiologically to survive in special habitats, may be called physiological ecotypes, and they are found in a number of species.

Experiments involving soil factors have an important bearing on the practice of growing wild plants in gardens for conservation purposes. It is one thing to collect the seeds, raise the seedlings and plant them out; it is another to maintain them in good health for a period of years. Thus, some 20 species were rescued from the Cow Green area of Upper Teesdale at the time of the building of the reservoir. Two series were prepared, one of which was grown at Durham University and the other at the Jodrell Bank Field Station of Manchester University. At the latter, after six years of cultivation it has been found that of 16 of the rarer species, five have grown very well indeed, seven have made good growth, two are merely survivors, one is doing very poorly indeed and one has died out completely. The performance at Durham University shows a similar diversity of behaviour, with differences in detail. The reasons for the failures (notably *Gentiana verna* L. and *Primula farinosa* L.) are still unknown. The two species mentioned both grew well for several years then declined in vigour. Experimental work is needed to work out the cultural conditions required and to make sure that they are maintained.

Another mode of infraspecific variation is that of polymorphism, exemplified by the variation in leaf-shape in the maritime *Centaurea* populations. In this mode, individuals within a population differ from one another genetically and sharply (e.g. in respect of one or two major genes) and the balance of the genotypes in the population is controlled by the environment. A well-known example is that of the cyanogenic glucosides in *Lotus corniculatus* L. studied by Jones (1962). The leaves of some plants contain a glucoside and an enzyme, and when the leaf is damaged (e.g. by a grazing animal) HCN is released. In one series of experiments in which leaves both with and without the glucoside were made available it was shown that a vole, two species of snail and a slug selected the non-glucoside leaves for their food. The proportion of plants with and without the glucoside varies from population to population, and selective grazing is one of the factors which may affect the proportion.

The reaction of species to grazing, though well studied in agriculture, has in recent years been rather neglected by naturalists. In older Floras it was not uncommon to read of the acceptability or otherwise of wild plants to grazing animals. I called this to mind last summer in observing populations of *Marrubium vulgare* L. apparently untouched in heavily rabbit-grazed turf on the Little Orme in N. Wales. The aromatic smell and bitter taste of this plant were well known to an older generation and an extract was used as a drug in pharmacy. Hegi (1921) drew attention to the fact that the plant is remarkably free from parasites, suggesting that some of its chemical contents (a lactone and an essential oil) protect it from attack by grazing animals as well as from parasites. Such reactions are obviously ecologically important and it would be interesting to confirm them by experiment.

HYBRIDIZATION AND GENETICS

The experiments and observations which I have mentioned so far have emphasized the ecological aspects of variation and the importance of the habitat. I want now to describe a number of experimental approaches of a more genetical nature which have been of value in the study and interpretation of natural populations, especially hybrid populations.

The first of these is the method of testing for hybridity by collecting seed in the field, growing it in the experimental garden, and observing the nature of the offspring produced, e.g. whether it segregates. I have already described an example of this in *Centaurea scabiosa*. I came across another of a rather different kind in Manchester recently, when I collected seed from a specimen of the tetraploid *Senecio vulgaris* L. var. *radiatus* Koch that was growing near some plants of the diploid *S. squalidus* L. When this seed was grown in the greenhouse it bred true apart from one plant which appeared to be the hybrid *S. squalidus* × *S. vulgaris*, and this was confirmed by a chromosome count of $2n = 30$. It was interesting subsequently to see that in her recent paper, Ingram (1977), who made a number of experimental crosses between the species, got a reasonable yield of hybrids from the cross using var. *radiatus* as the female parent but none from the cross using var. *vulgaris*. This fitted in well with my observations.

The hybridity of adult plants found in the wild can also be demonstrated by making an artificial cross and comparing the natural and artificial hybrids. I have done this for example with *Geum* × *intermedium* Ehrh. (the hybrid between *G. urbanum* L. and *G. rivale* L.). This involves a fair amount of preparation and time, but such experiments are valuable in revealing internal barriers to crossing which have a relevance to field populations and their interpretation. I should like to illustrate this from my own experiments on *Primula*, beginning with the cowslip, *P. veris* L. and the oxlip, *P. elatior* (L.) Hill. In Britain this hybrid is rare, in large part due to differences in habitat and flowering time, but it is also rare in central Europe where both habitat and flowering time overlap to a greater extent, and where the differences in insect pollinators are apparently not great. Experiments reveal a reason for this, for they show that whichever way the cross is made the seeds produced are small or empty, or both. This is due to seed-incompatibility caused by the breakdown of the endosperm and the embryo soon after fertilization. Only very rarely is a viable hybrid obtained and this is more likely to be triploid than diploid. It appears that, for genetical reasons, an unreduced oxlip pollen grain is more likely to produce a viable hybrid than a reduced one. At least one such triploid hybrid has been found in the field in Slovakia (Valentine 1966) and more should be sought in England.

I have confirmed these findings by producing artificial tetraploid oxlips. This can be done by treating the diploid seedlings with the drug colchicine. The tetraploid plants are slightly larger than the diploids, but moderately fertile. It is then found that the cross, diploid cowslip female × tetraploid oxlip male, gives a quite good yield of viable triploid seed.

A similar barrier to crossing at the seed stage, though less extreme, is found between the cowslip and the primrose, *P. vulgaris* Huds. In my experiments (Valentine 1955) I never obtained a viable seed when I made the cross with primrose as seed parent, but I did get a few viable seeds and some hybrids when I made the cross the other way round, with the cowslip as the seed parent. It is interesting to ask how this agrees with the distribution of the hybrid in the field. It is often observed that hybrids are found near cowslips rather than near primroses, and their number in field populations is not as great as might be expected if there were no internal barrier to crossing. I recently noticed an example near Cardigan which illustrated both these points. In a large meadow with a cowslip population in the centre and a primrose population at the margin I could find only two hybrids, and these were both among the cowslips. It would be interesting to make a careful survey of a number of populations with these points in mind.

A parallel example in a different genus is that of *Potentilla erecta* (L.) Raüsch. ($2n = 28$) and *P. anglica* Laich. ($2n = 56$). My own experiments, as well as the more numerous ones of Matfield *et al.* (1970), showed that the cross would succeed both ways, but was more often successful with *P. anglica* as the seed parent. This agrees with the pattern of distribution which I found some years ago along a hedgebank in Cumbria. Hybrids (which are infertile) occurred close to *P. anglica* in two places, next to *P. erecta* in one place, and with an additional occurrence next to both species. This is also an interesting case from the point of view of ecological isolation, as the habitat of *P. anglica* is not well characterized or clearly defined and further field observations are needed.

Yet another kind of experimental investigation is the exploration of the nature of the genetical differences between populations, up to and including the species level. For the British flora, the most extensive work is that done by Marsden-Jones & Turrill (1954) on British knapweeds (*Centaurea nigra* L. and *C. jacea* L.), and later (Marsden-Jones & Turrill 1957) on the bladder campions (*Silene maritima* With. and *S. vulgaris* (Moench) Garcke). In both cases a series of both oligogenic and polygenic differences was found, but the relative proportions of the two, their linkage, and the way in which they are built into a coherent system were not fully worked out. This difficult analysis and synthesis has rarely been attempted; the most successful piece of work is that of Clausen, Keck & Hiesey (1958) in California on the subspecies of *Potentilla glandulosa* Lindl.

Remarkable from the genetic viewpoint are the experiments of Bradshaw (1963) on *Alchemilla filicaulis* Bus. Although this species is an obligate apomict, it shows ecotypic variation. Bradshaw was able to show that upland and lowland populations differed genetically in habit and leaf-size, using both transplants and growing plants from seed. The mode of genetic variation here is unknown. Obviously it is not possible to do hybridization experiments, but a possible mechanism is by gene or chromosome mutation. In a chromosome complement of $2n = c105$, which is the number recorded for this species, gain or loss of a chromosome is not likely to affect viability, but might well affect potentially adaptive morphological and physiological characters. Similar questions arise in other apomictic genera, e.g. *Taraxacum*, where it has been shown that variation may be correlated with loss or duplication of a chromosome in a triploid complement.

CONCLUSION

I want to end my address by referring to some general matters which have relevance to my main topic of experimental work. The first of these concerns nomenclature. It will be clear from what I have said that studies of plant populations are currently carried out by people of rather varied training and aims, and this produces different kinds of results and different modes of interpretation. The systematist, whether of the old or the new style, naturally has a strong interest in classification. The experimentalist, often with a genetical or ecological background, may be primarily interested in evolution or adaptation. Thus on the one hand the systematist may be unaware of important experimental results and, on the other hand, the geneticist may not utilise the information in the taxonomic literature nor interpret his results in taxonomic terms. This is a loss to both. It must, however, be admitted that finding the right taxonomic treatment is often not easy. This is a subject I have recently discussed with reference to *Viola riviniana* Reichenb. (Valentine 1975), where in one and the same series of populations there is both ecotypic and polymorphic variation (as is the case with *Centaurea scabiosa*). A taxonomic treatment for this on a parochial scale can be found, but when the species extends over a whole continent, where parallel polymorphisms may be associated with more than one ecotype or geographical race, the complications are such that the taxonomic system as we know it at present cannot handle them. A new accessory terminology is probably needed, though none has yet been devised.

The other general point to which I should like to refer is that of information retrieval, which is closely linked with experimental work. I have been brought sharply into contact with this subject in the course of preparing accounts of a number of genera for the new *Flora of Great Britain and Ireland*. While a good knowledge of the plants in the field is very important in preparing these accounts, two vital sources of information which cannot be neglected are the literature and the herbarium. First some comments on the literature, which I can illustrate from the genus *Drosera*, which I have recently been studying. The taxonomic and ecological literature on the European sundews is not very extensive and is scattered. Nevertheless it is sometimes possible, by fitting together pieces of information from various sources, to develop ideas and hypotheses which were previously unsuspected. For example the sundews are said to be largely self-pollinated and this is probably true, though our knowledge of their floral biology is not great. There exists a sterile interspecific hybrid, *D.* × *obovata* Mert. & Koch, which has not been synthesized but which is almost certainly the cross between the diploid *D. rotundifolia* L. and the tetraploid *D. anglica* Huds. This hybrid is found in a good many localities in some of the regions (e.g. the Hebrides and north-western Scotland) where both species are common. The frequency of the hybrid would indicate that cross-pollination is fairly frequent, a conclusion at variance with our general knowledge of the species. How can this apparent contradiction be resolved? Well, it can be done by applying the observation, quoted by Hegi (1921), that the Round-leaved sundew can reproduce vegetatively by adventitious buds, which develop on the mature leaves in late summer and autumn. That such buds occur in British populations is confirmed by observations of colleagues at Manchester who have found the plantlets of the sundew in *Sphagnum* brought in from the field. Thus, if the hybrid can reproduce in the same way as the species — and this is a reasonable assumption — we can understand how hybrids, even if they arise only rarely, may persist and spread and become rather commoner than at first expected.

I suppose that the work I have just been describing is not strictly speaking experimental, but it is relevant to my theme for it certainly suggests experiments on hybridization and propagation which are needed to confirm the hypothesis about the hybrid sundew which I have put forward.

My second set of comments is concerned with herbarium material. This is often ample, but it may be deficient in a number of ways. First, specimens frequently lack any information on habitat even of the simplest kind. Second, a great many specimens have never been critically examined in the light of the published literature. This is a falling away from the old days of the Exchange Club, when critical notes on the exchanged specimens were always produced. Perhaps I can go further and say that collecting herbarium specimens has become less frequent and less widespread, and the new legislation and Code of Conduct do not encourage collectors.

Certainly, indiscriminate collecting is not desirable; but intelligent collecting, in which the specimens are treated as samples of a population and collected with ecotypic variation, polymorphism, or hybridization in view, are doubly valuable in that so few series of this kind are to be found in our large herbaria. W. B. Turrill tried to encourage collectors to press their experimental material and deposit it in a herbarium, and he had some success. I should like to see this continued and extended, and I should also like to see some of the larger institutions establishing, say, special herbaria of the British flora in order to illustrate the range and extent of ecotypic variation, or the nature and distribution of polymorphic variants. Such herbaria, by showing the gaps, would stimulate relevant and economical collection, and they would have a high value for both teaching and research.

My review is now concluded. It obviously has a strong, personal bias, and it is certainly a very incomplete and imperfect account of experimental work on the British flora. Not only have I left out a large body of physiological and ecological experiments but I have said little or nothing of the numerous cytological studies which have been prominent in recent times and little of the biochemical work which is now making its contribution. I have sought to concentrate today on experiments in which the plants themselves, in the greenhouse, the garden and the field, are the prime objects of study and experiment. This kind of work can become very sophisticated, but there are still many groups in which the careful observer with the minimum of apparatus can make useful observations and draw important conclusions. I do not know what proportion of British species has been studied experimentally in the sense in which I have applied the term, but I should be surprised if it is more than one-fifth, even including the work of Continental investigators. There is thus plenty of work waiting for us all.

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Quercus robur L. and *Quercus petraea* (Matt.) Liebl. : a multivariate approach to the hybrid problem, 2. The geographical distribution of population types

B. S. RUSHTON

School of Biological and Environmental Studies, The New University of Ulster, Coleraine, N. Ireland

ABSTRACT

The relationship between the geographical distribution and climatic and edaphic data of 135 population samples of *Quercus robur* L. and *Q. petraea* (Matt.) Liebl. from Wales, the Midlands and East Anglia was investigated using multivariate techniques. Populations containing only pure *Q. robur* trees were found mainly in East Anglia and the Midlands, generally associated with high pH, high exchangeable base status soils. *Q. robur* populations containing some hybrid trees were distributed more westerly. *Q. petraea* populations (both pure populations and those containing hybrids) were found mainly in Wales, and were generally edaphically and climatically distinct from the *Q. robur* populations. The general pattern of *Q. robur* and *Q. petraea* differences was also apparent on a small scale within one forest. Populations in which the majority of the trees were of hybrid origin were found along coastal river valleys in Wales. It is argued that in these populations hybridization is enhanced because they occupy an intermediate or hybrid habitat between the better drained, siliceous, nutrient-poor hill-tops and the wetter, more poorly drained, nutrient-richer valley-bottoms. Hybridity, as evidenced by the number of populations containing hybrids, increased towards the west. Within pure *Q. robur* populations, two distinct types could be recognized. One, with smaller leaves, fewer leaf-lobes, a better developed auricle and a more cordately shaped lamina base, was distributed more to the east of the area surveyed than the other. It is concluded that environmental factors significantly influence the pattern of variation within *Q. robur* and the pattern of hybridization between the species.

INTRODUCTION

Anderson (1948) has speculated on the importance of the habitat as a factor in controlling hybridization under natural conditions. He suggested than an F_1 hybrid generation should be uniform in its ecological requirements, which may be expected to be intermediate between those of the two parental species. This view is now widely accepted and many examples have been recorded. For example, Anderson & Hubricht (1938) have argued that the lack of naturally occurring hybrids between *Tradescantia subaspera* and *T. caniculata*, despite their high interfertility under artificial conditions, is due to the absence of a 'hybrid habitat'. Moore (1977) has used similar arguments to explain the rather narrow hybrid zones commonly found in vertebrates. Woodell (1965) has shown that limited hybridization takes place between *Primula veris* L. and *P. vulgaris* Huds. when the ecological barriers to hybridization have been suspended due to habitat disturbance. In *Quercus*, Muller (1952) reported several examples of the control of hybridization by ecological factors, namely edaphic and climatic restriction of hybrid establishment.

Segregation and recombination occurring in an F_2 generation indicates that this generation is more heterogeneous in its habitat requirements than the F_1 generation. Backcrossed F_2 individuals would show habitat preferences akin to those of the backcrossed parental species. An example of such ecological segregation (Grant 1971) has been described by Benson et al. (1967) in *Quercus douglasii* Hook. & Arn. and *Q. turbinella* Greene subsp. *californica* Tucker. In areas where these two species hybridise, the composition of hybrid populations was found to be related to degree of site exposure. Populations on south-west facing slopes were more like *Q. turbinella* subsp. *californica*; those on north-east facing slopes were more like *Q. douglasii*. It was concluded that selection among the F_2 generation, for different recombinant types, was occurring as a result of differential exposure.

In the British Isles, *Q. robur* and *Q. petraea* are not well separated geographically or climatically

(Jones 1959, Perring & Walters 1962). However, *Q. robur* has been described as 'characteristic' of the Midlands and the South and *Q. petraea* as 'characteristic' of the North and West (Yapp 1961). They appear to show different edaphic preferences, *Q. robur* preferring moist, heavy, basic soils rich in mineral nutrients and *Q. petraea* preferring well drained, acid soils (Jones 1959). Salisbury (1916, 1918) has provided evidence that in Hertfordshire the species are well separated edaphically. Soils of *Q. robur* populations had a higher proportion of silt and clay (*Q. robur* 53%, *Q. petraea* 27%) whilst those of *Q. petraea* populations had a higher proportion of sand (fine sand, *Q. robur* 19%, *Q. petraea* 25%; coarse sand, *Q. robur* 18%, *Q. petraea* 34%). The species also differ in respect to their tolerance of waterlogging, with *Q. robur* being tolerant of waterlogged conditions (Jones 1959).

On evidence from other genera, and other *Quercus* species, it would seem reasonable to suppose that hybrids between *Q. robur* and *Q. petraea* would show habitat preferences different from, and in some way intermediate between, the two parental species. Some evidence already exists to support this. Carlisle & Brown (1965) have shown that, in a mixed population, *Q. petraea* was the predominant species on slate whilst, on limestone and peat, both species occurred together with a range of intermediates. Krahl-Urban (1959) has argued that in the river plains of Jugoslavia *Q. robur* is the dominant species whilst *Q. petraea* is found on the adjacent mountainous areas. He recognized intermediate forms occurring between the two areas. Salisbury (1925), Tansley (1939) and Hicken (1971) have noted similar situations in Great Britain.

A survey of *Q. robur* and *Q. petraea* populations reported in the first paper (Rushton 1978) had indicated that seven population types could be recognized. This second paper is concerned with the geographical distribution of these population types. The first section of the paper deals with an ordination and objective classification of the total population data set. The second section describes the geographical distribution of the population types within the sampled area. The third section explores the relationship between the population types and climatic and edaphic data collected from the population sites.

INITIAL DATA CLASSIFICATION

In order to obtain an overall view of the variation within and between the 135 populations sampled, it became necessary to establish an objective classification of the population data. This was considered a pre-requisite for assessing the variational patterns on a geographical scale. Consequently, a matrix of 135 populations × 17 character-population means (raw data, i.e. not transformed to a hybrid index) was constructed and subjected to a principal component analysis (PCA) and cluster analysis (CA) using Ward's Error Sums of Squares method (Rushton 1978). The results are shown in Figs. 1–4 and Tables 1 and 2.

The results of the PCA are shown in Fig. 1. In Fig. 2, a frequency histogram has been constructed of the population types along the first Component. The seventh population type, viz. those populations differing from the respective pure species types by having significantly smaller leaves, have been included in their respective pure species classes. This gives six population types:

1. R, populations containing only pure *Q. robur* trees;
2. P, populations containing only pure *Q. petraea* trees;
3. M, mixed populations containing both pure *Q. robur* and pure *Q. petraea* trees;
4. IR, *Q. robur* populations with a range of intermediate forms probably of F_1 hybrid, and F_2 and subsequent backcross hybrid status;
5. IP, *Q. petraea* populations, as 4 above;
6. H, populations with a very high proportion of apparent F_1 hybrid and backcross derivatives.

PCA (Fig. 1) clearly separated the R and P populations. The separation of the IR from the R populations, and the IP from the P populations was clear, but with some overlap. The M and H populations occupied an intermediate position. It was apparent from Fig. 2d that the M populations appeared to fall into two groups, those dominated by *Q. robur*, and those dominated by *Q. petraea* trees.

Fig. 3 covers the same PCA as Fig. 1, showing the membership of the clusters at the 10 cluster level of CA of the same data matrix. Comparison of Figs. 1 and 3, together with Table 1 indicated that the objective CA corresponded well with the subjective classification of population types described in the

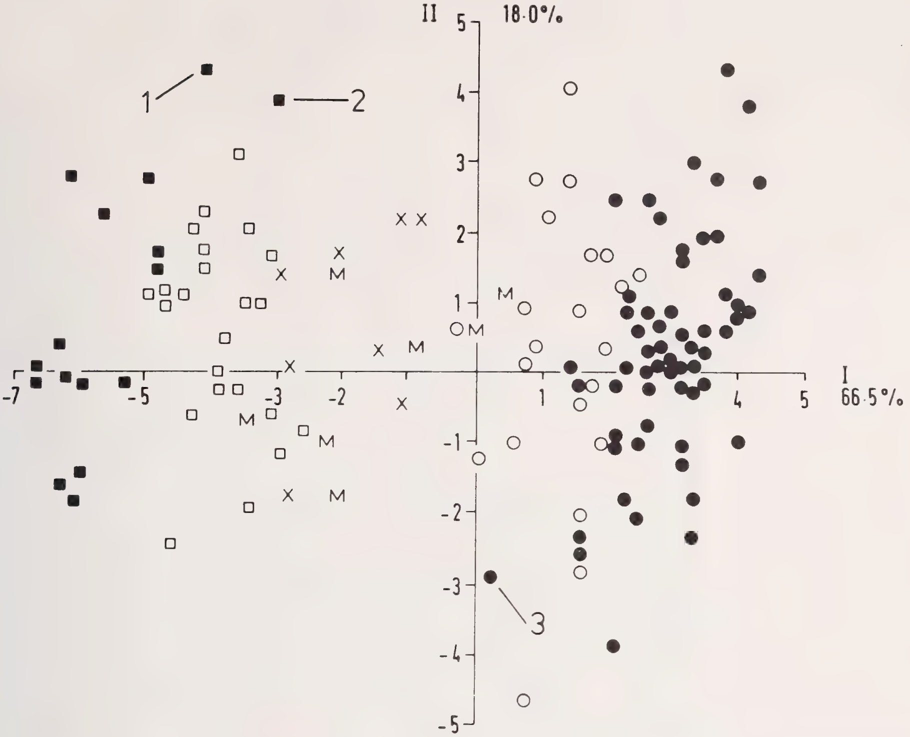

FIGURE 1. PCA of the matrix 135 populations × 17 character-population means (raw data). The first two components of the correlation matrix are shown together with the percentage of the total variance accounted for by each component. Population types: R, ●; IR, ○; H, X; M, M; IP, □; P, ■.

first paper. Thus, Cluster 8 (Fig. 3) contained only populations classified previously as R populations (Fig. 1). Similarly, Cluster 7 contained only populations previously classified as P populations. It is significant to note that in those clusters which showed mixed groupings of either R and IR (Clusters 1, 9 & 4, Table 1) or P and IP (Cluster 6, Table 1), the number of hybrid trees in the IP and IR populations was relatively small. The distribution of the cluster memberships along the first Component (Fig. 4) emphasized that the clusters were relatively distinct along this component.

Consideration of the vector loadings for the PCA (Table 2) indicated that all characters with the exception of WP had very high loadings along the first Component. However, even WP showed a significant correlation along the first Component. On the second Component, the highest vector loadings were L + P, LL, WP, LW and LD. Thus, along the second Component the variation within each population type was associated with leaf size characters. The spread of R and IR populations, and P and IP populations, along the second Component (Fig. 1) indicated that *Q. robur* was more variable for leaf size characters than *Q. petraea*. CA similarly produced clusters based on leaf size characters within each population type. For example, the two R clusters, 8 & 1 (Table 1), separated on the second Component of the PCA (Fig. 3). The H populations showed only a relatively small spread on both the first and second Components (Figs. 1 & 2c) and, indeed, showed only a marginal overlap with the IR and IP populations (Figs.1, 2b, c, e). The relative uniformity of the H populations is evidence that these populations include a substantial number of F_1 hybrids. Three populations, indicated in Fig. 1, did not conform to this pattern. The two P populations (Fig. 1, populations 1 & 2) were both of the smaller leaved type (Rushton 1978). The single R population (Fig. 1, population 3) proved to be the most westerly R population sampled. In CA, these unusual populations all clustered with mixed clusters, i.e. populations 1 and 2 with Cluster 6, population 3 with Cluster 9. (Table 1).

FIGURE 2. Frequency histogram distributions of the six population types along the first Component of the PCA from Fig. 1. Population types: a.R b.IR c.H d.M e.IP f.P.

It was concluded that the PCA and CA using the total data set supported the classification of the populations using the method of reference populations and pollen viabilities described in the first paper.

GEOGRAPHICAL DISTRIBUTION OF POPULATION TYPES

The 135 populations were from Wales, the Midlands and East Anglia. The sampling was thus predominantly east-west and, in consideration of the results below, this bias in the sampling should be borne in mind. Detailed locations may be obtained from the author. The geographical distribution of

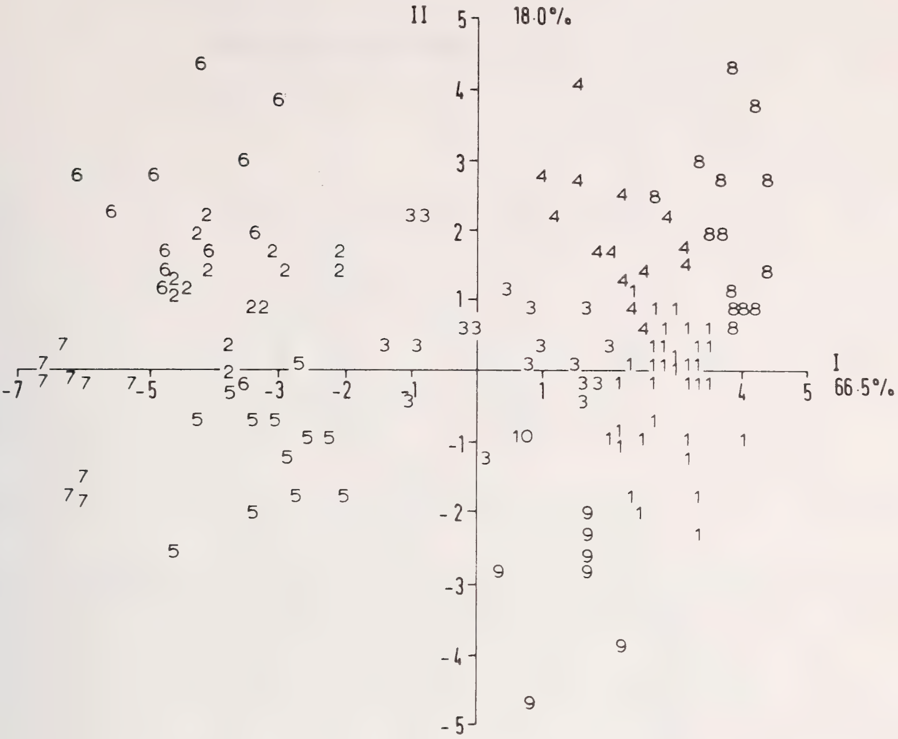

FIGURE 3. PCA of the matrix 135 populations × 17 character-population means (raw data), as in Fig. 1. The numbers refer to the cluster membership of ten population clusters derived from CA of the same data matrix.

the six population types is shown in Fig. 5; the distribution of the 10 CA clusters is shown in Fig. 6.

The two R clusters, 1 & 8 (Table 1) had a distribution that ranged through East Anglia and into the Midlands. Although the distribution of Clusters 1 and 8 overlapped, Cluster 8 was the more easterly (Figs. 6 & 7). Thus these two R clusters, with a marked morphological dissimilarity (Figs. 3 & 4), show some geographical separation. This required more detailed morphological analysis of the populations of these two clusters. Mean values for all 17 leaf characters were calculated and analyses of variance completed to determine if the character means for the two clusters were significantly different. The results are given in Table 3. As can be seen, the leaves of populations in Cluster 1 are significantly longer and wider than those of Cluster 8. The clusters were also significantly different for BS, AU and LN. It should be noted that clusters were not significantly different for the character ratios, i.e. PP, OB, LDR. These two clusters accounted for 47 out of 59 R populations. R populations (Fig. 5) were found in the Lincolnshire Wolds, East Anglia, Essex, Cheshire, the Midlands (Warwickshire, Staffordshire), Buckinghamshire, Oxfordshire, Gloucestershire, Shropshire and Worcestershire. Two exceptions were found in the Cardiff area and one in mid-Wales close to the English border, but, otherwise, R populations were completely absent from Wales.

17 out of 22 of the IR populations were in Clusters 3 & 4 (Table 1) but, since these also contained R, M and H populations, the geographical distribution of Clusters 3 & 4 (Fig. 6) was not illuminating. However, when the IR populations alone were examined (Fig. 5), differences between the distributions of R and IR populations were observed. Generally, the IR populations were distributed further to the west than the R populations. More specifically, concentration centres of IR populations were found along the North Wales coast (five IR populations) and the West Midlands (six IR populations). Only four IR populations were found in the eastern part of the area, one near Saffron Walden, one north of Oxford and two near Stanford, Lincolnshire.

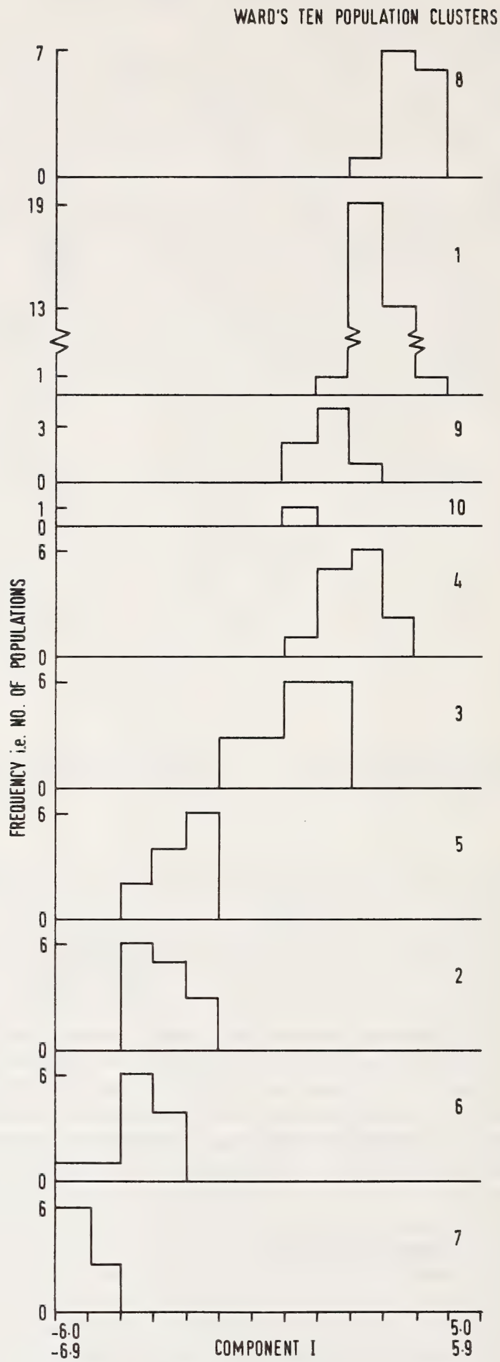

FIGURE 4. Frequency histogram distributions of the ten population clusters along the first Component of the PCA from Fig. 1.

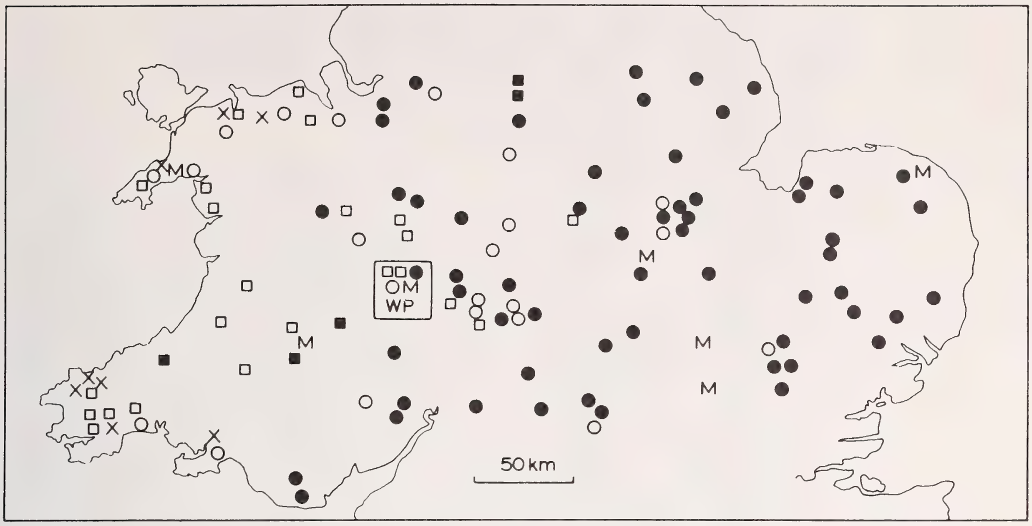

FIGURE 5. Geographical distribution of the six population types: R, ●; IR, ○; H, X; M, M; IP, □; P, ■. WP = 11 P population samples from the Wyre Forest. The other populations confined within the square box represent the remainder of the Wyre Forest populations.

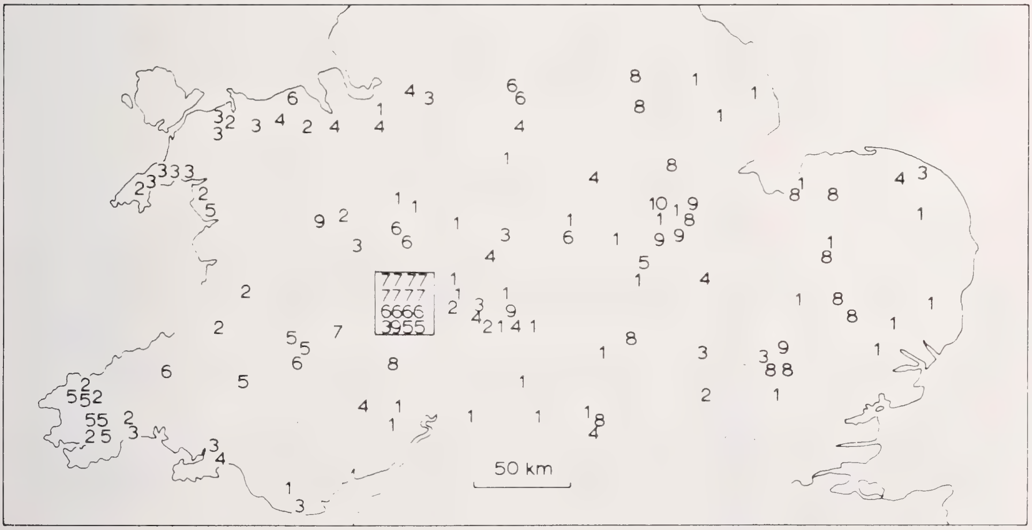

FIGURE 6. Geographical distribution of the ten population clusters derived from CA of the same data matrix as in Fig. 1. The population samples confined within the square box represent the 16 samples from the Wyre Forest.

TABLE 1. CORRESPONDENCE BETWEEN THE MEMBERSHIP OF TEN CLUSTERS OF OAK POPULATIONS DERIVED FROM CLUSTER ANALYSIS AND THE CLASSIFICATION OF THE SAME POPULATIONS BASED ON REFERENCE POPULATIONS

		Q. robur R	*Q. robur* with hybrids IR	Predominantly hybrids H	Mixed *Q. robur* and *Q. petraea* M	*Q. petraea* with hybrids IP	*Q. petraea* P	Totals
Clusters	8	14						14
	1	33	1					34
	9	4	3					7
	10		1					1
	4	6	8					14
	3	2	9	4	3			18
	5			2	3	7		12
	2			2	1	11		14
	6					5	7	12
	7						9	9
Totals		59	22	8	7	23	16	135

TABLE 2. VECTOR LOADINGS FOR THE FIRST TWO COMPONENTS OF THE CORRELATION MATRIX (PCA) FOR THE DATA MATRIX: 135 POPULATIONS × 17 POPULATION CHARACTER MEANS (RAW DATA)

	Component 1	Component 2
Lamina regularity (LR)	– 0·864	0·230
Basal shape of lamina (BS)	– 0·930	0·010
Auricle development (AU)	– 0·936	0·025
Simple hairs (SPH)	– 0·939	0·209
Stellate hairs (STH)	– 0·942	0·198
No. of lobe pairs (LN)	– 0·827	– 0·089
No. of intercalary veins (SN)	0·931	– 0·144
Percentage venation (VN)	0·938	– 0·102
Petiole ratio (PP)	– 0·928	– 0·050
Total leaf length (L + P)	– 0·809	– 0·560
Petiole length (PL)	– 0·933	– 0·079
Lamina shape (OB)	– 0·695	0·120
Lamina length (LL)	– 0·679	– 0·709
Lamina length to the widest part (WP)	– 0·184	– 0·896
Lobe depth ratio (LDR)	– 0·876	0·223
Lobe width (LW)	– 0·417	– 0·804
Depth of sinus (LD)	0·557	– 0·739

Vectors standardized so that the sum of elements squared equals the latent root.

The distribution of those populations with *Q. petraea* affinities (P and IP) was on the western side of the country with one exception, an IP population near Leicester. There was no clear delimiting zone between the P and IP populations except that, of the coastal populations of Wales having *Q. petraea* affinities, all were of the IP type.

H populations were confined to the coastal parts of Wales, four on the Pembrokeshire coast, one near Swansea, and three along the north-west coast. These appeared to occur in close association with populations of both the IR and IP types. The distribution of the M populations was primarily eastern. Only one was found along the Welsh coastline, on the Lleyn peninsula near Portmadoc.

THE DISTRIBUTION OF POPULATION TYPES AND EXTERNAL FACTORS

The correlation of the distribution of population types with external factors has been investigated using edaphic and climatic factors derived for each site.

At each site, five soil samples were removed at a depth of 20 cm. Each soil sample was divided into five sub-samples, and the following tests carried out on each sub-sample, with a mean value calculated for each site:

1. pH – measured using a glass electrode on a 1:2·5, fresh soil : distilled water suspension (Metson 1961).

2. Soil base status – since only comparative measurements were required, the pH method of determining total exchangeable bases using normal acetic acid (Brown 1943) was used. This method does not accurately reflect soil-nutrient status, since other sources of plant nutrients are available in the soil (Russell 1961). Also, a measure of total exchangeable bases does not differentiate the qualitative and quantitative differences that may be present in cations of different soil samples. However, soil samples from the same site are notoriously heterogeneous and to have provided a satisfactorily detailed chemical soil description for all 135 sites would have proved impossible. Thus recourse was made to this rather coarse measure of base status.

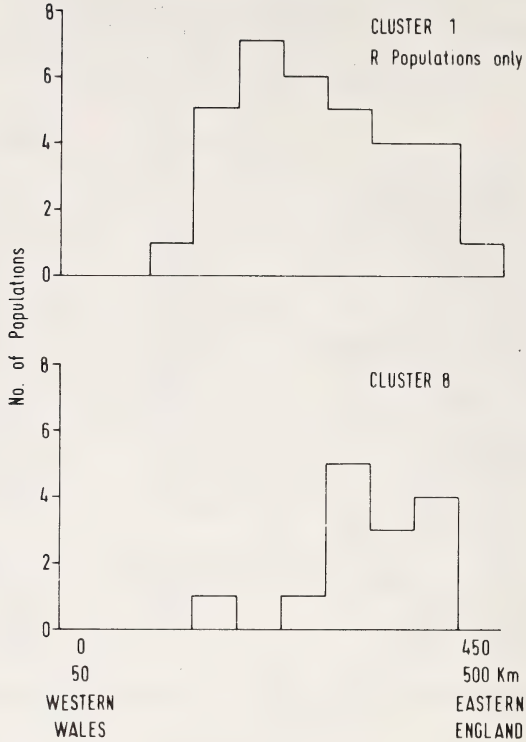

FIGURE 7. Geographical distribution of two R clusters, Clusters 1 and 8, from CA of the same data matrix as in Fig. 1.

The following data were also derived for each site from either Ordnance Survey maps (1 : 63360 series), local weather stations or published weather maps including Meteorological Office (Great Britain) records:

1. Altitude
2. East-West geographical position
3. North-South geographical position
4. February minimum temperature
5. January mean temperature
6. July mean temperature
7. Rainfall
8. Humidity

Values were interpolated when a site was not close to a climatological station, although this is not an ideal solution due to micro-meteorological effects. Humidity was derived from the ratio Precipitation/Saturation Deficit (Perring & Walters 1962). Limitation of the environmental factors to the above list follows the work of Perring & Walters (1962). Analysis of these data were completed by subjecting the 135 sites × 10 environmental variables matrix to a PCA. Prior to analysis, the humidity values were subjected to angular transformation. Following Austin (1968), pH values were not transformed; all other data were untransformed. The results are shown in Fig. 8. The distribution of the six population types along the first Component is shown in Fig. 9, and the distribution along Component 1 of the 10 clusters from the Ward's Error Sums of Squares CA of the total data set from Fig. 8 is presented in Fig. 10.

RESULTS

The majority of the environmental variables used in this analysis might be expected to be correlated with geographical position, e.g. temperature, and therefore the resultant ordination would be expected

TABLE 3. MEANS AND STANDARD DEVIATIONS OF 17 LEAF CHARACTERS FOR TWO CLUSTERS (CLUSTER 1 AND CLUSTER 8) OF *Q. ROBUR* POPULATIONS DERIVED FROM THE CLUSTER ANALYSIS OF 135 POPULATIONS

	Cluster 1		Cluster 8		
	Mean	Standard deviation	Mean	Standard deviation	*P*
Lamina regularity (Index, range 0–20) LR	6·46	1·65	6·54	1·86	NS
Basal shape of lamina (Index, range 0–20) BS	4·05	1·48	3·02	1·58	0·05–0·01
Auricle development (Index, range 0–20) AU	5·09	1·53	4·01	1·67	0·05–0·01
Simple hairs (Index, range 0–20) SPH	1·46	0·89	1·95	1·07	NS
Stellate hairs (Index, range 0–20) STH	0·74	0·70	0·78	0·72	NS
No. of lobe pairs (Total for 5 leaves) LN	22·90	1·06	21·77	1·75	0·01–0·001
No. of intercalary veins (Total for 5 leaves) SN	23·74	2·65	24·82	4·26	NS
Percentage venation VN	52·90	5·54	55·56	11·52	NS
Petiole ratio PP	20·51	4·92	23·08	4·12	NS
Total leaf length (mm) L + P	101·10	4·15	87·70	5·63	<0·001
Petiole length (mm) PL	4·93	0·89	3·80	0·86	<0·001
Lamina shape OB	1·62	0·05	1·64	0·07	NS
Lamina length (mm) LL	96·17	3·88	83·96	5·32	<0·001
Lamina length to the widest part (mm) WP	60·32	2·94	51·98	4·72	<0·001
Lobe depth ratio LDR	1·69	0·08	1·66	0·08	NS
Lobe width (mm) LW	29·59	1·94	24·98	2·14	<0·001
Depth of sinus (mm) LD	18·43	1·46	16·10	1·43	<0·001
No. of populations	33 (excluding one IR population)		14		

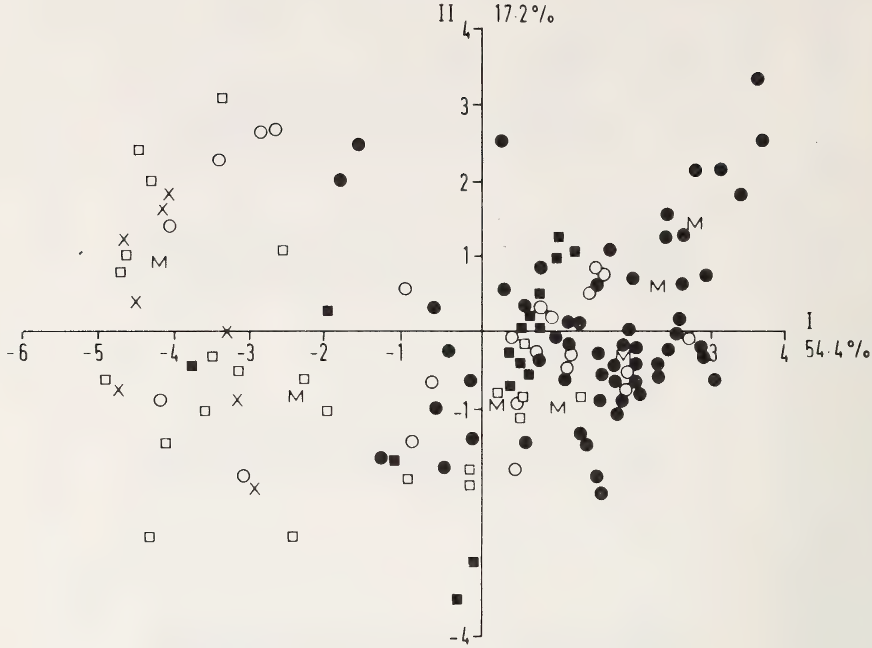

FIGURE 8. PCA of the matrix 135 populations × 10 environmental variables. The first two components of the correlation matrix are shown together with the percentage of the total variance accounted for by each component. Population types: R, ●; IR, ○; M, M; H, X; IP, □; P, ■.

to reflect geographical position. This is the underlying feature of Fig. 8. The populations towards the right-hand-side of the first Component were all from the eastern part of the surveyed area; those towards the left-hand-side of the first Component were all from the western part of the surveyed area. Examination of the vector loadings along Component 1 (Table 4) showed that east-west position, temperature, humidity and rainfall had high loadings. Altitude showed a low negative loading and north-south position a near zero loading. The two highest loadings given to variables on the second Component were soil pH and soil exchangeable base status; north-south position was also relatively high.

The distribution of population types along the first Component (Fig. 9) followed closely the geographical distribution observed in Fig. 5. The peak in the P populations at the centre of the ordination (Fig. 9f) was due entirely to the large number of populations and sub-populations taken from one site (Wyre Forest, v.c. 37, GR 32/745.762). This was reflected in the distribution of Cluster 7 (Fig. 10) which contained the majority of the Wyre Forest samples. The other clusters with large numbers of P and IP populations (Clusters 2, 5 and 6) were all distributed to the left of the R and IR populations (Fig. 10).

DISCUSSION

In certain geographical areas the ecological separation of *Q. robur* and *Q. petraea* has been questioned, e.g. Tansley (1939), and, therefore, we should initially ask whether the two species are ecologically well separated and, if so, only then proceed to examine the validity of the hybrid habitat.

Interpretation of the results is not straightforward because of:

1. the possibilities of planting (Tansley 1939, Cousens 1975). (Although Rackham (1974) argued that the plantation oak of the 18th and 19th centuries may have had little effect on existing oakwoods).
2. the paucity of populations in this investigation showing pure *Q. petraea* status.

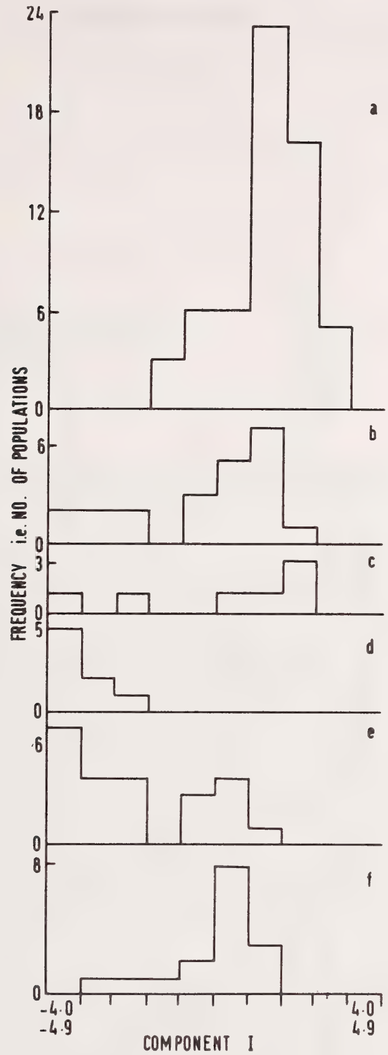

FIGURE 9. Frequency histogram distributions of the six population types along the first Component of the PCA from Fig. 8. Population types: a.R b.IR c.M d.H e.IP f.P.

3. the effect of a large number of populations and sub-populations from the one site, Wyre Forest.
4. the major problem of trying to relate the distribution of species to few variables whilst, in reality, it is the complex interaction of many variables which is usually responsible for such distributional patterns. This problem could be alleviated by the use of floristic data which provide an integrative assessment of the environmental regime of a site.

Despite these difficulties, a reasonably coherent pattern does emerge.

Populations with *Q. robur* affinities (R and IR) and those with *Q. petraea* affinities (P and IP) showed a consistent pattern of climatic and edaphic differences (Fig. 9, Table 4). However, the problematical positioning of the P populations from the Wyre Forest (see Fig. 9f) make unambiguous interpretation difficult. Examination of pH and exchangeable base levels for the P Wyre Forest populations indicated that they were not significantly different from the other P populations, and that their position along the component is more a reflection of climatic factors rather than soils status.

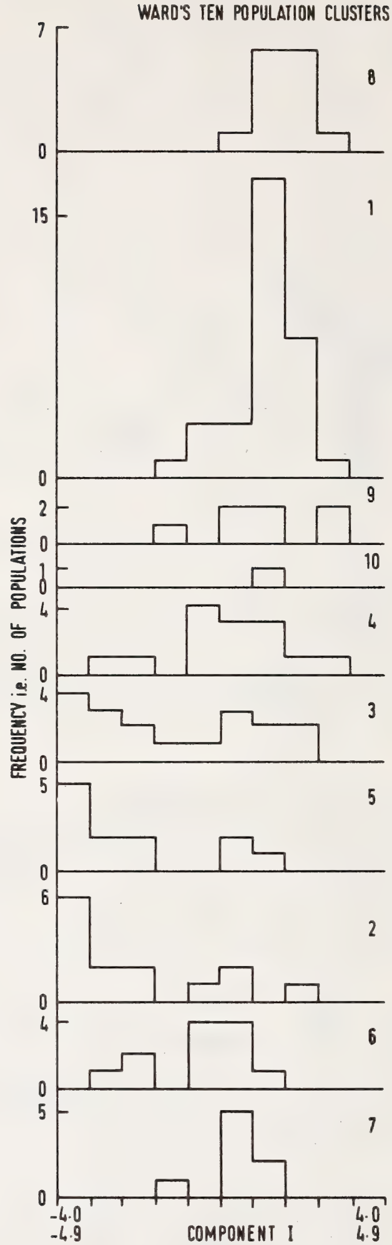

FIGURE 10. Frequency histogram distributions of the ten population clusters along the first Component of the PCA from Fig. 8.

Differences between pure populations and populations containing hybrids were less clear, particularly in the case of *Q. petraea* where there were relatively few P populations. The distribution of R and IR populations climatically and edaphically (Fig. 9a, b) showed little difference except that the IR populations had a greater spread along the first Component towards the IP populations (Fig. 9e).

Analysis of the geographical distribution of population types indicated that in the east the

TABLE 4. VECTOR LOADINGS FOR THE FIRST TWO COMPONENTS OF THE CORRELATION MATRIX (PCA) FOR THE DATA MATRIX: 135 POPULATIONS × 10 ENVIRONMENTAL FACTORS

	Component 1	Component 2
Altitude	− 0·20	− 0·36
Soil pH	0·43	0·74
Total exchangeable base status	0·52	0·71
East-West position	− 0·91	0·12
North-South position	− 0·01	0·59
February minimum temperature	− 0·92	0·29
January mean temperature	− 0·93	0·30
July mean temperature	0·82	0·05
Rainfall	− 0·90	0·00
Humidity	− 0·96	0·14

Vectors standardized so that the sum of elements squared equals the latent root.

populations were of the R type, but that further west, particularly in the Midlands and into Wales, the level of hybridization (measured by the number of populations with hybrids) increased. This cline of increasing hybridity in a westerly direction is similar to that described by Cousens (1965) where the level of hybridity in both species appeared to increase northwards into Scotland.

Q. petraea is not totally absent from the area of R populations in the east (see Perring & Walters 1962). Indeed Salisbury (1916, 1918) showed that in Hertfordshire *Q. robur* was the commoner woodland tree in the north and west of the county, whilst *Q. petraea* was commoner in the south-east. In the present investigation the nearest population sampled to these Hertfordshire populations (about 8 km away) proved to be mixed. Rackham (1974) has argued that the prehistoric forest of eastern England was primarily of *Q. robur* with a small proportion of *Q. petraea*, but also with a high degree of variability present in *Q. robur*. Part of this variability might still be present, reflected in the Cluster 1 and Cluster 8 R populations of East Anglia and the Midlands. Indeed, the smaller leaves of Cluster 8, the more easterly of the two clusters, and the larger leaves of the more westerly Cluster 1 might have an underlying physiological significance comparable with some of the examples discussed by Lewis (1972).

Within *Q. petraea*, the situation was less clear apart from the fact that a substantially large proportion of *Q. petraea* populations studied in Wales showed signs of hybridity. The almost complete absence of R populations from Wales was most noticeable. M and IR populations in Wales were always geographically close to IP populations suggesting that in small areas gene flow may be taking place between the species in both directions.

All H populations, without exception, were found close to the coast in river valleys in Wales. Tansley (1939) observed that all the oak populations he examined in Wales were *Q. petraea*. *Q. robur* trees, he argued, were either planted or near the bottom of river valleys. It is speculative to suggest that the H populations may occupy the true hybrid habitat between *Q. robur* and *Q. petraea*, i.e. between the drier, nutrient deficient siliceous areas (the mudstones, sandstones and slates) of the higher regions and the wetter, more poorly drained and conceivably nutrient-richer valley bottoms, and that in these areas hybrid swarms may be encouraged whilst introgression is not. Planting would only serve to increase the possibilities for gene exchange; the natural presence of *Q. robur* in the river valleys would have the same effect. It is interesting to note that Burtt-Davy (1933) observed that the *Q. petraea* × *Q. robur* hybrid was especially common along valley bottoms in hilly districts.

A similar situation is repeated, on a smaller scale, in the Wyre Forest. Salisbury (1925) has argued that in this woodland the higher parts have become low in base status, particularly Ca^{++}, and that the lower slopes have become enriched by salts being leached from above. Floristic composition appeared to support this edaphic separation: *Q. petraea* in the higher parts of the forest and *Q. robur* and hybrids at the foot of the slopes on the alluvial flats, particularly along Dowles Brook and the River Severn.

Hicken (1971) has more recently noted a similar pattern for the Wyre Forest flora and *Quercus* species. This pattern was also apparent from the present survey. The R and IR populations were found along one of the feeder streams into Dowles Brook; IP populations and P populations with a few *Q. robur* trees were generally found close to Dowles Brook whilst P populations were somewhat distant from the streams on higher ground.

From the above discussion, it is concluded that environmental factors are significant in influencing both the pattern of variation within *Q. robur* and the pattern of hybridization between the species.

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Studies on variation and evolution in *Centaurium erythraea* Rafn and *C. littorale* (D. Turner) Gilmour in the British Isles, 3. Breeding systems, floral biology and general discussion

R. A. E. UBSDELL

65 Hill Street, Reading, Berkshire

ABSTRACT

Studies on the distribution of *Centaurium erythraea* Rafn subsp. *erythraea* and *C. littorale* (D. Turner) Gilmour subsp. *littorale* show them to meet only in a few places on the coasts of the British Isles and northern Europe, and where they do meet ecological isolation is reinforced by slight differences in flowering time and the tendency of *C. erythraea* to inbreed. However, there are no totally effective reproductive barriers to gene exchange and hybridization may occur where the habitats of these two inter-fertile species are adjacent. The low fertility of the F_1 hybrid acts as a further isolating mechanism and hybridization does not normally extend beyond the F_1 generation.

Extensive hybridization has, however, occurred in areas of the sand dune systems on the Lancashire coast. In these areas man's interference with the natural vegetation has led to the breakdown of the naturally effective ecological isolation, causing the two species to grow together in mixed populations.

The difference in the pattern of hybridization in the areas concerned is shown to be partly due to a difference in the habitats available to the backcross hybrids, and partly to a difference in the fertility of the backcrosses.

In two areas backcrossing to *C. erythraea* has resulted in the increased variability of *C. erythraea*, while in other areas hybridization has resulted in the production of a new, allohexaploid species closely resembling the tetraploid *C. littorale* parent.

The nomenclature of all plants of hybrid origin is discussed and the name *Centaurium intermedium* (Wheldon) Druce is applied to the new, allohexaploid species.

INTRODUCTION

Morphological analysis of mixed populations of *C. erythraea* Rafn subsp. *erythraea* and *C. littorale* (D. Turner) Gilmour subsp. *littorale* from the coasts of S. Lancashire, v.c. 59, W. Lancashire, v.c. 60, Anglesey, v.c. 52 and Germany has shown that hybridization has taken place between the two species. In nine populations from the Lancashire coast backcrossing to *C. littorale* has taken place, while in another two backcrossing to *C. erythraea* has occurred. This is in contrast to the situation in the population from Anglesey and in two from Germany in which only F_1-like hybrids were found (Ubsdell 1976a).

Studies of cytology and pollen fertility showed both species to be tetraploid ($2n = 40$) and highly fertile, while the F_1 is tetraploid and almost sterile. Backcrossing to *C. erythraea* resulted in the formation of cytologically stable, fertile tetraploid plants, while backcrossing to *C. littorale* gave rise to cytologically stable, fertile hexaploid ($2n = 60$) plants (Ubsdell 1976b).

This paper is concerned with the isolating mechanisms that normally keep these two species distinct in the wild. A detailed study of the breeding systems, floral biology and ecology of these plants was carried out in order to find out why these mechanisms have broken down in certain areas, and why the outcome of hybridization differs in the areas studied.

BREEDING SYSTEMS

CROSS- AND SELF-FERTILITY

The amount of seed set in the wild under natural conditions by a representative number of plants of *C. erythraea* and *C. littorale* was calculated for individual plants as the mean number of seeds present

TABLE 1. SEED SET BY SELF-, OPEN- AND NATURAL-POLLINATION OF *C. ERYTHRAEA* AND *C. LITTORALE*, AND SEED VIABILITY

Cultivation[1] code	No. of plants used in experiments	Method of pollination	No. of successful pollinations/ total attempts	$\bar{x}$ seed[2] set per capsule by each method	%[3] seed set	%[4] germ- ination
I. *C.erythraea*						
R6	2	Open[a]	5/5	241	96[d]	98[f]
		Self[b]	2/2	225	92[e]	80[g]
		Natural[c]	9/9	258		
R9	2	Open	5/5	245	79	98
		Self	3/3	196	77	94
		Natural	8/8	255		
R34	2	Open	4/4	262	99	95
		Self	5/5	260	100+	94
		Natural	12/12	253		
R35	3	Open	6/6	237	100+	90
		Self	2/2	245	92	95
		Natural	5/5	269		
R36	3	Open	9/9	233	90	93
		Self	10/10	207	86	93
		Natural	12/12	261		
R46	2	Open	13/13	257	84	95
		Self	5/5	216	89	93
		Natural	8/8	241		
II. *C. littorale*						
R4	2	Open	4/4	175	48	66
		Self	4/4	83	52	20
		Natural	9/9	160		
R5	3	Open	4/4	158	57	62
		Self	2/2	90	46	10
		Natural	6/6	198		
R7	5	Open	6/6	210	53	60
		Self	10/10	105	49	16
		Natural	12/12	223		
R19	4	Open	7/7	217	44	60
		Self	4/4	94	42	10
		Natural	10/10	223		

1. Cultivation code and original locality:

C. erythraea
R6 Luccombe, Wight, v.c. 10
R9 Minsmere, E. Suffolk, v.c. 25
R34 Box Hill, Surrey, v.c. 17
R35 Sandown, Wight, v.c. 10
R36 Bude, E. Cornwall, v.c. 2
R46 Folkestone, E. Kent, v.c. 15

C. littorale
R4 Newborough, Anglesey, v.c. 52
R5 Holy Island, Cheviot, v.c. 68
R7 Ainsdale, S. Lancs., v.c. 59
R19 Ainsdale, S. Lancs., v.c. 59

2. Mean value for the number of seeds per capsule per plant set by each method—(a) Open-pollination (b) Self-pollination (c) Natural-pollination.
3. (d) Mean seed set from self-pollination (b) expressed as a percentage of the mean seed set from open-pollination (a); and (e) Mean seed set from self-pollination (b) expressed as a percentage of the mean seed set from natural-pollination (c).
4. (f) Germination of self-pollinated seed (% seed sown/seed germinated) expressed as a percentage of the germination (% seed sown/seed germinated) of open-pollinated seed (a); (g) similar for self (b) and natural (c) seed.

per capsule. Using the same method the amount of seed set by open pollination in the greenhouse was determined.

For the study of self-fertility, individual flowers were enclosed in bags before the stigma and anthers were mature and left for some time for seed to set by self-pollination. Self-fertility for individual plants was assessed by expressing the average seed set by a number of selfed capsules per plant as a percentage of the maximum possible — as calculated from open and naturally-pollinated capsules.

Viability of the seed set by selfing was estimated by comparing the percentage germination of selfed seeds with the percentage germination of both open- and naturally-pollinated seeds.

RESULTS

Plants of *C. erythraea* were found to be highly self-fertile with 77-100% seed set (Table 1) while plants of *C. littorale* were much less self-fertile with 42-53% seed set. All seed set by *C. erythraea* showed a high percentage germination (Table 1) while seed set by *C. littorale* as a result of self-pollination showed a lower percentage germination than seed set by open- and natural-pollination of this species.

FLORAL BIOLOGY AND POLLINATION MECHANISMS

It was thought that a study of the relative positions of stamens and stigma and their different rates of maturation might give useful information on the pollination mechanisms involved.

C, ERYTHRAEA

In this species the anthers and stigma are always to be found well above the corolla-tube but enclosed within the corolla-lobes. In the young buds the anthers start at a level below that of the stigma but then the filaments grow faster than the stigma until the anthers are either on a level with or just above the receptive part of the stigma in the mature flower.

The stigma becomes mature a day or two before the anthers dehisce and in a few flowers the style and stigma were observed bending to one side of the newly-opened corolla-lobes while the unripe anthers were bending to the opposite side. After one or two days the anthers dehisce allowing pollen to fall down on to the stigma and self-pollination may occur if cross-pollination has not already taken place. In the flowers in which the stigma was observed bending to one side of the flower and the anthers to the opposite side, the style and filaments later moved back towards each other in the centre of the flower allowing pollen to fall on to the stigma. In many flowers the filaments were later seen to actually bend down so the anthers could touch against the stigma and ensure self-pollination.

In dull weather the pale pink flowers of this species readily close, so that although the pollination mechanisms of this species allows some cross-pollination to take place, self-pollination is ensured should the former not occur.

C. LITTORALE

In the early development of the buds of this species the immature stigma is often seen to protrude beyond the corolla-lobes, but after a few days it becomes enclosed within the corolla-lobes so that in the mature flower both stigma and stamens are to be found above the corolla-tube but within the corolla-lobes. In some of the flowers of this species that were examined the anthers were found to be just above the receptive part of the stigma, although the majority had the anthers either just below or well below it.

The stigma becomes mature a day or two before the anthers dehisce and in the majority of flowers examined the ripe stigma appeared to bend towards one side of the open flower, while the unripe anthers were found bending towards the opposite side of the flower. After a few days the anthers dehisce and then the style and filaments move back towards the centre of the flower until the anthers and stigma come closer together. In those flowers in which the anthers and stigma can come into contact self-pollination can then take place, but in many flowers this is mechanically impossible because the stigma is well above the level of the anthers and so pollen cannot reach the stigma.

The flowers of this species are larger and brighter in colour (deep mauve) than those of *C. erythraea* and once open never close up again even in poor weather. It seems that cross-pollination is most likely to occur in this species, but if it fails self-pollination can take place in those flowers in which stigma and anthers can come into contact with each other.

HEXAPLOID PLANTS

The flowers of the hexaploid plants resemble those of *C. littorale* and the anthers were found to be either just above or just below the receptive part of the stigma. In nearly all flowers examined the filaments were seen to bend towards one side of the open flower while the stigma was held by the style towards the opposite side of the flower. Only after they had been apart for some time, presumably to allow cross-pollination to occur, did the stigma and anthers move back towards each other in the centre of the flower. In those flowers in which stigma and anthers can come into contact, self-pollination can take place.

POLLINATORS AND FLOWERING TIMES

FIELD OBSERVATIONS ON POLLINATING INSECTS

The flowers of *C. erythraea* are pink and fairly conspicuous while those of *C. littorale* are larger, deep mauve and even more conspicuous. Although the corolla forms a tube the stigma and anthers are exserted and thus open to pollination by many insects. Some field observations on insects active near *C. erythraea* and *C. littorale* were carried out to see which insects could be transferring pollen between these two species.

Butterflies (Lepidoptera), grasshoppers (Orthoptera), bees (Hymenoptera-Apidae), hoverflies (Diptera-Syrphidae) and other Diptera were observed but none was seen to visit either of the *Centaurium* species. Large patches of *Lotus corniculatus* and *Trifolium repens* were present in many of the habitats occupied by *Centaurium* and the bees were concentrating on those two species to the exclusion of all others. The only insects seen to visit flowers of *Centaurium* were small, black thrips (Thysanoptera), which were observed crawling all over the plants and appeared to move at random between plants of *Centaurium* and also over most of the other species in the area.

There is little recorded information about pollinators for *Centaurium* but Knuth (1909) gave a list of insects seen by Müller to visit flowers of *C. erythraea*. These included small flies of the families Empididae and Syrphidae (Diptera). Both families commonly visit open, unspecialized flowers, visiting nectarless ones for their pollen. Proctor & Yeo (1973), however, reported that flies of these two families often fail to effect pollination because they do not always touch against the stigma and anthers. Müller (1883) was of the opinion that the spiral twisting of the anthers of *Centaurium* is probably an adaptation to ensure their being touched by the thin proboscis of butterflies and moths (Lepidoptera). There is, however, some doubt as to whether they always effect pollination as Müller (1883) stated that *Lotus corniculatus* is also visited by Lepidoptera, which obtain nectar by boring at tissue at the base of the flowers and without effecting pollination.

A lot more observation is needed but it is possible that both cross- and self-pollination in these species of *Centaurium* could be carried out by casual visits from members of the Thysanoptera. Pollinators probably do not discriminate between *C. erythraea* and *C. littorale* on the basis of the attractiveness of the flowers and could visit flowers of both species at random. Thus, if the two species grow together in mixed populations there is no barrier to prevent cross-pollination between the two species from taking place.

FLOWERING TIMES

C. littorale starts to flower in the field about the middle of June and completes its main flowering period by the middle of July. *C. erythraea* starts to flower at the beginning of July and continues into August. There is, therefore, an overlap of two or more weeks in the flowering periods of the two species when cross-pollination could take place.

The stigmas of *C. littorale* become receptive in late June before the anthers of this species or those of *C. erythraea* have dehisced. The anthers of *C. littorale* soon dehisce but, at the time when most of the stigmas of this species are receptive, the only pollen available is its own.

The stigmas of *C. erythraea* become receptive at the beginning of July before the anthers have dehisced. So for a short period only pollen of *C. littorale* is available, and it is quite feasible for insects to transfer pollen from *C. littorale* to the stigmas of *C. erythraea* before most of its own pollen is ready. However, if *C.erythraea* is not fertilized by pollen from *C. littorale*, self-pollination will take place when its own pollen is ready by the flowers closing and the anthers and stigma coming into contact. Transfer of pollen from *C. erythraea* to the stigmas of *C. littorale* is unlikely to occur because of the different times of maturation. As already stated, insects probably do not discriminate between flowers of the two species and probably visit flowers of both at random. Transfer of pollen in early July could result in the pollination of *C. erythraea* by *C. littorale*, but transfer of pollen in early June can only result in the pollination of *C. littorale* by its own pollen.

Hybrid plants come into flower after *C. littorale* and at about the same time as *C. erythraea*. The hybrid stigmas are, therefore, receptive at the same time as are the stigmas of *C. erythraea*, when for a short time the only available pollen is that of *C. littorale*. Thus, pollen could easily be transferred by non-discriminating insects from *C. littorale* to the stigmas of the hybrid plants while their own pollen is immature. By the time the hybrid pollen is shed the stigmas of *C. littorale* will have been fertilized by their own pollen, and many of the flowers of *C. erythraea* will have closed for self-pollination. This may explain why backcrossing to *C. littorale* seems to have taken place most commonly, although some backcrossing to *C. erythraea* has also occurred. This could have happened by transfer of pollen in early or mid July before the flowers of *C. erythraea* close for self-pollination. However, the amount of backcrossing also depends upon the abundance of the backcross parent and upon the habitats available in the different areas; the importance of the latter in determining the presence of the various backcross types is stressed later.

GENERAL DISCUSSION

The relative importance of the various isolating mechanisms which normally keep *C. erythraea* and *C. littorale* distinct in the wild can now be considered. Artificial crosses between the two species have shown that there are no internal, reproductive barriers to gene exchange (Ubsdell 1976b). Reciprocal crosses gave a high seed set and high percentage germination, producing vigorous but almost sterile F_1 hybrids.

Distribution maps of *C. erythraea* and *C. littorale* indicate that the two species grow apart over much of their range but do meet in a few places on the coasts of the British Isles, France, Belgium, Holland, Denmark, Germany and Sweden. However, recent reports and field studies show that they actually meet in fewer places than this overlap suggests, and this is partly due to the destruction of many of their coastal habitats by man. They are known to occur together in the British Isles at Harlech and Morfa Dyffryn, Merioneth, v.c. 48, at Newborough Warren, Anglesey, v.c. 52, at Hightown, Freshfield, Ainsdale and Hesketh, S. Lancs., v.c. 59, at St Annes, W. Lancs., v.c. 60 and on parts of the coasts of Belgium, Denmark, Schleswig-Holstein in northern Germany, southern Sweden and the Swedish islands of Gotland and Öland.

Where they meet they are generally effectively isolated by different habitat preferences, *C. littorale* being found in more halophytic habitats such as young, wet dune-slacks and the more saline communities of salt-marsh sea meadow, while *C. erythraea* is found in old, dry dune-slacks and occasionally in the least saline of the salt-marsh sea meadow communities.

The results obtained from experiments on seed set by self- and open-pollination, and from observations on the floral biology and pollination mechanisms, indicate that *C. erythraea* is highly self-fertile and more likely to be inbreeding than *C. littorale*, which is less self-fertile and largely outbreeding. It is possible that the high degree of self-pollination shown by *C. erythraea* may act as a weak, external reproductive barrier reducing the amount of gene exchange between the two species if they come into contact.

There is also a difference in flowering periods, with *C. littorale* coming into flower at least two weeks before *C. erythraea*, and this would also help to reduce the amount of gene exchange, but there is an overlap of at least two weeks in which transfer of pollen, chiefly from *C. littorale* to the stigmas of *C. erythraea* by non-discriminating insects, could take place.

Thus, there are no totally effective reproductive barriers to gene exchange and so hybridization may take place where these two inter-fertile species come into contact. This has occurred at all the British localities listed above and at St Peter and Falshoft on the coast of Schleswig-Holstein.

The dune system at Newborough Warren has been little disturbed by man and although both species grow in the area they are mostly effectively isolated by the natural, isolating mechanisms described above. However, a few F_1-like plants were found where the habitats of the two were adjacent and where they were growing in close proximity. Hybrids have also been reported (Benoit & Richards 1963) from Merioneth but the area concerned has not been visited and so no information is available on the ecological situation.

In direct contrast, the dune systems on the Lancashire coast have been subject to much disturbance by man. At Hightown and Ainsdale urban developments have destroyed the habitats favoured by *C. erythraea* and it is now found in areas more suited to *C. littorale*, while at St Annes the situation has been reversed and habitats favoured by *C. littorale* have been destroyed and it is now found in those more suited to *C. erythraea*. In all these areas and at Freshfield, which was subject to disturbance prior to being made into a Nature Reserve in 1965, the two species grow intermingled in the same dune-slacks and extensive hybridization has taken place.

Hybrid plants have also been found in disturbed places on the coast of Schleswig-Holstein, but no ecological information is available on the situation in France, Belgium, Holland, Denmark and Sweden.

The availability of suitable habitats is one of the main factors governing the establishment of hybrids. The areas of sea meadow in Schleswig-Holstein are frequently denuded of vegetation when the turf is cut to provide material for the banks protecting the cultivated land from the sea, and such open habitats are ideal for the establishment of F_1 hybrids; as are the extensive areas of open ground found in the dune systems at Newborough Warren, Anglesey and on the Lancashire coast. These areas of open ground are particularly extensive around Hightown and Ainsdale because of constant trampling by weekend-trippers and holiday-makers.

Dune-slack habitats are also highly variable and Ranwell (1959, 1960) has demonstrated the gradient environments in dune systems. Such areas will contain many habitats intermediate between the young, wet dune-slacks favoured by *C. littorale* and the old, dry dune-slacks preferred by *C. erythraea*, in which F_1 hybrids can become established, while habitats most closely resembling those favoured by one or other of the two species will be suitable for the respective backcross hybrids. Stebbins & Anderson (1954) have pointed out the significance of habitat gradients for the survival of hybrids, and Bradshaw (1958) has shown that gradient environments in the dune system at Newborough Warren favour the development of hybrids between *Agrostis stolonifera* (a plant of wet slacks) and *A. tenuis* (a plant of drier slacks).

The relationship between the types of hybrids present in an area and the types of habitats available is clearly shown on the Lancashire coast, with backcrosses to *C. littorale* predominating in those areas (Hightown and Ainsdale) in which only *C. littorale*-like habitats are present, backcrosses to *C. erythraea* predominating at St Annes where only *C. erythraea*-like habitats are present, and both backcrosses occurring at Freshfield where both habitats still exist. This demonstrates that one of the major reasons for the difference in the outcome of hybridization between the different areas is the types of habitats available.

However, the outcome of hybridization also depends on the vigour and fertility of the F_1 hybrid, and on the degree of isolation from the parents. Previous work (Ubsdell 1976b) has shown that the F_1 hybrids are almost sterile, and so in order to survive they must overcome this sterility since they are unable to persist by vegetative reproduction. Selfing of the F_1 and crossing with other F_1 plants does not produce any increase in fertility, and the F_2 is equally sterile. At Newborough Warren the few F_1 plants do not grow near enough to the parents to backcross, and so hybridization does not extend beyond the F_1 generation, although there are plenty of suitable habitats for the hybrid derivatives. It is difficult to understand the situation in Schleswig-Holstein as little work has been done on the Continental plants, but it does seem that stabilization of hybrid segregates at the tetraploid level and in the absence of parents may have taken place.

On the Lancashire coast the F_1 hybrids grow intermingled in the same slacks as the parents and backcrossing to both has taken place. In both cases this has resulted in an increased fertility and a diminution of the cytological abnormalities exhibited by the almost sterile, tetraploid F_1 hybrid, although it seems to have been achieved by two separate methods.

The amount of backcrossing in any area will depend upon the frequency of the parents, the breeding systems of the parents, and the flowering periods of hybrids and parents. Despite the high degree of inbreeding shown by *C. erythraea*, some backcrossing to this parent has occurred at St Annes and in one population from Freshfield. This is because this parent is the most frequent in these areas where *C. erythraea*-like habitats occur, and the highly fertile, tetraploid backcross plants will be well adapted to survive in such habitats. In these areas introgression has taken place, and genes of *C. littorale* have been transferred to *C. erythraea* by backcrossing of the F_1 hybrid to *C. erythraea*, followed by natural selection of favourable recombinant types resembling the latter. This has resulted in increased variability of *C. erythraea* and some of the new gene combinations may be at a selective advantage in habitats other than those favoured by this species.

Backcrossing to *C. littorale* has occurred in all other areas on the Lancashire coast where this species is the most frequent parent. Backcrossing to this parent is also favoured by its tendency to outbreed, and pollen from this parent can be transferred to the stigmas of the hybrids during the short period before their own pollen is ripe. However, it has also been shown (Ubsdell 1976b) that backcrossing to this parent does not increase the fertility of the hybrids at the tetraploid level, since all tetraploid backcrosses to this species were found to be almost as sterile as the F_1 hybrids, unlike the backcrosses to *C. erythraea* which became more fertile. There may, therefore, be a strong selective advantage for plants that can overcome this sterility, and polyploidy is one way of achieving this. Backcrosses to *C. littorale* collected from Hightown, Ainsdale and Freshfield have been shown (Ubsdell 1976b) to be hexaploid, highly fertile and cytologically stable. They have also been shown (Ubsdell 1976b) to breed true and to be genetically isolated from the tetraploid parents and all tetraploid hybrids by the difference in chromosome number. They are able to compete sucessfully with the parents at Hightown, Freshfield and Ainsdale, and in some areas, notably at Hightown and Ainsdale, they are more abundant than the parents, and they may be at a selective advantage in these disturbed, somewhat intermediate habitats.

This study of variation and evolution has consequently shown that, in addition to the more expected process of introgression, a new species resulting from both hybridization and polyploidy has been produced by abrupt speciation. The origin of this species seems to be closely related to man's disruptive effect on the natural environment and, since there is little reason to assume any direct connections between the areas in which it was formed (Hightown, Freshfield and Ainsdale), it must be considered an example of the polytopic origin of an allopolyploid species.

It is possible to establish an approximate date for the formation of this new species, since the major disturbance of the dune systems of the Lancashire coast appears to have taken place during the building of the Liverpool-Southport railway in 1884 and the first record of hybrid plants was made by Wheldon (1897). His plants (**BM**) collected in 1894 from Hightown are identical to those of this new species, the nomenclature of which will now be discussed.

NOMENCLATURE OF PLANTS OF HYBRID ORIGIN

The nomenclature of all plants of hybrid origin has been confused in the literature by the lumping together of the tetraploid F_1 hybrids, the tetraploid backcrosses to *C. erythraea* and the hexaploid plants under the general name of *Centaurium intermedium* (Wheldon) Druce, although the original description of *Erythraea littoralis* var. *intermedia* Wheldon, upon which the name *C. intermedium* was based, refers only to the hexaploid plants. This present study has shown that the hexaploid plants should be recognized as a new allopolyploid species to which the name *C. intermedium* (Wheldon) Druce should be given, while the tetraploid F_1 and backcross hybrids to *C. erythraea* should be included under the general hybrid formula *C. erythraea* × *C. littorale* (Melderis 1972), as follows:

Tetraploid hybrids between *C. erythraea* and *C. littorale*
C. erythraea × *C. littorale*
C. × *intermedium sensu* Gilmour (1937) *p.p. et* O'Connor (1955) *p.p.*, *non* Druce (1905) *nec Erythraea littoralis* var. *intermedia* Wheldon, *Sci. Gossip*, n.s., **4**: 111 (1897).

Hexaploid plants
Centaurium intermedium (Wheldon) Druce, *Ann. Scot. Nat. Hist.*, **53**: 48–49 (1905)
Erythraea littoralis var. *intermedia* Wheldon (1897)
Lectotype (selected here): South Lancashire (v.c. 59), Hightown, "sand dunes", 21 July 1894, *Wheldon* (**BM**)

Wheldon described *Erythraea littoralis* var. *intermedia* from plants collected at Hightown, S. Lancashire. These specimens are at **BM** and are identical with the hexaploid plants. Druce's *C. intermedium* therefore also refers to these hexaploid plants. Gilmour and O'Connor lumped tetraploids and hexaploids together, while O'Connor and Melderis considered the hexaploid to be a polyploid form of *C. littorale*.

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Spore size in *Asplenium adiantum-nigrum* L. and *A. onopteris* L.

R. H. ROBERTS

51 Belmont Road, Bangor, Gwynedd

ABSTRACT

Spore samples from herbarium specimens of *Asplenium adiantum-nigrum* L. *sensu stricto* and *A. onopteris* L. have been measured. The results show that difference in spore length clearly discriminates between the two species. Means based on samples of 50 spores vary from $28{\cdot}9 \pm 1{\cdot}3\mu m$ to $32{\cdot}4 \pm 2{\cdot}2$ μm, with a range of 25-39 μm in *A. onopteris*, and from $39{\cdot}2 \pm 2{\cdot}4$ μm to $41{\cdot}9 \pm 3{\cdot}0$ μm, with a range of 32-52 μm in *A. adiantum-nigrum*.

For identification purposes a sample of ten spores has been found sufficient to give reliable discrimination.

INTRODUCTION

Among the species of the genus *Asplenium* L. which occur in Europe none has proved more difficult taxonomically than those of the *A. adiantum-nigrum* aggregate. In the British Isles this consists of *A. adiantum-nigrum* L. *sensu stricto, A. onopteris* L. and *A. cuneifolium* Viv. The last named is found only on ultrabasic rocks such as serpentine, or on screes derived from them, and its occurrence in Scotland and Ireland has only been confirmed recently (Roberts & Stirling 1974; Roberts *et al.* 1978). On the other hand *A. onopteris* has been known in Ireland at least since the beginning of the 19th century (Mackay 1836), but its taxonomic status has always been controversial.

Some authors (e.g. Mackay 1836; Newman 1854; Crabbe, Jermy & Lovis 1964) have recognised *A. onopteris* as a species distinct from *A. adiantum-nigrum sensu stricto* and separated from it by its much larger fronds, tripinnate throughout, the apices of the fronds and pinnae having long, caudate tips. Other authors (e.g. Luerssen 1889; Praeger 1919; Hyde, Wade & Harrison 1969), realising that this description excluded many plants which, in their view, belonged to *A. onopteris*, broadened the description to such an extent that it included plants which were virtually indistinguishable from the more finely divided variants of *A. adiantum-nigrum*.

A synopsis of the descriptions of *A. onopteris* (as *A. acutum* Bory or *A. adiantum-nigrum* var. *acutum* (Bory) Pollini) by various authors was given by Newman (1854), who showed that there was no unanimity of opinion among taxonomists regarding the characters which could be used to separate these plants from typical *A. adiantum-nigrum*. Praeger (1919) made a study of '*A. adiantum-nigrum* var. *acutum*' in Ireland, but failed to find any points of discontinuity in the variation of the characters which had been proposed to separate it from the typical variety.

Fresh light was thrown on the problem as a result of the cytological and cytotaxonomic work of Manton (1950) and Shivas (1955, 1969). They showed that while *A. adiantum-nigrum sensu stricto* is tetraploid, with $n = 72$, *A. onopteris* is uniformly diploid, with $n = 36$. Shivas further showed that *A. adiantum-nigrum* is an allotetraploid derived from diploid *A. onopteris* and diploid *A. cuneifolium*. This research demonstrated the existence of three members within the *A. adiantum-nigrum* complex and also accounted for their close morphological similarity.

The taxonomic problems, however, have remained largely unresolved. Over 40 years after the publication of Praeger's paper (1919), de Joncheere (1963) concluded that, while *A. onopteris* is quite different from North European *A. adiantum-nigrum,* there is a complete sequence without a clear demarcation line right down to extremes in the Canary Islands and Palestine. A critical study of the morphological characters of these two species in France was made recently by Senesse (1973), who also found that all the characters which have been proposed for separating them are continuous variables. He concluded that it is possible to assign critical populations to their correct taxa only by the use of a method involving the relative dimensions of the frond, the pinnae and the pinnules. Nevertheless he expressed the opinion that *A. onopteris* is a distinct species.

C

Heufler (1856) noticed an appreciable difference in size and shape between the spores of *A. onopteris* and those of *A. adiantum-nigrum*. However, he gave no actual values, nor is it clear whether his measurements included the perispore. Moreover, Heufler was uncertain whether or not the differences he observed were the result of environmental conditions. Luerssen (1889), however, failed to confirm Heufler's observations on spore size and concluded that they had no taxonomic significance. This view seems to have been accepted by most authors since Luerssen's day and there is no reference to spore characters in the descriptions of *A. onopteris* in any recent British Flora or in *Flora Europaea* (Crabbe *et al.* 1964).

This study was undertaken in order to ascertain the value of spore size as a discriminant of *A. onopteris*.

METHODS

Harris (1955) has discussed the use of spore characters in the classification of New Zealand ferns. For a critical comparison between two species he measured a sample of 50 spores. As a test of the reliability of the mean value a second sample of 50 spores was measured and the difference between the two means was used to indicate whether a larger sample was necessary. This procedure has been adopted here, but in addition the difference between the means of the two samples was tested for significance by calculating its standard error. It was found that the difference between the means of two separate samples from the same frond was very small and not statistically significant ($t = 0{\cdot}5$; $p > 0{\cdot}6$). Consequently measurements of random samples of 50 spores were considered sufficient for the purpose of this study.

TABLE 1. SPORE LENGTH IN 21 SPECIMENS OF *A. ONOPTERIS*
Each mean is based on a sample of 50 spores

Details of specimen	Mean length (μm)	Standard deviation (μm)	Range of variation (μm)
Garrycloyne, Mid Cork, v.c. H4, M.J.P.S., 1977 (**DBN**)	30·3	±1·9	27–35
Near Bandon, Mid Cork, v.c. H4, J.K.McD., 1975 (**DBN**)	31·6	±2·4	26–36
Whitegate, E. Cork, v.c. H5, R.A.P., 1896 (**DBN**)	30·2	±1·6	27–34
Snowhill, Kilkenny, v.c. H11, R.L.P., 1899 (**DBN**)	31·2	±1·9	28–37
Upper Lake, Killarney, S. Kerry, v.c. H1, R.L.P., 1911 (**DBN**)	30·0	±1·7	26–34
Innishannon, Mid Cork, v.c. H4, anon., 1862 (**DBN**)	29·1	±1·8	25–32
Lough Hyne, W. Cork, v.c. H3, R.A.P., 1889 (**DBN**)	29·5	±1·6	26–33
Carra Lake, S. Kerry, v.c. H1, E.M.B., 1881 (**DBN**)	29·1	±2·2	25–36
Dunran Wood, Wicklow, v.c. H20, anon, 1854 (**DBN**)	30·4	±1·9	26–34
Newtownards, Down, v.c. H38, R.L.P., 1892 (**DBN**)	29·9	±2·3	25–35
Newtownards, Down, v.c. H38, R.L.P., 1937 (**DBN**)	30·7	±2·9	26–36
Cloughjordan, N. Tipperary, v.c. H10, R.L.P., 1900 (**DBN**)	28·9	±1·3	25–32
Menton, Alpes Maritimes, France, H.S.T., 1886 (**NMW**)	29·2	±1·8	25–34
Menton, Alpes Maritimes, France, G.B., 1890 (**NMW**)	31·6	±2·4	28–37
Isola d'Ischia, Italy, T.R., 1966 (**DBN**)	29·9	±1·8	25–35
Tossa, Catalonia, Spain, D.T., 1936 (**UNCW**)	31·1	±2·2	25–37
Estepona, Spain, B.M.A., 1974 (**herb. R**)	32·1	±2·8	26–39
Algeciras, Spain, A.McG.S., 1974 (**herb. R**)	31·3	±2·8	26–37
Algeciras, Spain, A.McG.S., 1974 (**herb. R**)	32·4	±2·2	28–36
Les Colarches, Corsica, J.E.L., 1970 (**NMW**)	29·8	±2·0	25–36
Madeira, ex herb. W.R.McNab, n.d. (**DBN**)	29·4	±2·3	25–37

Initials given in the table refer to the following collectors: Mrs B. M. Allen, Miss E. M. Battersby, G. Bryan, J. E. Lousley, Miss J. K. McDonnell, R. A. Phillips, R. L. Praeger, T. Reichstein, Miss M. J. P. Scannell, A. McG. Stirling, D. Thoday, H. S. Thompson.

herb. R = herbarium R. H. Roberts

Spores were obtained by removing a portion of a fertile frond and washing it under running water to remove any extraneous spores. It was then put in a paper envelope to dry, after which spores from it were placed on a glass slide and mounted in gum chloral. After 48 hours measurements of the exine were made using a calibrated eyepiece micrometer. Earlier observations had shown that measurements of the perispore were unsatisfactory and gave erratic results.

RESULTS

The mean values of spore length for *A. onopteris* with the standard deviation and range of variation for each sample are shown in Table 1 and those for *A. adiantum-nigrum* in Table 2. Measurements of spore width (more strictly, 'depth' when measured in lateral view) were made in only five samples of each species and are not presented here. However, those that were made suggest that there is no difference between the two species in the ratio of spore length to spore width. In both of them this ratio is about 1·36:1, and the results do not substantiate Heufler's statement that there is a difference in shape between the spores of these species.

It had been expected that measurements obtained from the older herbarium specimens would differ substantially from those taken from the more recently gathered ones because of shrinkage of the spores on drying. However, the differences were found to be too small to affect the results. The data have therefore been presented together regardless of the age of the specimens.

It can be seen from Tables 1 and 2 that mean spore length for *A. onopteris* varies from 28·9 to 32·4 μm and for *A. adiantum-nigrum* from 39·2 to 41·9 μm. Thus between the highest value for *A. onopteris* and the lowest value for *A. adiantum-nigrum* there is a difference of 6·8 μm. This difference proved to be highly significant (t = 14·8; $p<0{\cdot}001$).

Measurements of 50 spores is time-consuming and may not be considered practicable for purposes of identification. Means have therefore been calculated for each ten consecutive values in each sample of

TABLE 2. SPORE LENGTH IN 21 SPECIMENS OF *A. ADIANTUM-NIGRUM*
Each mean is based on a sample of 50 spores

Details of specimen	Mean length (μm)	Standard deviation (μm)	Range of variation (μm)
Stanner Rocks, Radnor, v.c. 43, 1972 (**herb. R**)	40·5	±2·8	35–47
Harlech, Merioneth, v.c. 48, 1976 (**herb. R**)	39·5	±3·3	32–52
Moel Hebog, Caerns., v.c. 49, 1965 (**herb. R**)	39·3	±3·2	32–51
Llanberis Pass, Caerns., v.c. 49, 1971 (**herb. R**)	40·2	±3·2	34–47
Llanberis Pass, Caerns., v.c. 49, 1971 (**herb. R**)	41·9	±3·0	36–50
Conway, Caerns., v.c. 49, 1962 (**herb. R**)	41·5	±3·2	36–48
Bangor, Caerns., v.c. 49, 1974 (**herb. R**)	40·5	±2·6	36–47
Bangor, Caerns., v.c. 49, 1977 (**herb. R**)	40·9	±2·6	35–50
Llandudno, Caerns., v.c. 49, 1976 (**herb. R**)	41·8	±3·2	3–49
Great Orme, Caerns., v.c. 49, 1960 (**herb. R**)	39·8	±2·9	34–47
Llangollen, Denbigh, v.c. 50, 1973 (**herb. R**)	39·6	±3·4	34–52
Beaumaris, Anglesey, v.c. 52, 1970 (**herb. R**)	39·2	±2·4	34–46
Pentraeth, Anglesey, v.c. 52, 1966 (**herb. R**)	40·4	±2·8	36–48
Pentraeth, Anglesey, v.c. 52, 1970 (**herb. R**)	39·9	±2·8	32–47
Penmon, Anglesey, v.c. 52, 1968 (**herb. R**)	39·8	±2·5	35–45
Garrycloyne, Mid Cork, v.c. H4, M.J.P.S., 1977 (**DBN**)	40·0	±2·9	35–48
Garrycloyne, Mid Cork, v.c. H4, M.J.P.S., 1977 (**DBN**)	40·1	±3·1	34–48
Whitegate, E. Cork, v.c. H5, M.J.P.S., 1976 (**DBN**)	39·7	±2·8	34–47
Kilworth, E. Cork, v.c. H5, M.J.P.S., 1977 (**DBN**)	39·9	±2·9	34–48
Kilworth, E. Cork, v.c. H5, M.J.P.S., 1977 (**DBN**)	40·7	±3·0	34–51
Aghada, E. Cork, v.c. H5, M.J.P.S., 1977 (**DBN**)	39·6	±3·3	32–48

Specimens collected by R. H. Roberts except those marked M.J.P.S. by Miss M. J. P. Scannell

50. These vary from 27·9 to 33·0 μm for *A. onopteris* and from 38·2 to 42·8 μm for *A. adiantum-nigrum*. Thus with samples of only ten spores the difference between the limits of the ranges of variation in the two species is just over 5μm and is highly significant (t % 4·7; $p<0{\cdot}001$). The distributions of spore length in the two species are shown in Fig. 1 and those of the means of samples of ten spores in Fig. 2.

A. onopteris has hitherto proved extremely difficult (except in its extreme forms) to separate from *A. adiantum-nigrum*. Indeed, the true identity of many of the specimens included in Tables 1 and 2 only became clear during the course of this study. Because of this difficulty its distribution has not been known with certainty. For example, it has been reported from south-western England (Warburg 1962) and even from eastern Scotland (Hyde *et al.* 1969), records which are now thought to be almost

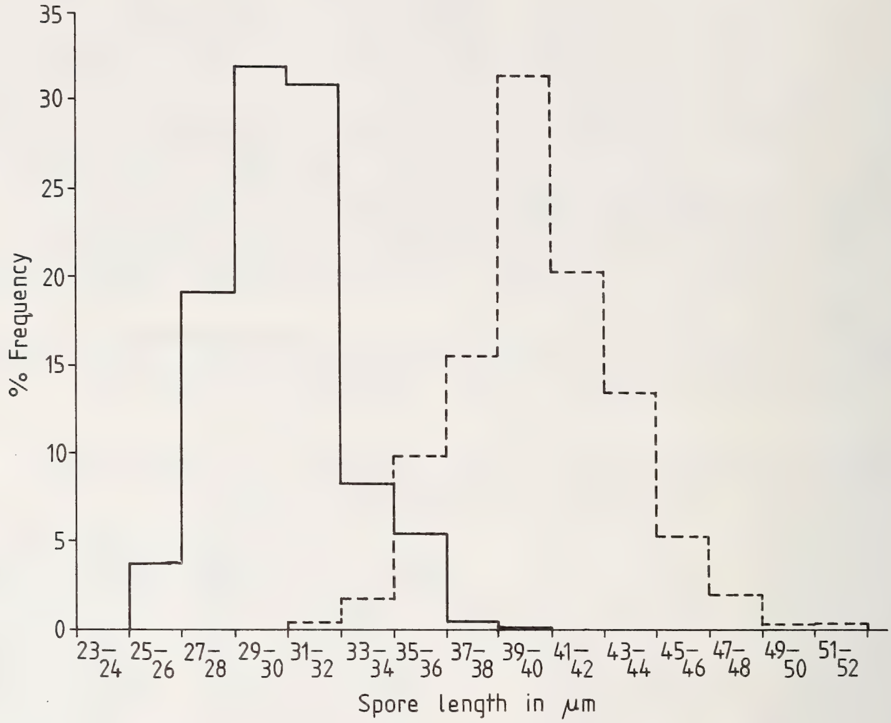

FIGURE 1. Histograms of spore length in *Asplenium onopteris* (unbroken line) and *A. adiantum-nigrum* (broken line), based on 1,050 spores of each species.

certainly erroneous. Jermy (1978) has emphasized this difficulty recently and has suggested that specimens from W. Cornwall, v.c.1, and from Down, v.c. H38, require further study. These records have consequently been omitted from the distribution map of *A. onopteris* in the *Atlas of ferns of the British Isles*. However, two specimens gathered in Down at different times by Praeger, and determined by him as *A. adiantum-nigrum* var. *acutum*, are included in this study. These had been confirmed as *A. onopteris* by D. M. Synnott, who has also (pers. comm. 1978) found spore size useful for the determination of this taxon. On the basis of spore length (Table 1) it is now clear that Praeger's specimens from Down are quite unambiguously *A. onopteris*.

As has been pointed out, the taxonomic status of *A. onopteris* has always been uncertain. However, as this study has shown, the difference in spore length between it and *A. adiantum-nigrum* is large enough to give a clear and reliable separation of the two taxa, and supports the view that *A. onopteris* should be recognised as a distinct species.

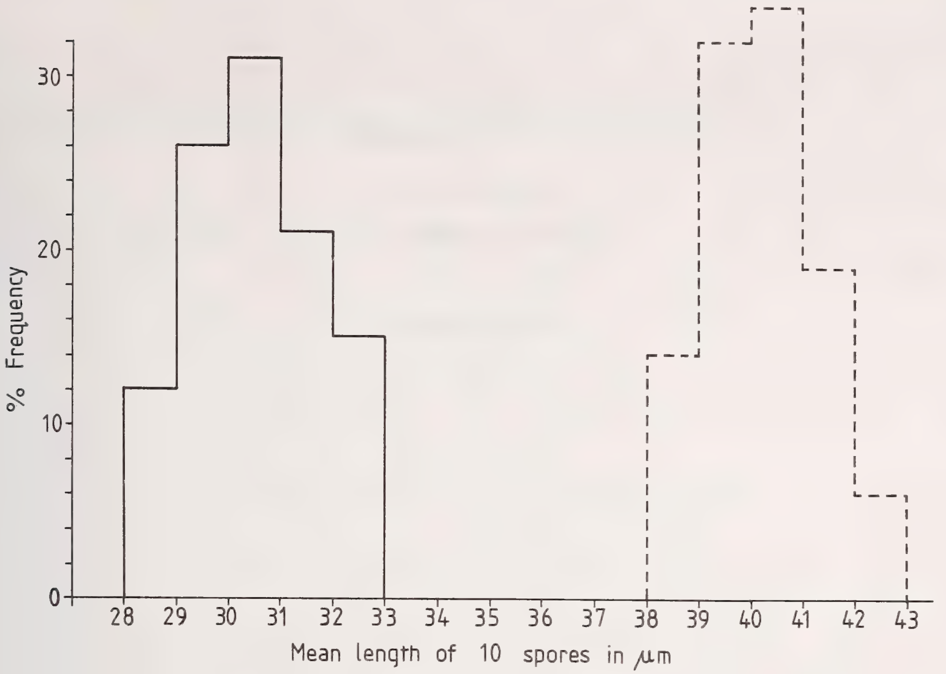

FIGURE 2. Histograms of mean length of random samples of 10 spores from *Asplenium onopteris* (unbroken line) and *A. adiantum-nigrum* (broken line).

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Preparing a new Flora of the Shropshire region using a federal system of recording

J. R. PACKHAM
The Polytechnic, Wolverhampton

P. H. OSWALD
Nature Conservancy Council, Godwin House, Huntingdon

F. H. PERRING
Institute of Terrestrial Ecology, Monks Wood, Huntingdon

C. A. SINKER
Field Studies Council, Preston Montford, Shrewsbury

and

I. C. TRUEMAN
The Polytechnic, Wolverhampton

ABSTRACT

A new Flora of Shropshire will cover a rectangular block of 10km squares, and records for species of three frequency classes will be collected in different ways—common (A) species only at the 10km square level; intermediate (B) species in 2 × 2km 'tetrads' but with the records localized to the 1km square; and rare (C) species by 6-figure grid references. Special cards prepared for each of these categories are illustrated. To co-ordinate the 80 or so recorders and avoid overlaps, one person is appointed to take charge of each 10km square both for recording and for data-handling. Recorders are kept in touch and helped in several other ways including evening classes, residential courses, special identification sessions, publication of identification keys and the holding of an Annual Meeting. These activities may explain why the number of recorders contributing during the first three years of this Project, due to be concluded by 1982, has not fallen.

INTRODUCTION

'There must be a beginning to any great matter, but the continuing of the same unto the end until it be thoroughly finished yields the true glory.' (Sir Francis Drake to Sir Francis Walsingham, after Cadiz, 17th May 1587).

The only comprehensive Flora of Shropshire (Salop, v.c. 40) is that of the Rev. William Leighton (1841), and even this strangely lacks the ferns and fern allies, a deficiency not made good until the publication by William Phillips of a paper in 1878. The Caradoc and Severn Valley Field Club appointed a committee in 1897 'to take into consideration the production of a new Flora of Shropshire'. Despite several changes in editorship a new Flora was ready for publication in 1913; however, response to the prospectus issued at that time was disappointing, and the Flora was never printed. Thus only two accounts of the vascular plants growing in the county have been published since 1841. The first is in Volume 1 of the Victoria County History of Shropshire (Phillips *et al.* 1908), and the second is the handlist produced by Lloyd & Rutter (1957). Both borrowed extensively from the manuscript of 1913 and neither gives an up-to-date account of the flora as it is today.

THE NEW FLORA PROJECT

Despite the lack of a comprehensive modern Flora, botanists have been studying the plants of Shropshire more or less assiduously since Leighton's time, and information is scattered in the national literature and herbaria, as well as more locally, notably in the herbaria at Ludlow and Shrewsbury Museums and in the Transactions of the Caradoc and Severn Valley Field Club. Furthermore, since the Second World War interest in wild life in Shropshire has increased steadily. The existence of a Field Studies Council Centre at Preston Montford has brought a series of national botanical experts to the county to lead courses, while the former Shropshire Adult College at Attingham Park held annual botanical courses from 1968 to 1975 run with particular emphasis on the flora of the park and the county. The presence of a Regional Office of the Nature Conservancy Council, also at Attingham Park, the growth of the Shropshire Conservation Trust and the activities of the Extra-mural Department of Birmingham University and the Polytechnic, Wolverhampton, have all fostered interest in the flora and given opportunities for raising the level of knowledge of plant identification among resident and visiting botanists.

It was with these considerations in mind that four of the writers of this paper, P. H. Oswald, J. R.

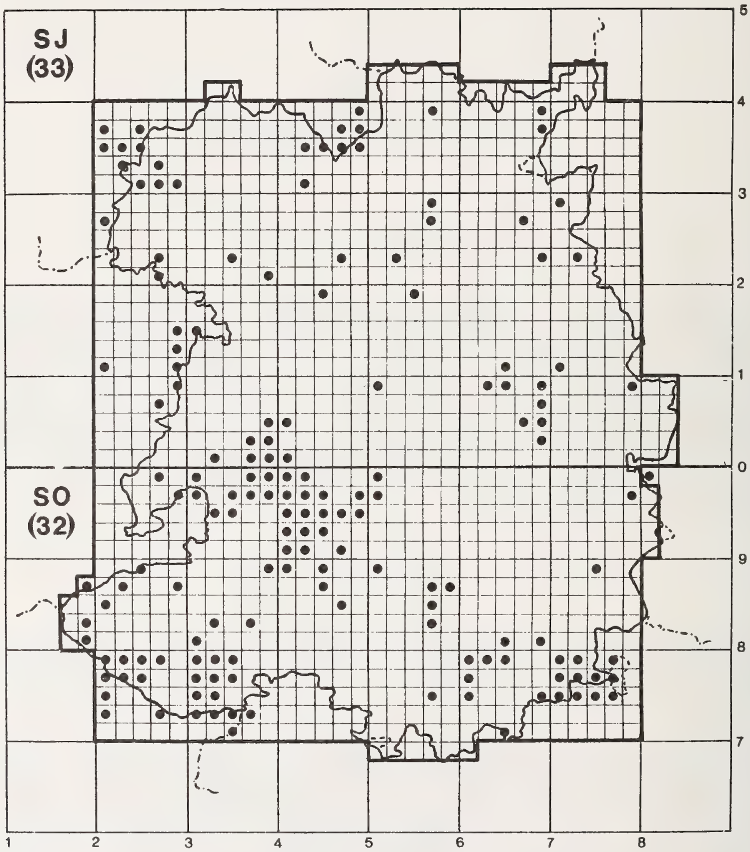

FIGURE 1. 'Greater Shropshire'.

The area to be mapped is limited by heavy straight lines and includes small portions of adjacent counties. The bold irregular outline shows the administrative county of Salop and the dotted line Watsonian vice-county 40 where this differs from the administrative county. The 2 × 2km 'tetrad' records for intermediate (B) species 40 (*Calluna vulgaris*) are shown.

Packham, F. H. Perring and C. A. Sinker, began to discuss a co-ordinated survey aimed at the publication of a new county Flora in 1982. The inaugural meeting of the Shropshire Flora Project, to which all those thought likely to be interested were invited, was held at Preston Montford Field Centre on 22nd January 1975. The enthusiasm with which the proposal and the suggested methods of recording were received encouraged the organizers to press ahead with the Project. The editorial committee has now been increased to five members by the addition of I. C. Trueman, who has recently become B.S.B.I. recorder for Salop, v.c. 40.

This paper describes the methods being used to prepare the Flora, particularly where they differ from techniques used by others, for example those described by Woodell (1975).

AREA TO BE COVERED

The majority of local Floras cover an administrative county or a Watsonian vice-county or a combination of these. Yet many counties are very irregular in shape, with intrusions from or extrusions into neighbouring ones. Shropshire is no exception, particularly on its western border with Montgomery, v.c. 47 (now part of Powys). To restrict our Flora, and the maps which will illustrate it, to Shropshire alone would have missed interesting features of local plant distribution in relation to geology, relief and climate, especially on the Welsh border where changes occur over very short distances. This special feature of the region was one of the primary *raisons d'être* of the Project. We therefore decided to record within a rectangle and, because the recording unit was to be the 10km square or the 2 × 2km subdivision of that square ('tetrad'), it seemed sensible to make the basic area a rectangle of 10km squares including almost the whole of present-day Salop and vice-county 40. The resulting block consists of 42 10km squares (six from west to east by seven from south to north). This and 50 additional tetrads around its margins, included to cover the rest of the county, comprise an area of 4,400km^2 or 1,100 2 × 2km tetrads. We are grateful to Dr J. G. Dony for help with the preparation of the map (Fig. 1) showing the outlines of the administrative county of Salop and of v.c. 40.

NATURE AND SCOPE OF THE PROJECTED FLORA

A decision was made at an early stage to trace as many old records as possible (a task entrusted to P.H.O.), but to restrict the main records of vascular plants to the period 1970–1980. The maps produced will thus represent species distributions for a particular period in time, enabling accurate comparisons to be made in the future. Considerable interest was expressed in the lower plants, but we decided that full-scale mapping of these was not feasible, though we intend to include records of some of them in habitat studies. It is hoped to produce an annotated list of bryophytes with a discussion of their distributions and ecology, so the editors are collecting records for these plants, especially if made in the period 1970–1980.

We intend that the new Flora should have a similar scope to such modern classics as the Floras of Derbyshire (Clapham 1969) and Hertfordshire (Dony 1967), having sections on climate, habitat studies, the post-glacial history of the flora, and the distribution of flowering plants and pteridophytes in relation to geology, geomorphology, soils and land-use. Its principal differences from the county Floras published so far will lie in the methods of recording and map assembly, and in the phyto-sociological background which it is hoped to provide.

At an early stage we decided that the species should be divided into three frequency classes for recording purposes — the common (A) species, the rare (C) species and the intermediate (B) species.

COMMON (A) SPECIES

From previous knowledge of the flora and from a study of *Atlas of the British flora* (Perring & Walters 1962), it appeared that there were about 200 species which would almost certainly occur in every 10km square in our area, the majority in nearly every tetrad. It might be argued that detailed maps showing the distribution of these widespread species could be valuable, but we believe the task of handling the data involved (amounting to perhaps 60% of the total number of records for less than 20% of the species in the flora) would unjustifiably restrict the time available for dealing effectively with the 80% or more of the species with limited and more interesting distributions.

167	Scrophularia nodosa		Common Figwort
168	Senecio jacobaea		Common Ragwort
169	Senecio vulgaris		Groundsel
170	Silene dioica		Red Campion
171	Sinapis arvensis		Charlock, Wild Mustard
172	Sisymbrium officinale		Hedge Mustard
173	Solanum dulcamara		Bittersweet, Woody Nightshade
174	Sonchus arvensis		Perennial Sow-thistle, Field Milk-thistle
175	Sonchus asper		Prickly Sow-thistle, Spiny Sow-thistle, Spiny Milk-thistle
176	Sonchus oleraceus		Smooth Sow-thistle, Sow-thistle, Milk-thistle
177	Sorbus aucuparia		Rowan, Mountain Ash
178	Sparganium erectum		Branched Bur-reed
179	Spergula arvensis		Corn Spurrey
180	Stachys sylvatica		Hedge Woundwort
181	Stellaria graminea		Lesser Stitchwort
182	Stellaria holostea		Greater Stitchwort
183	Stellaria media s.s.		Common Chickweed
184	Succisa pratensis		Devil's-bit Scabious
185	Tamus communis		Black Bryony
186	Taraxacum agg.		Dandelion
187	Taraxacum officinale s.l. *		Common Dandelion
188	Teucrium scorodonia		Wood Sage
	Tilia x europaea	see	Tilia x vulgaris
189	Tilia x vulgaris		Lime
190	Torilis japonica		Upright Hedge-parsley
191	Trifolium dubium		Lesser or Lesser Yellow Trefoil
192	Trifolium pratense		Red Clover
193	Trifolium repens		White Clover, Dutch Clover
194	Tripleurospermum maritimum subsp. inodorum		Scentless Mayweed
195	Trisetum flavescens		Yellow Oat-grass
196	Tussilago farfara		Colt's-foot
197	Urtica dioica		Common Nettle, Stinging Nettle
198	Veronica arvensis		Wall Speedwell
199	Veronica beccabunga		Brooklime
200	Veronica chamaedrys		Germander Speedwell
201	Veronica persica		Common or Large Field-speedwell
202	Veronica serpyllifolia		Thyme-leaved Speedwell
203	Vicia cracca		Tufted Vetch
204	Vicia sepium		Bush Vetch
205	Viola riviniana		Common Dog-violet

KEY

agg. - aggregate (group of closely related species)
s.l. - sensu lato (used to show that a scientific name is here used "in the broad sense", e.g. of Arenaria serpyllifolia to cover A. leptoclados)
s.s. - sensu stricto (used to show that a scientific name is here used "in the strict sense")
* - aggregate of which a specimen should be retained
** - difficult species of which a specimen should be retained

In a few cases (e.g. Polygonum aviculare agg.) recorders are given the choice of recording the aggregate or collecting a specimen for species identification.

SHROPSHIRE FLORA: 'A' LIST

10 KM | S | | | |

Recorder ....
Address ....
....

1	Acer campestre		Field Maple
2	Acer pseudoplatanus		Sycamore
3	Achillea millefolium		Yarrow, Milfoil
4	Aegopodium podagraria		Ground-elder, Goutweed, Bishop's Weed, Herb Gerard
5	Aethusa cynapium		Fool's Parsley
6	Agrimonia eupatoria		Agrimony
7	Agropyron repens		Common Couch, Scutch, Twitch
8	Agrostis stolonifera **		Creeping Bent, White Bent, Fiorin
9	Agrostis tenuis **		Common Bent, Fine Bent
10	Ajuga reptans		Bugle
11	Alliaria petiolata		Garlic Mustard, Hedge Garlic, Jack-by-the-hedge
12	Allium ursinum		Ramsons
13	Alnus glutinosa		Alder
14	Alopecurus geniculatus		Marsh Foxtail
15	Alopecurus pratensis		Meadow Foxtail
16	Anagallis arvensis		Scarlet Pimpernel, Shepherd's or Poor Man's Weatherglass
17	Anemone nemorosa		Wood Anemone
18	Angelica sylvestris		Wild Angelica
19	Anisantha sterilis		Barren Brome
20	Anthoxanthum odoratum		Sweet Vernal-grass
21	Anthriscus sylvestris		Cow Parsley, Keck, Wild Chervil
22	Apium nodiflorum		Fool's Water-cress
23	Arctium minus s.l.		Lesser Burdock
24	Arenaria serpyllifolia s.l.		Thyme-leaved Sandwort
25	Arrhenatherum elatius		False Oat-grass
26	Artemisia vulgaris		Mugwort
27	Arum maculatum		Lords-and-Ladies, Cuckoo-pint
28	Asplenium ruta-muraria		Wall-rue
29	Athyrium filix-femina		Lady-fern
30	Ballota nigra		Black Horehound
31	Bellis perennis		Daisy
32	Betula pendula		Silver Birch
33	Betula pubescens		Downy Birch
	Betula verrucosa	see	Betula pendula
34	Brachypodium sylvaticum		False Brome
35	Bromus mollis agg.		Soft-brome, Lop-grass
	Bromus sterilis	see	Anisantha sterilis
36	Callitriche stagnalis **		Common Water-starwort
37	Caltha palustris		Marsh-marigold, Kingcup
38	Calystegia sepium s.l.		Hedge Bindweed, Bellbine
39	Calystegia sepium ssp. sepium **		Hedge Bindweed
40	Calystegia sepium ssp. silvatica **		Large Bindweed
41	Campanula rotundifolia		Harebell
42	Capsella bursa-pastoris		Shepherd's-purse
43	Cardamine flexuosa		Wavy or Wood Bitter-cress
44	Cardamine hirsuta		Hairy Bitter-cress
45	Cardamine pratensis		Cuckooflower, Lady's Smock
46	Carex flacca		Glaucous Sedge, Carnation-grass
47	Centaurea nigra		Common or Lesser Knapweed, Hardheads
48	Cerastium fontanum ssp. triviale		Common Mouse-ear, Mouse-ear Chickweed

FIGURE 2. Front and back of folded A4 card listing some 200 common (A) species or aggregates.

Because this initial selection, however carefully made, might need revision, recorders were asked to note A species which they regarded as scarce in a 10km square ('seen in less than, say, five localities despite a careful search'); as a result, four species, *Allium ursinum*, *Equisetum fluviatile*, *E. palustre* and *Odontites verna*, were transferred to B species status at the end of the second full recording season.

Each species or aggregate on the A card (Fig. 2) is given a Latin name, one or more English names (precedence being given to those selected by Dony, Perring & Rob 1974) and a reference number, and recorders put a ring around the number of each species when it is encountered anywhere within the 10km square. If an A species is present but scarce, a cross is put beside the ringed reference number, and grid references of localities in which it occurs are noted.

Dates of recording visits

* 'Aggregates' of which specimens should be retained

** Difficult species often requiring expert confirmation

Stellaria neglecta 353 Gr Chickwd	T. campestre 368 Hop Trefoil	Valeriana dioica 383 Marsh Valer	V. tetrasperma 398 Smooth Tare
Symphoricarpos rivul 354 Snowberry	hybridum 369 Alsike Clvr	officinalis 384 C Valerian	Vinca minor 399 Lsr Perlwink
Symphytum officin * 355 C Comfrey	medium 370 Zigzag Clvr	Valerianella locus 385 C Cornsalad	Viola arvensis 400 Field Pansy
Syringa vulgaris 356 Lilac	striatum 371 Knottd Clvr	Verbascum thapsus 386 Grt Mullein	hirta 401 Hairy Violet
Taraxacum laevig * 357 Dandelion	Triglochin palustris 372 Marsh Arrowg	Veronica agrestis 387 Grn Fd-spdwl	lutea 402 Mtn Pansy
spectabile * 358 Dandelion	Typha angustifolia 373 L Reedmace	filiformis 388 Slndr Spdwl	odorata 403 Sweet Violet
Taxus baccata 359 Yew	latifolia 374 Gr Reedmace	hederifolia 389 Ivylvd Spdwl	palustris 404 Marsh Violet
Teesdalia nudicaul 360 Shpds Cress	Ulex europaeus 375 Gorse	montana 390 Wd Spdwl	reichenbach 405 Early Dogvlt
Thelycrania sanguin 361 Dogwood	gallii 376 Wstn Gorse	officinalis 391 Heath Spdwl	tricolor 406 Wild Pansy
Thelypteris limbosp 362 Lmn-sc Fern	Ulmus glabra 377 Wych Elm	polita 392 Grey Spdwl	Viscum album 407 Mistletoe
Thlaspi arvense 363 Fld Penny-cr	procera 378 English Elm	scutellata 393 Marsh Spdwl	Vulpia bromoides 408 Squirtl Fesc
Thymus drucei 364 Wild Thyme	Umbilicus rupestris 379 Navelwort	Viburnum opulus 394 Guelder-rose	Zerna erecta 409 Uprt Brome
Tilia cordata ** 365 Sm-lvd Lime	Urtica urens 380 Small Nettle	Vicia hirsuta 395 Hairy Tare	ramosa 410 Hairy-brome
Tragopogon pratensis 366 Goats-brd	Vaccinium myrtill 381 Bilberry	sativa 396 Com Vetch	
Trifolium arvense 367 Hare's-foot	oxycoccos 382 Cranberry	sylvatica 397 Wood Vetch	

Alchemilla glab 411 Lady's-mantle	Polypodium int ** 415 Polypody	419	423
vestita 412 Lady's-mantle	vulgare ** 416 Polypody	420	424
xanthochlora 413 Lady's-mantle	Rosa villosa * 417	421	425
Dryopteris borr ** 414 Scaly M-Fn	418	422	426

Use a separate B list card for each 2 km x 2 km tetrad. The cross symbol below has been marked to show the presence of a species in the north-west kilometre square of a tetrad.

Achillea ptarmica
1 Sneezewort

The Flora of Shropshire

Designed and produced in The Polytechnic Wolverhampton

FIGURE 3. Back of a B species card to show the data required and the method of recording. Note that records are made on a 1km square basis although the Flora maps will show records only for tetrads.

INTERMEDIATE (B) SPECIES

There proved to be over 400 species for which previous knowledge of distribution and ecology suggested that tetrad distribution maps could be most informative. At the same time it was agreed that records should, as far as possible, be so localized that, should some B species prove to be unexpectedly rare, it would be easy to relocate them. Thus the B species card (Fig. 3), besides carrying Latin and English names (frequently abbreviated) and a reference number for each species, has a cross beside each name, the quarters of which can be filled in, so that recorders can indicate which of the 1km squares in any tetrad a species has been recorded in without having to use a B card for each 1km square.

RARE (C) SPECIES

One of us (C.A.S.) compiled a list of rare species and critical taxa, based on accumulated data, intended to indicate all those recorded from only three or fewer 10km squares in Shropshire. It was agreed that,

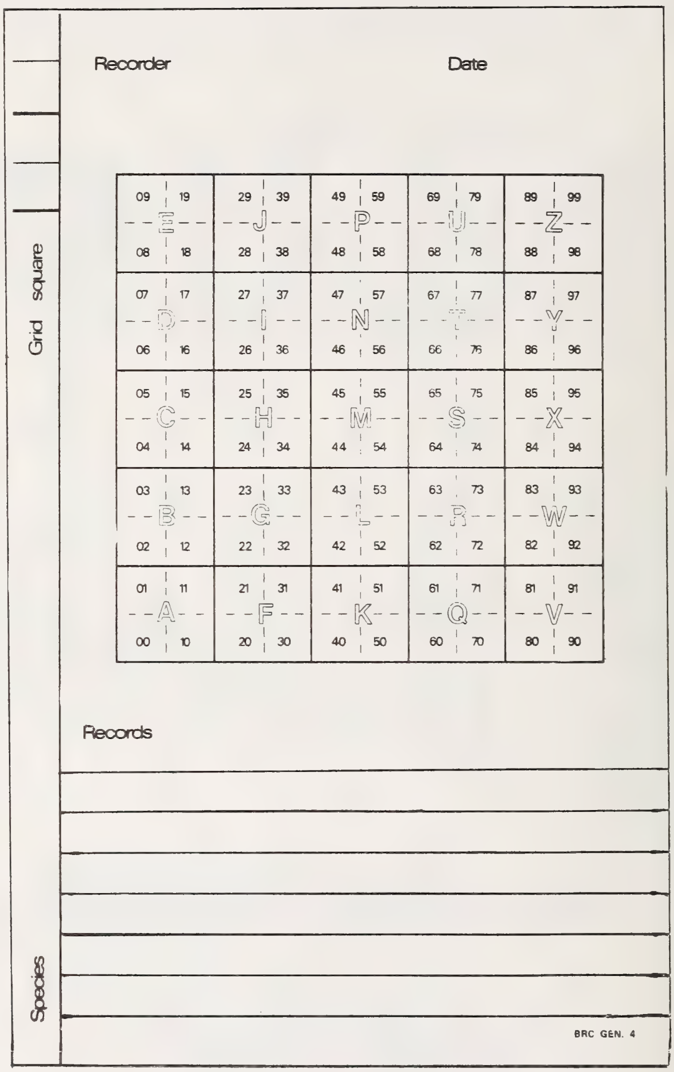

FIGURE 4. 'BRC GEN. 4' card used to record rare (C) species and critical taxa, indicating tetrad lettering and 1km square numbering.

for conservation purposes and for future reviews of their status, records of these taxa must be exactly localized, though not necessarily published. Records of any of them and of any newly discovered taxon are transferred to a 'grid square' recording card, 'BRC GEN. 4' (Fig. 4). This is divided by bold lines into 25 tetrads, each of which bears a letter, and by pecked lines into 100 1km squares, each of which bears a two-figure number. One such card can be used for all records of a C species within a particular 10 km square. The number of each 1km square in which the species is seen is ringed and, in addition, a 6-figure map reference and habitat record are noted for each occurrence in the space at the bottom of the card or on the back. Incidentally, the cards also provide a handy reference to recorders on tetrad notation.

ROLE OF THE RECORDERS AND THEIR ORGANIZATION

Because Shropshire is so large and the number of workers so great (80 or more active workers each year throughout the Project so far), a federal structure has been adopted with one person appointed as co-ordinator to collate the records for each 10km square. Informal arrangements are made between the recorders for each square to ensure that the coverage is as even as possible — a process facilitated by the issue of lists of the names and addresses of all those involved in the Project.

In the first season (1975) the survey of the common plants on the A list was begun and a roadside verge survey was carried out. For the latter a stratified random sample of about 80 100-yard lengths of both verges of minor roads was examined in early summer and again in late summer. The results have now been analysed and will be published shortly (Sinker, Packham & Trueman in press). These initial exercises helped to establish the recorder network and produced quick results, thus giving the volunteers confidence in the value of their contributions.

During 1975 a first draft of the instructions to be used for general recording was prepared by the executive editor (J. R. P.) and distributed for comment to the other editors in November 1975. A second draft (which owed much to suggestions by P.H.O.) was produced in greater numbers and distributed to some of the recorders and co-ordinators a month later. The many useful comments received assisted in the preparation of a final version, *Recording for the Shropshire Flora*, which was issued at the first Annual Meeting of the Project at Preston Montford on 23rd January 1976.

These Annual Meetings are an important feature of the Flora Project. They undoubtedly give the recorders a feeling of belonging to a viable organization, an opportunity to review progress and ask questions about methods, and a strong social base which is essential to friendly co-operation in a shared venture. By the time of the third Annual Meeting in March 1978, for example, it was possible to demonstrate the value of the B and C species recording and the rapid progress which had been made in the preparation of maps during the previous 12 months.

It was originally intended to assemble all the B species maps by computer directly from the B cards, using the method described by Visvalingam *et al.* (1975). This may still be done as a check, but the invention of a 'minimap' card (Fig. 5), which enables co-ordinators to build up a full set of tetrad maps for B species in their 10km squares, has reduced the need for mechanization while involving the recorders more directly in the preparation of the results, thus helping to maintain their interest in the Project. The number above each minimap corresponds to the species number on the B card. An entry for species 40, *Calluna vulgaris*, in grid-square SO68 is shown in Fig. 5, whilst the complete map for this species is illustrated in Fig. 1. Complete maps for all B species are assembled by Miss M. J. Lee, Miss H. Davidson and others.

Perhaps the Annual Meetings and the preparation of interim results contribute to the fact that, contrary to the findings of Woodell (1975) that 'Inevitably the number of helpers soon declined', we have noticed no decline in the numbers contributing; over 50 people regularly attend these meetings.

Four other activities undoubtedly contribute to this state of affairs.

1. Three of the authors (C.A.S., J.R.P. & I.C.T.) have run a series of evening classes on plant classification, identification, distribution and ecology, in Shrewsbury and Bridgnorth.
2. Week and weekend courses on different groups have been run by F.H.P. at Preston Montford Field Centre, which have been attended largely by Shropshire-based botanists or those making regular visits to the county.
3. Once or twice each year F.H.P. has held two-hour 'surgeries' in Shrewsbury to which any member

of the Project can bring 'difficult' plants for identification. Unidentified material has then been submitted to experts *en bloc* and returned to finders at the next 'surgery'. The resident editors have provided a similar service more informally.

4. Keys to some of the initially more 'difficult' groups have been prepared , such as the lateral key to common grasses (Sinker 1975).

Thus our experience leads us to believe that the target we have set ourselves of publishing a Flora of the Shropshire region by 1982, though difficult, should not be impossible to achieve. There is certainly no lack of determination on the part of the recorders or the editors to pursue the Flora Project 'until it be thoroughly finished'.

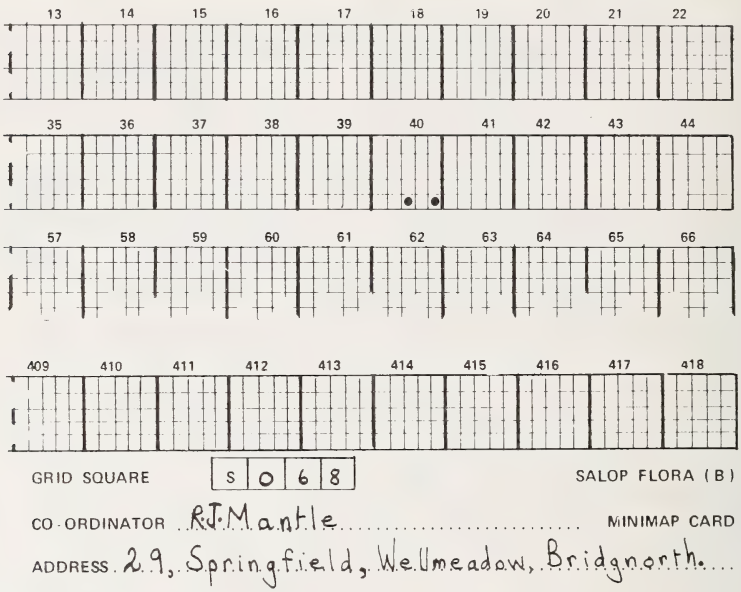

FIGURE 5. Two portions of a 'minimap' card.

A single card enables the co-ordinators for the 10km grid squares to make species distribution maps on a tetrad basis for up to 430 B species or aggregates. A specimen entry has been made for B species 40 (*Calluna vulgaris*) in grid-square SO68.

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The status of, and correct name for, *Erica* 'Stuartii'

D. McCLINTOCK

Bracken Hill, Platt, Kent

ABSTRACT

Erica 'Stuartii' was found in Connemara, Ireland in 1890. Its status has been an enigma ever since. A chance reversion on it in Holland in 1977 shows it to be of the ultimate parentage *E. mackaiana* × *E. tetralix*. Its history is set out, and its nomenclature discussed. Linton called this unique and aberrant clone *E.* × *stuartii,* but the correct authority is (Macf.) E. F. Linton. With the recent abolition of Article 71 of the *International code of botanical nomenclature* (on monstrosities), the earlier *E.* × *stuartii* has to take precedence over *E.* × *praegeri* for all forms of this hybrid.

INTRODUCTION

Webb (1954) wrote that *Erica stuartii* was one of the mystery plants of Ireland: there was little to do in unravelling its origin but to await further evidence. This paper reports further, possibly conclusive, evidence and discusses the nomenclature of the taxon. It is a sterile clone, distinctive in its small, narrow, pinched corolla, white at the base, beetroot purple (*Horticultural Colour Chart* 830/3) towards the apex, the shorter corolla allowing the anthers to protrude.

It has been described on several occasions, for example by Macfarlane (1893), Linton (1902a, 1902b) and Webb (1954), who also gave details of its history and discussed it. Colgan (1903) commented on the morphology of its corolla — see also Webb (1955). Its doubtful status led McClintock (e.g. 1965, 1966, 1969, 1972, 1973) to suggest it was best referred to with a clonal nomenclature, as *E.* 'Stuartii', a practice which has been generally followed in the horticultural literature. There is a colour photograph in Proudley & Proudley (1974).

It may be mentioned that, just as *E. mackaiana* and *E.* × *praegeri* have often been confused with *E.* × *watsonii* (which is *E. ciliaris* × *E. tetralix*), so has *E.* 'Stuartii' been with the last (Kircher 1975). But in Germany at least this error has been corrected (van de Laar 1976, Anonymous 1977).

HISTORY

The plant was discovered on Monday 11th August 1890 by Dr Charles Stuart, an eminent horticulturist, on an excursion of the Scottish Alpine Botanical Club to Connemara, when all nine members present picked it (Craig 1893). Its patch covered an area of several square feet and was quite near the area of rather dry, rocky ground on which *E. mackaiana** grows, but in the rather boggy part adjoining the more natural habitat of *E. tetralix* (Macfarlane 1893, Praeger 1909), i.e. the habitat was intermediate between that of the two species. Macfarlane also wrote that in transverse section the outline of the leaf was intermediate between that of *E. tetralix* and *E. mackaiana.*

Fortunately the finders were gardeners, which meant that the plant was soon in cultivation by several members of the Club and at the Royal Botanic Garden at Edinburgh. It is still listed by nurserymen and quite widely grown. If the specimens had suffered the usual botanical fate and been pressed, dried, killed, the event of 1977 could never have happened. The mystery would have remained for ever, for no-one has managed to find even a trace of this extensive patch (e.g. Praeger 1908) — perhaps it was destroyed by peat-cutting. This is in contradistinction to *E. mackaiana* 'Plena' ('Crawfordii'), the only double-flowered *Erica* in cultivation, which was found in the same area in 1869, 1901, 1965 and 1970.

* This, the correct name, is used throughout for consistency, except in direct quotations, although most of the sources cited used the then current *E. Mackaii* or *E. Mackayi.*

STATUS

Macfarlane (1893) proposed that the plant be called "*E. Tetralix* sub-species *Stuarti*", following the then widely held view that *E. mackaiana* was also a subspecies of *E. tetralix* — and he rated the pale-flowered garden cultivar 'Lawsoniana' (which is in fact a form of *E. mackaiana*) as a fourth. The source of that is still undiscovered, but in 1962 it sported the superb white-flowered 'Dr Ronald Gray'. Later on, Macfarlane considered 'Stuartii' to be a hybrid of *E. tetralix* with some other species (Linton 1902a). There is at the Natural History Museum (**BM**) a letter dated 16th May 1902 from W. B. Boyd (who was on the 1890 excursion, grew the plant and gave specimens to Macfarlane and Linton to work on) in which he said that Dr Stuart was sure it was a hybrid and he, Boyd, was sure too: Dr Macfarlane had changed his mind.

Linton rushed in, "unaware . . . of the careful account of Macfarlane", and "at once" decided that one parent must be *E. mediterranea* (= *E. erigena*) (Balfour 1902), despite "the natural objection that the flowering season . . . does not coincide with that of other Irish species", and the other parent was *E. mackaiana* (Linton 1902a). Linton added that Dr Stuart had written to say he was disposed to consider his, Linton's, opinion the correct one. Balfour (1893) had originally been "inclined to look for some relationship with *E. mediterranea*", but later (Balfour 1902) stated that he and Dr Macfarlane remained convinced that there was no *E. mediterranea* 'blood' in 'Stuartii', although he was disposed at first to look for some such relationship.

Nevertheless Praeger (1909, 1934, 1950, 1951) had no doubt of the correctness of this postulated parentage which, he wrote, was apparently corroborated by Smith (1930). Druce (1908, p. 47) and Hanbury (1925, p. 31) were also of the same opinion. This was further discussed by Webb (1954), who noted that the epidermis was similar to that of *E.* × *praegeri*.

It must here be noted that what is now generally accepted to be the hybrid between *E. mackaiana* and *E. tetralix* was only described as such, as *E.* ×*praegeri*, by Ostenfeld (1912). Yet intermediates had been noticed for nearly a century earlier, e.g. specimens of Mackay's dated 1838 "collected along with *E. mackaiana* and apparently intermediate between it and *E. tetralix*". Mackay was noted in print (Dennes 1846) as saying that *E. mackaiana* passed into *E. tetralix* by intermediate forms. Regel (1843) wrote "Eine der *E. Tetralix* sehr nahe verwandte Pflanze, von der mir der Dr Klotzsch mittheilte, dass er an Ort und Stelle Formen gesammelt habe, die vollkommen die Mitte zwischen beiden Species hielten". There is a specimen in **CGE** dated August 1855 from the roadside between Roundstone and Clifden annotated "seems intermediate between *E. mackaiana* and *E. tetralix*", and so it is. Linton himself collected specimens (**OXF**) near Roundstone on 10th August 1885 which he labelled "*foliis glabris appropinquis E. Mackaiana*" without suggesting it was the hybrid it is. Yet only a few years later neither he nor any of the others even mentioned these pertinent intermediates.

Chopinet's opinion (1967) was "Cette bruyère serait une forme tétraploïde issue du double croisement *Erica mediterranea* × (*E. tetralix* × *E. ciliaris*). C'est un hybride complexe . . . parfois consideré comme un cultivar de *E.* × *watsonii*". I have failed to discover the evidence on which this was based.

Since those days, no progress had been made in unravelling the puzzle of Dr Stuart's plant. The writer had just noticed that the sepals resembled those of *E.* × *praegeri* rather than those of *E. mackaiana*, with which species some opinions tended to connect the plant (e.g. Druce 1928, p. 76), but had done nothing about it.

THE EVENT OF 1977

In August 1977 an alert nurseryman of Boskoop in Holland, Mr Rinus Zwijnenburg, noticed a reversion on *E.* 'Stuartii', which is now in the herbarium of the Heather Society. He passed it to Mr Harry van de Laar at the Experimental Station there, who posted it to the writer. He in turn sent it on to Professor Webb, remarking that it seemed to match *E.* × *praegeri*. Webb replied that "the mutant branch passed all tests for *praegeri*". He slit open one corolla to see the ovary, and removed the least advanced flower to look for pollen, and found none. In all, he wrote, this was strong circumstantial evidence for saying that 'Stuartii' was a chance mutant of *E.* × *praegeri*, this branch having reverted to type.

There seems no reason not to accept this view, which comes after other evidence mentioned earlier, all gradually tending this way, of the plant's intermediacy between *E. mackaiana* and *E. tetralix*. This is by no means the first time that reversions on heathers have elucidated or proved the source of a clone. That of *Calluna vulgaris* 'Ruth Sparkes' is in fact recorded in the literature, but other, erroneous, claims are still made. The truth was demonstrated by a double reversion which Mr C. D. Brickell, the present Director of the Royal Horticultural Society's garden at Wisley, and the writer found on a plant there (now in its herbarium), the top shoot being 'Ruth Sparkes', the next 'Alba Plena' and the lowest 'Alba Elegans', the original clone from which first the double-flowered white plant arose, and then the yellow-foliaged 'Ruth Sparkes'. Similarly *Daboecia cantabrica* 'Pink' has shown its connection with 'Bicolor' by reversion, and other examples could be quoted.

NOMENCLATURE

The question must now be dealt with of how 'Stuartii' should be named.

E. × *praegeri* has been used, almost universally, for the hybrid *E. mackaiana* × *E. tetralix* ever since 1912. Dandy (1958), misunderstanding a chance remark of Professor Webb, changed this to *E.* × *stuartii.* I argued against this in 1965, on the ground that 'Stuartii' was a possibly monstrous plant. Webb (1967) was of the same opinion — and earlier, on 24th September 1964, had written to me, calling it "a *praegeri* that had gone wrong somehow", adding that it had totally shrivelled pollen like *E.* × *praegeri* and unlike *E. mackaiana.* Colgan (1903) described it as "a morbid state". And Dandy (1969), echoing Webb (1967), retracted. This left *E.* × *praegeri* in the clear position it had previously occupied.

But the International Botanical Congress at Leningrad in 1975 altered this by deleting *in toto* Article 71 of the *International code of botanical nomenclature* ("A name is to be rejected if it is based on a monstrosity"), no doubt because of the difficulty of defining what a monstrosity is. 'Stuartii' having been revealed as deriving from *E. mackaiana* × *E. tetralix, E.* × *stuartii* emerges as the correct binomial for 'Stuartii', and also for all the other forms of this cross, because it antedates *E.* × *praegeri* by ten years. That Linton erred in its parentage is no bar to this, because the application of the name is not in doubt.

Linton, however, is not the original author of the epithet. As shown above, the taxon was first described as *Stuartii* by Macfarlane (1893). The correct citation of this name must therefore be *E.* × *stuartii* (Macf.) E. F. Linton.

This international *volte-face* therefore compels another deplorable name change. *E.* × *praegeri* sinks into synonymy and *E.* × *stuartii* must be used for all the nothomorphs, or cultivars, of *E. mackaiana* × *E. tetralix*, however different 'Stuartii' itself and its type specimen (**BM**) look from all the others. The clones 'Connemara' and 'Stuartii' from W. Galway (v.c. H16), 'Irish Lemon', 'Irish Orange' and 'Nacung' from W. Donegal (v.c. H35), must all henceforward be named as of *E.* × *stuartii* with, if wished, *E.* × *praegeri* as its synonym. The cultivar name 'Stuartii', having been given prior to 1959, is legitimate in its Latin form, as is the repetition in *E.* × *stuartii* 'Stuartii', which is paralleled elsewhere.

ACKNOWLEDGMENTS

I am grateful to Dr R. K. Brummitt, Mr R. D. Meikle and Professor D. A. Webb, who commented on the draft of this paper, and to the curators of herbaria who answered my letters about specimens in their care; and to Mr Zwijnenburg for his pregnant observation.

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The occurrence of *Orchis robusta* (T. Stephenson) Gölz & Reinhard in Crete

N. R. CAMPBELL

11 St Mary's Lane, Hertingfordbury, Hertford, Herts.

ABSTRACT

The identity of a colony of orchids by the Geropotamos in southern Crete is discussed and it is concluded that the plants are referable to *Orchis robusta* (T. Stephenson) Gölz & Reinhard. This, as well as *O. palustris* Jacq. found near Frangocastello in southern Crete, is new to the island.

INTRODUCTION

Gölz & Reinhard (1976) carried out a comparative investigation into the taxonomic status of *Orchis laxiflora* Lam., *O. palustris* Jacq. and certain other members of this complex. Apart from the conclusion, based largely on statistical analysis of the results of systematic measurements of plant and flower dimensions, that both *O. laxiflora* and *O. palustris* fully deserve specific rank, they also claimed specific rank for *O. palustris* var. *robusta* T. Stephenson under the name of *O. robusta* (T. Stephenson) Gölz & Reinhard. Plants from Algerian sites, not including Stephenson's original site in Algeria, which was found to have been destroyed, and plants from a site in Mallorca were studied. Various mean dimensions and standard deviations obtained from *O. laxiflora*, *O. palustris*, the Algerian plants and the Mallorquin plants were tabulated. 23 primary dimensions were determined for comparison as was an additional series of ratios derived from the primary dimensions.

The late Mr Len Beer (pers. comm. 1976) informed me that he had seen and photographed an unusual orchid found by him on the Geropotamos delta in southern Crete, near to Festos. He called it "*Orchis elaterum*", a name which I assumed to refer to *Dactylorhiza elata* (Poiret) Soó, but his photograph suggested a closer relationship to *Orchis palustris*. Mr Beer died tragically before I could discuss his findings with him and I resolved to find and identify the orchid in question.

I was only able to make a very brief visit to the site on April 17th, 1977, when I observed five plants of unusually noble stature, only one of which had opened a single flower. The plants were very tall, with conspicuous, rather vertically inclined leaves and the inflorescences on that day were notable for their tightly packed flower buds nearly enveloped by large leafy bracts. My immediate reaction was to regard the plants as examples of *Dactylorhiza elata*, but, on being consulted, Prof. H. Sundermann of Wuppertal dismissed the possibility of their being *Dactylorhizae* and very kindly drew my attention to the recently published paper of Gölz & Reinhard, with the suggestion that the Cretan orchids might prove to be *Orchis robusta*.

On April 22nd, 1978, I again found the site, by then greatly imperilled by river-dredging and other civil engineering work, and noted five plants as before, only one of which showed a single open flower. On April 30th I paid a visit to an *O. laxiflora* site, also in southern Crete (at Frangocastello). I found only one plant of *O. laxiflora* still in bloom, but in addition a single fully flowering plant of *O. palustris*. This was a small plant, comparable in size with *O. laxiflora*, but unmistakably *O. palustris*.

OBSERVATIONS

On May 5th I revisited the Geropotamos site and eventually found 25 plants, varying in size and development from those still in tight bud to those commencing to wither. 15 plants were selected as sufficiently close to full flowering and not too badly damaged by predators to enable in most cases the full series of measurements to be made, for comparison with those of Gölz & Reinhard. The plants were

TABLE 1. COMPARATIVE DIMENSIONS OF *ORCHIS PALUSTRIS*, *O. ROBUSTA* (2 RACES) AND THE GEROPOTAMOS PLANTS. DATA IN THE FIRST THREE COLUMNS FROM GÖLZ & REINHARD (1976)

	O. palustris	*O. robusta* (Mallorca)	*O. robusta* (Algeria)	Geropotamos plants
1. Height of plants (cm)	32·7	62·1	50·6	58
2. Number of leaves	4·39	6·4	6·33	5·4 (a)
3. Length of second leaf from bottom (cm)	9·99	23·4	26·7	25
4. Width of second leaf from bottom (cm)	0·878	2·12	2·21	2·1
5. Length of top leaf (cm)	5·02	7·35	5·82	6·6
6. Length of uppermost stem internode (cm)	5·48	4·58	4·09	9 (b)
7. Number of flowers	9·67	29·1	30·3	27 (c)
8. Length of inflorescence (cm)	9·41	14·7	14·4	22
9. Length of flower stalk (5 lowest flowers (cm))	4·79	4·37	3·95	6
10. Length of bract (mm)	19·5	32·7	28·6	25
11. Width of bract (mm)	4·52	6·45	6·17	5·3
12. Length of ovary (mm)	15·19	21·35	19·38	18
13. Length of sepals (mm)	10·7	13·33	12·55	10
14. Width of sepals (mm)	4·23	4·84	5·28	4·7
15. Length of upper petals (mm)	8·49	10·5	10·26	9
16. Width of upper petals (mm)	3·72	3·84	4·43	4
17. Length of lip (mm)	10·82	14·15	12·36	10·5
18. Length of lateral lobe of lip (mm)	9·1	13·1	10·36	9·6
19. Length of central lobe of lip (mm)	3·28	3·56	4·46	3–4 (d)
20. Maximum width of lip (mm)	13·8	20·7	21·1	13·5
21. Width of base of lip (mm)	5·51	7·62	9·18	4
22. Length of spur (mm)	15·2	12·45	15·9	15
23. Diameter of spur, cylindrical section near base (mm)	2·24	2·43	2·33	2 (e)

Dimensions 10 to 23 all refer to the fourth flower from the bottom.
(a) This figure is minimal since the characteristic bottom leaf, just above soil level, had in several cases almost certainly been eaten by predators and was accordingly not available for counting.
(b) This dimension reflects the fact that the top leaves were very bract-like and occupied a position on the stem more closely related to the true bracts than to the more characteristic foliage leaves.
(c) This figure is minimal since it was not always practicable to make an accurate count of unopened flowers, the buds being very tightly packed.
(d) This figure is imprecise since the exact dimension employed by Gölz & Reinhard was not fully appreciated until the flowers were withering.
(e) This figure was difficult to determine in view of the strong tendency to flattening of the spurs. It is generally the mean of two measurements at 90°.

all stout-stemmed, long-leaved, tall (up to 94 cm) and with elongated, spirally arranged inflorescences bearing up to 27 flowers. The flowers were of the characteristic *O. palustris*-type, in that they were violet-red in colour and with the lip strongly three-lobed with the central lobe divided near to the tip and having a white patch at its base bearing longitudinal, broken, violet, approximately parallel lines. The lip was widely spreading, with moderately wavy margins and folded only as the flowers began to wither. The two upper petals and the upper sepal formed a tightly closed hood, while the two lateral sepals were reflexed and nearly vertical. The bracts were leafy, green above with dark violet veins and purple-brown beneath. The spurs were generally cylindrical-conical with a tendency to flattening and, in one case only, a slight broadening at the tip remotely suggestive of the bifurcation characteristic of *O. laxiflora*. (Danesch & Danesch (1969) provide a photograph of *O. palustris* from Italy which similarly shows variation of the spur from conical to forked). Careful removal of soil, from one plant only, showed an ovoid tuber of about 2 cm diameter. The soil, which was wet, sandy and very well consolidated, had a pH of 7·4 (direct measurement).

Table 1 shows the published findings of Gölz & Reinhard concerning *O. palustris* and the two races of *O. robusta* from Mallorca and Algeria, as well as my own measurements of the Geropotamos plants. Measurements of *O. laxiflora* are omitted as irrelevant to the identification of the Cretan orchids, which were clearly closer to *O. palustris*. Only the primary dimensions are quoted and then only the mean values, since these are sufficient to make the identity of the Geropotamos plants abundantly clear. Dimensions 1–5, 7 and 8 all indicate closer correspondence of the Geropotamos plants to *O. robusta* than to *O. palustris*. Dimensions 6, 7 and 9 reflect a general tendency for the inflorescence to be more lax than in either *O. robusta* or *O. palustris*. Dimensions 10 to 23 reflect the tendency for the flowers to lie in size between those of *O. robusta* and those of *O. palustris*. Gölz & Reinhard pointed out that Stephenson's herbarium specimens include three plants with rather lax inflorescences and somewhat smaller flowers than those of the rest and they noted that some of the Algerian plants examined by them tended in certain characteristics towards *O. palustris*.

It is noteworthy that Stephenson's first impression of the Algerian plants in bud or early flower suggested to him a North African variant of *Dactylorhiza elata* (Stephenson 1931). Gölz & Reinhard also commented on the *D. elata*-like appearance of the Mallorquin plants on first sight. The late flowering of the Geropotamos plants is in line with that of *O. robusta* from Algerian sources.

CONCLUSIONS

This isolated race of plants of the *O. palustris* complex observed by the Geropotamos in southern Crete is very close to the Algerian orchids described by Stephenson as *O. palustris* var. *robusta* and to those described by Gölz & Reinhard from Algerian and Mallorquin sources as *O. robusta*. The Cretan plants have certain racial peculiarities in that (1) there is a tendency towards greater laxness of inflorescence, and (2) they have smaller flowers, but the link with Stephenson's Algerian race is extremely clear.

The Cretan race may therefore be correctly cited as *Orchis palustris* var. *robusta* T. Stephenson or (if the conclusions of Gölz & Reinhard be accepted) *Orchis robusta* (T. Stephenson) Gölz & Reinhard.

ACKNOWLEDGMENTS

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Short Notes

THE DISTRIBUTION OF *CAREX HUMILIS* LEYSS. IN BRITAIN

Carex humilis is a Eurasian sedge extending from France in the west to Manchuria in the east, and from Spain, central Italy and Greece in the south to Poland and central Russia in the north. It is absent from Scandinavia. It is a plant of fully exposed and comparatively dry slopes, preferring a southerly aspect but by no means exclusively so, and in this respect is more akin to *C. ornithopoda* Willd. than to *C. digitata* L. (the three are grouped in Section *Digitatae* Fries). In Britain its headquarters are the chalk downlands where the counties of Wiltshire, Hampshire and Dorset meet, with outliers to the west and north-west on the Carboniferous limestone of the Mendips and of the Avon and Wye gorges. There is a single record, not recently confirmed, from the oolite at Bathampton. As may be seen, *C. humilis* is always strongly calcicolous, the pH as so far measured in Britain ranging between 7.3 and 7.9, with one reading (Crook Peak) at 6.4.

It is difficult to explain why this sedge is absent from the eastern downs. Coombe (1954) has suggested that the pattern is partly dictated by ancient clearances. Wells (1975) conjectures that the plant colonised arable land centuries ago when more favourable climatic conditions enabled it to set seed more readily than it does now. If this is so the present rapid destruction of the sedge may be irreversible.

The downlands of Britain have been variously cultivated through the ages, but the ploughing of sheep-runs in order to grow oats or barley or for conversion to cattle pastures has hitherto spared the steeper gradients and the ancient earthworks, both favourite habitats of *C. humilis*. Nowadays, however, the steepest slopes can be sprayed, from the air, with fertilisers and many of the earthworks (e.g. Stockton, Buzbury) are being used as winter stockyards. The growth of stronger grasses encouraged by the fertiliser, and the trampling by cattle, as well as their feeding methods (so much more destructive than those of sheep), can be quickly fatal to the sedge. Nevertheless there are many downland stations where it may still be counted in thousands. Furthermore, despite the plant's apparent inability to set much seed, detached pieces of it are sometimes capable, as pieces of *C. montana* are not, of re-rooting themselves. Such survivors may be found round the borders of fields that have been ploughed, and in this way the sedge may linger in, and might one day recolonise, areas from which it appears to have been eradicated.

Carex humilis is the earliest sedge to flower in Britain. The tufts of bright lemon-yellow anthers, curved over on relatively long filaments, usually enable it to be picked out by mid-March, a fortnight before *C. montana* has reached that stage. In April and May the mats of needle-like leaves are a vivid emerald green that stands out from the surrounding herbage, while in later summer these leaves, bronzed but still full of colour, continue to contrast with the dying grasses around them. By September, however, when the grasses are showing fresh growth, *C. humilis* is often very hard to detect until, at the turn of the year, those slopes on which the sedge is massed develop a characteristic red-brown colour.

The recorded British stations are listed below, with grid-references. All that have been traced have been surveyed since 1970, and the present size of each population is indicated by the letters A = 1 to 20, B = 21 to100, C = 101 to 1000, D = over 1000. Where the sedge has not been refound by R. W. D. the date of the last known sighting, with reference, is given.

N. Somerset, v.c.6: 31/2.5, Brean Down (D); 31/3.5, Crook Peak (C); 31/5.7, Leigh Woods (A); 31/7.6, Bathampton Down (White 1912).

N. Wilts., v.c.7: 41/0.6, Bishops Cannings (B).

S. Wilts., v.c.8: 31/8.3, Kelsey Farm Down (A); 31/9.1, Ashmore Down (B); Ashcombe's Bottom, 3 places (A,A,C); Malacombe Bottom (C); Pitt Place (Grose 1957), ploughed; 31/9.2, Win Green, 2 places (B,C); Malacombe Bottom (A); Winkelbury Hill, 2 places (B,B); Gallows Hill, 2 places (D,D); Trow Down (D); Middle Down, 2 places (D,D); Manwood Copse (D); Prescombe Down (D); Sutton Down (B); Woodminton Down (D); 31/9.3, Hindon (A); Tytherington Down (C); Well Bottom (B); Boyton Down, 1951, 2 small patches (D.E.Coombe field record);

Sherrington Down (Grose 1957), ploughed; Stockton Down, 3 places (C,D,D); Chilmark (B, a second station destroyed by road-widening *c* 1970); Starveall (D); Wyle Down (C); 31/9.4 Heytesbury (C); Knook Castle, 1973 (D.E.Coombe field record); Imber, Fore Down, 1968 (Grose 1969); Codford, 2 places (B,C); Edington, 1952 (Grose 1953); Tinhead (B); 40/0.1, Bokerley Dyke and Martin Down (D); Tidpit, Windmill Hill (D); 41/0.2, Woodminton Down (D, continuation of colony in 31/9.2); Marleycombe Hill (C); Knapp Down, 4 places (B,C,D,D); Chiselbury Camp, 1951, a few small patches (D.E.Coombe field record); Knowle Hill, 2 places (B,D); Vernditch Chase (C); Compton Down, 1967 (T.C.E.Wells field record); Hut Bottom, 2 places (A,B); Church Bottom, on east side almost continuous (D), on west side 3 places (D,D,D); Knighton Wood (C); Hoopside (B), and a second place, 1967 (T.C.E. Wells field record); Croucheston Drove, 4 places (A,B,D,D); Burcombe Down (B); Throope Hill, 2 places (B,D); Little Toyd Down (Welch & Grose 1943), ploughed; Stratford Tony Down (C); 41/0.3, Wylye Down (D, continuation of colony in 31/9.3); Church Dean Down (B); Deptford, 2 places (A,C); Upper Farm Down (C); Steeple Langford (D); Grovely (B); Berwick St James and Hadden Hill (Welch & Grose 1943), ploughed; 41/0.4, Tilshead (C); Yarnbury Castle (B); Parsonage Down, 2 places (D,D); 41/1.2, Salisbury Race Course, 1960+ (D.E.Coombe field record), site levelled *c* 1970; Grim's Ditch (C); Coombe Bissett Down (C, formerly plentiful, down since heavily fertilised); Homington, south (D); Homington, north (C); Whitsbury Gallops, 1951 (D.E.Coombe field record), re-seeded; Wick and New Court Down, largely ploughed but sedge survives in 2 enclosures (B,B); Gallows Hill (D); Odstock, 3 places (A,B,C); Clearbury Ring (B); 41/1.3, Druid's Lodge (C); Middle Woodford, 1952 (D.E.Coombe field record); Lake Down, 1951, 2 places (D.E.Coombe field record); Great Durnford (A); Hillcrest Bungalow, 1951 (Grose 1952); Figsbury Ring (A); Stock Bottom (B); 41/1.4, Alton Down (C); Wilsford Down (B); Stonehenge, 1973 (Coombe 1977, p. 94), now probably extinct through visitors' trampling; Durrington Down (Welch & Grose 1943), re-seeded; 41/1.5, Rushall Down (B); 41/2.2, Pepperbox Hill (C); 41/2.3, Porton (Wells *et al.* 1976, p. 623); Winterbourne Down (C); 41/2.4, Tidworth (B).

Dorset, v.c. 9: 30/8.9, Deverel Down (B); 31/8.0, Durweston Middle Hill, 1892, **BM**, **CGE**; Enford Bottom (A); 31/8.1, Hambledon Hill, 2 places (B,D); Hod Hill (D); 31/9.0, Buzbury Rings, 1977 (D.E.Coombe field record), cattle-trampled; Pimperne Long Barrow, 1956, **K**, cattle-trampled; Badbury Rings (A); Tarrant Rawston (D); Long Crichel Horse Down, 1892, **BM**; 31/9.1, Gunville Down (D); Tarrant Hinton (A); Chettle House (Mansel-Pleydell 1895), ploughed; Thickthorn Down (Biological Records Centre), ploughed; Week Street Down (C); Gussage Down (D); 41/0.1, Ackling Dyke (B); Oakley Down (A); Knowlton Temple (B); Pembridge Down (C).

S. Hants., v.c. 11: 41/0.1, Gallows Hill (B–extension of Wiltshire colony); Mizmaze (C).

W. Gloucs., v.c.34: 31/5.7, Clifton (C); 32/5.1, Symonds Yat, 2 places (B,B).

Hereford, v.c.36: 32/5.1, Great Doward, 2 places (B,B).

Derbys., v.c.57: 43/1.7, Miller's Dale, a curious plant, collected by D. M. Heath in 1930 as *C. humilis*, is in **OXF**. Kükenthal rejected the determination but could not name the sedge. It is probably very immature *C. ornithopoda*.

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R. W. David

× *PSEUDORHIZA BRUNIANA* (BRÜGGER) P. F. HUNT IN ORKNEY

A single plant of what is believed to be the first record from the British Isles of the hybrid *Dactylorhiza maculata* (L.) Soó subsp. *ericetorum* (Linton) Hunt & Summerhayes × *Pseudorchis albida* (L.) Á. & D. Löve (= × *Pseudorhiza bruniana* (Brügger) P. F. Hunt) was found near Stenness, Orkney, on 22nd June, 1977, by J. Edelsten and the writer. It is also the first record from the British Isles of a hybrid of this generic combination.

The tightly-packed head of small whitish flowers was taken at first glance to belong to *P. albida*, for which we were looking at the time (a colony had been found nearby in 1975 by N. Picozzi). At second glance, however, the stem and leaves were clearly of the *D. maculata* type. Closer examination showed that the flowers themselves were intermediate between those of the two species. All the floral segments were marked with *D. maculata*-type spots; the lip was shortish, longitudinally rectangular and with very small side-lobes; and the other segments were convergent, forming an *Orchis*-like hood or galea. It has since been pointed out by R. H. Roberts (*in litt*. 1977) that the spur was also intermediate—too broad at the base for *D. maculata* and too long for *P. albida*.

Photographs of the plant were submitted to Messrs G. Rodway, R. H. Roberts and P.F. Hunt as referees, and they agreed on the plant's putative identity. Colour prints, 25 × 20 cm, showing the whole plant at a reproduction ratio of about × 0.8, and the flowerhead at about × 6, have been deposited with the Royal Botanic Gardens, Kew. These prints were made by the CIBA process and should, therefore, be reasonably permanent.

The area was flat, dryish moorland at *c* 30 m altitude, the dominant vegetation being short heather which was evidently burnt at intervals. *D. maculata* subsp. *ericetorum* was extremely abundant, and there were also many specimens of *D. purpurella* (T. & T.A. Steph.) Soó, though these—like the hybrid—were within a few metres of the road; the materials used in roadmaking were perhaps less acid than the ambient soil.

D. fuchsii (Druce) Soó is a scarce plant in Orkney, and the nearest known colony is some 14 km to the east. The possibility of the hybrid being *D. fuchsii* × *P. albida* (= × *Pseudorhiza nieschalkii* (Senghas) P. F. Hunt) can, therefore, be discounted.

D. M. T. Ettlinger

MYRIOPHYLLUM AQUATICUM (VELLOSO) VERDC. IN EAST SUSSEX

In Chicken's (1977) note on *Myriophyllum aquaticum* (Velloso) Verdc. (*M. brasiliense* Camb.) in Britain it was suggested that this plant might be found elsewhere in Britain besides Cornwall, and it was reported that it is reputedly frost-tender.

This species grows in a small pond at an altitude of 550 feet near Duddleswell, in Ashdown Forest, E. Sussex, v.c.14, where it was first identified by Dr C. T. Prime in 1976. During the winter of 1976/77 the ice on this pond was approximately 2″ thick yet the growth during the summer of 1977 was prolific, the plant growing thickly up to 10 ft from the bank along two sides of the pond. The winter of 1977/78 was just as cold, but the plant is now (July 1978) in an equal state of luxuriance and producing female flowers in abundance. A specimen is in **LTR**.

I understand (E. Chicken *in litt. ad* C. A. Stace 1978) that the Cornish plant had died out by July 1977, but that whether this disappearance can be attributed to the drought of 1976 or to the frosts of 1976/77 must remain uncertain; Mr Chicken believes the former.

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J. M. Milner

VARIATION IN FLOWER AND FRUIT RATIOS OF *ONONIS REPENS* L. IN THE BRITISH ISLES

Wild colonies of *Ononis repens* L. growing in various localities in the British Isles were sampled. Wherever possible the lengths of the wings, keel, fruiting calyx and capsule were measured from their base to their farthest tips. The ratios wing/keel length and fruiting calyx/capsule length are summarised in Table 1, which shows the range of variation in these parameters within the localities sampled. Duncan's Multiple Range Test (5% level) demarcates these localities into two homogeneous subgroups (localities 1-5 and 6-20) on the basis of the wing/keel ratio, but these do not correspond to any distinct geographical separation. No such demarcation on the fruiting calyx/capsule ratio is possible.

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C. E. STEPHENS

(Department of Botany, University of Cape Coast, Ghana)

TABLE 1. WING/KEEL AND FRUITING CALYX/CAPSULE RATIOS OF *ONONIS REPENS* IN THE BRITISH ISLES

Locality	Wing/Keel Ratio n	Mean & S.E.	Fruiting Calyx/Capsule Ratio n	Mean & S.E.
1. Stroud Road, E. Gloucs., v.c. 33	25	0·93 ± 0·006	—	—
2. Oxwich Road, Glam., v.c. 41	33	0·94 ± 0·006	—	—
3. Slapton Sands, S. Devon, v.c. 3	66	0·96 ± 0·004	66	9·3 ± 0·02
4. Luce Sands, Wigtown, v.c. 74	33	0·96 ± 0·005	—	—
5. Oxwich Burrows, Glam., v.c. 41	34	0·96 ± 0·005	—	—
6. Courtown Harbour, Wexford, v.c. H12	33	0·97 ± 0·007	—	—
7. Boxhill, Surrey, v.c. 17	35	0·98 ± 0·007	50	9·4 ± 0·02
8. Rodborough Common, W. Gloucs., v.c. 34	50	0·98 ± 0·007	50	9·8 ± 0·01
9. Whitburn Coast, Durham, v.c. 66	51	0·98 ± 0·006	63	9·9 ± 0·01
10. Tunstall, E. Suffolk, v.c. 25	47	0·98 ± 0·005	67	11·0 ± 0·02
11. Albury, Surrey, v.c. 17	50	0·98 ± 0·006	—	—
12. Clonakilty Bay, W. Cork, v.c. H3	20	0·99 ± 0·001	—	—
13. Newmarket, W. Suffolk, v.c. 26	50	0·99 ± 0·006	56	8·8 ± 0·01
14. Holy Island Dunes, Cheviot, v.c. 68	50	0·99 ± 0·006	—	—
15. Drigg Dunes, Cumberland, v.c. 70	43	0·99 ± 0·009	—	—
16. Newark/Sleaford Road, S. Lincs., v.c. 53	54	1·00 ± 0·005	34	8·3 ± 0·01
17. Quarrington, S. Lincs., v.c. 53	92	1·00 ± 0·004	—	—
18. Beachy Head, E. Sussex, v.c. 14	35	1·01 ± 0·010	45	9·8 ± 0·02
19. Lay-town, W. Meath, v.c. H23	99	1·01 ± 0·080	—	—
20. Hartlepool Dunes, Durham, v.c. 66	50	1·01 ± 0·008	98	10·0 ± 0·01
21. Berwick, Cheviot, v.c. 68	—	—	37	9·2 ± 0·01
22. Corbridge, S. Northumb., v.c. 67	—	—	50	11·0 ± 0·02

SOME MORPHOLOGICAL VARIATION IN *ONONIS SPINOSA* L. IN THE BRITISH ISLES

Wild colonies of *Ononis spinosa* L. growing in various localities in the British Isles were sampled. Each plant was measured as follows: terminal leaflet length/greatest width (leaflet index), flower wing/keel

TABLE 1. LEAFLET, FLOWER AND FRUIT INDICES OF *ONONIS SPINOSA* L. IN THE BRITISH ISLES

	Leaflet index		Flower Index		Fruit Index	
	n	Mean & S.E.	n	Mean & S.E.	n	Mean & S.E.
1. Huntingdon, Hunts., v.c. 31	49	2·32 ± ·04	48	0·97 ± ·003	49	0·92 ± ·009
2. Quarrington South, S. Lincs, v.c. 53	92	2·36 ± ·04	55	0·99 ± ·006	48	0·90 ± ·008
3. Stow-on-the-Wold, E. Gloucs, v.c. 33	50	2·48 ± ·05	33	0·94 ± ·007	33	0·80 ± ·011
4. Quarrington North, S. Lincs, v.c. 53	50	2·50 ± ·05	49	1·05 ± ·008	36	0·83 ± ·008
5. Newark/Sleaford Road, S. Lincs, v.c. 53	50	2·58 ± ·05	50	0·98 ± ·007	28	0·94 ± ·024
6. Wyre, Hereford, v.c. 36	50	2·59 ± ·05	50	0·95 ± ·005	50	0·90 ± ·010
7. Merrow Common, Surrey, v.c. 17	50	2·60 ± ·06	48	0·97 ± ·004	40	0·91 ± ·009
8. Cranbourne, Dorset, v.c. 9	50	2·78 ± ·06	50	1·00 ± ·006	50	0·89 ± ·009
9. Eastbourne, E. Sussex, v.c. 14	68	2·84 ± ·05	40	0·99 ± ·007	40	0·83 ± ·012
10. Northwood, Salop, v.c. 40	49	2·93 ± ·06	49	0·97 ± ·007	49	0·89 ± ·009

length (flower index), and fruiting calyx/capsule length (fruit index). Table 1 presents a summary of the results.

Many of the populations sampled differ significantly when all three indices are considered together, although for each index the populations show a fairly continuous variation. The Merrow Common, Cranbourne, Eastbourne and Northwood populations are rather close for all three parameters; they all tend to have high leaflet indices (more lanceolate leaflets), flower indices approaching unity, and fruit indices less than unity (calyx shorter than fruit).

ACKNOWLEDGMENT

This is part of postgraduate research work in Biostatistics undertaken at the University of Waterloo, Ontario, Canada; the author is obliged to Professor J. K. Morton for providing the original data (not included here) for this investigation.

C. E. STEPHENS
(Department of Botany, University of Cape Coast, Ghana)

SOME OBSERVATIONS ON *CATAPODIUM RIGIDUM* (L.) C. E. HUBBARD SUBSP. *MAJUS* (C. PRESL) PERRING & SELL

Perring and Sell (1967) separated *Catapodium rigidum* (L.) C. E. Hubbard subsp. *majus* (C.Presl) Perring & Sell from subsp. *rigidum* 'by its taller habit, wider leaves and open pyramidal inflorescence. It occurs in the south and west of the British Isles,, often near the sea, and abroad in south-west Europe and much of the Mediterranean region'. Lousley (1971) commented: 'further experience in the field suggests that it only occurs in places where one would expect a grass to be more luxuriant and that its characters may be related to climatic conditions'.

I have observed this taxon for several years on the Isles of Scilly, in The Burren, Co. Clare, and in southern Italy along the coast from Naples to Paestum. In cultivation the growth habit remains constant. Germination is fairly quick after seed-fall and both seed-set and germination percentage appear to be high. From comparison of autumn and spring sowing, it is clear that a period of vernalization is necessary for flowering. It produces a large population of plants from self-seeding and a dense stand survives to full growth. It would appear that plants require a minimum of competition from other species but are able to withstand strong competition from their own species.

Plants from The Burren self-seeded in cultivation; seeds germinated following a brief period of rain in early September 1976 and by the end of the month had produced seedlings 8 cm high. Several severe frosts in December did not affect the plants. On March 8th 1977, 20 autumn-sown seedlings were

TABLE 1. MEASUREMENTS OF *CATAPODIUM RIGIDUM* (L.) C. E. HUBBARD SUBSP. *RIGIDUM* AND SUBSP. *MAJUS* (C. PRESL) PERRING & SELL

	subsp. *rigidum*	subsp. *majus*
Lower glume length	1·3–1·9 mm	1·0–2·0 mm
Upper glume length	1·4–2·4 mm	1·6–2·5 mm
Lowest lemma length	2·0–2·5 mm	2·0–1·8 mm
Spikelet length	3·5–5·0 mm	4·5–6·0 mm
Panicle length	3·5–4·0 cm	3·0–9·0 cm
Leaf length	2·5–4·0 cm	6·0–13·0 cm
Leaf width	0·8–1·5 mm	1·0–3·5 mm
Ligule length	1·0–1·5 mm	2·0–3·5 mm
Plant height	3·0–12·0 cm	18·0–38·0 cm

space-planted and by May 30th their leaves were 6–18 cm long. Seed was also sown on March 8th, but by May 30th had only produced plants with leaves less than 4 cm, which had only increased to 7 cm by the end of June, by which time no flowering culms had appeared. Inflorescences opened on June 8th on the autumn sowings whilst the spring sowing did not produce a culm until early August. These facts may account for some of the observed variation in the development of wild plants, some of which could have germinated in the spring.

From observation of the growth-habit and the habitats of subsp. *majus*, it is doubtful whether Lousley's (1971) comment can be upheld. The general nature of the habitats of both subspecies are similar and both can be found growing together in The Burren and in southern Italy. Subsp. *majus* in Tresco Abbey Gardens, Isles of Scilly, is a slightly smaller than average plant for this subspecies, probably due to acidity. Lousley's *Flora* includes records from cultivated land, which is potentially acidic and where subsp. *majus* could have taken up added nutrition from fertilizer. The large plants seen in The Burren and in southern Italy grow on calcareous rock and soil. Whilst pH requirements vary in plants, a high pH becomes an essential factor in enhancing available nutrition, however low.

Subsp. *majus* in southern Italy is found at the foot of walls adjacent to pavement stones, on garden walls, on ancient stone ruins, in rubble at the base of limestone cliffs and on open road verges. In The Burren it is seen among stones and open low grass cover on walled green lanes and tracks, and in shallow pockets on limestone rocks, in all cases in open conditions with little or no other plant competition and not near any sources from which it could derive added plant nutrition. Its proximity to the sea is marked and it can be seen at 300m at Ravello facing the coast above Amalfi.

Some measurements of plants of the two subspecies are given in Table 1. The measurements for subsp. *majus* are taken from wild material in The Burren, southern Italy and Tresco and from cultivated material. The length of the glumes and lemmas of the two taxa are similar. In subsp. *majus* the length of the ligule, spikelet and panicle are greater than in subsp. *rigidum* and the open pyramidal shape of the panicle in subsp. *majus* is distinct. Also the greater leaf-width and -length and the greater height of subsp. *majus* shows it to be a distinct taxon.

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P. J. O. Trist

Book Reviews

Introduction to ecological biochemistry. J. B. Harborne. Pp. xiv +243, with 91 text-figures. Academic Press, London & New York. 1977. Price £7·00.

The role of chemicals in the interactions between living organisms is a rapidly growing research field spanning several scientific disciplines. Symposium volumes have been published in recent years bringing together selected topics in this field, but multi-author symposia, although they can be valuable and stimulating, cannot provide a comprehensive and unified account of a subject. Such an account has to be essentially the work of a single mind, but in a multidisciplinary field there are few who can attempt it. J. B. Harborne has somehow managed to summarize almost the whole of this vast subject in 230 pages of interesting and informative text. He starts with a chapter on the biochemical adaptations of plants to their environment and then goes on to consider chemical interactions between plants and animals (biochemistry of plant pollination, plant toxins, hormonal interactions, insect and vertebrate feeding preferences). There is one chapter dealing with animal pheromones and chemical defence mechanisms, and the final chapters consider biochemical interactions among higher plants and between higher plants and plant pathogens. These last two chapters have particularly stimulating discussions of the concept of allelopathy and the roles of pathotoxins and phytoalexins in plant disease and its resistance.

Although clearly most at home in his own particular research subject, the author covers the whole field with remarkable facility. The book is chiefly concerned with breaking down the barriers between plant and animal biochemistry, and it does this so successfully that notable omissions from a zoologist's point of view, such as the chemistry of arthropod and vertebrate venoms, can readily be forgiven. There are very useful selective bibliographies at the end of each chapter. The subject index is a little odd. For instance, who would be likely to look up "pronghorn deer secretions" under "P", or "directions of evolution of cyanic colour" under "D"? On the other hand, for "terpenes" one has to think to look under "M" (for monoterpenes). However, this is carping. Dr Harborne has produced a book for which students and research workers in many branches of biological science will be grateful.

R. L. Blackman

Spotter's guide to wild flowers. C. Humphries; *Spotter's guide to garden flowers*, B. Ambrose; *Spotter's guide to trees*, E. Harris; *Spotter's guide to the seashore*, S. Swallow. Each pp. 64. Usborne Publishing, London. 1978. Price £1·50 (hardback), 65p (paperback).

Books for young people which encourage an interest in the countryside are now in great demand, and the Spotter's Guide series of pocket books sets out to provide for this need. Each book in the series is presented as a game; in the *Spotter's guide to wild flowers* each flower shown, when spotted and recognized, can be ticked in the circle provided. A score card at the end of the book awards points, 5 to 25, in which uncommon plants merit the higher scores. The illustrations by Hilary Burn, assisted by Joyce Bee and Christine Hawes, are mostly adequate for reasonably accurate identification; many have a close-up of a single flower or fruit inset, but in a few, e.g. wood sorrel, the scale could be misleading.

The selection of plants is less happy. 123 species are described, and in line with other books in the series the book claims to cover an area shown on a given map of the whole of Europe. To claim from northern Scandinavia to Crete, and from Spain to Romania and part of the Soviet Union, as "countries covered by this book" with 123 species only is plainly ludicrous. But presumably the books will be used mostly in Britain, where most of the plants selected can be found. Even here, spotting the "corky-fruited water dropwort" (*Oenanthe pimpinelloides*) could confuse even an experienced field botanist; whilst "Triangular-stalked Garlic or Three-cornered Leek" (*Allium triquetrum*), the only species stated to be "not in Britain", could easily be spotted in south-western Britain. The inclusion of Red Helleborine (*Cephalanthera rubra*) is especially unfortunate in this year when there has been an appeal not to visit the plant in Britain, where visitor pressure and trampling at the site have caused anxiety for the orchid's survival. To expect the young 'spotters' to find their Red Helleborine overseas instead of in Britain is surely unrealistic, and a less rare orchid could have been used equally well as a top scorer.

At the end of the book there are instructions for extending the study from identification to photography, listing the species found in a quadrat, or noting seasonal changes; a few puzzles and a quiz are included, and advice is also given on books to read and clubs to join. Others in the series include the excellent *Spotter's guide to trees*, in which Annabel Milne and Peter Stebbing have illustrated in colour 36 conifers and 50 broad-leaved trees, two to a page, each with good paintings of leaves and fruit and an outline to show the shape of the tree. An interesting bark drawing is included for each species. In addition there are six shrubs (in black and white) and two pages of drawings of winter twigs. The *Spotter's guide to garden flowers* is less successful, the colours as reproduced being mostly neither accurate nor artistic; but there is a nine-page section on "Easy gardening". In the *Spotter's guide to the seashore* there are 19 flowering plants, including one grass (*Ammophila arenaria*) and *Triglochin maritima*. The list of eleven consultants on the title page of this booklet surely guarantees accurate representation of the 18 groups of plants and animals described. A guide to rocks and minerals and one to birds make up the six titles now available in this series.

The idea for the series as a whole is splendid. These pocket books are good value at a penny per page, and they should give potential young naturalists a good deal of fun and at the same time an introduction to the selected subjects in the field.

M. Briggs

The biology and chemistry of the Compositae. Edited by V. H. Heywood, J. B. Harborne & B. L. Turner. Vol. 1, pp. xiv + 619; Vol. 2, pp. xiv + 569. Academic Press, London and New York. 1977. Price £55 (£27·50 per volume).

These two volumes contain a series of 42 papers presented at an international symposium on "The Biology and Chemistry of the Compositae", held at the University of Reading on July 14th–18th, 1975, under the auspices of the Linnean Society of London and the Phytochemical Society. This particular publication, the latest volume in the *Biology and Chemistry* series, is an improvement on its predecessors dealing with the Umbelliferae and Cruciferae in that it is an organized textbook rather than a random collection of papers.

The contributions are of three kinds. Firstly, there are twelve review chapters written at the family level and dealing with a range of topics such as corolla and capitulum evolution, flavonoid phytochemistry, cytology and pollen morphology. Secondly, a number of specialists were invited to prepare a systematic report of each tribe including a description of the tribe, a list of valid and accepted genera and the approximate number of species they contain, and a discussion of significant systematic data. Thirdly, chemists and biochemists were similarly invited to review each tribe from a chemical point of view. In addition to the main chapters, two useful appendices have been added: a list of the principal works on pollen morphology and a complete alphabetical list of the genera in the Compositae. Chapters 41 and 42 provide two summaries respectively on the chemistry of the Compositae by Mabry & Bohlmann and on the biology of the Compositae by Turner. One of the highlights of the meeting was an extremely erudite cautionary tale about the systematics of the Compositae presented by Merxmüller, and one wonders why it is missing from the text. The first chapter *An overture to the Compositae*, is a rather dull replacement written by the editors for Cronquist's *The Compositae revisited*, recently published in *Brittonia*, **29**: 137–153 (1977).

The Compositae, which consist of about 13,000 species, have not really been tackled systematically to generic level since the works of Bentham, Hoffman and Dalle Torre & Harms, which are all essentially pre-Darwinian classifications in concept. There have been numerous attempts to produce phylogenetic classifications, particularly in the works of Small, Cronquist and Wagenitz, but all have relied on old typo-morphological classifications for their evolutionary discussions. It was with this background that the symposium was devised, and the aims of the meeting can be summarized in four questions: (i) What is the evolutionary history of the family? (ii) What are the relationships of taxa within the family? (iii) What is the current state of systematic knowledge in the family? (iv) Which areas are in need of further investigation?

The family reviewers tackle the first question in a number of different ways with considerable vigour. Turner sets the pattern in his *Fossil history and geography*, in which he accounts for worldwide distribution in the light of modern views of earth history. His basic conclusions are that the family originated in western Gondwanaland during the Cretaceous period and that its closest living relatives are to be found in a South American family, the Calyceraceae. Such a view is supported by data on pollen morphology and anatomy in the very excellent chapter on palynology by Skvala and his colleagues. Stebbins, however, when reviewing anatomical data, considers the Campanulaceae to have had most recent common ancestry with the Compositae. The phytochemists generally favour the Boraginaceae as an ancestral group, whereas, according to Turner, Cronquist's view is that the Compositae are derived from the Rubiaceae. On a different note, Burtt, Leppik, Stebbins, Jeffrey and Baagøe present a fascinating series of papers giving data and speculative ideas on the structure and evolution of the capitulum and the corolla. Burtt sets the scene by demonstrating the considerable diversity of the capitulum and the others present their highly personalized accounts of the details. Jeffrey is particularly at odds with Leppik, for example, when he considers the bilabiate corolla to be primitive. Stebbins differs again, and it is obvious that diversity of opinion stems as much from individual eccentricity as from the intrinsically difficult subject matter. The net result is that we are clearly not yet on very firm ground when discussing the phylogeny of the family.

Comments regarding relationships within the family dominate the majority of the tribal reviews. The patchiness or lack of useful available data is particularly highlighted, and it is obvious that for some characters, especially chemical features, knowledge for whole tribes is entirely wanting. Apart from those one or two tribes, such as the Tageteae, which are regarded by most people as being monophyletic assemblages, most reviewers agree that the tribal groupings of the pre-evolutionary synantherologists are poly- or paraphyletic groupings. Many attempts at rectification are attempted. In some groups, e.g. the Cardueae and the Calendulae, it seems to be an easy matter to form monophyletic groups simply by transferring one or two genera to other tribes. Sometimes a few more genera need to be transferred, such as the 26 that Nordenstam excludes from the Senecioneae; and in even more drastic situations the ever-confident Americans, Stuessy and Powell & Turner, have not hesitated to disband the Helenieae, rearrange the Heliantheae and even create a new tribe and a few subtribes. The most alarming observation from all this activity is, that although much of the rearrangement is based on a wealth of new data, *a priori* value judgements abound and some of the new groups are not really much better than the old.

To answer the last two questions we only need to say that this work contains a wealth of data and many new ideas on where to go next. Nevertheless, one message that becomes very clear is that if we are to progress in the future, a drastic reappraisal of our methods and the way which we gather information must be a priority. Thus, if we want to create phylogenetic classifications, loose-thinking Besseyan methods must be abandoned. If we want to analyse the morphology of the capitulum or the evolution and biosynthesis of a chemical compound, systematic studies must be more rigorous. These two books are a magnificent starting point and will probably represent the key reference work for the next century.

The editors and publishers must be congratulated for such a welcome effort. The quality of editing and printing is extremely high, although some of the typesetting errors, for example the omissions from the table on page 877, are unforgivable. It is without doubt a very fascinating plant family and any serious student of the group can hardly afford not to have a copy, despite the price.

C. J. Humphries

The flora of West Yorkshire. Frederic Arnold Lees. Pp. 843, with one map. Lovell Reeve, London, 1888. Reprint with new Foreword by M. R. D. Seaward. E.P. Publishing, Wakefield, Yorks. 1978. Price £10·00.

Published 90 years ago and still the standard Flora of vice-counties 63 and 64, Lees' *Flora of West Yorkshire* is the most comprehensive of the 19th century county Floras, including accounts of Characeae, bryophytes, lichens, fungi and fresh-water algae. Indeed the cryptogam content occupies

254 pages, which is over half that devoted to phanerogams. In addition to an extensive bibliography, much other useful information is included, especially to the student of local plant names; and with no modern Flora in active preparation, a reprint of this now scarce work is to be welcomed.

E.P. Publishing claim their reprint to be a facsimile; but theirs is a loose interpretation of that term when, with a format somewhat larger than the 1888 original, the reprint is considerably slimmer. Compression has been obtained by printing four pages of the original edition on to one. However, the type is so clear and clean that no difficulty whatever should be experienced in reading. Cost is no doubt responsible for the replacement of the original four-colour map by a black-and-white version; but inclusion of new material (a portrait of the author and two other plates, as well as a new foreword) is helpful. The Foreword includes a detailed biographical and bibliographical study of Lees by M. R. D. Seaward, editor of *The Naturalist*, which adds considerably to the value of this most desirable reprint.

G. A. MATTHEWS

Essays in plant taxonomy. Edited by H. E. Street. Pp. 304, with 6 plates and 20 text figures. Academic Press, London, New York & San Francisco. 1978. Price £12·50.

To celebrate the seventieth birthday of Professor T. G. Tutin, 16 friends, some of them former pupils, have joined in weaving this garland of botanical essays, and I am sure all who know Professor Tutin (and perhaps some who have not yet had that pleasure) will want to be associated with the contributors in wishing him many happy returns.

Since it is now acknowledged that environment may have a profound influence upon the genotype, I like to think that the manifold achievements of Professor Tutin are, in a measure, the outcome of those early years when (*teste* A. R. Clapham) the budding scholar was wheeled around Kew in a push-chair, steered on occasion, I may add, by a former member of the Herbarium staff. With such a start in life, how could Thomas fail!

But what of the essays? Let me be frank. The *Festschrift* is not my favourite class of literature. Too often it is an ill-assorted compote, doing honour neither to the dedicatee nor to the contributors, and protected from criticism only because its object is so patently well-meant. I am, however, glad to make an exception of this volume, which is admirably planned and executed, and most revealing as a survey of current taxonomic thought. Sadly, the editor, Professor H. E. Street, did not live to see publication; but if his work was primarily intended as a tribute to a fellow-botanist, it serves no less as a handsome memorial to his own abilities. I can echo the prefatory comment that "a wider audience of biologists will find here a readable and up-to-date assessment of this foundation area of plant science". And certainly, most certainly, I can recommend these pages for study by every practising taxonomist, whatever his speciality. It is specialization, the baneful requisite of present-day science, that narrows our vision and postpones the day when herbarium and laboratory worker, field botanist and gardener can together push towards the ultimate, if unattainable, goal of an omega taxonomy, a goal which, for all the conference and symposia reports, is not so much nearer than when it was first espied, 40 years ago, by Dr W. B. Turrill.

It would be unfair to make comparisons between the essays. Some, like C. A. Stace's "Breeding systems, variation patterns and species delimitation", are limpid expositions of very general interest; others have a more limited appeal, though, surprisingly enough, for one who can scarcely tell a *Fucus* from a Fungus, I found D. L. Hawksworth's essay on Lichens a fascinating chapter, which opened my eyes to an unimagined situation, and which might have brought a less sanguine nomenclaturist to the verge of tears. In fact all these essays, taken together, reflect the skill of editor and contributors alike in providing contrast without clash. The general and the particular, the straightforward and the recondite, are so juxtaposed that the reader passes from the one to the other just as he begins to wish for a change of scene. Moreover the generous lists of references at the end of each chapter hold out the prospect of further intellectual stimulus for those who want to read on.

What conclusions are to be drawn from the survey? First, that the passing of time, and perhaps involvement with *Flora Europaea*, have made the erstwhile exponents of experimental taxonomy rather more diffident, and rather less contemptuous of their orthodox brethren. The herbarium botanist is no longer seen as the obscurantist scribbler of the 1940's,

"Thron'd in the centre of his thin designs,
Proud of a vast extent of flimsy lines".

Ecology, cytology, numerical taxonomy and phytochemistry, the computer and the scanning electron microscope have not carried and will not individually carry us much further than the grey-haired myopic with the dangling hand-lens, but together these newer sciences and techniques may help to guide the old sage as he gropes towards the light.

Secondly, again and again these essays suggest that the limitations imposed by the conventional hierarchy of ranks, especially of infraspecific ranks, are unduly restricting the scope of taxonomy and the statement of scientific truths. The new wine is bursting the old bottles:

"It must be agreed that there are some sorts of populations, particularly those where hybridization is frequent, in which any attempt to apply an orthodox infraspecific classification would be doomed to failure" (D. H. Valentine).

". . . in groups with different sorts of variation patterns from these the provisions of the *International Code* are quite inadequate at around the species level as well as below it" (C. A. Stace).

"The most difficult problems are often met with at the infraspecific level" (P. F. Parker).

"There is a need to reconsider, and if possible to obtain a consensus of agreement on, the use of the variety and the subspecies" (P. W. Richards).

"In such cases as the preceding examples, the traditional taxonomic framework seems inadequate" (I. B. K. Richardson).

But what is the alternative? Many new hierarchies have been proposed in the past; few have survived their authors. True, the classification of crop plants calls for a special nomenclature of ranks (see Chapt. 6), and I have little doubt that the call will be answered once taxonomists, as a whole, can be persuaded that useful plants are as deserving of serious attention as their 'wild' ancestors. But in the more usual cases it looks as if the species-subspecies-variety-form concept has come to stay, even if it becomes increasingly apparent that, at the lower end of the scale, these ranks have acquired so many possible meanings as to have become virtually meaningless. Yet, maddeningly enough, they are often very useful. *Styrax officinalis* and *Styrax californicus* are outwardly no more than two species, one from the eastern Mediterranean, the other from California. But write "*Styrax officinalis* var. *officinalis*" and "*S. officinalis* var. *californicus*", and an intriguing situation is at once exposed. However, it must be admitted that the term 'subsp.', 'var.' or 'f.' tells us nothing more about a taxon than its possible affinity. What we need are not new ranks but rather some formulae akin to chemical formulae, which could be attached to a name, which could be added to or amended as information became available, and which would, at a glance, furnish us with essential information about the ecology, cytology, breeding system, etc. of the taxon under consideration. Maybe we do not yet know enough about plants to make such a scheme generally possible, but there must surely be some carefully studied areas or groups (at least in the British flora) which could be used for a start.

And all the time, while we consider such refinements, vast areas of the globe, virtually untouched by the taxonomist, are undergoing rapid, irreversible change. Plants which might alter the course of history, or at least the course of taxonomy, are being lost for ever. I am glad that Professor Heywood should close the volume on this sombre note, for while I believe there is room for refined taxonomy, and indeed a positive need for it, at the same time I am all too painfully aware of the amount that remains to be done, at a simple, unsophisticated level, in the short time that remains before our herbaria become the final, inadequate refugia of a lost world.

R. D. Meikle

Seedlings of the north-western European lowland. A Flora of seedlings. F. M. Muller. Pp. 654, with 1211 line drawings. Dr W. Junk, The Hague, and Centre for Agricultural Publishing and Documentation, Wageningen. 1978. Price Dfl.150, $73·00.

This is the most comprehensive book available on the subject; of the 1211 species included, about 1000 are British. Every species is described in detail and illustrated. The descriptions appear to be accurate and complete, and the illustrations are clear and of generous size, taking up more than half of the book. Identification keys are provided, but trials with these proved disappointing. The samples were common weeds from garden and municipal flower beds, and with about half of them the key failed to lead to the correct result. The main difficulty seemed to be the use of leaf length/width ratio, which in practice varies rather more than the keys have allowed for. The author does warn of this in the introduction, and advises readers to try the neighbouring keys if in difficulty.

The volume could be improved by the provision of notes on the observation of seedling characters, which are only dealt with very briefly. The author states that information on habitat has been left out, presumably for reasons of space, but this would be a welcome addition, especially if keys of habitat were provided. Other books available on the same subject include Chancellor (1966), which is a very attractive publication, but covers only 87 species, all British weeds. For those who read German, there is Csapody (1968), which includes about 500 British species, but no monocotyledons. The *Geigy weed tables* (1968–75) give line-drawings of about 250 species, but there are no keys or descriptions of seedlings as such. Hence, Dr Muller's volume is the best available for identifying British seedlings, in spite of the qualifications made above.

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R. J. Pankhurst

Badgeworth Nature Reserve handbook. Edited by Sonia Holland. Pp. 32, with 5 plates and 4 text figures. Gloucestershire Trust for Nature Conservation, Cheltenham. 1977. Price 50p.

If you look in the *Guinness book of records* for the smallest official nature reserve in the world you will find the 'honour' belongs to Badgeworth in Gloucestershire, where its 364 square yards are devoted to protecting one of the only two sites in Britain for the Adder's-tongue Spearwort, *Ranunculus ophioglossifolius*. Yet this tiny site and this one rare plant are the subject of one of the fullest nature reserve guides currently available. In truth it is more like a Biological Flora account from the *Journal of Ecology*, packed with fascinating information based on years of careful observation and recording by a succession of honorary wardens and research workers, notably from the Botany Department of Bristol University.

The history of the plant in Britain, and at this site in particular, is fully documented and makes it clear that an absence of knowledge of its biology in the early days was almost disastrous. First found at Badgeworth in 1890 it was not seen again until 1911, and in the first 44 years following its discovery it was seen in only ten. Attempts to transplant the buttercup to other pools nearby on the advice of G. C. Druce were a failure. However, since first being acquired as a reserve by the Cotteswold Naturalists' Field Club in 1933 for £53 (at £763/acre at that time it must also be one of the most expensive nature reserves ever purchased), it has failed to appear in only six out of the last 45 years, and has been seen every year since 1970. Why? Because the biology of the species is understood and the appropriate management to produce a crop is carried out: keep down *Glyceria*, create bare mud and, given a reasonably wet winter, seedlings of *R. ophioglossifolius* will come up in thousands and mature to seed-shedding plants.

Badgeworth and its Committee and the Adder's-tongue Spearwort are now justly famous throughout the world; by level-headed enthusiasm and constant vigilance the Committee has ensured the survival of a most attractive plant as a member of the British flora. Their example is a lesson to us all. If our endangered wild plants are to be saved these are the lengths to which we may have to go in many cases. We need a thousand Badgeworths.

Read this attractive booklet—there is inspiration to the very last sentence: "The village of Badgeworth now has its 'Buttercup Queen' whose coming is the main event of the local church fete"; surely such involvement is the ultimate in successful conservation.

F. H. Perring

Population biology of plants. J. L. Harper. Pp. xxiv + 892. Academic Press, London & New York. 1977. Price £30·00.

The very existence of the word vegetation gives emphasis to the relative permanence of terrestrial communities of plants and contrasts with the much more dynamic concept of communities of animals, for which no equivalent word exists. This difference has had a marked influence on the attitudes of ecologists. While animal ecology has been very largely concerned with populations and their dynamics, plant ecologists have often neglected the simple fact that terrestrial vegetation not only is composed of individual plants but changes as a consequence of their reproduction, growth and death.

In 1967 Professor Harper drew attention to the comparative neglect of population studies by plant ecologists in his presidential address *A Darwinian approach to plant ecology* given to the British Ecological Society. In its general content and attitude his book is an expansion of this lecture. The book is the only one in its field and will be an invaluable source of information and references, as well as a powerful stimulant to further work.

An unusual and helpful feature of the book is the presentation at the beginning of summaries of all the chapters. The first chapter then develops a diagrammatic model of a population of seed-plants and each subsequent chapter deals with a part of this model, which is generally indicated in red on the same diagram below each chapter heading. Successive chapters deal with dispersal of seed, the seed-bank, populations of seedlings, the influence of density on growth, morphology, reproduction and mortality, the influence of environment, competition, predators and pathogens, the dynamics of natural populations, reproduction and natural selection.

From even this summary it will be clear that the book's title is misleading and should more appropriately be *Population ecology of seed-plants*. It does not include population genetics, although the final chapter discusses natural selection. Almost exclusively the examples and discussion are of seed-plants. Cryptogams are mentioned only as pathogens and there is almost no reference to phytoplankton, to which incidentally the concepts of population dynamics have been widely applied.

If we accept this more limited description of its scope, the book offers a comprehensive treatment of the subject. It certainly causes the reader to look at many aspects of plant ecology in new and rewarding ways, and it draws extensively on concepts and theories developed in animal ecology and applies them to plants. Many of the examples described are taken from the work of Harper and his students, and it is a challenge, rather than a criticism, to recognize how many of the examples are based on analysis of populations made over rather short periods. There is a dearth of population studies which extend beyond the three years required to obtain a Ph.D. in British universities, and yet some individuals in populations of trees and many herbaceous plants live longer than man.

One hopes that those with enthusiasm for field studies may take up this challenge. In one respect, which is mentioned on the book's dust cover, flowering plants are ideal organisms for the study of population dynamics; they stand still to be counted. Observations over periods of several years of populations of uncommon species would provide valuable information about their biology and for their conservation. Answers are needed to such questions as: How frequent is reproduction from seed? Is there a store of dormant seed in the soil? In what habitats do seedlings become established? How long do individuals live? What are the main causes of mortality? Anyone intending to embark on such studies must regard this book as a prerequisite.

The book is written in Harper's distinctive style. It is very readable and lively but difficult to assimilate in large doses. The text of 778 pages is very long, partly because a great deal has been included which is subordinate to the main theme. There are also instances where similar examples are discussed in detail and it might have been better to select one example and simply make reference to others.

Unfortunately quite a large number of errors have survived into the final text, including some errors of algebraic symbols. Several of the diagrams and tables need additional information to make them fully intelligible.

C. D. PIGOTT

Flora van Nederland. H. Heukels. 19th edition. Edited by S. J. van Ooststroom. Pp. 925, with 1 map and 1038 line-drawings. Wolters–Noordhoff, Groningen. 1977. Price Hfl.46·75.

The 18th edition of this most useful Flora of Dutch vascular plants was reviewed in *Watsonia*, **11**: 262

(1977). This (19th) edition is essentially the same but includes a revised treatment of *Rubus* by Dr A. van de Beek and an Addenda section with less extensive modifications (e.g. revisions of the *Polygonum aviculare* group, *Odontites* and *Filago*).

N. K. B. Robson

Flowering plants. Evolution and classification of higher categories. Edited by K. Kubitzki. Plant Systematics and Evolution, Supplement 1. Pp. 416, with 120 text-figures. Springer-Verlag, Vienna & New York. 1977. DM 198, $91·10.

The family classification of flowering plants, although not yet stable, is at least showing signs of stability. The position of certain genera, such as *Adoxa*, is still not generally agreed on, but most differences are now in the 'lumping versus splitting' category. For example: Are the Leguminosae one family or three? Are the Labiatae separable from the Verbenaceae? How many distinct families are included in the Urticaceae sensu Bentham & Hooker?

What is far from being decided is the grouping of families into orders and higher categories; and so it is with family and order relationships that most of the contributors to this Symposium Volume are concerned. The symposium was held in Hamburg, in September 1976, and comprised 22 papers and a summary lecture, the papers being grouped under three headings: (1) General principles and methods, (2) Evolutionary aspects and taxonomic evidence, and (3) Evolution and classification of major taxa.

Recent studies on these major taxa have involved various characters besides the traditional gross-morphological ones; those that are discussed in this volume include topics such as chemistry (e.g. the occurrence of iridoids, benzylisoquinoline alkaloids or ellagitannins), ovule structure (number of integuments, thickness of the nucellus) and development (e.g. the direction of maturation of polyandrous androecia). Since Cronquist and Takhtajan used the last-mentioned character to differentiate the Dilleniidae (centrifugal) from the Rosidae (centripetal) these subclasses have been accepted by many workers (including a majority of the contributors to this volume), despite the manifest anomalies that such a single-character classification produces. Thus the Paeoniaceae are still placed near the Dilleniaceae by several authors instead of close to the Ranunculaceae, and the Myrtales repose uncomfortably in the Rosidae rather than near the Theaceae and Guttiferae, to which they seem, at least to the reviewer, to have closest affinities.

Apart from Meeuse, who maintains that the Angiosperms are polyphyletic (the flower for him being a biological entity, not a morphological one), there is general agreement that they can at least be treated as monophyletic. But are the Monocotyledons really as distinct as they have been thought to be? Huber points out various Diocotyledon and Monocotyledon families with similar characters and regards the two classes as extreme wings of a natural unit, with the Annonaceae, Aristolochiaceae, Nymphaeaceae and Piperaceae as connecting links.

The main difficulty, which is mentioned repeatedly, is in recognizing convergence. Kubitzki is partly correct in remarking that "without convergence a purely phenetic classification would be a phylogenetic one"; but convergence usually affects single characters or character syndromes, not evolutionary lines, and can usually be detected when these evolutionary lines are elucidated, e.g. by the correlation of character trends. Convergence is said to have obscured the natural relationships in, for example, the advanced Monocotyledons (Huber) and the Asteridae, i.e. most of the old Gamopetalae (Wagenitz).

Another current problem that is discussed in this work concerns the interrelationships of the major Dicotyledon groups. Following the very elegant description by Endress of evolutionary trends in the Hamamelidales–Fagales group, the most outstanding of which is towards adaptation to wind-pollination, Ehrendorfer postulates that the extant members of this group form the remnants and descendents of an ancient "transitional field" from the Magnoliidae to the Rosidae–Dilleniidae. In it he discerns an early phase of flower reduction and a trend toward anemophily, whereas the Rosidae and Dilleniidae are said to constitute a later phase of floral elaboration and intensified adaptation towards zoophily. He therefore interprets the occurrence of fascicles of stamens in these subclasses as due to secondary polyandry (i.e. 'multiplication' of single stamens, or 'dédoublement'). This idea is also accepted by several other contributors, for example by Gottesberger, who argues that cantharophily (beetle-pollination) has had an important influence on Angiosperm evolution. He suggests that an increase in stamen number would have been connected with a need to protect the flower from rough treatment by the beetles. Nowhere is the evidence for such an increase provided, and I doubt if it exists. Theories which interpret stamen fascicles as primary, not secondary, structures in the Angiosperms seem to accord far better with known fossil forms and with the overall evolutionary trends in the polyandrous families.

Space does not permit even a mention of the many other fascinating problems that are discussed in this absorbing book. Anyone who is at all interested in the evolution and classification of the flowering plants should make an effort to examine it. Having examined it, they will almost certainly want to buy it; but the price may well prove to be a deterrent.

N. K. B. Robson

Advances in botanical research. Volume 5. Edited by H. W. Woolhouse. Pp. xi + 240. Academic Press, London, New York & San Francisco. 1977. Price not stated.

In volume 5 of this series the article entitled 'The evolution of vascular land plants in relation to supracellular transport processes' (pages 153–219) will be of interest to many *Watsonia* readers. In it, J. A. Raven (Dundee) examines the origin of the vascular plants from their putative ancestors, the green algae, by considering how the transport processes of the latter group have been exposed to selective pressures, causing them to evolve into the transport processes (the apoplast, the symplast and the gas-filled intercellular spaces) of vascular plants.

The article might have been subtitled 'New support for an old idea', for the green algae most likely to have given rise eventually to vascular plants are considered to be aquatic filamentous Charophyceae. The sequential acquisition of the following features, selected during the conquest of land, is visualized as giving rise to the higher plants: aerial meiospores, parenchymatous axes, cuticle, xylem, phloem, intercellular gas spaces, stomata, secondary thickening, megaphylls and seeds. The earliest known vascular plants (Rhyniales, such as *Cooksonia* from the Upper Silurian) fit in well with this putative sequence.

The chapter under review (as the rest of the book) contains rather too many annoying grammatical imperfections. *Coleochaete* is spelled in four different ways within six pages, and there are numerous other minor misprints as well. The subject index is poorly organized, and one quickly gains the impression that this book falls well below the usual high standards of Academic Press. These blemishes apart, Raven's article is interesting and provocative; its persuasiveness I leave for individuals to judge.

C. A. Stace

Flora of Moray, Nairn and East Inverness. Mary McCallum Webster. Pp. xii + 606, with 17 colour plates, 7 monochrome plates and 50 text-figures. Aberdeen University Press. 1978. Price £15·00.

The publication at any time of a definitive work on the flora of any of the botanical divisions of Scotland is an event of sufficient rarity to attract considerable interest and comment. The advent of a comprehensive, hard-backed Scottish local Flora of over six hundred pages, lavishly illustrated with colour photographs and line drawings, is an unprecedented occurrence. Most modern works on local flora are so beset by problems of cost and other strictures that the end-product comprises little more than a checklist with minimal supporting information. Clearly there have been no such restrictions in the case of the present volume, as one may judge from the price, which certainly places it among the most expensive of its type.

The author is well known in botanical circles as an acknowledged authority on the plant life of the Scottish Highlands and particularly of those divisions which are the subject of this Flora. An intimate knowledge of the area and its botanical features is evident throughout the book, notably in the chapters on 'Vegetation' and 'Discovery of the flora'; but it is in the section devoted to 'The flora', comprising nearly 500 of the 600 pages, that we find the clearest evidence of Miss McCallum Webster's talents as a field botanist. A very large proportion of the records quoted are based on the author's own herbarium specimens and field observations over many years. The search for literature and herbarium references has been pursued with a diligence surely unequalled by any recent author, and the resulting very large volume of data seems to have been incorporated into the Flora in its entirety. Considering the obvious effect on the length of the text, the apparent decision to detail *all* herbarium specimens might fairly be questioned. The listing of such records frequently extends the entry, even for a number of relatively common species, to half of a page. *Agrostis stolonifera*, *Deschampsia caespitosa* and *Callitriche stagnalis* may be quoted as examples. Further useful saving in space could well have been made by omitting taxonomic details. Such information is more efficiently dispensed elsewhere, and this volume is scarcely one to be carried with the botanist in the field. Space could perhaps have been used to better purpose by some amplification of ecological and distributional information for individual species from the author's personal observations. For instance we are left to wonder what her opinion might be regarding the past and present status of *Draba norvegica* on Cairn Gorm, and whether *Paris* may still be found at Ness Islands.

There has obviously been considerable contact with and co-operation from a number of specialists in various genera. Field botanists will particularly welcome the line drawings and key for *Rosa* by Melville and the key to *Hieracium* and notes on the subspecies of *Pilosella officinarum* by Sell. Hubbard contributes a useful tentative key to the subspecies of *Festuca rubra*. This must surely be the first of the local floras to deal extensively with the microspecies of *Taraxacum*. Details of the 63 taxa recorded in this genus occupy 13 pages. Nomenclature has been brought into line with modern practice but readers will find relatively few unfamiliar names. Apparently *Salix nigricans* must now become *S. myrsinifolia* and *Dryopteris abbreviata* gives place to *D. oreades*.

The numerous colour photographs, mostly the author's own work, have generally been carefully chosen and are of excellent quality, although a notable exception is the close-up of *Menyanthes trifoliata* on Plate 16. The thistle purporting to be *Cirsium vulgare* on Plate 18 is in fact *C. eriophorum*. The monochrome photographs of montane species by M. C. F. Proctor are of a very high standard, and the knowledge that most of them may also be seen in Raven & Walters' *Mountain flowers* detracts little from our appreciation of their quality. The line drawings, nearly all by Olga Stewart, are deserving of the highest praise both for their botanical accuracy and their aesthetic appeal. Even such 'critical' subjects as the brambles have been tackled with considerable success. It is regrettable that frond silhouettes were chosen to illustrate the distinguishing characters of certain *Asplenium* and *Polypodium* species. The result fails to impress in an artistic sense, and the examples of *P. vulgare* and *P. interjectum* chosen are not typical of the respective species.

Over 300 small maps—eight to a page—indicate the distribution of selected species within the survey area on a 10 km grid basis. It is not easy to link these to the respective species in the 'Flora' section, however, as the latter quotes no grid references. A map of the area at the front of the book is probably unique in showing not only the vice-county boundaries but also the pre- and post-1975 administrative boundaries.

Typographical errors and mis-spelling of names are commendably rare in a work which must have been a proof reader's nightmare. An errata slip is included and the following additional examples may be quoted: '*Potentilla tabernaemontanae*' (p. 35), '*Scirpus tabernaemontanae*' (p. 462), '*Hieracium argentum*' (p. 392), 'Ounstead' for 'Ounsted' (p. 569 and elsewhere), 'Wedgewood' for 'Wedgwood' (p. 570 and elsewhere). The date (1973) has unfortunately been omitted in the reference to the recent discovery of *Phyllodoce caerulea* in Easterness (Beinn Bheoil).

Botanists will certainly find much of value in this Flora, as will those with wider interests. In addition to a section on 'Geology and soils' (contributed by J. H. Gauld of the Macaulay Institute for Soil Research), there are chapters on 'Topography' and 'Climate'. Miss McCallum Webster is to be heartily congratulated for this publication, which is a fitting culmination to her many years of valuable field work in the area. A place will certainly be found for it on many a bookshelf even at the high, if not excessive, price of £15·00.

A. McG. Stirling

Watsonia, **12**, 273–275 (1979).

Obituaries

ROBERT MACKECHNIE
(1902–1978)

Robert Mackechnie died suddenly at his home on 5th April 1978, and Scottish field botany thereby lost an erudite practitioner devoted to thorough and painstaking recording of the occurrence and behaviour of (mainly) vascular plants. He joined the Botanical Society and Exchange Club in 1937 and in 1952 became local secretary, recorder and referee for vice-counties 75, 76 and 77 (Ayr, Renfrew and Lanark). He regarded these responsibilities in terms of 'holding a watching brief' and never contemplated anything as formal as writing a Flora. Of the three vice-counties he wrote on only v.c.77: in the Lanarkshire volume of the *Third statistical account of Scotland*; and in his Presidential Address to the Andersonian Naturalists of Glasgow (Plant recording in Clydesdale, *Glasg. Nat.*, **18**: 3–14).

In 1954 he attended a meeting of the Scottish local secretaries and recorders, and in the following year it was natural that he should be invited to join the recently formed Committee for the Study of the Scottish Flora. Three years later he was asked to fill the vacant Chairmanship of the Committee, and he continued to be so elected annually and, indeed, died in office, although in 1971 he contemplated standing down. He was never really happy in the committee room and only a sense of duty to his friends and colleagues—and the pleasure of meeting some of them—took him there. He will be remembered by the members of the societies as chairman of meetings, where his dry wit could produce some remarkably apposite humorous phraseology, and as a participant in field meetings, where the quiet, bulky, waterproof-clad figure would be constantly accosted with cries of 'What have you got there, Mr Mackechnie?' and where, also, he was at his happiest and at his best, especially in Caricetum. He led meetings for the Committee at Dalmellington 1956, Hunter's Quay 1957, Bute 1958, Unst 1960, Lanark twice in 1962, Perth 1964 and 1975 and, overseas, in Norway 1963 and the Pyrenees 1967.

Very little of his knowledge and wisdom was published, merely the occasional book review, obituary or report of a field meeting. His intimate acquaintance with the botany of many parts of Scotland would have formed the basis of a Scottish volume on the lines of Praeger's *The botanist in Ireland*, a book he much admired; but modesty dictated that he wrote for publication only when requested and, even, persuaded to do so. His expertise was passed on mainly verbally and in letters, and his help in supplying information—usually on the distribution of Scottish plants—is acknowledged in numerous publications.

His name is scattered through the Plant Records sections of the Society's journals during the 1930s, 1940s and 1950s, often in connection with new vice-county records. The first series of records was for 1933 and included his confirmation in 1929 of Don's record of *Ophioglossum vulgatum* for v.c. 90. Two earlier finds, *Glyceria declinata* 1932 and *Veronica filiformis* 1927, were printed later. His last records were *Trifolium micranthum* and *Silybum marianum* from v.c.74 in 1971. His most notable discovery was in 1935, when a puzzling water dock from v.c. 86 turned out to be *Rumex aquaticus*, a species new to Britain. A majority of the records are coupled with the name of E. C. Wallace, reflecting a life-long friendship that began with correspondence in 1926, exchanges of specimens and a series of almost annual botanical trips together in Scotland over a period of some 30 years. His herbarium of some 12,000 carefully pressed and annotated, but mostly unmounted, specimens has recently been presented by his widow to the Royal Botanic Garden, Edinburgh.

Mackechnie hid his light under a bushel. He was the most unaggressive of men and shunned publicity, accepting it only when he became convinced that doing so would help botany and botanists. He seldom expressed his opinions unless they were sought, and hence he could often be silent throughout committee meetings; but under a discerning chairman he would contribute valuably. Recognition (election as Associate of the Linnean Society of London *honoris causa* in 1953 and as Vice-President of our own Society in 1964 and 1966) elated him just as apparent rejection (the vote on the future of the Committee for the Study of the Scottish Flora in 1977) disappointed him; but it was completely in character that he mentioned neither his delight nor his distress unless specifically asked about his reactions. His reply would then be devastatingly honest!

Robert Mackechnie was a teacher by both inclination and training; and he had the admirable, but now old-fashioned, conviction that it was his duty to take infinite pains to help those who at least professed to want to help themselves, but otherwise never to inflict his own interests on others. The number of us whose lives have been immeasurably richer through having known Bob Mackechnie either personally or as a correspondent must be exceedingly large, and if we all attempt to follow his example, his memorial will be as great as it will be appropriate.

B. W. Ribbons

JAMES ROBERT MATTHEWS
(1889–1978)

It is hard to imagine anyone who displayed more fully than J. R. Matthews the best characteristics of a long line of Scottish Professors. As Regius Professor of Botany in the University of Aberdeen for 25 years until his retirement in 1959, his kindly personality and the width of his understanding of the subject made a deep impression on colleagues and students alike. He died in Banchory on April 12th, 1978, and one cannot help reflecting that a link with the botany of Bayley Balfour, Bower, Wright Smith and many others is thereby broken. The subject must move on but the contribution of these men has helped to make it what it is.

Matthews was born and brought up in Perthshire, where the wealth of the flora must have inspired his life-long enthusiasm for Scottish plants. He studied in Edinburgh and for a time joined the staff of the Botany Department at Birkbeck College, London, before returning to Edinburgh. Later, in 1929, he became Professor of Botany in Reading University, which he left in 1934 when he was elected to the Aberdeen Chair. Following the tradition in which he was trained, his interests centred in angiosperm taxonomy; but these were days when a University teacher had to turn his hand to almost every branch of his subject, and in a sense it was this comprehensiveness which was one of his major strengths. He was a student of the British flora at a time when the ecological approach, under the pervading influence of A. G. Tansley, was gaining ground. Although not primarily an ecologist, Matthews was closely associated with this movement in its early days. His attractive study of the vegetation of the White Moss Loch (1914) in his native Perthshire bears witness to this interest in field ecology, which he retained throughout his life. He became a member of the British Ecological Society in its early days, and was elected President in 1934. The preparation of a Presidential Address gave him the opportunity to bring to fruition his thoughts in another, related field—that of the 'Geographical relationships of the British flora'. Few Presidential Addresses have received such wide acclaim, securing as it did a permanent and important place in phytogeographical literature.

It is, however, for his unsurpassed clarity and masterly style of lecturing and teaching that the majority of those who were fortunate enough to have been among his students will remember him. He was proud of the fact that, at the same time as reading for his Edinburgh M. A., he had taken a teacher's training course, and he regarded teaching as the prime duty of the University lecturer. Besides the botany students, many a forester and agriculturalist can pay tribute to the excellence of the example he set, for, true to the Scottish tradition, he invariably took upon himself the entire first-year lecture course. Another of his gifts was that of a great facility of expression through the medium of the written word. His publications are models of scientific writing, and those of us who were able to submit to him our earlier attempts at this art have much to thank him for.

While the University and his Department always had first claim on his attention, many other institutions have cause to be grateful for his wise counsel. As Chairman of Council of Management of the Macaulay Institute for Soil Research, for example, his contribution was of the utmost value during an important period of the Institute's development and expansion. In like manner, he gave invaluable service to the Scottish Horticultural Research Institute; other organizations which benefited from his advice on their Boards of Governors included the North of Scotland College of Agriculture and the Rowett Research Institute. Perhaps, however, it would be for the part he played in promoting the cause of Nature Conservation in Scotland that he might be happiest to be remembered. He contributed to the preparation of the first list of sites for consideration as possible Nature Reserves in Scotland (Cmd. 7235), and was later Chairman of the Scottish Committee of the Nature Conservancy. His untiring efforts in this field were among the many services for which the award of the C.B.E. in 1956 gave due recognition.

In addition, it is fitting to refer to his delight in field botany. He was a member both of the B.S.B.I. and of the Botanical Society of Edinburgh, the latter from his student years onwards. In his younger days he was a keen participant in and leader of its excursions. He took his students into the field and made a point of exposing them to the special appeal of our arctic-alpine flora. Later, when he no longer felt equal to this type of activity, he gave every encouragement to his staff to make field classes an integral part of his Department's activities. It was typical of him that he gave support and encouragement to the Scottish Field Studies Association in its pioneering days, as a member of its Executive Committee (and later Honorary President). He was also instrumental in setting up (and devising the name of, the Committee for the Study of the Scottish Flora—a joint venture of the B.S.B.I. and the Botanical Society of Edinburgh.

Closely related to these concerns was his involvement with horticulture. In addition to its scientific aspects, he was a keen and expert gardener himself. He took his duties as Curator of the Cruickshank Botanic Garden in Aberdeen, which are associated with those of the Regius Chair, very seriously, and under his direction the garden was greatly enhanced, becoming an outstandingly attractive and useful setting for the Botany Department. It gave him great pleasure to be a recipient of the Veitch Memorial Medal in Horticulture, which was indicative of his high standing in this field. Gardening was an interest which remained with him in his retirement as a major source of recreation and relaxation until, sadly, failing health and eyesight deprived him of the pleasure he had derived from it.

This appreciation is written by one who knew him chiefly in his later years at Aberdeen, and a great deal that could be said remains unsaid. In common with a number of others I was launched on my professional career by Professor Matthews. There is much that I owe to him, not least the conviction that despite the modern tendency to fragmentation, the study of plants deserves to remain a broadly based and integrated discipline.

C. H. Gimingham

Reports

VICE-COUNTY RECORDERS' CONFERENCE, BEAMISH HALL, NR STANLEY, CO. DURHAM

9th–12th SEPTEMBER, 1977

INTRODUCTION

This conference drew together in surroundings of great beauty and conditions of great comfort 45 Vice-county Recorders and several local members, who are always welcome on these occasions.

Members from Co. Durham, looking forward with pleasure to being the hosts at this Recorders' Conference, could hardly have anticipated the dual success which the event was to achieve. For not only were the discussions on recognising, recording and describing the British flora most profitable, but the actual recording of the local flora was advanced by a substantial amount.

In the period specifically set aside for recording, twelve new tetrads were fully covered and additions made to six others. The most interesting finds were *Hypericum humifusum* and *Gnaphalium sylvaticum*, both of which are uncommon in the county. Several members from southern counties were agreeably surprised that 200 records could be added in one afternoon to tetrads apparently composed of old pit heaps, dwelling houses and waste ground.

On the final day the 'other half' of Co. Durham was seen at its best as forays were made, in autumnal sunshine, into the Weardale hills. Some of the most exciting records were made by members who left the party early, after promising to record from underworked areas on their respective journeys home. Mr Ballantyne made the only known modern record of *Dianthus deltoides* at Edmundbyers and Dr Corner, who visited the highest point in the county (2452 ft), proved that *Carex bigelowii* could still be found in v.c.66 and added a new lichen, *Parmelia alpicola*, to the Durham list.

FRIDAY, 9TH SEPTEMBER

G. G. Graham. *The flora of Co. Durham*.

The opening paper on the first evening traditionally belongs to the host Recorder, and on this occasion Gordon Graham gave a fascinating account of a fascinating flora, well illustrated with 'tetrad' distribution maps. However, much of what he had to say illuminated the problem of such detailed mapping in a northern under-populated county and there is still much which the short-term visitor from elsewhere can contribute.

SATURDAY, 10TH SEPTEMBER

F. H. Perring. *The future of vascular plant recording in the British Isles*.

The proposed new *Flora of Great Britain and Ireland* (see below) presents a challenge to all B.S.B.I. members, but particularly to Vice-county Recorders. For each taxon described an up-to-date vice-county list and, in most cases, a distribution map will be required. The Flora will include many infraspecific taxa and many established aliens not previously mapped. Thus, over the next ten years there is a need not only to revise the existing maps in the *Atlas of the British flora* and the *Critical supplement*, but to prepare many new ones.

Vice-county records will be coordinated by D. H. Kent in collaboration with J. Bevan (England), G. Ellis (Wales), P. Harrold (Scotland) and M. J. P. Scannell and D. M. Synnott (Ireland).

The maps will be prepared by the Biological Records Centre at Monks Wood at a planned rate of about 200 taxa per annum, and will be based largely on information from Vice-county Recorders, to whom recording forms will be sent annually in the autumn for return one year later. The first forms (for 100 taxa only) will go out in 1979. Besides appearing in the new *Flora* the maps will be published in A4-sized parts, of which the first, *Atlas of ferns of the British Isles*, has already appeared.

F. B. Stubbs. *Plant galls.*
A gall consists of plant tissue in which cells have increased in size or in number through the action of some other living organism. The relationship is almost always parasitic, secretions from the gall agent disturbing the hormone balance of the plant.

Any part of a plant can be affected, and galls have been observed on members of most classes of the vegetable kingdom. The flowering plants, and the dicotyledons in particular, are by far the most susceptible group. Gall agents include insects of several orders, the gall-wasps, gall-midges and aphides offering the most examples. Other invertebrates concerned are the gall-mites and eel-worms. Fungi and bacteria can also be responsible.

The gall is not an organism in its own right, and should be described in relation to both host plant and causative agent. Strictly, each should be identified, but many galls have such clear characteristics in themselves that a confident verdict can normally be offered on that basis. For everyday purposes, the only available work is *Plant galls in colour*, by A. Darlington, illustrated by M. J. D. Hirons (Blandford).

During 1974 a limited survey of plant galls in Yorkshire and Durham gained support, and gave results which indicated that a project on a wider basis was feasible. The B.S.B.I. is now planning such a survey, and details are being discussed.

During the afternoon members chose between gall-hunting around Beamish Hall and tetrad-mapping in the neighbourhood. Members who spent the afternoon in the grounds of Beamish Hall listed 23 galls: at the same time 25 new flowering plants were noted on the Tetrad Card, which had already been quite well covered. This illustrated the point that galls can be noted without sacrificing other work in the field.

A. P. Conolly. *Alien Polygonums.*
Following a brief survey of the salient features distinguishing the four larger species of *Reynoutria* and *Polygonum* naturalized in the British Isles, some problems and complications were described, along with some of the new observations which may help solve some of these problems. These include the characterization of the dwarf variety of *Reynoutria japonica* (var. *compacta*) and the occasional confusion between *R. japonica* and *R. sachalinensis*, which may result from inadequacy of herbarium specimens, because of unusual leaf-shape or size, or even from genuinely anomalous variants. In the consequent search for additional, reliable, diagnostic characters leaf epidermal features are being investigated: *R. sachalinensis* shows marked differences from *R. japonica* in cuticular sculpture of the lower epidermis and alone has multicellular flexuous hairs. For both species inflorescence and floral features of male-sterile and of female-sterile plants were described, as also was the rare occurrence (in *R. sachalinensis*) of polygamy, i.e. apparently male, female and hermaphrodite flowers all on one specimen.

The distinction of the pubescent variant of *P. polystachyum* from hairy-stemmed varieties of *P. molle* was shown to be based on floral characters: size and form of perianth, length of style and form of fruit. Moreover *P. polystachyum* is heterostylous, as is *P. campanulatum*. Difficulties in distinguishing the variants of *P. molle* on the basis of the density and direction of application of the pubescence are still not resolved.

A provisional key to the larger alien species of *Reynoutria* and *Polygonum* was provided.

P. Davis. *The aims, objectives and potential of a Local Records Centre.*
A brief resumé of the historical development of Local Records Centres in Britain was given. The majority of these have been established in Museums, mainly because these establishments have collections with data, historical literature sources, links with local naturalists and national experts, resident biological and geological expertise, contact with statutory and voluntary conservation organisations and, perhaps most important, they are *permanent* establishments of data storage.

An account of the establishment of the North East Environmental Records Centre (NEERC) at Sunderland Museum was followed by an examination of the Centre's Working Document. This identifies the objectives, terms of reference (the standards and procedures followed) and proposed duties of the Records Centre. These were discussed in some detail, with particular reference to recording methods, liaison with other bodies and the problems of confidentiality.

The cooperation between the NEERC and the Durham Flora Project was described. This includes the exchange of data (on completion of the Flora these data will find a permanent and secure home in the Records Centre) and the verification and storage of voucher specimens. The costs of administration (contact with recorders and experts) and materials (cards, herbarium sheets and folders) have been borne by the Records Centre, and it is hoped that finances will be found for the eventual preparation and publication of the Durham Flora.

D. H. Valentine. *Flora of Great Britain and Ireland.*
A new Flora, under this title, has been launched, under the editorship of D. H. Valentine, C. A. Stace and P. D. Sell. Contributions from specialists are being invited.

The aim is to produce a new work on a large scale (five volumes) in which an attempt will be made to produce a new synthesis of existing floristic information, much of which is scattered in the literature and hard to find.

The plan is to describe family and genus, adding in each case explanatory notes on taxonomy and distribution, and to key the species. For each species, the type will be cited when it is known, synonymy given and then a full and careful description. Subspecies, varieties and forms will be named and briefly described. It is intended to include an updated distribution map from the *Atlas* as well as a vice-county list of occurrences. Habitat notes will be as full as possible.

Paragraphs on Reproductive Biology, Variation and Biosystematics, and Hybrids will follow. In these both observational and experimental work will be summarised and references given to important publications.

The *Flora* will deal fully with the apomictic groups such as *Taraxacum*, *Hieracium* and *Rubus*, in which many microspecies have been described. It will also attempt to give adequate descriptions and accounts of the naturalised aliens, of which there are at least 800, as well as the more important crop plants.

SUNDAY, 11TH SEPTEMBER
P. Taschereau. *The genus Atriplex in Britain.*
Problems with *Atriplex* identification and taxonomy centre especially on the coastal members of the *A. hastata* complex. In Britain the complex consists of *A. hastata* (now called *A. prostrata*), *A. glabriuscula*, *A. longipes* and *A. praecox*. In some regions the members of this group are very distinct and, once known, can be readily identified. In other areas individual plants having the characters of more than one taxa are common, as are plants that have some, but not all, the critical taxonomic characters of a particular species.

The following aspects of the *Atriplex* problem were discussed: the taxonomic characters used in distinguishing species; causes of variation; the impossibility of determining much herbarium material further than to the complex; the history of the taxonomic treatment of *Atriplex* in Britain.

On the excursion on Sunday afternoon members first visited the beach north of Sunderland, where Pierre Taschereau was able to demonstrate some of the problems referred to in his paper. *Atriplex prostrata* was present and distinctive by the car park, but the majority of *Atriplex* plants on the beach, though 'close' to *A. glabriuscula*, did not have all the characters of this species, i.e. the bracteoles were thickened to various degrees and their margins united up to various levels, and the seed radicle was obliquely out-pointing to slightly up-curving but not strongly ascending as in typical *A. glabriuscula*.

The second part of the excursion was to Waldridge Fell and was noteworthy for the verification of *Dryopteris carthusiana* and for the raising of the number of *Rubus* species found in the area to 13 as Alan Newton identified *R. fissus*, *R. errabundus* and *R. echinatoides*.

J. Edmonds. *A proposed Black Nightshade Survey.*
One of the most widespread and variable species in the genus *Solanum* (Solanaceae) is the plant known as the Black, Common, or Garden Nightshade, *Solanum nigrum*. The plants generally referred to as *S. nigrum* in fact constitute a number of distinct species, of which six are found in Britain. They are all vigorous weeds of arable land and waste places, although *S. nigrum* sensu stricto is probably the only native representative of this group in Britain, where it is widely distributed in central and southern regions.

Two subspecies of the hexaploid *S. nigrum* are currently recognised, the eglandular-haired subsp. *nigrum*, and the glandular-haired subsp. *schultesii*. Similar, and very considerable, morphological variation characterises both subspecies in that plants may be procumbent, decumbent/ascending or erect; their leaf margins may be entire or lobed; the number of flowers per inflorescence can vary; and the berries may be green, greenish-yellow, brown or purplish-black.

A closely related species is the tetraploid *S. villosum*; this is probably a casual in Britain, but is common in Eurasia and Africa. It differs from *S. nigrum* in having peduncles which are often shorter than the pedicels; fewer flowers per inflorescence (≤ 5); triangular sepals in fruit; and red, orange or yellow berries which are longer than broad. Two subspecies are also recognised in this taxon, the glandular-haired, smooth-stemmed subsp. *villosum* and the eglandular-haired, rough dentate-stemmed *S. villosum* subsp. *alatum*.

A South American diploid frequently found in Britain is *S. sarrachoides*. This is characterised by its light yellowish-green coloration; being covered with dense, spreading, glandular hairs; the strongly accrescent/adherent calyces enclosing at least the lower half of the berry; and the berries containing stone-cells. A variant of *S. sarrachoides* was described by Georg Bitter in 1912 as *S. nitidibaccatum* (see Leslie, A. C., *B.S.B.I. News*, **12**: 13 (1976)) and it is this variant which is most commonly found in Britain. A knowledge of the range of variation exhibited by this taxon would clarify the taxonomic rank at which such variation should be recognised.

The diploid *S. sublobatum* is another species native to South America which is occasionally found as a casual in Britain. This species is characterised by a soft, tomentose, eglandular pubescence; generally having entire and often elliptic leaves; strongly deflexed peduncles, which are leaf-opposed in fruit; and broadly ovoid, dull, purple berries.

Another closely related diploid found in Britain is *S. nodiflorum*; though comparatively rare in Europe, this species is widely distributed throughout the tropical parts of the world. It is distinguishable by its umbellate cymes; tiny flowers with anthers 1–1.5 mm; erecto-patent fruiting pedicels; and globose, shiny, black berries containing small seeds (<1.5 mm).

The final casual which may be found in Britain, usually as an escape from cultivation, is the plant known as the Garden Huckleberry, *S. scabrum* Mill. This is another hexaploid species and is characterised by its prominent dentately-winged stems which are $\pm$ glabrous; simple or branched cymes which are 5-35-flowered; brown anthers; and broadly ovoid, large (15–17 mm) purple berries.

It would be very useful to collect data on the range of morphological variation exhibited by *S. nigrum* sensu stricto, about which very little is known. In particular, it would be interesting to know whether any of the more variable features, especially the indumentum types and berry colours, are associated with specific habitats or definable geographical areas.

D. H. Valentine. *Viola*.

A sketch was given of British members of the genus, their characteristics and some of their problems. In the section *Melanium* (the pansies), which was treated very briefly, cleistogamous flowers are not produced. A special problem of interest is the flower-colour polymorphism of *V. lutea* (from purple through intermediates to yellow), which has never been adequately mapped.

In section *Viola* subsection *Viola*, attention was drawn to *V. calcarea*, a dwarf plant related to *V. hirta*. The status of *V. calcarea* is probably no more than that of a variety, but detailed field investigation of its flowering time, form and habitat is needed. In section *Viola* subsection *Rostratae* (the dog-violets), the distinguishing characters of the six British species were reviewed. Attention was drawn to the hybrids, which are all infertile, and to the way in which the pollen and the abortive cleistogamous flowers can be used in identification.

C. N. Page. *Pteridophyte distributions and recording*.

We now have excellent and critical maps of patterns of pteridophyte distributions in the British Isles. Though these maps answer well the 'what' and 'where' of the problems of plant ranges, there is little information on the underlying causes of these patterns—the 'how' and 'why' of the same problems. It may therefore be timely to begin to make a shift in emphasis, so that pure geographic recording is not the sole aim in the field, but forms a foundation for fundamental ecological data.

We must begin the steady accumulation by recorders of observations on the behaviour and success of species in natural or semi-natural situations throughout their ranges, and especially long-term observations on individual plants or populations. Even fairly elementary observations can be very useful when collected from across a species-range, and can themselves form a basis for more detailed elaboration in due course. The type of information gathered will clearly vary widely with location and experience of the recorder. Experience will, of course, only be gained as efforts to collect this type of information are made, and no recorders should feel inhibited from beginning to make observations in their own areas.

M. Walpole. *Review of local Floras published in the last two years.*
Following Dr Dony's summary of a questionnaire sent out to all Recorders entitled 'Putting a quart into a pint pot', which he gave at the last Recorders' Conference in 1975 (see *Watsonia*, **11**: 174–175 (1976)), and his analysis of what recorders considered should be included in a local Flora, I have looked at seven Floras and analysed their contents under the following five categories: title pages; contents pages; accounts of common species; accounts of rare species; treatment of a critical family. The new Floras selected were those of Guernsey, Surrey, Essex, Middlesex, Herefordshire, Lincolnshire and Sutherland, whilst two 'old' ones, White's *Flora of Bristol* (1912) and Dony's *Flora of Bedfordshire* (1953), have been used as a basis for comparison.

The analysis showed that a good Flora is a combination of many subjects, not only of botanical content, and that it is not necessarily the most fashionable approach which is the most illuminating.

T. Sands. *The future for botanical conservation.*
Whilst working at the Council for Nature and, latterly, with the Society for the Promotion of Nature Conservation on the Conservation of Wild Creatures and Wild Plants Bill, I was disappointed to have to agree to withdraw the clause making it illegal to sell wild plants because we did not have sufficient evidence. It is also disappointing that since the Bill became law in 1975 no successful case involving wild plants has yet come before the courts. In both these situations could not B.S.B.I. members be doing more?

More thought needs to be given to the interpretation, publicity and enforcement of the 1975 Act. Are all landowners now aware that it is illegal for the public to uproot wild plants on their land without permission? With the Schedules of the Act due for revision in 1980 at the latest, has the B.S.B.I. collected all the information on endangered species necessary to advise the Nature Conservancy Council?

The Act does nothing to protect sites of rare species from the main threat, habitat destruction, and it must be obvious that the B.S.B.I. should ensure that planners and Conservation Trusts are aware of all the important sites for plants in each County.

Finally, are we doing enough to educate the general public? The posters already produced by the B.S.B.I. depicting rare species are a start, but are not regional posters for popular areas like the Peak District or Snowdonia also needed? Should they not show quite common, but attractive, species and be aimed at changing people's attitudes to collecting wild flowers, not solely at protecting a few endangered species?

If British botanists are to play an even greater part in nature conservation in the 1980s than they have done hitherto, then there may be a need to expand the Society's structure to include full-time staff capable of undertaking the administration involved. There are several grant-giving bodies which might support such a development. Is the B.S.B.I. prepared to accept the challenge?

L. Farrell & F. H. Perring

ANNUAL GENERAL MEETING, 6th MAY, 1978

The Annual General Meeting of the Society was held in the Linnean Society of London, Burlington House, Piccadilly, London on Saturday, May 6th, 1978 at 12 noon, with 98 members present. Professor D. H. Valentine (President) took the chair.

The minutes of the last Annual General Meeting, as published in *Watsonia* **12**: 59–60 (1978), were passed.

REPORT OF COUNCIL

The Report of Council for the calendar year 1977 had been circulated to members and, proposed by Miss E. Young, seconded by Mrs A. Lee, was adopted by the meeting.

TREASURER'S REPORT AND ACCOUNTS

The excess of expenditure over income of £1,206 was largely due to non-recurring items, but with a general increase in expenditure the Treasurer appealed for a better response to the covenant scheme, by which an increase in subscription rate could be postponed. The Treasurer's Report and Accounts, proposed by Mr J. C. Gardiner, seconded by Dr Y. Heslop-Harrison, were adopted by the meeting. Thanks were recorded to Miss E. Young for dealing with tax covenants; to Mr F. Perring (senior) and Mrs M. Perring for handling publications sales; and to the Hon. Treasurer for his work on the finances and the standing orders for journals for the Society.

ELECTION OF OFFICERS

Mrs M. Briggs (Honorary General Secretary); Mr M. Walpole (Honorary Treasurer); Drs S. M. Coles, G. Halliday, N. K. B. Robson, C. A. Stace and D. L. Wigston (Honorary Editors); Mrs J. M. Mullin (Honorary Meetings Secretary); Miss L. Farrell (Honorary Field Secretary); and Mrs R. M. Hamilton (Honorary Membership Secretary) had been nominated. Their re-election en bloc was proposed by Mr R. J. Pankhurst, seconded by Miss E. M. Conacher and passed unanimously. The Chairman thanked all the officers for their hard work which ensured the smooth running of the Society.

ELECTION OF COUNCIL MEMBERS

Mrs O. M. Stewart, Mr E. D. Wiggins and Dr P. M. Wade had been nominated. Proposed by Mr J. M. Mullin and seconded by Miss J. Martin, they were elected unanimously. Their order of precedence (for Rule 10), as given, was determined by ballot.

ELECTION OF HONORARY MEMBER

Council had nominated Miss M. McC. Webster, and Professor Valentine proposed with pleasure this award to a distinguished field botanist who had helped many members over many years, and was author of the *Flora of Moray, Nairn and East Inverness*. Seconded by Mr E. C. Wallace, the election was carried with warm applause.

REPORT ON B.S.B.I. COMMITTEE FOR SCOTLAND

The councils of the Botanical Society of Edinburgh and of this Society had jointly agreed to formally disband the Committee for the study of the Scottish Flora as from 30th June 1978. Plans for continued liaison between the two societies in Scotland had been agreed and B.S.B.I. members resident in Scotland had elected a Committee for Scotland at a meeting held in Edinburgh on 5th November 1977.

The meeting recorded thanks to all who had served as officers and members of the Committee for the study of the Scottish Flora during the 23 years of its existence, particularly to the late Mr R. Mackechnie who, sadly, had died earlier this year but until then had been Chairman throughout the term of the Committee, and to Mr B. W. Ribbons who had been a founder member and Secretary to the Committee for 15 years.

CHANGES TO THE RULES

The following changes to the Rules were passed:

(a) Rule 28

Any member whose subscription shall be in arrears for five months on the first day of June in any one year shall cease to be a member.

(b) Rule 4

Add: Regional Committees shall report to Council.

(c) Rule 11

Delete: The terms of reference of the Committee for the study of the Scottish Flora as set out in Schedule III.

Add: In Scotland members shall elect the Committee which shall from the Committee appoint the member of the Council for Scotland.

(d) Schedule III

Deleted.

ELECTION OF HONORARY AUDITORS

Messrs Thornton Baker & Co. were unanimously re-elected as Honorary Auditors, and the Honorary General Secretary was instructed to write to them conveying the Society's appreciation and thanks.

ANY OTHER BUSINESS

There being no further business the meeting closed at 12.27.

M. BRIGGS

EXCURSIONS HELD IN CONNECTION WITH THE ANNUAL GENERAL MEETING

On the afternoon of Saturday, May 6th 1978, about 40 members met at the Chelsea Physic Garden and were welcomed by Allen Paterson, the curator. The arrival of the members heralded the first sunshine for many days, and people found it too hot to spend long in the greenhouses. Some of the more interesting species were trees, including the famous 'Willow Pattern Tree' *Koelreuteria paniculata*. The garden at first appears small but on inspection it proves to be full of delight for the inquiring botanist. After looking around for one and a half hours, the party gathered on the lawns for tea.

The following day, May 7th, saw a continuation of the fine weather for the boat trip along the River Thames from Wargrave. 'Pink Champagne' left on a four-hour cruise upstream to Sonning and downstream to Marsh Lock on the outskirts of Henley.

Altogether 60 members took the risk of a ducking, and thoroughly enjoyed being able to see the rare Summer Snowflake or Loddon Lily, *Leucojum aestivum*, in its hundreds, on the Thames islands.

L. FARRELL

MEETING OF MEMBERS RESIDENT IN SCOTLAND 5th NOVEMBER, 1977

A meeting of members resident in Scotland called on Saturday, November 5th, 1977 was held at the Royal Botanic Garden, Edinburgh, at 14.30. Mrs M. Briggs, Hon. General Secretary representing Council, took the Chair.

The business of the meeting was to elect a B.S.B.I. Committee for Scotland. Ten nominations, duly proposed, seconded and accompanied by the agreement of the nominees, had been received. The election en bloc of the ten committee members was proposed by Miss E. P. Beattie, seconded by Dr H. A. P. Ingram, and the candidates were elected with few abstentions and no votes against.

The Chairman, in welcoming the newly elected Committee, also thanked the Committee for the Study of the Scottish Flora for the work carried out for B.S.B.I. members in the past 22 years. In particular thanks were recorded to R. Mackechnie, Hon. Chairman, and B. W. Ribbons, Hon. Secretary of the C.S.S.F. Arrangements were in hand to ensure continuing liaison with the Botanical Society of Edinburgh, and the Autumn Exhibition Meetings would be organized jointly by the two Societies as in past years.

There being no further business from the floor the Chairman thanked members for attending and the meeting closed at 14.42.

M. BRIGGS

FIELD MEETING TO POLAND, 2nd–24th AUGUST, 1976

Eight of the twelve who attended the last of the overseas meetings to be organized by the C.S.S.F. left a Heathrow Airport covered in dried, burnt-up grass after many weeks of drought, and little more than two hours later landed at Warsaw Okecie Airport where the grass was long and green. The following three days were devoted to independent sightseeing in the capital, including a visit to Chopin's birthplace, Zelazowa Wola, a trip on the Wisla and a walk round the Botanic Garden; and botanizing along the shores of the Wisla and on waste ground in the city. *Cannabis sativa* was common in Warsaw and at Zelazowa Wola. Along the river, the North American alien *Sicyos angulatus* (Cucurbitaceae) was naturalized and two species of *Eragrostis* were found. The weed-grasses *Echinochloa crus-galli, Digitaria sanguinalis, Setaria viridis, S. verticillata, S. lutescens* and *Poa palustris*, all rare in Britain, were abundant in all the waste places.

Most of Friday 6th August was taken up with the journey south to Kraków, mostly over rolling agricultural lowlands but latterly over wooded hills. At Kraków Drs Romana Czapik and Maria Reymanówna arranged a delightful and instructive programme of botanizing and sightseeing, including visits to the oldest building of the Jagellonian University, the Collegium Maius, the rocksalt mines at Wieliczka and the Botanic Garden, founded in 1784, which was shown to us by Dr Wanda Sterminska. Dr Czapik and Dr A. Jankun took us to the marshes between Kostrze and Tyniec on the right bank of the Wisla, west of the city. Here *Phragmites australis, Hottonia palustris, Hydrocharis morsus-ranae, Lemna minor, L. polyrhiza* and *L. trisulca* and other familiar plants, grew with *Cirsium canum*, a thistle with swollen root-stocks, and *Arctium tomentosum*. *Trapa* and *Salvinia* were formerly present. Before lunching at a village inn we spent a little time on a limestone hillock where the flora included *Ajuga genevensis, Dianthus carthusianorum, D. deltoides, Trifolium montanum* and *Veronica spicata*. On our last day at Kraków Dr Reymanówna and Mgr B. Zemanek escorted us to a beautiful wooded limestone gorge in the Ojców National Park. Growing with the thistle *Cirsium oleraceum*, by the roadside, two umbellifers, *Chaerophyllum aromaticum* and *C. hirsutum*, caught our attention. In the beech/hornbeam woods, besides many familiar British species, there was an abundance of *Asarum europaeum*, the rose-coloured *Geranium palustre* and the oval-fruited *Lunaria rediviva*, together with *Euonymus verrucosus, Isopyrum thalictroides*, the bicoloured *Melampyrum nemorosum* and the beautiful *Ranunculus lanuginosus*.

A two-hour coach journey on the morning of Tuesday 10th August took us further south to Zakopane which lies at the foot of the Polish Tatra mountains. Excursions were made to the Alpinarium in the town, to Kasprowy Wierch (1985m) by way of Dolina (= valley) Jaworzynka or the cable car via Myslenickie Turnie, the lakes Morskie Oko and Czarny Staw, Dolina za Mnichem, Dolina Roztoki, Hala Piec and Swinica (2300m) in the High Tatra; and to Dolina Chocholowska, Dolina Koscieliska, Giewont (1894m), Kopa Kondracka (2005m) with its granite cap and the ridge Czerwone Wierchy, in the Western Tatra. Dr Jankun accompanied us to the lakes and to Dolina Chocholowska. The Tatras constitute the highest part of the Carpathians and include the granitic High Tatra and the limestone and dolomitic Western Tatra, all within a National Park of some 22,000 hectares. From Zakopane the view to the south reveals the vegetation zones: fir (*Abies alba*) and beech (*Fagus sylvatica*) forest up to *c* 1250m, predominantly spruce (*Picea abies* subsp. *abies*) forest up to *c* 1500m, with dwarf trees in which patches of *Pinus mugo* are conspicuous, up to 1800m. Higher still are meadows and rocks.

On each day we noted a few hundred species of vascular plants and those we saw most frequently were: in the Tatra generally—*Campanula polymorpha, Cystopteris fragilis, Homogyne alpina* forming ground cover in the spruce forest, *Juncus trifidus* common at high altitudes in the granitic areas, *Parnassia palustris*, viviparous *Poa alpina, Polygonum bistorta* common in the high meadows, *Primula elatior, Solidago virgaurea, Stellaria nemorum, Swertia perennis, Thymus pulegioides, Vaccinium myrtillus* and *Viola biflora*; in the High Tatra—*Campanula alpina, Cicerbita alpina, Gnaphalium supinum, Lycopodium annotinum, L. selago, Pinus mugo, Vaccinium uliginosum* and *V. vitis-idaea*; and in the Western Tatra—*Pedicularis verticillata* and *Phyteuma orbiculare*. Some species we saw in one locality only in the Tatra: *Aster alpinus, Anthoxanthum odoratum, Cardamine trifolia, Carex demissa, Centaurea jacea, Equisetum palustre, E. sylvaticum, Filipendula vulgaris, Galium uliginosum, Holcus lanatus, Hesperis matronalis, Leucanthemum vulgare, Lychnis flos-cuculi, Lysimachia nummularia, Maianthemum bifolium, Potentilla anserina, Pyrola minor* and *Salix purpurea* (all in the foothills 950–1300m between Dolina Bystrej and Dolina Biatego); *Galium anisophyllon, Hieracium caespitosum, Linaria vulgaris, Pedicularis palustris, Pinus cembra, Salvia glutinosa, Saxifraga bryoides* and *Thelypteris limbosperma* (all at Dolina Rybiego Potoku and Morskie Oko); *Agrostis rupestris, Athyrium distentifolium, Angelica archangelica, Betula pendula, Carex echinata, Cytisus scoparius, Eriophorum angustifolium, E. vaginatum, Helictotrichon versicolor, Hieracium* sect. *Alpestria, Hypericum tetrapterum, Juncus filiformis, Lilium martagon, Pedicularis oederi, Pyrola rotundifolia* and *Rumex acetosella* (all in Dolina Roztoki); *Arenaria serpyllifolia, Cirsium arvense, C.*

vulgare, Dianthus superbus, Luzula pilosa, Polygonum hydropiper, Sagina procumbens, Silene pusilla and *Veronica beccabunga* (all in Dolina Chocholowska); *Aegopodium podagraria, Agropyron caninum, A. repens, Alnus viridis* (introduced; like *Rhododendron*, it is absent from the Tatra), *Alopecurus pratensis, Caltha palustris, Campanula patula, Carex ornithopoda, Chenopodium bonus-henricus, Equisetum arvense, Festuca ovina, F. pratensis, Filipendula ulmaria, Geranium phaeum, Geum rivale, Gypsophila repens, Lolium perenne, Melica nutans, Milium effusum, Moehringia muscosa, M. trinervia, Poa trivialis, Polypodium vulgare, Polystichum aculeatum, Ribes uva-crispa, Rosa pendulina, Rumex crispus, R. obtusifolius, Salix silesiaca, Sedum telephium* subsp. *fabaria, Sinapis arvensis, Stachys sylvatica, Stellaria media, Trifolium badium* and *Vicia sepium* (all in Dolina Koscieliska); *Bupleurum falcatum, Epilobium alpestre, Hieracium villosum* group, *Moneses uniflora, Salix alpina, Saxifraga oppositifolia, Sesleria caerulea* and *Veronica fruiticans* (all on Giewont); *Carex frigida, Gentiana verna, Hedysarum hedysaroides, Helianthemum nummularium* subsp. *grandiflorum, Thymus pulcherrimus* and *Trollius europaeus* subsp. *transsilvanicus* (all on Kopa Kondracka).

Space does not permit descriptions of each excursion but reference may usefully be made to *The Polish Tatra Mountains* by G. E. Barrett in the *Quarterly Bulletin of the Alpine Garden Society*, **44**: 20–33 (1976). The high ridge path roughly following the boundary between Czechoslovakia and Poland at heights of 1800–2100m afforded a particularly glorious walk with breathtaking views into both countries. Here we found two of the very few plants of the Tatra which occur in the Arctic (*Dryas octopetala* and *Salix herbacea*), together with many colourful plants normally found on the high mountains of Europe. The descent from Matotaczniak by a path which was steep and rough in places had, unfortunately, to be hurried but in the rich limestone flora we noted *Ranunculus platanifolius, Delphinium elatum* and the west-Carpathian endemic *D. oxysepalum*.

On Tuesday, 17th August Mgr Zemanek and Dr R. Ochyra accompanied us to the Babia Góra National Park, 60km west from Zakopane in the West Beskid Mountains. We got to the summit of Djablak (1725m) and were able to set foot in Czechoslovakia, in which country the southern slopes of the mountain lie. This sandstone area, like the Tatra, had successively forest of beech, pine and spruce, dwarf mountain pine, montane meadows and a boulder-covered top. Before emerging on to the *Pinus mugo* slopes we walked through a short steep valley covered with *Doronicum austriacum* under *Acer pseudoplatanus* and *Sorbus aucuparia* trees. On the rocks above alongside the steep path grew *Saxifraga aizoon, Sedum telephium* subsp. *fabaria. Ranunculus oreophilus*, the beautiful magenta *Campanula patula* and fruiting *Pulsatilla alba. Luzula spadicea* was abundant at the summit. In addition we saw for the first time *Anemone narcissiflora, Carex bigelowii* and *C. leporina, Euphorbia cyparissias, Laserpitium archangelica, Petasites kablikianus, Polystichum braunii, Ranunculus auricomus* and *Senecio subalpinus*. Our route was by the "blue" path from Lipnicka to the tourist hostel on Markowe Szczawiny and from there by the "yellow" path to the summit and the "red" path down to the starting point.

Our second botanizing trip away from the Tatras was on 20th August to the Pieniny National Park, where we also attained the highest summit, Trzy Korony (982m). Dr Elźbieta Kotejowa travelled from Kraków to meet us at Nowy Targ and to accompany us through the magnificent Jurassic limestone of wooded valleys with precipitous rocks above. Our route was the "yellow" path from Sromowce-Nizne to Chwala Bogu, the "blue" one from there to the summit, thence descending by the "green" route via Polana Ligarki. On the cliffs in the narrow valley at the beginning, and also at the summit, *Alyssum saxatile* was growing as a native plant and in the high meadows near Chwala Bogu fruiting *Laserpitium latifolium* was a striking sight. Our list for the day contained some 300 species and, naturally, included nearly all the species we saw in the Western Tatra together with *Cardamine bulbifera, Ononis arvensis* and *Stachys alpina* (all at Babia Góra also), *Actaea spicata, Clinopodium vulgare, Galeopsis pubescens, Lathyrus vernus, Lunaria rediviva* and *Mentha longifolia* (all at Ojców also) and the subendemic *Symphytum cordatum*.

It is with great pleasure that I record thanks to the botanists who spent time with us in the field and to Drs Czapik and Reymanówna also for the help and advice during the planning of our visit. Mr and Mrs G. E. Barrett generously allowed me to draw freely upon their experience gained from a visit to Zakopane in 1975. The organization of the Polish National Parks greatly impressed us. The strict rules about not leaving the (usually roughly paved) paths and no picking of plants enable large numbers of visitors to walk into all parts without causing damage to the substratum or to the flora. Edelweiss flowered happily beside paths walked over by hundreds of tourists!

B. W. Ribbons

FIELD MEETINGS, 1977

ENGLAND

CAMBRIDGESHIRE. JULY 31ST

A party consisting of 40 members and their guests began the day of studying the established aliens in Cambridgeshire with a tour around two of the chalk pits at Cherry Hinton, famous for their alien and native plants. *Lonicera caprifolium*, first noted here in 1763, was in fine fruit and is evidently more frequent in these pits than is generally supposed. The Russian *Dipsacus strigosus*, first collected here in 1828 (as *D. pilosus*), was just opening its greenish-white corollas (those of *D. pilosus* are more creamy-white). Other well established aliens included *Falcaria vulgaris* (first recorded at this site in 1949) and *Solidago gigantea* subsp. *serotina* (1958), whilst *Alyssum saxatile* (1973) and the North American *Rhus typhina* (1973) are relative newcomers, showing signs of persistence. After lunch in Cherry Hinton Close the party moved to the Teversham by-pass. Here *Verbascum speciosum* (1976) was growing with another as yet unidentified *Verbascum* species. A third mullein, the Caucasian *V. pyramidatum* (1975), was found well established on waste ground by an old railway track at Fordham. Putative hybrids with *V. thapsus* (also present) weie noted, probably the first British record of this combination.

At Swaffham Prior the last flowers of the south-eastern European *Symphytum tauricum* (1973) showed how similar this is to *S. orientale*, whilst the new by-pass and the adjacent cornfields yielded a host of alien and native plants. These included *Centaurea cyanus* and *Sanguisorba minor* subsp. *muricata;* the latter can be seen firmly entrenched on several road-verges around Cambridge.

Beside the Burwell end of the Devil's Dyke *Agrostemma githago* persists in the corner of a cornfield where it is maintained by the farmer who originally sowed it here (and in a few neighbouring field borders) using locally collected seed. At the Newmarket end of the Dyke the rosettes of *Bunias orientalis* (1954) were all that could be seen, since the regular mowing by the Jockey Club generally prevents flowering.

A few miles to the south, in woodland around the margin of a large estate at Stetchworth, a very big stand of *Doronicum pardalianches* was noted; the late owner knew the plant in this area for over 70 years. On the road home close to the Gogmagog golf course the last stop was by the 'N.R.' post which marks the solitary clump of *Beta trigyna* (1945). This plant has increased only in size over 32 years at this site, but one small seedling was noticed this year in the mown grass at the base of the parent plant.

A. C. LESLIE

LEICESTERSHIRE. AUGUST 20TH

22 members and friends took part in this meeting to study the elms of eastern and southern Leicestershire with the assistance of Dr R. Melville from Kew. In the morning the country to the north-west of Lutterworth around Ullesthorpe, Ashby Parva and Dunton Bassett was covered. Here *Ulmus procera* Salisb. (abundant), *U. glabra* Huds. (fairly frequent) and *U. coritana* Melville (frequent) are the species present, as well as numerous intermediates (putative hybrids) between *U. glabra* and the smooth-leaved *U. coritana* and a number between *U. procera* and *U. coritana*. Dr Melville also pointed out a number of trees in which characters of *U. plotii* Druce were evident. Good specimens of *U. coritana* were found only about a mile from the type locality (from which it has now gone).

After lunch above the Grand Union Canal at Smeeton Westerby the area to the east of Leicester, from Kibworth Harcourt to Launde and Lowesby, was investigated. Here *U. procera* is less common and *U. glabra* more so, and among the smooth-leaved elms *U. plotii* takes over from *U. coritana* as the predominant taxon. Excellent specimens of *U. plotii* were seen in two areas near Lowesby, giving a very characteristic shape to the scenery. Many of the elms seen after lunch were difficult to identify, apparently combining the characters of *U. glabra, U. coritana* and *U. plotii* in a complex pattern of combinations. The binomials *U. elegantissima* Horwood and *U. diversifolia* Melville belong to this assemblage, but no trees close to typical representatives of either of these were seen, despite careful searching for the former in its type locality at Launde.

The day provided a good introduction to the complexities of the genus and to the structure of the elm population of Leicestershire, from which *U. carpinifolia* Gled. is almost and *U. angustifolia* (Weston) Weston totally absent. Unfortunately Dutch Elm Disease, so evident during the excursion, is still rampant in the East Midlands, and many of the trees studied on August 20th were dead by the autumn.

C. A. STACE

WALES

NEWPORT, MON. SEPTEMBER 24TH

A dismal weather forecast reduced an anticipated turnout to Newport rubbish tip and docks to 21 members. The downpour of the first 15 minutes fortunately did not persist and an interested party were seen comparing the yellow to coppery awns of *Setaria glauca* and the whitish ones of *S. viridis*. *Chenopodium* species were very common, mainly *C. album* but tinges of red picked out frequent plants of *C. rubrum* and *C. polyspermum*. The smooth nettle-shaped leaves and upright growth of *C. rubrum* separated it from the more prostrate growth and blackish seeds of *C. polyspermum*. The long narrow leaves of *C. ficifolium* have two lobes near the petiole and its upright growth set it apart from the others. At a distant part of the tip a bulldozer had scraped all but one of the *C. glaucum* plants out of existence, but the remaining plant was a good specimen and the leaves were turned over to explain its name. An unexamined part of the tip was next inspected and proved fruitful. *Hyoscyamus niger*, very rare in Gwent, bore two blooms of dark-veined, tawny-yellow petals. A small bushy plant with bright red flowers borne in the axils of its linear bracts, which themselves are smaller copies of its leaves, was making its first known appearance on the tip. Its distinctive calyx and epicalyx identified it as *Lythrum junceum*. A prostrate *Amaranthus* with smallish leaves and mostly axillary flowers had numerous branches which grew outwards in all directions to make a large rosette. Eric Clement has identified it as *Amaranthus standleyanus*, an adventive from Argentina. Several large grasses were examined; these included *Sorghum halepense, Echinochloa crus-galli* and *E. utilis*. The orange petals still protruded from among the prickly involucre of *Carthamus tinctorius*, giving the party a better idea of this Composite which is used for dyeing, than did the dried up specimen previously found. Though at their best in July, two large spreading plants of *Vicia villosa* subsp. *villosa* still displayed plenty of their large *V. cracca*-like blooms, though the flowers of these plants had white wings. To many, the single plant of the fragrant *Origanum marjorana* made their day. Apart from the fragrance that lingers on the fingers for five minutes or more, the tiny white flowers emerging from the little 'balls' of bracts are quite distinctive. After looking at *Artemisia biennis*, *Lagurus ovatus, Poa compressa* (not common now in Gwent) and some poor plants of *Verbascum phlomoides*, poor at least compared with the seven-foot specimens of 1976, the party returned to the cars and lunch.

Heavy rain kept everyone in their cars, but soon after the afternoon session got under way the skies cleared again. On railway ballast near the entrance to the docks *Achillea ligustica* was examined and, though it flowers earlier than common yarrow, some flowers were found; they are greener and the leaves are larger and much more finely divided. *Hieracium maculatum* and *Scrophularia scorodonia* were past their best. Also past its best, though some flowers were soon found, was *Rhynchosinapis cheiranthos*. A water-filled hollow surrounded by *Polypogon monspeliensis* in all stages, including germinating seeds still in the heads resting on the wet mud, had photographers busy. While walking to the dock's marsh, people remarked on the predominance on the tip of *Hirschfeldia incana*. *Reseda alba* thrives where the ground is disturbed and like *A. ligustica* and *S. scorodonia* has been present for more than 30 years. Expressions of appreciation arose as the marsh revealed its treasures: *Centaurium pulchellum, Cyperus longus, C. eragrostis, Anaphalis margaritacea, Carex divisa, Juncus subnodulosus, Trifolium resupinatum* and the pervading *Scirpus holoschoenus*.

Adrian Grenfell noticed *Linaria vulgaris* and *L. repens* on the way out to the main gates and a quick search discovered *L.* × *sepium*. He and Bob Cropper returned to the tip with the leader to photograph the *Lythrum* and together found two plants of *Eryngium planum* and one of *Guizotia abyssinica*.

T. G. EVANS

SCOTLAND

KINROSS-SHIRE, FIFE. JUNE 18TH

This outing was attended by a coach-load of 46 members of Kirkcaldy Naturalists' Society who, in a last-minute arrangement, were joined by a party of 18 from Edinburgh Natural History Society. The purpose was to tour the small county of Kinross and to observe a few of the plants listed in the leader's recently published checklist *Wild flowers of Kinross*.

The schedule was a tight one and allowed halts of only a short duration. The first visit was to the south shore of Loch Leven N.N.R., where, in a marsh, there flourished *Menyanthes trifoliata, Crepis paludosa, Dactylorhiza incarnata* and *Briza media*. The wooded gorge at Rumbling Bridge forming the Perth/Kinross boundary was an attractive scene, but impossible to explore with such a large party.

In the Ochils, a stop in upper Glen Dey brought *Meum athamanticum* and, by the burn, good stands of *Geranium sylvaticum, Rumex alpinus* and a few interesting plants of *Mimulus*. Scotlandwell yielded little other than bracing liquid refreshment, but along the road at Arnot Tower some naturalized species were admired, including large colonies of *Arum maculatum*.

As a result of this and a later excursion with the Perthshire Society of Natural Science, the following additions and emendations should be made to the checklist (those described as 'new' are not mentioned in it): *Allium paradoxum* (new — near Cleish), *Arenaria balearica* (new — Arnot Tower), *Agropyron caninum* (new — Rumbling Bridge and Cauldron Linn), *Brachypodium sylvaticum* (Cauldron Linn), *Bromus ramosus* (Cauldron Linn), *Carex remota* (Cauldron Linn), *Melica uniflora* (Rumbling Bridge), *Milium effusum* (new—near Cauldron Linn), *Populus tremula* (Powmill, planted) and *Rubus saxatilis* (Cauldron Linn). In addition, an unusual *Acer* at Rumbling Bridge belonging to the *A. cappadocicum* group was the subject of some discussion.

G. H. Ballantyne

MELROSE, SELKIRK AND ROXBURGH. JUNE 26TH–JULY 1ST

The object of the meeting was to record in areas of Selkirk and Roxburgh, vice-counties 79 and 80, unknown to the recorder. The first day was spent by the banks of the Tweed and Ettrick in v.c. 79 with a brief incursion over the Gala Water into v.c. 80 to see some wool-aliens. Upstream from Galafoot *Rumex longifolius* was a first localized record for v.c. 79. It was seen again on the Ettrick below Selkirk in the company of the probable hybrid *R.* × *arnottii*, new to the vice-county. Above Galafoot the first localized records for v.c. 79 for the following species were made: *Papaver dubium, P. rhoeas, Rorippa islandica, R. sylvestris, Euphorbia helioscopia, E. peplus* and *Carduus nutans*. No *Symphytum officinale* was seen, all plants being *S.* × *uplandicum*. On the north side of the Ettrick at Selkirk there was a large colony of *Cirsium heterophyllum* and at the river's edge that menace of many river banks, *Heracleum mantegazzianum*, was well established.

On Monday Stantling Craig reservoir in v.c. 79 was visited in the morning. Apart from an abundance of *Chara* sp. demonstrated by Alan Silverside's grab, there were no aquatics of interest. *Mimulus luteus* was common by the burn running into the reservoir and *Hieracium sparsifolium* grew on a rocky bluff by the outflow. In the afternoon Bowhill near Selkirk, also in v.c. 79, produced *Poa chaixii* and *Festuca heterophylla* as first post-1930 records and *Luzula luzuloides* as a first record. The Upper Loch was species-poor but the Lower Loch contained *Nuphar lutea, Typha latifolia* and *Schoenoplectus lacustris*, with *Apium inundatum* abundant although easily overlooked in a fen community at the northern end (second vice-county record). Late in the afternoon a foray was made to see *Trientalis europaea* (known for over a century), passing on the way the only site for *Myrica gale*. I am indebted to Arthur Smith of Selkirk for showing me these localities on a previous occasion.

Tuesday saw the party en route for Monteviot estate in v.c. 80. In the oak wood by Perch Pond *Poa chaixii* was the dominant species of the woodland floor. *Luzula luzuloides* and *Festuca heterophylla* (first records) also occurred locally with fine clumps of *Carex muricata* and *C. sylvatica*. The pond contained *Potamogeton berchtoldii* and *P. obtusifolius*. The policies of the house supported many exotics. Of interest was the large stand of *Polygonum sachalinense* (first record) near the riverbank, with *Milium effusum* and *Allium carinatum* near the dovecot. Blackrigg Plantation Moss was disappointing, with a large central drainage channel giving rise to the anomaly of *Potentilla palustris* and *Urtica dioica* as associates. An artificial pool was choked with *Myriophyllum spicatum*.

On the next day reservoirs in the Hawick area of v.c. 80 were examined. Near Williestruther Loch good *Salix phylicifolia* occurred in a roadside fen. The loch itself produced the third vice-county record for *Ceratophyllum demersum* and an abundance of tadpoles. Acreknowe reservoir was singularly uninteresting, but the abandoned army camp of Stobs with its loch and two ponds constructed during the first world war had more variety. The ponds contained much *Potamogeton alpinus, Hippuris vulgaris* and a floating-leaved, non-flowering *Sparganium* sp.; the loch *Potamogeton berchtoldii* and *Myriophyllum alterniflorum*. A mire on the watershed presented a nice ecological picture with islands of

Sphagnum (six species) surrounded by *Potamogeton polygonifolius, Menyanthes* and *Carex diandra*. The search for *Cryptogramma crispa* on Penchrise Pen (1438′) was unsuccessful.

On Thursday the attempt to refind *Linnaea* on Wooden Hill (651′) was also unsuccessful but at least 100 immature spikes of *Goodyera repens* were seen with the handsome feather moss *Ptilium crista-castrensis* in the pine wood. In nearby Wooden Glen *Polystichum setiferum* was doing well and at the ruins of Roxburgh Castle we saw *Ballota nigra*, which has been known from there for at least 150 years.

On the final morning Troney Hill (755′) near Minto was visited. *Myosotis ramosissima* grew on the heavily grazed summit. The basic agglomerate crag on the north-eastern side had little of interest apart from *Saxifraga granulata*, which had survived the previous summer's drought. Malcolms Moss to the south-west more than compensated for the morning's dullness. *Listera cordata* was found in abundance growing from a carpet of *Sphagnum recurvum* and diffuse *Juncus acutiflorus* under birch, and two small colonies of *Goodyera repens* grew on *Sphagnum* hummocks with *Vaccinium myrtillus*. To finish the day, the dry basaltic rocks of Chesters Craigs produced *Carex muricata, Koeleria cristata, Myosotis ramosissima* and *Senecio viscosus*. An unusual species of this 'natural' habitat was *Draba muralis*. It seemed that *Dianthus deltoides*, reliably recorded in the last century, was extinct.

Although the week had been poorly attended, a number of good records were made and the overall picture of plant distribution for the area was improved.

R. W. M. Corner

NEWTON STEWART, WIGTOWN AND KIRKCUDBRIGHT. JULY 8TH–15TH

On the Friday evening members were introduced to one another and briefed in the well-equipped biology laboratory of the Douglas Ewart School, our regular venue throughout the week. Aims and features of the field meeting were explained; under-recorded 10km squares in vice-counties 73 and 74 had been identified and were to be visited, special attention being paid to those habitats whose characteristic species were missing from the composite lists (more noticeable for v.c. 74 than for v.c. 73); recording at the quadrant level (i.e. 5 × 5km square) was desired and post–1930 records for many species were sought. It was intended that visitors to Galloway should experience the range of habitats available.

The following morning a large party proceeded to the military experimental range to the east of Kirkcudbright in v.c. 73 where special access arrangements had been made. Three independent groups recorded in squares 25/64 and 74 where shingle, rocky cliffs and turf on Carboniferous rocks provided a range of habitats. *Glaucium flavum* and *Crambe maritima* still grow in profusion in Mullock Bay and it was nice that *Vicia lutea* was seen again in the same locality where Dr Milne-Redhead found it in 1958. *Erinus alpinus* is spreading in the district and was seen on walls at Balmae. *Polygonum nodosum* was found on a damp track and became the first new vice-county record; one plant of *Anacamptis pyramidalis* confirmed an old record in McAndrew's list of 1882. 12 additions were made to the three quadrants 25/64SE, 74SW and 74NW.

On Sunday 13 people worked the squares 25/47 and 57 in v.c. 73, which provided examples of typical mid-altitude Galloway moorland. Some ascended the Grey Mare's Tail burn, noting well-established *Cotoneaster simonsii* and delighting in *Vicia orobus* and *Rubus saxatilis*. Those who penetrated Tonderghie Burn discovered a flush supporting *Cirsium heterophyllum*, a scarce plant in v.c. 73. Eight additions were made to the quadrant 25/47SE including the hybrid *Epilobium adenocaulon* × *E. montanum*, with both parents present in the vicinity. A smaller, less energetic party explored the shores of Clatteringshaws Loch, adding four records to the quadrant 25/57NE, including *Juncus tenuis*.

By kind permission of the Stair Estates members were able to record in open water and wetland habitats and in the grounds of Castle Kennedy in v.c. 74 on the Monday. Five different groups circumnavigated the Black and White Lochs, took to the water in a rubber dinghy, landing on islands and probing the depths, visited the gardens, or pioneered in the nearby Auchrochar Wetlands, a complex of *Carex, Juncus, Typha* and *Salix* communities. The impressive number of additions to the composite card for 25/16 totalled 108 and included new vice-county records for the introductions/escapes *Linaria purpurea, Reynoutria sachalinensis* and *Chenopodium polyspermum* and confirmation of pre-1930 records for *Elatine hexandra* and *Anagallis minima*.

Division of labour characterized Tuesday's work in woodland and moorland habitats in squares 25/55 and 56, v.c. 73. A small party walked the Corse O'Slakes road from Creetown to Skyre Burn adding only five species to 25/55NW. Another party explored Skyre Burn itself while eight members went up to Gatehouse of Fleet station, working 25/56SE and SW. Most additional records were from the disused railway track. *Dryopteris abbreviata* and *Anagallis minima* were second records while *Chenopodium polyspermum* and *Dactylorhiza maculata* × *Gymnadenia conopsea* were new vice-county records. En route for Newton Stewart the party stopped to see *Lathyrus sylvestris*, added eight records to 25/45SE and saw five species of *Sedum* growing together. The tale of 'the curious thistle' was then investigated—on waste ground near the shore recently deep-dug and planted with potatoes. In 1976 five plants of milk thistle, *Silybum marianum*, appeared and this year two; the only previous record for the species in v.c. 73 was by G. T. West in 1905 at exactly the same locality—an amazing example of the long viability of seed.

Back in v.c. 74 on Wednesday three parties explored wooded burns on the eastern side of Loch Ryan and another the shoreline of the inlet, all in 25/06. Only the Claddy House Burn contained remnants of semi-natural woodland but the moorland above was less modified. Nevertheless, 76 species were added to the card total. A loner began a composite card for the seven 1km squares in 25/07 while a splinter group worked the under-recorded square 25/26, adding 62 records including first ones for *Dryopteris abbreviata* and *Bromus* × *pseudothominii*.

Thursday was spent on the magnificent Machars coast in v.c. 74. In the morning recording in squares 25/45 and 46 on the saltmarsh by Grange of Cree and Baldoon produced first vice-county records for *Spartina* sp., *Parapholis strigosa* and *Puccinellia distans*. Later the west coast shingle yielded *Glaucium flavum*, *Vicia sylvatica* and *Malva moschata* in profusion and *Mertensia maritima* near its southern limits of distribution, while at Monreith Bay the sandy substrate supported typically *Calystegia soldanella*, *Eryngium maritimum* and *Euphorbia paralias*—a northern limit reached on the Solway shore. 32 additions were made to the square 25/34, including *Tragopogon pratensis*, a new vice-county record.

The final day of the meeting saw the party divide into two. Those remaining in v.c. 74 added 17 records to the card for 25/37 by exploring the gorge of the River Cree at Bargrennan and wetlands at Glenhapple. Those in v.c. 73 visited briefly the famous *Linum anglicum* site at Brighouse, where signs of human interference caused concern, and Ross Bay, hoping (but failing) to substantiate another old record for *Anacamptis pyramidalis*. On the shores of the River Dee at Crossmichael in 25/67NE the search for *Nuphar pumila* went unrewarded, but *Nuphar* × *spennerana* and *N. lutea* were seen and impressive carpets of *Pilularia globulifera* with *Subularia aquatica*, *Elatine hexandra*, *Baldellia ranunculoides* and *Eleocharis acicularis*.

As vice-county recorders we knew the week to be most successful. In addition true summer weather had blessed every day. We appreciated the participation of local botanists, the fresh outlook of those from further north or south and the support and interest of Dr Garry Fry of the Nature Conservancy Council and Dr Peter Hopkins of the Scottish Wildlife Trust.

J. Martin & O. Stewart

GLEN NEVIS, WESTERNESS. JULY 17TH

The object of the meeting was to visit a small outcrop and lochan at about 2,000ft on the north-western face of Stob Bhan. Here a narrow cleft up the almost sheer face has relatively neutral soil (pH 6·4), whereas lower down the slope the soil is slightly more acid (pH 5·8) and the area is strewn with boulders.

The species found confirmed the abrupt change in acidity in line with the cleft in the rock-face. The day's efforts added a further 60 species to the quadrant's records. Many plants indicating both acid and calcareous soils were found in close proximity, including *Asplenium viride*, *Botrychium lunaria*, *Cardaminopsis petraea*, *Carex atrata*, *Coeloglossum viride*, *Eleocharis pauciflora*, *Loiseleuria procumbens*, *Polystichum lonchitis*, *Rubus saxatilis*, *Saussurea alpina* and *Trollius europaeus*.

J. A. S. Newman

KINDROGAN, E. PERTH. AUGUST 10TH–17TH

The week was spent exploring some of the richer parts of vice-counties 88, 89 and 90, concentrating on the true water plants (especially *Potamogeton* species) but also including the more interesting species of stream and lochsides. The objects of the meeting were firstly to help members unfamiliar with the area to identify aquatic species, and secondly to study the ecology. Mapping was not of prime importance as this part of Scotland has already been fairly well mapped, but quite a number of plants were added to the squares.

11th August. Since many members had recently travelled long distances our walks were confined to the wetlands near Kindrogan (37/06), especially the Brerachan Water with its many ox-bows. Although the beautiful display of summer flowers (including much *Trollius*) was over, a number of plants were seen (the record card for the day reached at least 225 species). Most interesting were *Potamogeton alpinus, Carex vesicaria* and *Salix nigricans*. There was also *Callitriche hamulata* and the inevitable *Myriophyllum alterniflorum* which continued to give us trouble for some days as members tried to make it *M. spicatum*. These plants belonged mainly to the mesotrophic group. Incidentally, *Epilobium adenocaulon* by the drive was shown to those who had not already seen it.

12th August. Today we were more ambitious and visited the rich chain of lochs between Dunkeld and Blairgowrie. *Isoetes lacustris* was refound in the Loch of Lowes Reserve (37/04), also several Potamogetons including *P. obtusifolius, P. berchtoldii* and *P. pusillus. Rumex longifolius* × *R. obtusifolius*, common in the area, was noted near the shore. *Subularia* was still in flower, and *Eleocharis acicularis* thriving to such an extent that one creeping stem examined measured 20 cm. By far the best find of the day was *Elatine hexandra*, new to the Reserve. Soon afterwards, another piece was discovered, washed up in another part of the same shore. Continuing to Clunie Loch (37/14), *Najas flexilis* (so carefully noted and hedged in with rocks by the leader a few days before) was found to have floated away, but owing to our persistence it was refound not far away. Plenty of *Zannichellia* was seen in fruit along with the usual Potamogetons. There was just time for a quick dash to Marlee (Drumellie) Loch (37/14), where *Potamogeton* × *nitens* was shown along with the parents. One may add that *Callitriche hermaphroditica* was conspicuous in all these lochs, usually fruiting abundantly, and *Littorella* locally common, still in flower on muddy margins.

13th August. Today we went west to the Tummel area, spending the day in 37/75. Loch Kinardochy proved disappointing and we pressed on to the base-rich Lochan an Daim. First we explored the margin, refinding *Utricularia intermedia* and *U. neglecta* (going through the usual agonies of indecision regarding the latter as it was sterile, but finally deciding on vegetative characters that it really was *U. neglecta*). We then proceeded to the well-known limestone pavement. Our most rewarding find (already known from the locality) was *Juncus alpinoarticulatus* in mires. Especially interesting is that it was discovered in what appears to be a new locality not far from the road. Earlier, we visited a limestone quarry, where the party set about counting the plants of *Gentianella amarella* subsp. *druceana* (which at the time of Dandy's list was included in subsp. *septentrionalis*). Owing to the very dry season, perhaps, this plant was not producing many flowering stems. We finished with a short visit to Loch Tummel where time only allowed us to enjoy refinding *Pilularia* and *Isoetes lacustris*.

14th August. We spent most of our time at Loch Moraig (27/96) near Blair Atholl, and it was disappointing to find, besides the usual Potamogetons which came in masses on our drags, that there was nothing more interesting to report than *Carex vesicaria* among the usual quantities of *C. rostrata*, and a number of colonies of *Viola tricolor* together with *V. lutea*, mostly the yellow and purple forms. It did not take long to find some almost certain hybrids (**herb. U.K.D.**), but these will be checked by an expert. Finally we returned to 37/16 where we drove to the lochs near Ashintully by Kirkmichael. It was disappointing to find that the robust *Utricularia vulgaris* agg. in a pool with much *Hippuris* could not be determined as the hoped-for subsp. *vulgaris* (so rare in the northern part of Scotland) in the absence of flowers, though microscopic examination of the vegetative characters in the laboratory appeared to indicate that it was so.

15th August. We spent the morning in Forfar (Angus) walking round the picturesque loch by Drumore, Blacklunans (37/16). Our prime objective was *Potamogeton praelongus* and a number of plants were blown up on the shore or brought in by our drags. Secondly we wanted to see the numerous fruiting plants of *P. filiformis* which grew close into the shore in various places. Nearby among boulders we found *Dryopteris carthusiana* × *D. dilatata* (**herb. U.K. D.**), which I believe was new to most of us and probably a first record for Angus. We made a short stop at the old Bridge of Brewlands for *Ceterach*, which has covered part of the bridge with surprising speed since its discovery less than 20 years ago. Arriving at our final destination, Auchintaple Loch (also in 37/16) in Glenisla, we just had time to re-find the scattered plants of *Equisetum hyemale* in flushes by the loch before the rain came on, the first we had in that week of good weather.

16th August. As a climax to our meeting we decided to return to Angus and climb to Loch Brandy (*c* 2,050 ft) in Glen Clova. Nothing new was expected in the waters of this well-known loch but we were pleased to find *Lobelia* still in flower in a pool at this late season, having so far only seen it withering or in fruit. Along with it grew *Isoetes lacustris* (found also in another pool), and *Sparganium angustifolium* in flower. Small willows were found on the loch margin, and some, hitherto overlooked, were *Salix aurita* × *S. repens*. Part of the pleasure of this day was the lovely views and our tea-break in the dried-up bed of the burn along with *Epilobium alsinifolium*.

The localities for Potamogetons were too numerous to list in detail, but the following species were seen: *P. natans, P. polygonifolius, P. gramineus, P.* × *nitens, P. alpinus, P. praelongus, P. perfoliatus, P. pusillus, P. obtusifolius, P. berchtoldii, P. crispus* and *P. filiformis*.

On the final evening we had a quiz, 35 water-plants in dishes in the laboratory being numbered while members were issued with similarly numbered sheets and required to put down the names. The leader then gave a short demonstration of the method of floating out the more delicate water-plants on 'flimsies'.

U. K. Duncan

BEN VORLICH, DUNBARTON. AUGUST 20TH

This joint meeting with the Andersonian Naturalists of Glasgow attracted an attendance of eight, including a Swedish botany student holidaying in the area. Due to poor weather conditions the more interesting upper parts of the eastern side of the mountain were not reached; consequently, the main objective of the meeting, to attempt to confirm a few of the older records, was not achieved. A good selection of montane plants was, however, seen during the ascent from Ardlui. A particularly useful record was *Loisleuria procumbens* at the unusually low altitude of 1500 feet—the second record for the vice-county. Among the more interesting species noted were *Polystichum lonchitis, Cerastium alpinum, Sibbaldia procumbens, Vaccinium uliginosum, Tofieldia pusilla, Carex saxatilis* and *Poa glauca*.

A. McG. Stirling

OBAN, MAIN ARGYLL. AUGUST 20TH–21ST

Three attended this Field Meeting. On Saturday we investigated the flora of Loch Tromlee and surrounding marsh, which proved interesting, with a good assortment of sedges and a nice aquatic flora. We saw *Carex limosa, C. lasiocarpa, C. paniculata, C. diandra, C. vesicaria* and *C. rostrata*. More interesting was the occurrence of two large colonies of a sedge allied to *C. rostrata* and *C. vesicaria* but quite distinct from these—the plant appears to be fertile and presumably not a hybrid. Apart from the sedges, *Sparganium ramosum, S. emersum,* and *S. minimum* were noted, as were *Nuphar lutea, Nymphaea alba, Utricularia intermedia, Potamogeton lucens, P. alpinus* and probably *P. gramineus*. In the marsh *Veronica scutellata, Carum verticillatum* and *Trollius europaeus* occurred.

On Sunday we decided to investigate Kerrera, as ferry communications with Lismore were unsuitable. The result was moderate only. We noted *Carex paniculata, C. diandra, Blysmus rufus, Puccinellia maritima, Suaeda maritima, Spergularia salina, Sagina nodosa* and *Veronica anagallis-aquatica*. The beautiful scenery did much to make up for the rather limited flora.

A. G. Kenneth

IRELAND

DUNMORE EAST, CO. WATERFORD. MAY 21ST–22ND

Although not an isolated county, Waterford has never been intensively botanized. A party of six members assembled at Dunmore East on the south-eastern coast of Waterford on the Saturday, where we were joined by Mr Sean Diamond of the National Soil Survey, who is at present surveying the soils of the county. The weather was magnificent and this added greatly to the enjoyment of the weekend. During the first morning we visited Knockavelish Head, Rathmoylan Bridge and Brownstown Head.

There has been a great deal of land improvement and reseeding in Waterford during the last 20 years. As a result many areas of scrub and wetland have been converted into intensively cultivated farmland, but there has been comparatively little hedgerow removal. The main hedgerow species tends to be *Ulex europaeus*.

In the afternoon the first stop was at Newtown Cove, south of Tramore, where a small ash/oak wood in a ravine changes to scrub and then to a grassy cliff near the sea. After this we headed a few miles inland to see a part of the extensive volcanic area which is unique to Waterford. Outcrops of acid volcanic rock covered with *Ulex* scrub stand out amid a maze of small grass-fields. At Ballynaclogh Maura Scannell of the Botanic Gardens, Dublin, was able to show us the exact spot where she first found *Viola lactea*. This rare cream-flowered violet was in full bloom on slightly disturbed ground in the transition zone from poor grassland to *Ulex* heath. The day concluded with a walk through the Tramore dunes. Here, despite a marathon walk by some of the party, no sign of *Polygonum maritimum* was seen at its station at the eastern end of the dunes.

On the Sunday, with a party reduced to four, we first visited Belle Lake, the largest stretch of lowland freshwater in the county. Of particular interest here was the strip of undisturbed ashwood between the road and the lake. After this, brief stops were made at Woodstown strand and Passage East before going on to Cheekpoint, where the Barrow and Suir rivers meet in a spectacular setting. At Cheekpoint and a little upstream along the Suir at Faithlegg a watch was kept for *Asplenium onopteris*, as it has been found in previous years at Snowhill on the opposite bank.

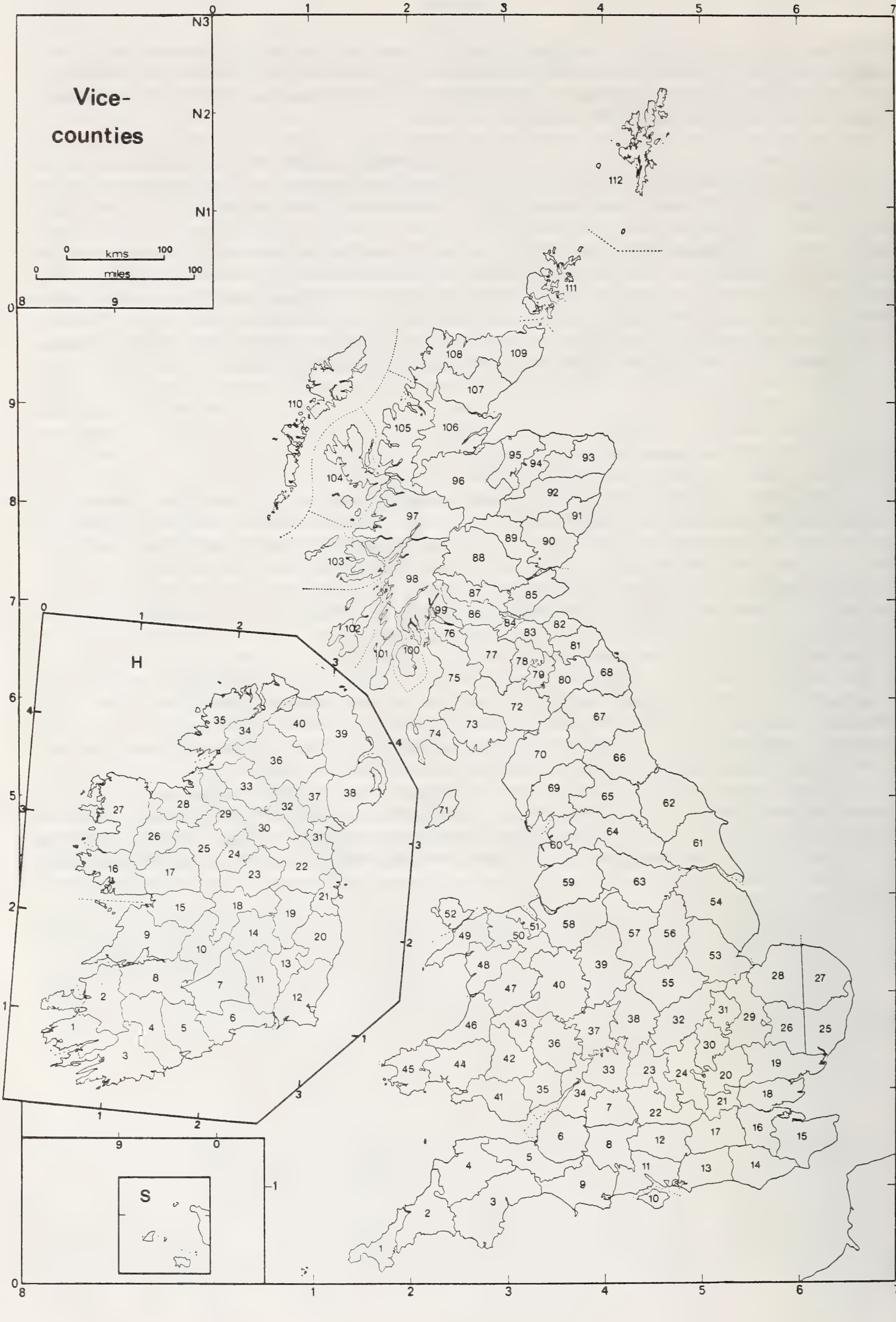
In all, five 10km grid squares were visited and record cards filled in for these.

A. M. O'Sullivan

KANTURK, CO CORK. JULY 15TH–19TH

The purpose of this four-day meeting was to add to the floristic knowledge of this greatly neglected part of Cork and to explore the area generally. Up to 11 members attended on various days. On the Friday, Banteer and district (Mid Cork, v.c. H4) was worked. The small lakes shown on the map to the west of the village proved difficult to find, and difficult of access. One near the railway line with open water yielded little diversity: *Carex rostrata* and *Potentilla palustris* predominated, with massive stands of *Osmunda regalis* on the periphery. The other lakes – actually dark, humid marshes – were tree-enclosed, and held stands of *Veronica scutellata, Equisetum fluviatile, Sparganium erectum* and little else. Weedkiller had largely destroyed the vegetation about the railway line, though *Pimpinella major* grew on embankments. Part of the Glen river, a tributary of the Blackwater, yielded *Impatiens glandulifera*; the Blackwater populations are probably derived from this source. In a marsh at Frenche's Road near Nad *Carex hostiana* × *C. lepidocarpa* occurred with *C. hostiana*, allowing a useful comparison of characters, while *Equisetum palustre, Carex dioica, Anagallis tenella* and fruiting *Pinguicula grandiflora* were frequent along flushes. *Euphorbia hyberna* was common in this whole area on acid soils and naturalized clumps of *Lysimachia punctata* occurred here and there on damp ground.

Saturday morning saw the party at interesting Lough Gurtavehy in the Caherbarnagh mountains west of Millstreet (W. Cork, v.c.H3). It was a pleasure to have with us for a day former B.S.B.I. President Dr John Dony and his wife. Due to the prolonged dry spell the lough proved little more than pond-sized. Nevertheless, the following plants recorded by A. G. More in 1868 were refound immediately: *Littorella uniflora* and *Lobelia dortmanna* (both abundant and in flower), and *Callitriche intermedia, Myriophyllum alterniflorum* and a non-sporing *Isoetes* species. Dried-up mountain rills were decked with *Saxifraga* × *polita* and naturalized *Epilobium brunnescens. Saxifraga spathularis* was mostly confined to the cliffs with *Campanula rotundifolia* (very rare and local in Cork), while *S. hirsuta* was not seen on this visit. Two *Alchemilla* species (in leaf only) were seen, probably *A. glabra* and *A. filicaulis* subsp. *vestita*, the latter in company with massive vegetative clumps of *Geum rivale*, which is frequent in these mountains but rare in the lowlands of Cork. That the barren, montane ground about the lough was once clothed with woodland (probably birch) is suggested by its Irish place-name, and more convincingly by the present abundance of *Luzula sylvatica* and *Deschampsia flexuosa*, with some scattered clumps of *Carex sylvatica*. *Carex pallescens*, in fine fruit, was collected from high ground, the stem angles notable for the presence of soft, elongated cilia, which gave them a rather hairy aspect. As the terrain proved too rough for some party members it was decided to move on, leaving such species as *Thelypteris phegopteris, Cystopteris fragilis, Asplenium viride* and *Hymenophyllum wilsonii* (as noted by



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The current status of the Characeae (Stoneworts) in the British Isles

J. A. MOORE

Department of Botany, British Museum (Natural History), Cromwell Road, London

ABSTRACT

A review of the species diversity, ecology and distribution of the Characeae in the British Isles, based mainly on information collated at the British Museum (Natural History) from 1972 to 1977, is presented.

INTRODUCTION

Charophytes are the only non-vascular plants mentioned in the rules of the B.S.B.I. (paragraph 2), and the Society has maintained a long-standing interest in the group, probably because these algae are often collected with other aquatic macrophytes such as *Potamogeton* species. It is hoped that this outline of the current status of the group will encourage B.S.B.I. members to take an interest in these plants and contribute to their study. More work must be carried out on specimens in the field and laboratory before an attempt can be made to revise the taxonomy of the group in the British Isles. The nomenclature used here is that of Allen (1950) (Table 1).

Charophytes have been classified as green algae (Chlorophyta), although their gross morphology is such that they can be mistaken for aquatic vascular plants. However, microscopical examination of the thallus reveals unusual characters, such as the unique structure of the sex organs (Fig. 1), so that some authors treat the group as a separate division of the lower plants. Recent work by Stewart & Mattox (1975) suggests that the Chlorophyta should be divided into two classes, the Chlorophyceae and Charophyceae. In their view the Charophyceae includes not only the Characeae (Stoneworts) but also other erstwhile members of the Chlorophyceae such as the Zygnematales and Coleochaetales. Therefore the terms Charophyceae and Charophyta can no longer be used to mean the Characeae alone. In this paper the term charophyte is used as a common name solely for members of the family Characeae.

MORPHOLOGY

A specialized terminology is used to describe the unique morphology of the group. The two tribes, the Chareae (*Chara, Lamprothamnium* and *Nitellopsis*), and the Nitelleae (*Nitella, Tolypella*), are distinguished by the number and arrangement of the cells that make up the crown (coronula) at the apex of the oogonium. The coronula in the Chareae is formed of five cells in one tier and in the Nitelleae it is a double tier of ten cells. The main axes of plants in the Chareae support whorls of simple branchlets at the nodes. In the Nitelleae the whorls are made up of rays which may be simple or divided.

Features peculiar to species of *Chara* include the covering of cortical cells and the spine-cells, bract-cells and stipulodes. These features vary from species to species. The cortex is made up of longitudinally arranged primary and secondary rows of cells with the spine-cells borne only on the primary rows. The spine-cells may be elongate, papilliform, solitary or in clusters. The bract-cells may vary in length and are borne at the nodes of the branchlets. The stipulodes are a double row of cells found at the bases of the branchlet whorls, and may also vary in length. The antheridia and oogonia occur at the branchlet nodes in association with the bract-cells.

Lamprothamnium is ecorticate and has only a single row of downward-pointing stipulodes. In *Nitellopsis* the stipulodes and cortex are absent but the starch-storage organs (bulbils), found at the

TABLE 1. COMPARISON OF THE NOMENCLATURE OF BRITISH CHARACEAE USED BY ALLEN WITH THAT USED BY WOOD & IMAHORI

ALLEN (1950)	WOOD & IMAHORI (1964, 1965)
(1) *Chara aculeolata* Kütz.	*C. hispida* L.
(2) *C. aspera* Deth. ex Willd.	*C. globularis* var. *aspera* (Deth. ex Willd.) R.D.Wood
(3) *C. baltica* Bruz.	*C. hispida* var. *baltica* (Bruz.) R.D.Wood
(4) *C. braunii* C.C.Gmel.	*C. braunii* C.C.Gmel.
(5) *C. canescens* Desv. & Lois.	*C. canescens* Desv. & Lois.
(6) *C. connivens* Salzm. ex A.Br.	*C. globularis* var. *globularis* f. *connivens* (Salzm. ex A.Br.) R.D.Wood
(7) *C. contraria* A.Br. ex Kütz.	*C. vulgaris* var. *vulgaris* f. *contraria* (A.Br. ex Kütz.) R.D.Wood
var. *hispidula* A.Br.	*C. vulgaris* var. *vulgaris* f. *hispidula* (A.Br.) R.D.Wood
(8) *C. delicatula* C.A.Ag. *sensu* Groves & Bullock-Webster, non Desv.	*C. globularis* var. *virgata* (Kütz.) R.D.Wood
var. *annulata* (Lilj.) J.Gr. & Bull.-Webst.	*C. globularis* var. *virgata* (Kütz.) R.D.Wood
var. *barbata* (Gant.) J.Gr. & Bull.-Webst.	*C. globularis* var. *virgata* (Kütz.) R.D.Wood
(9) *C. denudata* A.Br.	*C. vulgaris* var. *denudata* (A.Br.) R.D.Wood
(10) *C. desmacantha* (H. & J.Gr.) J.Gr. & Bull.-Webst.	*C. globularis* var. *aspera* f. *curta* (Nolte ex Kütz.) R.D.Wood
(11) *C. fragifera* Dur.	*C. globularis* var. *globularis* f. *fragifera* (Dur.) R.D.Wood
(12) *C. globularis* Thuill.	*C. globularis* Thuill.
var. *capillacea* (Thuill.) Zanev.	*C. globularis* Thuill.
(13) *C. hispida* L.	*C. hispida* L.
(14) *C. muscosa* J.Gr. & Bull.-Webst.	*C. vulgaris* var. *vulgaris* f. *muscosa* (J.Gr. & Bull.-Webst.) R.D.Wood
(15) *C. rudis* (A.Br.) Leonh.	*C. hispida* var. *major* (Hartm.) R.D.Wood f. *rudis* (A.Br.) R.D.Wood
(16) *C. tomentosa* L.	*C. tomentosa* L.
(17) *C. vulgaris* L.	*C. vulgaris* L.
var. *crassicaulis* (Schl. ex A.Br.) Kütz.	*C. vulgaris* var. *vulgaris* f. *crassicaulis* (Schl. ex A.Br.) R.D.Wood
var. *longibracteata* (Kütz.) J.Gr. & Bull.-Webst.	*C. vulgaris* var. *vulgaris* f. *longibracteata* (Kütz.) H. & J.Gr.
var. *papillata* Wallr. ex A.Br.	*C. vulgaris* L.
var. *refracta* (Kütz.) J.Gr. & Bull.-Webst.	*C. vulgaris* L.

(18)	*Lamprothamnium papulosum* (Wallr.) J.Gr.	*L. papulosum* (Wallr.) J.Gr.
(19)	*Nitella capillaris* (Krock.) J.Gr. & Bull.-Webst.	*N. syncarpa* (Thuill.) Chev. var. *capitata* (Nees.) Kütz.
(20)	*N. confervacea* (Bréb.) A.Br. ex Leonh.	*N. gracilis* var. *confervacea* Bréb.
(21)	*N. flexilis* (L.) C.A.Ag.	*N. flexilis* (L.) C.A.Ag.
	var. *crassa* A.Br.	*N. flexilis* (L.) C.A.Ag.
	var. *fryeri* J.Gr. & Bull.-Webst.	*N. flexilis* (L.) C.A.Ag.
	var. *nidifica* Hartm. ex Wallm.	*N. flexilis* var. *flexilis* f. *nidifica* (Hartm. ex Wallm.) R.D.Wood
(22)	*N. gracilis* (Sm.) C.A.Ag.	*N. gracilis* (Sm.) C.A.Ag.
(23)	*N. hyalina* (DC.) C.A.Ag.	*N. hyalina* (DC.) C.A.Ag.
(24)	*N. mucronata* (A.Br.) Miq.	*N. furcata* (Roxb. ex Bruz.) C.A.Ag. subsp. *mucronata* (A.Br.) R.D.Wood
	var. *gracillima* J.Gr. & Bull.-Webst.	*N. furcata* subsp. *mucronata* (A.Br.) R.D.Wood
	var. *heteromorpha* A.Br.	*N. furcata* subsp. *mucronata* (A.Br.) R.D.Wood
(25)	*N. opaca* (Bruz.) C.A.Ag.	*N. flexilis* (L.) C.A.Ag.
	var. *attenuata* H. & J.Gr.	*N. flexilis* var. *flexilis* f. *attenuata* (H. & J.Gr.) R.D.Wood
(26)	*N. spanioclema* J.Gr. & Bull.-Webst. ex Bull.-Webst.	*N. flexilis* var. *spanioclema* (J.Gr. & Bull.-Webst. ex Bull.-Webst.) R.D.Wood
(27)	*N. tenuissima* (Desv.) Kütz.	*N. tenuissima* (Desv.) Kütz.
(28)	*N. translucens* (Pers.) C.A.Ag.	*N. translucens* (Pers.) C.A.Ag.
(29)	*Nitellopsis obtusa* (Desv.) J.Gr.	*Nitellopsis obtusa* (Desv.) J.Gr.
(30)	*Tolypella glomerata* (Desv.) Leonh.	*T. nidifica* var. *glomerata* (Desv.) R.D.Wood
	var. *erythrocarpa* J.Gr. & Bull.-Webst.	*T. nidifica* (O.Müll.) Leonh.
(31)	*T. intricata* (Trent. ex Roth) Leonh.	*T. intricata* (Trent. ex Roth) Leonh.
(32)	*T. nidifica* (O.Müll.) Leonh.	*T. nidifica* (O.Müll.) Leonh.
(33)	*T. prolifera* (Ziz ex A.Br.) Leonh.	*T. intricata* var. *intricata* f. *prolifera* (Ziz ex A.Br.) R.D.Wood

Entries under Wood & Imahori's classification refer to the type variety and form unless otherwise stated. Five varieties recognized by Allen but not dealt with by Wood & Imahori are omitted.

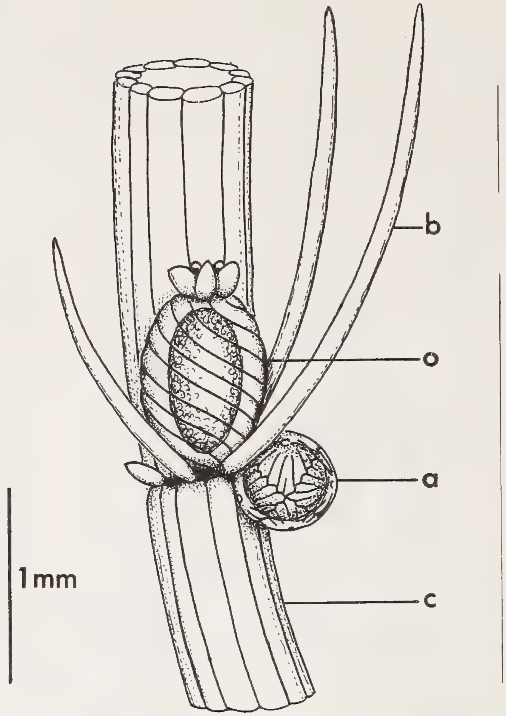

FIGURE 1. Fertile branchlet node of a monoecious species of *Chara*. a. antheridium, b. bract-cell, c. cortical row, o. oogonium. The male organ or antheridium is spherical and bright orange when mature. The female organ or oogonium is oval and brownish-black when mature.

stem nodes, are very distinctive being large, white and star-shaped. In species of *Nitella* and *Tolypella* the cortex, stipulodes, spine-cells and bract-cells are absent. The rays of *Nitella* species may be divided more than once and the ultimate ray, or dactyl, may be one- to three-celled. The rays of *Tolypella* are multicellular.

Species of *Chara* and *Tolypella* take up lime and become encrusted so that they are grey-green in colour, brittle and rough to the touch. This character has given the whole group the common name Stoneworts. For a general account of the structure of charophytes the works of Groves & Bullock-Webster (1920), Fritsch (1935) and Wood & Imahori (1965) may be consulted.

RECENT STUDY

Since the death of G. O. Allen in 1963, few serious attempts have been made to study charophytes in the British Isles, although staff at the British Museum (Natural History), London, have maintained an identification service and kept a routine index of records.

A survey of the Characeae, in southern and eastern England, with special reference to their conservation, was carried out in 1976 and 1977 (Moore 1977) with the aid of a grant from the World Wildlife Fund (W.W.F.). During the survey 120 samples were collected from 17 vice-counties and an attempt was made to visit many of the previously important charophyte sites. The information collected during these field visits, supplemented by the regular contributions of a handful of enthusiasts since 1972, has formed the basis for this paper.

LITERATURE

To stimulate interest in these plants, work has begun on an inexpensive illustrated handbook to accompany the two British standard works on Characeae by Allen (1950) and Groves & Bullock-Webster (1920, 1924). Allen's work was based on that of Groves & Bullock-Webster, which he partly revised and greatly condensed. It has few diagrams and is now out of print. Groves & Bullock-Webster's work has fine illustrations of all the species and was reprinted in 1971 in one volume. A recent world revision by Wood & Imahori (1964, 1965), comprising an extensive monograph with excellent illustrations, is also available.

Allen listed 33 species and 20 extra varieties for the British Isles; 13 of these 53 taxa may be considered common, 37 rare and three possibly extinct. Only 25 species and 11 extra varieties have been recorded since 1972; these relatively low figures may be due partly to lack of interest in the group coupled with the destruction of suitable habitats. Table 1 compares the nomenclature of Allen with that of Wood & Imahori.

HABITATS AND CONSERVATION

DESTRUCTION OF HABITATS

Destruction of the aquatic environment occurs in many ways. Pollution by agricultural run-off and by sewage, causing eutrophication and deoxygenation (Mellanby 1970), is a serious threat in many highly cultivated and densely populated areas. This has happened in the Norfolk Broads where the influx of summer visitors has caused problems with the inadequate disposal of sewage and the increase in traffic of powered craft on the waterways. A B.S.B.I. excursion to Hickling Broad, E. Norfolk, v.c. 27, in 1960 yielded six species of charophyte from this once excellent site whence ten species had been previously recorded (Phillips 1963). In 1974 only some poorly developed plants of *Chara globularis* were found in the Broad. This decline in species diversity has accompanied the now well-documented disturbance and pollution of Broadland (George 1976, 1977).

Urban development and the drainage of wetland for arable use are other destructive factors. Similarly, the increasing demands made on underground water supplies, especially in times of drought as in 1976, result in a lowering of the water-table, thus causing areas of fenland to dry out (Moore 1977).

Moreover, the lack of suitable management for drainage dyke systems often results in either over-zealous mechanical cleaning or no cleaning at all. The former method ensures that no plant can survive to recolonize a dyke, whilst the latter allows invasive species to multiply, eventually choking the waterway.

SPORE DORMANCY

Charophytes are often found as the first macrophytic colonizers of a newly dredged dyke or pool, and they are able to grow quickly before other vegetation is introduced. It seems probable that spores can remain dormant in the soil for some time awaiting suitable conditions for germination.

In 1976 some experimental peat diggings were carried out at Wicken Fen, Cambs., v.c. 29, to investigate this phenomenon (Moore 1977). The only charophyte to appear in these diggings so far is *Chara hispida*. The rare *Nitella tenuissima* and nine other species had been previously recorded from the fen, although recent collections have yielded only seven species. *N. tenuissima* was last collected at the fen in 1957 from experimental peat diggings being worked by Cambridge University (Walters 1958). Previously the plant had been found at the fen in 1922 and, before that, at the turn of the century. The intermittent appearance of this species may be partly due to the cessation of regular peat-digging, since peat from the fens is no longer used for fuel, so that spores are not brought to the surface regularly. The plant also seems to require warm and wet weather conditions such as those of the summer of 1957 (D. E. Coombe pers. comm. 1975). Similar conditions may have been incidental when the species was cultured in the laboratory in *c*1930 by Professor H. Godwin from a block of Wicken peat (D. E. Coombe pers. comm. 1975).

Similar experimental diggings have been completed at Redgrave Fen on the Norfolk/Suffolk border, v.c. 25–28. In this instance the pits have been dug primarily to assist the spread of the rare spider *Dolomedes plantarius* (Clerck), but it is hoped that a suitable habitat for Characeae will also result.

CANALS

Two canal systems were surveyed during the W.W.F. project. Both are undergoing restoration and proved to be interesting examples of the way in which controlled dredging can assist the spread of the Characeae.

The Basingstoke Canal, which runs from the outskirts of Basingstoke, N. Hants., v.c. 12, to the River Wey Navigation at Byfleet, Surrey, v.c. 17, is being restored by Hampshire County Council. Two species of charophyte, *Chara globularis* and *C. vulgaris*, were present in a recently dredged stretch of canal at Odiham, N. Hants.

Work has begun on restoring the Thames and Severn Canal in Gloucestershire (v.c. 33 & 34), and two species, *Nitella flexilis* and *Tolypella glomerata*, were found in the first-dredged stretch near Coates. It is probable that, when these canals are eventually re-opened for navigation and recreation, their suitability as sites for the conservation of charophytes and other aquatics will decrease.

OTHER MAN-MADE HABITATS

Gravel extraction and subsequent flooding is a continuing process that creates new habitats for aquatics in many parts of the country. This may balance, in part, some of the loss of habitats that has been discussed above. However, there are human pressures at flooded pits similar to those at canals, as sailing and fishing are often encouraged, although some pits have been designated as nature reserves. Several pit complexes were visited during the W.W.F. project, including the Cotswold Water Park at Ashton Keynes, N. Wilts., v.c. 7 and E. Gloucs., v.c. 33, and Fairford, E. Gloucs., where six species were found (Moore & Bailey 1977, 1978).

Seven species were collected at the marl pits around Crockford Bridge, New Forest, S. Hants., v.c. 11, where some of the pools are little more than a series of pony hoof-prints on damp ground by the river. The site has a rich flora and is worth further investigation.

Other man-made sites where charophytes have been found include trout hatcheries, reservoirs and ornamental ponds in formal gardens, especially where the water supply is calcareous.

BRECKLAND MERES

Four species of charophyte have been found in the Breckland Meres, W. Norfolk, v.c. 28: *C. contraria, C. globularis, N. flexilis/opaca* agg. and *T. glomerata*. The ecology of these interesting lakes and ponds is documented in a report to the Nature Conservancy Council (Watson 1974) which demonstrates the part played by the Characeae in the calcium cycle. Many of the Meres remain undisturbed because they are on Ministry of Defence land, to which access is restricted.

BRACKISH HABITATS

Some species will tolerate brackish conditions and can be solely maritime in distribution (Moore 1976). In the past, coastal sites such as the Suffolk Broads have yielded important collections of charophytes. Although several such sites were visited during the W.W.F. project, collections were disappointing. However, the rare *Lamprothamnium papulosum* was found in the Fleet, Dorset, v.c. 9. This species can survive in salinities of *c*30‰, although the optimum salinity for growth is between 24‰ and 28‰ (Daniel 1975), i.e. approximately four-fifths the salinity of sea-water, which is *c*35‰ in the Eastern Atlantic European Basin (Wright & Worthington 1970). Salinity is, in this context, measured as total dissolved solids in parts per thousand (‰).

ECOLOGY AND DISTRIBUTION OF THE SPECIES

In the following list the 25 species are arranged alphabetically, with ecological notes and a list of recent records for each species. The records are abbreviated to vice-county number followed by the number of times recorded shown in parentheses. Taxa not recorded during this survey are omitted, but due to the incomplete geographical coverage of this survey they should not be presumed to be extinct. Synonymy which may be helpful when studying old collections of Characeae is shown in parentheses.

1. *Chara aculeolata* Kütz. (*C. polyacantha* A.Br.)
   Scarce, most often recorded from v.c. 27 and v.c. 29, usually in peat ditches.
   Previous records: one or two sites in more than 20 vice-counties.
   Recent records: v.c. 27(6), 29(1).

2. *C. aspera* Deth. ex Willd.
Frequent throughout the British Isles, often in lakes, occasionally in ditches.
Previous records: one or two sites in more than 30 vice-counties.

2a. var. *aspera*
Recent records: v.c. 1(1), 17(1), 27(4), 89(1), 95(1), 111(1), H1(1), H28(1).

2b. var. *lacustris* H. & J.Gr.
Recent records: v.c. 111(1).

3. *C. baltica* Bruz.
Rare, usually in brackish habitats.
Previous records: v.c. 1, 9, 15, 27, 110, 111 and the Channel Islands.
Recent records: v.c. 27(1), 112(1).

4. *C. canescens* Desv. & Lois. (*C. crinita* Wallr.)
Rare, maritime in distribution; parthenogenetic.
Previous records: v.c. 1, 9, 15, 25, 27, 111, H1, H12, H15, H17.
Recent records: v.c. H9(2), H12(1).

5. *C. contraria* A.Br. ex Kütz.
Frequent throughout the British Isles in many different types of habitat.
Previous records: from more than 45 vice-counties.

5a. var. *contraria*
Recent records: v.c. 7(2), 11(1), 27(2), 28(3), 29(3), 33(3), 41(1), 57(1), 111(1), 112(3), H1(1), H10(1).

5b. var. *hispidula* A.Br.
Recent records: v.c. 28(2), 33(1), 112(1).

6. *C. delicatula* C.A.Ag. *sensu* Groves & Bullock-Webster, non Desv.
Common throughout the British Isles but most often recorded from Scotland and Ireland. Occasionally found in running water and will tolerate acid conditions more readily than other species of *Chara*. See also *C. globularis*.
Previous records: from more than 60 vice-counties.
The taxonomy and nomenclature of *C. delicatula* and *C. globularis* is very confused and is under investigation by the author.

6a. var. *delicatula*
Recent records: v.c. 1(1), 5(1), 7(1), 9(1), 11(11), 12(1), 15(1), 21(1), 22(1), 27(5), 28(2), 29(3), 33(5), 35(1), 48(1), 52(1), 53(1), 73(1), 88(1), 89(1), 97(6), 98(1), 100(1), 101(1), 103(1), 109(1), 111(1), 112(1), H2(1), H7(2). H16(1), H33(2), H39(1).

6b. var. *annulata* (Lilj.) J.Gr. & Bull.-Webst.
Recent records: v.c. 89(1), 97(2), 98(1), 101(1), 112(1).

6c. var. *barbata* (Gant.) J.Gr. & Bull.-Webst.
Recent records: v.c. H1(1).

7. *C. desmacantha* (H. & J.Gr.) J.Gr. & Bull.-Webst.
Scarce, most often recorded from Ireland.
Previous records: one or two sites in more than 20 vice-counties scattered throughout the British Isles.
Recent records: v.c. 27(1), 111(1), H7(1), H10(1).

8. *C. fragifera* Dur.
Only recorded from the pools on or near the Lizard Peninsula, Cornwall.
Recent records: v.c. 1(4).

9. *C. globularis* Thuill. including var. *capillacea* (Thuill.) Zanev. *sensu* Allen (*C. fragilis* Desv.)
Frequent throughout the British Isles but most often recorded from the southern half. Rare in running water.

Previous records: from about 40 vice-counties.
Recent records: v.c. 11(3), 12 (1), 17(1), 23(1), 26(1), 27(2), 28(4), 29(1), 30(1), 31(1), 33(2), 34(3), 45(1), 64(1), H10(2), H16(1).

9/6. *C. globularis/delicatula* agg.
Specimens which cannot be placed in either *C. globularis* or *C. delicatula*, because they display characters typical of both species, are included here as an aggregate of those species. This is strong evidence to support the incorporation of *C. delicatula* within *C. globularis*, as suggested by Wood & Imahori (1965).
Recent records: v.c. 11(2), 12(1).

10. *C. hispida* L.
Common throughout the British Isles in many different types of habitat.
Most often recorded from base-rich and calcareous peaty water; occasionally from artificial sites, e.g. concrete-lined reservoirs.
Previous records: from about 60 vice-counties.
Recent records: v.c. 11(6), 15(1), 22(1), 24(1), 26(1), 27(9), 28(3), 29(5), 30(1), 32(2), 33(1), 34(1), 45(1), 53(3), 54(1), 56(1), 57(2), 80(1), H7(1), H13(1).

11. *C. rudis* (A.Br.) Leonh.
Scarce, most often recorded from Ireland; rare in England and Wales; usually found in lakes.
Previous records: one or two sites in more than 20 vice-counties.
Recent records: v.c. 96(1).

12. *C. tomentosa* L.
Recorded from only five vice-counties (v.c. H10, H15, H23, H24, H25), within the area drained by the River Shannon, Ireland.
Recent records: v.c. H10(1).

13. *C. vulgaris* L. (*C. foetida* A.Br.)
The commonest species of charophyte, found throughout the British Isles in many different types of habitat; less often recorded from Scotland.
Previous records: from about 100 vice-counties.

13a. var. *vulgaris*
Recent records: v.c 5(1), 6(1), 7(2), 11(8), 12(5), 14(3), 15(2), 17(1), 20(1), 21(1), 23(1), 24(1), 26(1), 27(8), 28(3), 29(4), 31(1), 33(6), 34(3), 35(6), 53(3), 54(1), 55(1), 57(2), 64(1), 66(1), 108(1), H7(1), H10(1), H13(1), H38(2), H39(1).

13b. var. *crassicaulis* (Schl. ex A.Br.) Kütz.
Recent records: v.c. 23(1).

13c. var. *longibracteata* (Kütz.) J.Gr. & Bull.-Webst.
Recent records: v.c. 11(2), 21(1), 23(1), 24(2), 25(1), 26(1), 27(7), 28(1), 29(1), 31(2), 32(1), 33(3), 34(2), 35(4), 41(2), 54(1), 55(1), H13(1), H33(1).

13d. var. *papillata* Wallr. ex A. Br.
Recent records: v.c. 11(3), 21(1), 23(1), 24(1), 26(1), 27(7), 28(3), 29(1), 31(1), 33(5), 34(2), 53(1), 54(2), H5(1), H10(1).

13e. var. *refracta* (Kütz.) J.Gr. & Bull.-Webst.
Recent records: v.c. 28(1), 54(1).

14. *Lamprothamnium papulosum* (Wallr.) J.Gr. (*Lamprothamnus alopecuroides* (Del. ex A.Br.) A.Br.)
The ecology of this species has been discussed above. A rare plant, previously recorded from only two vice-counties, v.c. 9 and v.c. 10. There is an unconfirmed record for N.Uist, v.c. 110 (Dunn 1937), but no specimen can be traced. For the history of this plant in the British Isles see Moore, Jermy & Mullin (1975).
Recent records: v.c. 9(3), 11(2), H9(2), H12(1).

15. *Nitella confervacea* (Bréb.) A.Br. ex Leonh. (*N. batrachosperma* (Reich.) A.Br., *N. nordstedtiana* J.Gr.)
A rare plant of coastal lakes in western Scotland and Ireland; a very small, delicate species which is easily overlooked.
Previous records: v.c. 110, H1, H2, H16, H27, H35.
Recent records: v.c. 97(2), 112(1).

16. *N. flexilis* (L.) C.A.Ag.
Common throughout the British Isles; usually in ponds and lakes, rarely in running water. See also *N. opaca*.
Previous records: from more than 50 vice-counties.
Recent records: v.c. 11(4), 12(2), 17(3), 29(1), 31(1), 33(1), 34(1), 40(1), 47(1), 49(1), 72(1), 73(2), 88(1), 97(2).

17. *N. gracilis* (Sm.) C.A.Ag.
A rare plant recorded only once from each of the vice-counties listed below, the habitats varying from ditches to pools and lakes.
Previous records: v.c. 1, 13, 17, 40, 49, 108, H1, H2, H20.
Recent records: v.c. 21(1), 27(1), 89(1).

18. *N. mucronata* (A.Br.) Miq.
Scarce; in ditches, ponds and, occasionally, running water.
Previous records: from twelve vice-counties, mainly in southern England.
18a. var. *mucronata*
Recent records: v.c. 6(1), 11(2), 23(1), 27(1), 89(1).
18b. var. *gracillima* J.Gr. & Bull.-Webst.
Recent records: v.c. 27(1), 29(2).

19. *N. opaca* (Bruz.) C.A.Ag.
Common throughout the British Isles in lakes, ponds, ditches and streams.
Previous records: from more than 50 vice-counties.
19a. var. *opaca*
Recent records: v.c. 1(1), 11(1), 24(1), 33(2), 35(1), 49(1), 73(1), 89(1), 97(1).
19b. var. *attenuata* H. & J.Gr.
Recent records: v.c. 11(4), 35(1), 99(1).
19c. var. *brachyclema* J.Gr. & Bull.-Webst.
Recent records: v.c. 27(1).

19/16. *N. opaca/flexilis* agg.
Specimens which cannot be placed in either *N. flexilis* or *N. opaca* because they display characters typical of both species are included here as an aggregate of those species. This is strong evidence to support the incorporation of *N. opaca* within *N. flexilis*, as suggested by Wood & Imahori (1965).
Recent records: v.c. 11(3), 28(1), 29(2), 49(1), 70(1), 80(1), 89(1), 95(1), 97(6), 98(1), 101(1), 112(1), H2(1), H33(1).

20. *N. spanioclema* J.Gr. & Bull.-Webst. ex Bull.-Webst.
Rare; in lakes.
Previous records: v.c. 69, 87, H34, H35.
Recent records: v.c. 89(1).

21. *N. translucens* (Pers.) C.A.Ag.
Frequent throughout the British Isles in lakes and ponds.
Previous records: from about 30 vice-counties.
Recent records: v.c. 9(3), 11(13), 12(1), 69(2), 97(1), H2(1).

22. *Nitellopsis obtusa* (Desv.) J.Gr. (*Lychnothamnus stelliger* (Bauer) A.Br.)
Rare; usually in deep brackish water. Most often recorded from the Norfolk Broads, v.c. 27.
Previous records: v.c. 3, 9, 11, 17, 27, 32, 89.
Recent records: v.c. 27(3).

23. *Tolypella glomerata* (Desv.) Leonh.
Frequent throughout the British Isles in ponds and ditches; often in brackish water near the coast, such as pools in dune-slacks.
Previous records: from about 50 vice-counties but recorded only once in the majority of these.
Recent records: v.c. 7(1), 11(6), 15(1), 28(2), 29(1), 33(3), 34(1), 53(1), 54(1), H12(1).

24. *T. intricata* (Trent. ex Roth) Leonh.
Scarce; in pools and ditches.
Previous records: one or two sites in about 20 vice-counties, mainly in southern England.
Recent records: v.c. 29(1).

25. *T. prolifera* (Ziz ex A.Br.) Leonh.
Scarce; often in slow-moving water in ditches and canals.
Previous records: from 15 vice-counties, mainly in southern England.
Recent records: v.c. 33(1).

The co-operation of collectors has already enabled a start to be made on a series of county charophyte Floras. The first of these will be a section in *A supplement to the Flora of Gloucestershire* (S. C. Holland *et al.*, in preparation), and preliminary work has begun on a Flora of Hampshire. Figures 2 and 3 illustrate the known localities of charophytes for the years 1972–1977. The pattern revealed in Fig. 2 largely coincides with the distribution of chalk and limestone areas of the country, but in Fig. 3 the coincidence is less precise. This is because the genus *Nitella* is more tolerant of acid conditions than are other charophytes.

ADVICE FOR COLLECTORS

The following notes describe basic techniques and the equipment needed by botanists who wish to collect charophytes.

1. Shallow pools can be sampled by hand but a 'grab and line' is necessary for deeper water. For very large ponds and lakes a boat is essential to ensure collection of deep water specimens. In all cases care should be taken to collect both sexes of dioecious species.
2. Specimens can be kept alive for about two weeks in polythene bags, provided they are in good condition and stored in a cool shady place or refrigerator. Animal life and debris should be removed and excess moisture poured off before storage.
3. For longer-term storage, specimens can be 'pickled' in tubes of 4% formalin or 60% alcohol. The tubes should be *full* of preservative and water-tight.
4. Specimens can be dried to make herbarium sheets, but this method of preservation is not recommended as the plants are brittle and easily damaged and they may become impossible to identify satisfactorily.
5. Fresh material sent for identification through the post should be enclosed in a polythene bag, wrapped in newspaper (to absorb leaking moisture), and enclosed in a strong envelope or padded bag. The packet must be marked 'Live plant material, open at once'. Preserved material should be sent in a well-sealed plastic (not glass) tube of 4% formalin. Full collection details should accompany each specimen, including a six-figure grid reference.

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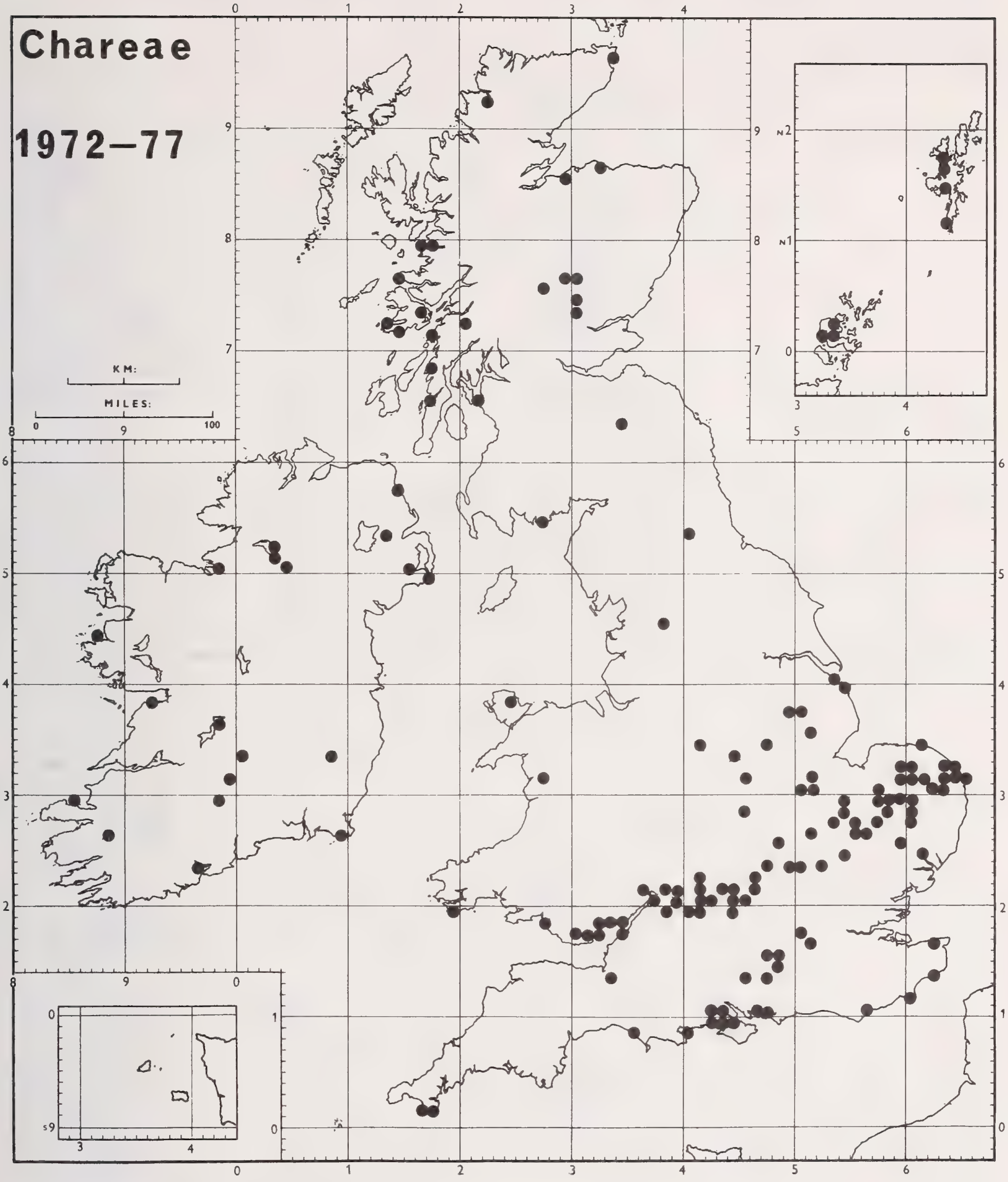

FIGURE 2. Distribution map of the Chareae (*Chara, Lamprothamnium, Nitellopsis*) based on records collated at the British Museum (Natural History) from 1972 to 1977.

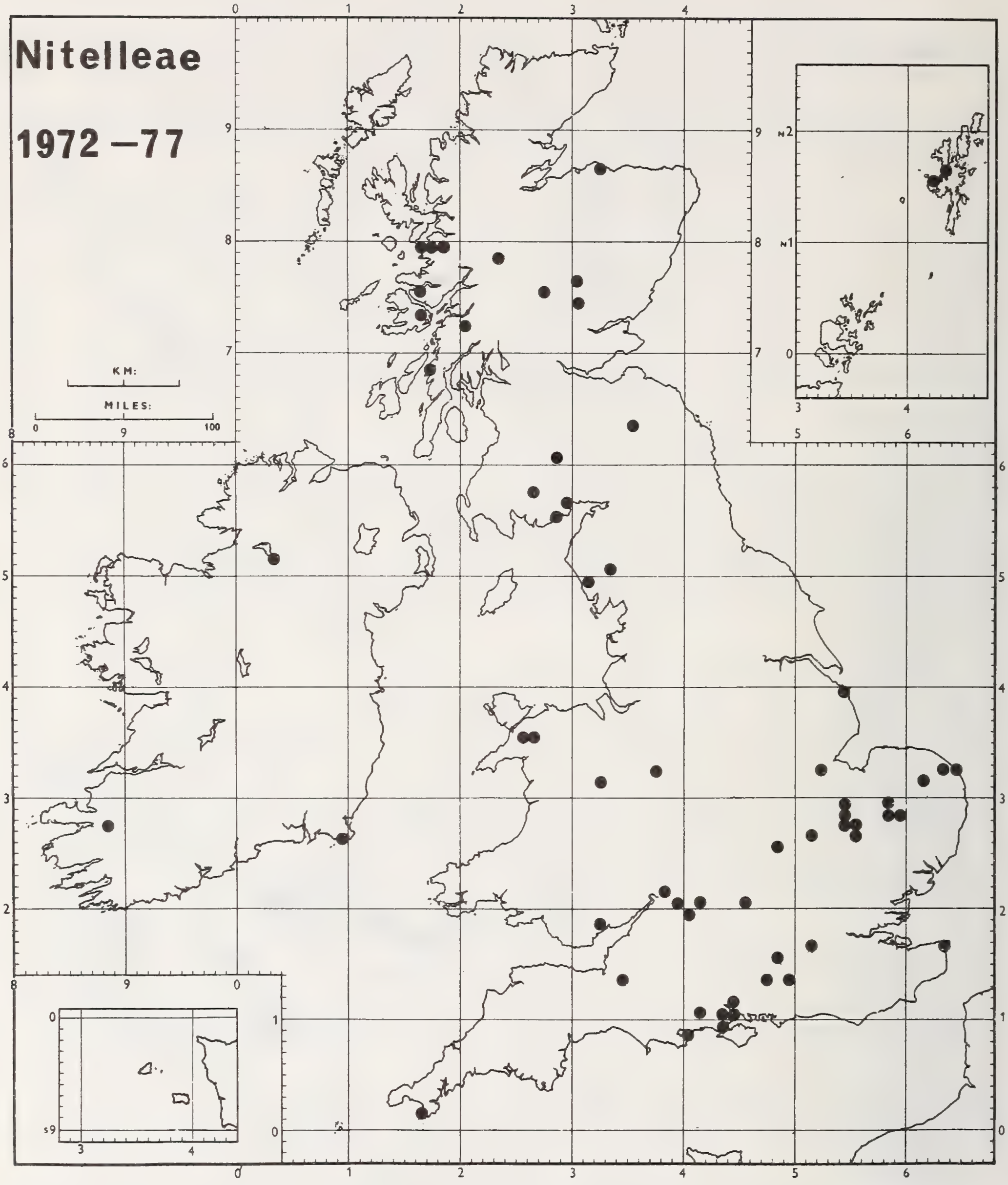

FIGURE 3. Distribution map of the Nitelleae (*Nitella, Tolypella*) based on records collated at the British Museum (Natural History) from 1972 to 1977.

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Sisymbrium volgense Bieb. ex E. Fourn. in Britain

E. J. CLEMENT

13 Shelford, Burritt Road, Kingston-upon-Thames, Surrey

ABSTRACT

A new locality for the alien *Sisymbrium volgense* Bieb. ex E. Fourn. is reported. The history of this species in Britain is given and a description is presented.

FIRST RECORD FOR SOUTH LANCS.

On 12th July, 1977, Miss Vera Gordon found a flourishing colony of the adventive *Sisymbrium volgense* Bieb. ex E. Fourn. between a factory wall and the towing path of the Leeds and Liverpool Canal in Bootle, Liverpool, S. Lancs., v.c. 59. This is the first record for the vice-county. Predictably (see below), one of the near-by factories was a flour-mill of long standing. A search for other aliens in the neighbourhood revealed nothing unusual, with the exception of a clump of depauperate *Holoschoenus vulgaris* Link on the canal bank; a common origin seems unlikely.

The *Sisymbrium* grew in a large, rhizomatous patch measuring some 21 × 22 feet, but no more plants could be found during a search along several miles of adjacent towpath. It seems probable that a single seed or rhizome fragment founded the colony; assuming a 3-inch radial extension per year the time of origin would have been about 1930. Several other British records are of a similar date, when the species occurred mainly as an adventive near flour-mills or docks which were importing Russian corn. It is certainly no recent arrival in S. Lancs.

HISTORY IN BRITAIN

This species was given for Britain by Ball (1964) and appears in Clapham (1962); Dandy (1958), however, excluded it for Britain, whilst McClintock (1957) defined it as being established in two localities. Clearly a review of its status in Britain is desirable, and this follows. Personal enquiries, together with a search of literature and herbaria, reveals that prior to 1977 no-one had seen this species in Britain since 1959. It has been reliably recorded from five vice-counties:

Surrey, v.c. 17. Disturbed ground in field outside Kew Herbarium, A. K. Jackson, N. Y. Sandwith & T. A. Sprague, 1934, **BM**, **K**; Green Lane Refuse Tip, Malden, R. C. Wingfield, 1957–8, **BM**.

E. Gloucs., v.c. 33. Gloucester Docks, J. E. Lousley, 1956, **BM**, **K**, **RNG**.

W. Gloucs., v.c. 34. On made ground, St Philip's Marsh, Bristol, C. Bucknall, 1896; same place, J. W. White, 1907, **BM**; same place, I. M. Roper, 1909, **BM**; same place, G. C. Druce, 1916; Avonmouth Docks, N. Y. Sandwith, 1927 & 1938, **K**; same place, J. E. Lousley, 1956 & 1959, **BM**, **K**, **RNG**.

Glam., v.c. 41. Barry Dock, R. Melville, 1930, **K**.

S. Lancs., v.c. 59. Liverpool, V. Gordon, 1977, **herb. E. J. Clement**, **LPL**.

It is probable that this species persisted at Bristol from 1896 to at least 1916, as Roper (1910) said 'This alien has been well established for some years on ground that has been raised by tipping city refuse', and at Avonmouth Docks from 1927 to 1959, there still being three widely separated colonies there in 1959.

The Barry Dock plant was from waste ground by railway sidings, where cleanings from the Rank's Flour Mill nearby were the main source of aliens. Avonmouth and Gloucester Docks are likewise well known for their grain-aliens. The origin of the Surrey records remains unexplained: the Kew record was ignored, or overlooked, by Bangerter & Welch (1952).

DISTRIBUTION OUTSIDE BRITAIN

In continental northern Europe this plant has a similar history, again being introduced with Russian corn, and it persists in similar spots. It occurs as an alien in Norway, Sweden, Finland, Denmark, Holland, Belgium, Germany, Poland (Majewski 1971), France, Czechoslovakia (Jehlík 1971) and various parts of the USSR; it enjoys the more continental climate and sets seed much more readily, even in Norway, than in Britain, and is otherwise better established. In southern Finland, however, Kääntönen (1976) remarked on the absence of seedlings during ten years of growth. Curiously, unlike other Russian weeds, it has not become naturalised in N. America — the abstract to the contrary in Kent (1971) is incorrect, as the original paper by Jörgensen & Ouren (1969) states 'It has not been possible to find records from outside Europe, nor have we been able to locate any unpublished finds in Argentina and Australia.' I have not been able to fault this statement.

The species is native only in south-eastern European Russia, in the lower reaches of the rivers Volga and Don (Vasil'chenko 1970).

NOMENCLATURE

The Bristol plant was at first known incorrectly as *Sisymbrium hispanicum* Jacq. (White 1912); it had later been independently refereed in 1910 both as *S. obtusangulum* Schleich. ex Willd. and as *Brassica elongata* Ehrh. *S. hispanicum* was, indeed, about the nearest match in the descriptions provided by de Candolle (1824). The first correct determination, by A. Thellung, was published by Druce (1920), 24 years after the original discovery.

Marschall von Bieberstein first determined herbarium sheets as *S. wolgensis* [*sic*], but published no description. Ledebour (1841) mentioned this as an observation, at the same time wrongly ascribing the plant to *S. austriacum* Jacq. Not until Fournier (1865), on the publication of his second doctorate thesis, did the name become valid according to the *International code of botanical nomenclature* — his amendment of the spelling is unfortunate, but must be adhered to. Lawalrée (1957) and many others are incorrect in persistently using the familar spelling and citation of *S. wolgense* Bieb. ex Ledeb. or *S. wolgense* Bieb. Note that the author is occasionally quoted as P. N. Eugène Fournier (e.g. Anonymous 1974), the style that he chose for his earlier work of 1861. Fournier only saw one herbarium sheet — the holotype specimen in Herb. Cosson in **P** (Eichwald, Becker *Pl. Volgae Inferioris* n. 103); there is not a photograph of it in **BM** or **K**, but there can be no reasonable doubt about its identity.

DESCRIPTION

Illustrations of this species in the world's literature are scarce and not very easily accessible; Suireishchikov (1907), Voronov (1931), Jehlík (1971), Sharova (1971) and Hejný (1973) are examples. Descriptions may be found in many non-Russian works, but a number of misleading or incorrect phrases occur. Nor does the Liverpool specimen key out very convincingly using Ball (1964). Hence, it is not inappropriate to provide another description here.

A rhizomatous and mostly glabrous perennial. Stems 30–75 cm, upright, branched above, glaucous to pruinose, normally with very inconspicuous, sparse, minute (<0.5 mm) hairs within 1–2 cm of the root collar. Lower and middle leaves 5–15 cm, very variable (especially between different colonies), triangular to ovate in outline, unequally dentate or lobed, typically prominently hastate, normally pinnatifid or pinnatisect towards the base with 1–3(4) pairs of lobes, with teeth with a callous apex, glabrous; lowest leaves usually uniformly and minutely pubescent, but these soon withering away. Upper leaves obtuse to subacute, $\pm$ entire, lanceolate to rhombic, long cuneate, the petiole length increasing down the plant. Inflorescence ebracteate. Pedicels 4–6 mm at flowering, little increasing at fruiting, slender, erecto-patent. Sepals 3.5–4.5 mm, erecto-patent, the outer with a minute swelling below the tip (best seen in the buds) and saccate at base. Petals 7–9 mm, bright yellow. Anthers *c* 1.5 mm. Mature siliquae 2.5–4 cm (but in British specimens often failing to develop past 1–2.5 cm and containing no viable seed), 1 mm diameter, subtorulose, frequently slightly curved; valves 3-veined but only the middle one distinct; style almost absent (<0.5 mm). Seeds not seen. $2n = 14$ (Czechoslovakian specimen from Bratislava, 17/8/1972, *V. Feráková*, **CGE**).

When in flower the plant has very much the appearance of a *Brassica* species, being glabrous and glaucous; indeed, it was as a *Brassica* that I originally tried to match it. Its true affinity is exposed as the fruits develop. Other authors remark on the similarity to *Brassica juncea* (L.) Czern., whilst in **CGE** the only British gathering labelled as '*S. volgense*' is in reality a giant plant of *Brassica nigra* (L.) Koch (A. C. Leslie pers. comm. 1977).

Earlier descriptions, including the type description, have wrongly stated that it is an annual or biennial, as are the common weeds in this genus. The lower and middle leaves are sometimes described as being pubescent beneath with pubescent petioles, and as always being pinnatifid, and the stems as being hairy below. Most flowering or fruiting specimens that I have seen have appeared to be glabrous, the extreme basal parts of the stems often being absent. The species is markedly variable, particularly in leaf-shape, and it may well be possible to individually recognize each colony or clone in Britain — the Liverpool one is unusual in that many lower leaves are unlobed and truncate at the base with little or no sign of being hastate.

The non-glaucous *S. strictissimum* L. is the only other patch-forming perennial *Sisymbrium* occurring in Europe; it is immediately separated by its always unlobed and acuminate leaves which are hairy beneath. The biennial to perennial *S. austriacum* Jacq. has a longer style, 1–3 mm long in fruit, and smaller petals, 3.5–5 mm long; there appear to be no recent records for this species in Britain and very few of the older records were correctly identified. It is closely related to the tufted *S. polymorphum* (Murray) Roth but lacks the narrowly linear, lateral leaf-lobes characteristic of that species.

FUTURE OF THE SPECIES IN BRITAIN

Fragments of rootstock of the Liverpool colony have been introduced into private cultivation by C. G. Hanson (Ware, Herts.) and J. R. Palmer (South Darenth, W. Kent), as the colony could easily be destroyed by local redevelopment.

Remarks upon the persistent tendency of this species have been made at almost every British locality. It seems quite possible that it may still persist at more than one of these sites and perhaps also remains elsewhere still undiscovered or overlooked as a nondescript yellow crucifer. With its continued spread on the Continent further introduction becomes more likely; lack of seed-set is no serious handicap — *Artemisia verlotiorum* Lamotte has already demonstrated this fact in south-eastern England. Man's eagerness to remove soil from one site to another makes for very successful dispersal of ruderal species with a rhizomatous underground system.

ACKNOWLEDGMENTS

I am indebted to many correspondents who have helped by drawing my attention to records or references, notably to Mrs M. C. Foster, Miss V. Gordon, D. H. Kent, A. C. Leslie and Dr F. H. Perring.

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Variation of morphological and chemical characteristics of acorns from populations of *Quercus petraea* (Matt.) Liebl., *Q. robur* L. and their hybrids

P. C. BROOKES* and D. L. WIGSTON†

Department of Biological Studies, Lanchester Polytechnic, Coventry

ABSTRACT

Variation of morphology and inorganic nutrient content within and between natural populations and individuals of *Quercus petraea* (Matt.) Liebl., *Q. robur* L. and *Q. petraea* × *Q. robur* (*Q.* × *rosacea* Bechst.) is described. It is concluded that acorn shape and size are unreliable discriminants between the two oak species, and also between them and their hybrids. No significant differences in N, P, K, Ca, Mg and Na content of *Q. petraea* and *Q. robur* were detected, although the usually smaller acorns of *Q. petraea* clearly illustrate the tendency of both species to have higher concentrations of elements in acorns below 0·2 g cotyledon dry-weight. No regularity in the occurrence of years of high acorn productivity ('mast' years) and little or no productivity ('blank' years) was discovered.

INTRODUCTION

The acorn is the fruit of the oak—a nut which is partially enveloped by a cup formed at the base. In the literature on the native species of oak, *Quercus petraea* (Matt.) Liebl. and *Q. robur* L., reference is made to variability in form and production of acorns, but the nature and extent of this variability is rarely defined. Acorn fall and viability have been examined (e.g. Ovington & Murray 1964, Shaw 1968a, 1968b) and also subsequent seedling establishment and regeneration potential (e.g. Jarvis 1963, Shaw 1968a). These reports refer to *Q. petraea*; little attention has been paid to *Q. robur*, which is surprising considering that *Q. robur* acorns have been favoured for planting in the past (Jones 1959) although today *Q. petraea* is preferred (Penistan 1974). Rushton (1977) distinguished between acorns collected from natural populations and artificially produced acorns from crossing experiments. He pointed out that differences recorded by him in acorn shape between the parent species and F_1 hybrids from controlled crossing experiments were consistent with published accounts, whereas those recorded by Wigston (1971) from field collections might be attributed to differential growth markedly influenced by external factors.

In this paper the following characters of acorns are examined:

1. development and fall,
2. fresh-weight/dry-weight relationships,
3. size and shape,
4. nutrient content (cotyledon potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), nitrogen (N), sodium (Na)).

Variation in these characters is examined at the following 'levels':

A. between acorns of a single tree,
B. between different trees of the same population,
C. between different populations from the same local area,
D. between different populations from different regions of the British Isles.

Each of A–D is considered both within a single year and between years.

* Present address: Soils and Plant Nutrition Department, Rothamstead Experimental Station.
† Present address: School of Environmental Sciences, Plymouth Polytechnic.

TABLE 1. ACORN PRODUCTION IN SAMPLE SITES

Site	Period of observation	Acorn production
(a) Sites on acid peat among granite clitter, Dartmoor, (*Q. robur*)		
Wistman's Wood, GR 20/613.773, v.c. 3	1965–69	1965 & 69; early seed development aborted by autumn
		1966 & 68; no seed production or development
		1967 ; moderate crop of small acorns
	1971–74	1971 ; moderate crop of small acorns
		1972 ; no seed production or development
		1973 ; early seed development aborted by autumn
		1974 ; poor crop of very small acorns
Higher Hisley, GR 20/781.800, v.c. 3	1965–68	1965 ; moderate crop of small acorns
		1966 & 68; poor crop of small acorns
		1967 ; good crop of small acorns
	1972–74	1972 ; poor crop of small acorns
		1973 & 74; good crop of smallish acorns
(b) Mixed woods with hybrids on the margins of the Dartmoor granite		
Dean Wood, GR 20/705.646, v.c. 3	1969	1969 ; moderate crop of variable acorns
Meldon Wood, GR 20/ 564.923, v.c. 4	1969	1969 ; moderate crop of variable acorns
(c) Largely *Q. petraea* woods on the margins of the Dartmoor granite		
Steps Bridge, GR 20/804.886, v. c. 3	1965–67	1965 ; poor crop of normal-sized acorns
		1966 & 67; moderate crop of normal-sized acorns
	1972–74	1972 ; no seed production or development
		1973 ; poor crop of normal-sized acorns
		1974 ; moderate crop of normal-sized acorns
Yarner Wood National Nature Reserve, GR 20/777.808, v.c. 3	1972–74	1972 & 73; no seed production or development
		1974 ; good crop of normal-sized acorns
(d) *Q. robur* wood on abandoned coal waste, Warks.		
Alvecote Pools Nature Reserve, GR 43/255.045, v.c. 38	1972–74	1972 & 74; good crop of normal-sized acorns
		1973 ; good crop including very large acorns
(e) Mixed Wood including hybrids, Staffs.		
Leek Nature Reserve, GR 43/005.525, v.c. 39	1973–74	1973 ; moderate crop of normal-sized acorns
		1974 ; very little seed production or development

TABLE 2. COMPARISON OF FIVE ADJACENT TREES, *Q. ROBUR*, ALVECOTE POOLS NATURE RESERVE

Tree	Acorn size range (g) 1973	Acorn size range (g) 1974	Acorn shape range 1973	Acorn shape range 1974
15	No crop	0·50–3·0	No crop	1·60–2·20
15a	(3–4·5) 6·0–12·0	0·10–3·05	1·30–1·75	1·00–1·40
15b	2·5–5·5	No crop	1·20–1·50	No crop
15c	3·0–6·0	No crop	(1·15-)1·40–1·70	No crop
15d	3·0–8·5	0·5–4·5	1·15–1·55	1·05–1·40

SITES, MATERIALS AND METHODS

Acorns were collected from sites in N. and S. Devon, v.c. 3 & 4, Warks., v.c. 38, and Staffs., v.c. 39, between 1965 and 1974 (Table 1). Populations and individual trees were identified by leaf character analysis (Wigston 1975). In 1973 and 1974 it was possible to pick acorns from individual trees at Alvecote Pools Nature Reserve, but in all other years and for all other populations acorns had fallen prior to collection.

The acorns were collected for seedling growth trials (Wigston 1971, Brookes 1976) and thus observations were made on fresh material. However, nutrient and dry-matter analysis of seedling growth required destructive sampling, and *estimates* of initial cotyledon dry-weight and nutrient content are required. Acorns, like most fruits and seeds, lose moisture until ripe; extreme desiccation leads to loss of acorn viability, particularly if they 'chit' (showing pre-dormancy radicle emergence). Acorns were therefore collected at or as soon after acorn fall as possible, and stored in damp absorbent material. Damp *Sphagnum* and vermiculite are suitable, and partially dried acorns quickly regain moisture and retain viability (Wigston 1971).

Dry-weight was determined after heating at 105°C to constant weight. The nutrient content of cotyledon pairs was determined by dry-ashing at 450°C, dissolving the residue in 0·6N HCl prior to suitable dilution (Brookes 1976). Cotyledon K, Ca, Mg and Na were determined by atomic absorption spectrometry (Price 1972). P was determined colorimetrically (Olsen & Dean 1965) and N by Kjeldahl digest (Bremner 1965) followed by ammonia probe measurement (Brookes 1976).

ACORN PRODUCTION

The term 'mast' is a general term for fruit of the Fagaceae, especially implying 'pannage' – food for swine. In the literature on native oak, 'mast years' are referred to, when acorns are produced in substantial quantities. Conversely 'blank years', such as 1972, are reported, when acorn production is low or non-existent throughout much of Great Britain (Penistan 1974). Rushton (1977) attributed different success rates of artificial crossing in 1969–71 to different amounts of acorn production between years. Some authors refer to 'cycles' of mast and blank years (e.g. Jones 1959, Penistan 1974) implying *regular* alternation of acorn production and non-production.

The data of Table 1 show that for the sites investigated mast and blank years do occur, but these are not necessarily the same for different populations and differences occur between *Q. petraea* and *Q. robur* populations. There is no indication of 'cycles' of acorn production. Also a distinction must be made between blank years with no initial acorn development and those where a substantial number of developing acorns abort. Acorn crops also vary between trees of the same species in homogeneous populations. A group of five adjacent trees at Alvecote Pools Nature Reserve showed considerable differences between each other in acorn production and morphology in 1973 and 1974 (Table 2).

FRESH-WEIGHT/DRY-WEIGHT RELATIONSHIPS

Fresh-weight/dry-weight relationships for *Q. petraea* and *Q. robur* acorns (treated to avoid desiccation) show good correlation between the two variables. Fig. 1 is a scatter diagram illustrating this for 1973. The two species differ in size range, but the proportions of water content are the same. However, exceptionally small *Q. robur* acorns obtained from Wistman's Wood in 1974 gave a much higher water content per unit cotyledon weight than acorns in normal size ranges. This appears to be due to testas which are relatively thick compared with the cotyledons.

It is necessary to establish this fresh-weight/dry-weight correlation in order to *estimate* the initial cotyledon *dry*-weight from total *fresh*-weight in seedling growth trials.

ACORN MORPHOLOGY

Q. robur is stated to have large elongate acorns, whereas those of *Q. petraea* are smaller and rounded (Jones 1959).

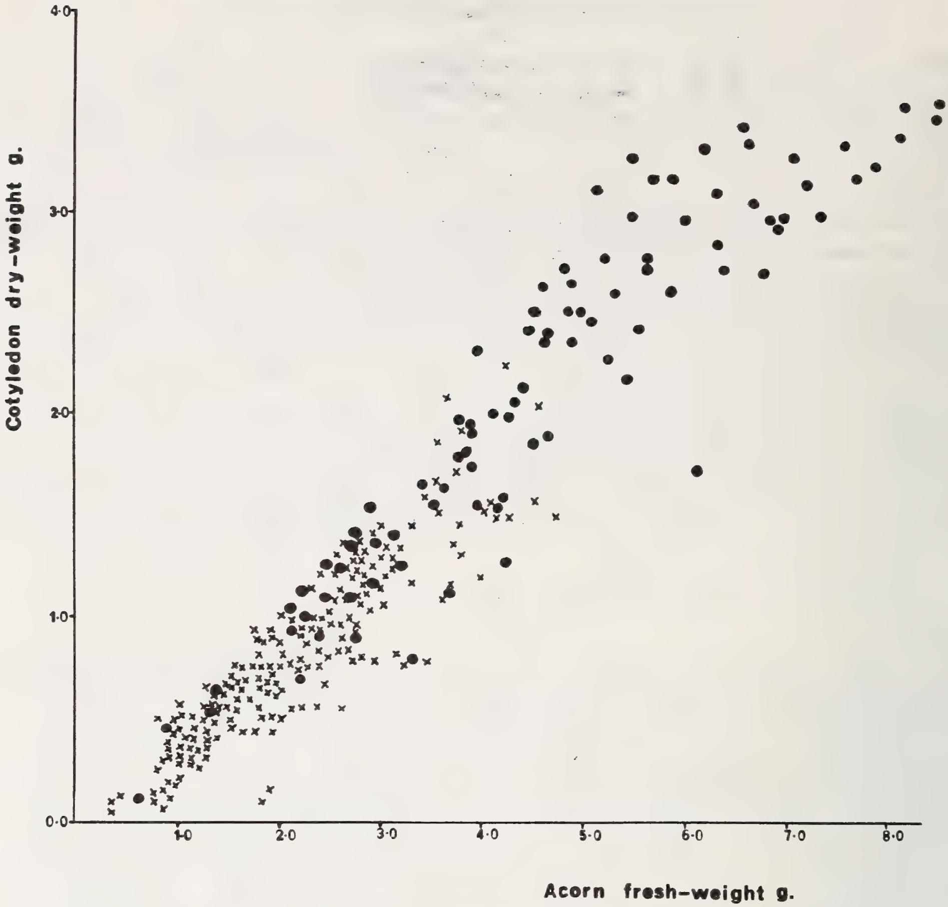

FIGURE 1. Scatter diagram of fresh-weight/dry-weight, 1973; circles – *Q. robur*, crosses – *Q. petraea*.

Figure 2 shows frequency distributions of acorn fresh-weights for *Q. petraea* and *Q. robur* populations sampled in 1973. Although the modal values are distinct there is much overlap. The acorn sizes of most populations are normally-distributed (Wigston 1971) but some have 'skew' distributions. For example, some trees at Alvecote Pools Nature Reserve in 1973 produced exceptionally large acorns (Table 2). The high-level oakwoods of the Dartmoor granite rarely produce good acorn crops, the many blank years being often due to abortion of developing acorns; when acorn crops are produced, the acorns are usually very small (Fig. 3A) and of low viability. These very small Dartmoor *Q. robur* acorns are rounded (wider than long) – a shape diagnostic for *Q. petraea* (Fig. 3B). This could suggest that acorn shape is more a function of size than a reflection of genetic differences.

In populations dominated by trees of hybrid status, such as Dean Wood and Meldon (Table 1), intermediate and bimodal size and shape distributions are obtained. In artificial crosses Rushton (1977) reported that the acorn shape of hybrids fell midway between that of *Q. petraea* and *Q. robur*, but was very variable and considerably overlapped the ranges shown by the parent species. The hybrid acorns were generally smaller than either species. Experimental crosses have low fertility (Rushton 1977) but trees diagnosed as hybrids on morphological characters can produce substantial crops of acorns (Wigston 1971, 1974).

As with other taxonomic characters (Jones 1959), acorn shape is more variable in *Q. robur* than *Q. petraea*, but so also is the size range.

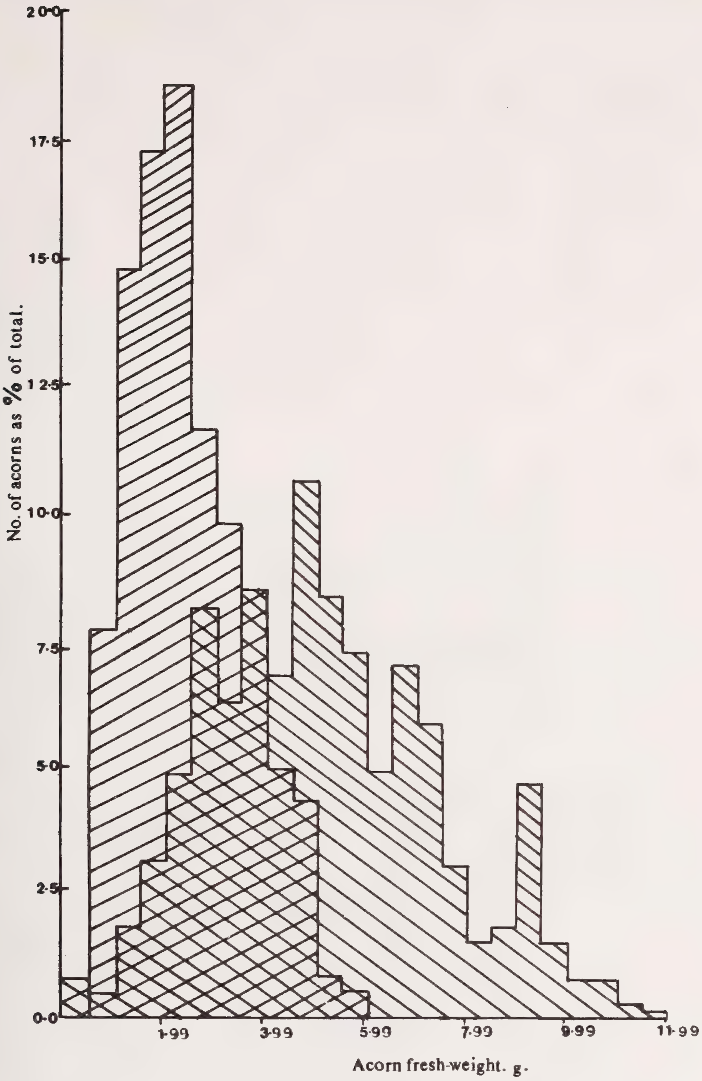

FIGURE 2. Acorn fresh-weight distributions, 1973; right-hand peak – *Q. robur*, left-hand peak – *Q. petraea*.

VARIATION WITHIN POPULATIONS

Table 2 shows data for five adjacent trees at Alvecote Pools Nature Reserve for 1973 and 1974. The remarkably large acorns produced by trees 15a and 15d in 1973 did not occur in 1974 (Fig. 4). Trees 15b and 15c produced similar frequency ranges of normal-sized acorns in 1973, but those of 15c were much more elongate than those of 15b. The crop for tree 15 in 1974 had remarkably elongate acorns for their size, which was at the lower end of the normal *Q. robur* range.

Table 3 shows 1973 data for five areas at Steps Bridge which differ in aspect, exposure, slope and soil-type. Although within the normal ranges for *Q. petraea*, the five samples show considerable variation between each other in size and shape.

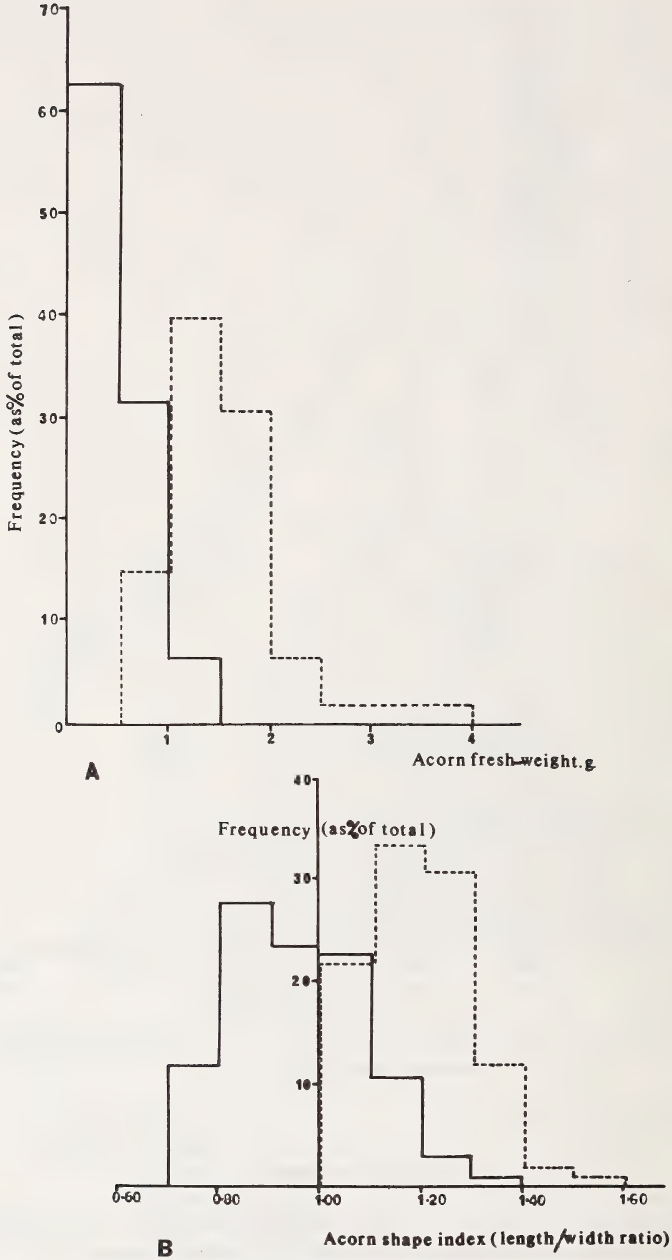

FIGURE 3. A. Acorn weight distributions; B. Acorn shape distributions. Dotted line – Wistman's Wood 1967, solid line – Wistman's Wood 1974.

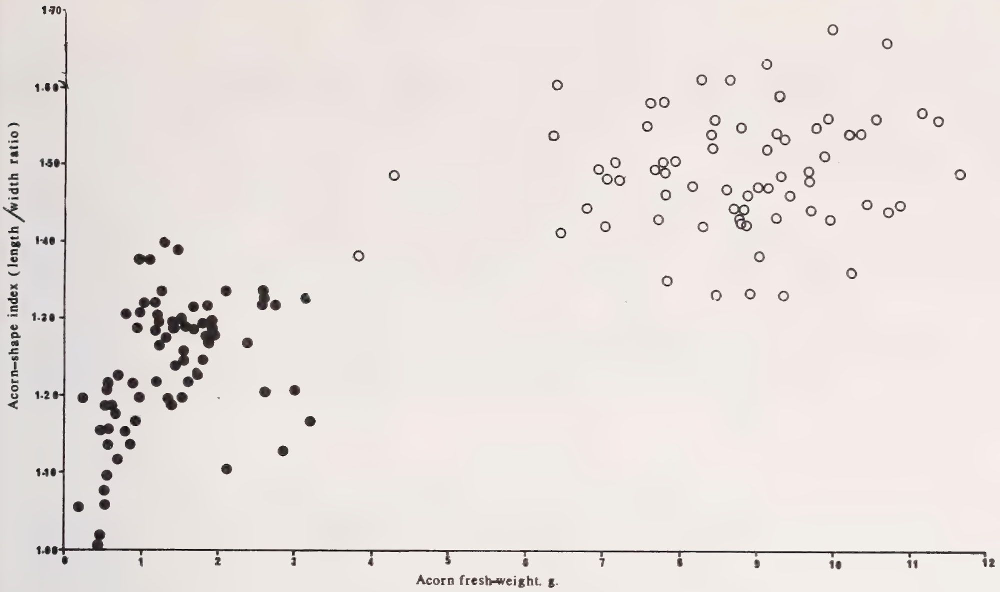

FIGURE 4. Alvecote Pools Nature Reserve, tree 15a (*Q. robur*). Scatter diagram of acorn shape/acorn fresh-weight; closed circles – 1974, open circles – 1973.

TABLE 3. COMPARISON OF FIVE AREAS AT STEPS BRIDGE, *Q. PETRAEA*, 1973

Area	Acorn size range (g)	Acorn shape range
1. Mid-valley bottom (roadside)	0·5–6·0	1·00–1·60 (-1·80)
2. Lower valley, steep north-facing slope	0·1–5·0	1·00–1·80
3. Level area between upper and lower steep north-facing slopes	0·1–4·5	1·00–1·75 (-1·85)
4. Upper valley, steep north-facing slope	0·1–3·0 (3·5–4·5)	1·00–1·80
5. Valley bottom	1·5–6·0	1·05–1·50

TABLE 4. MEAN ACORN NUTRIENT CONCENTRATIONS AND RANGES (mg nutrient g^{-1} cotyledon), ALL POPULATIONS, 1973

	Q. robur	*Q. petraea*
N	15·3, 9·4–21·4	12·6, 8·5–17·7
P	1·60, 0·81–2·45	1·65, 0·56–2·04
K	11·70, 5·14–16·17	9·57, 6·50–21·30
Ca	0·79, 0·35–1·56	2·27, 0·42–3·40
Mg	0·79, 0·39–0·98	0·83, 0·46–1·58
Na	0·34, 0·14–1·11	0·17, 0·11–1·07

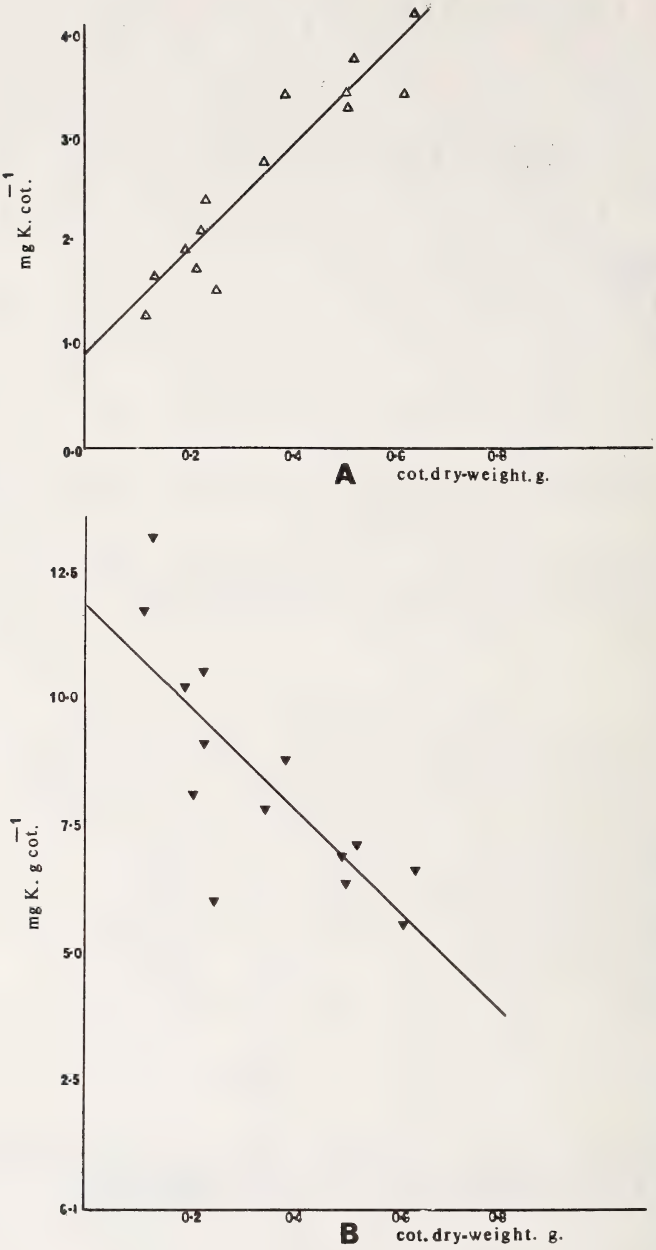

FIGURE 5. Cotyledon K content of *Q. petraea* from Yarner Wood. A: mg K. cotyledon^{-1} against cotyledon dry-weight. $r = 0·94$, $p < 0·05$, $y = 5·0x + 0·92$. B: mg K. g cotyledon^{-1} against cotyledon dry-weight, $r = -0·79$, $p < 0·05$, $y = 11·96–9·90x$.

COTYLEDON NUTRIENT RESERVES

Studies of mineral nutrient metabolism of developing seedlings (e.g. Ovington & MacRae 1960, Newnham & Carlisle 1969) have used acorns of very limited provenance and morphology, usually at our level of variation 'A' only. Brookes (1976) carried out determinations of N, P, K, Ca, Mg and Na levels of cotyledon pairs from acorns from a range of sites, prior to trials which examined seedling growth and nutrient metabolism at levels of variation from A to D. Table 4 shows data for the above elements for 1973. High K content is characteristic of both *Q. petraea* and *Q. robur* acorns, but the difference between the two species in mean values and range for all six elements are not significant. As expected, for all elements, with increasing acorn size (expressed as cotyledon dry-weight) total nutrient content increases. Fig. 5A shows this relationship for K in *Q. petraea* acorns. However, the relationship is more variable for Ca and Na in both species.

If the amount of nutrient per unit cotyledon dry-weight is considered (Fig. 5B), the data show that as acorn size *decreases*, the proportions of nutrients *increase*, departing from linearity below cotyledon dry-weight of 0.2 g. This is most marked in the normally smaller acorns of *Q. petraea* (Brookes 1976).

DISCUSSION

Individual trees show marked variation in acorn morphology within and between years, and different trees of the same population may yield acorns substantially different in the same year. Also there are clearly marked differences between acorns from controlled crossing experiments (Rushton 1977) and collections from natural populations (Wigston 1971, Brookes 1976). The reported differences between *Q. petraea* and *Q. robur* acorns in size and shape do appear in this investigation, but there is so much variation within and between populations and individuals of both species and their hybrids that we do not consider acorn morphology to be a reliable discriminant between *Q. petraea* and *Q. robur*, or between them and their hybrids.

Some authors (e.g. Jones 1959, Penistan 1974) refer to cycles of mast and blank years, but their occurrence is in fact irregular, and the term cycle should not be used. Blank years can apply to individual trees within a population where overall acorn production is high (Brookes 1976) or to local populations in a region exhibiting a good mast year (Wigston 1971).

Few differences in acorn nutrient concentrations between *Q. petraea* and *Q. robur* were observed, and in view of the large number of acorns analysed it is likely that there are no significant differences between the two species in this respect. An interesting feature of the data is that acorn nutrient *concentration* is greater in small acorns than large ones for an individual tree or population, although large acorns have greater *amounts* of these nutrients than small ones.

CONCLUSIONS

The purpose of this study of acorn morphological and chemical characteristics was to establish the nature and range of variation within and between populations and individuals of the two British oak species and their hybrids, prior to seedling growth trials. In our opinion, results based on samples of restricted provenance and size (e.g. those obtained by Jarvis 1963, Ovington & MacRae 1960, Newnham & Carlisle 1969) cannot be regarded as providing valid evidence of variation in nutrient reserves and subsequent seedling response, or account for the differences between the growth of *Q. petraea* and *Q. robur* described by Brookes (1976).

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The distribution of *Leucojum aestivum* L. in the British Isles

L. FARRELL

48 High Street, Needingworth, Cambs.

ABSTRACT

Many of the records for *Leucojum aestivum* were made before 1950 and no indication of the population size was given. A field survey of the southern English sites was carried out during April and May, 1974–1978. Species lists, habitat descriptions and population estimates were made. Any threats to the survival of the sites were noted. An assessment of the most important localities in terms of population size was included.

INTRODUCTION

Since 1974 an investigation has been undertaken into the present status in the British Isles of the Loddon Lily or Summer Snowflake (*Leucojum aestivum* L.). As the species flowers very early in the season, in late April and early May, it is often overlooked by botanists later in the year. The inaccessibility of the sites is also a problem, as they are often dense willow carrs, very muddy channels or islands. The following two statements give some indication of the habitat and distribution of the species:

'Native. Wet meadows and willow thickets, very local; from Devon and Kent to Oxford and Suffolk and from Wexford and Cork to Antrim and Fermanagh; certainly native along the Thames and Shannon and probably elsewhere within the range given above. Commonly cultivated and sometimes found as an escape in other places' (Warburg 1962).

'This bulbous herb occurs in wet meadows and willow thickets by rivers in well over 30 localities in Wiltshire and Dorset, and in the valley of the River Thames in Berkshire, Oxfordshire and Buckinghamshire. Formerly also in Devon, Hampshire, Kent and Middlesex. It still occurs in at least one locality in Limerick in western Ireland. Records from elsewhere are undoubtedly of garden origin. Although losses in the past of this attractive plant have been due to uprooting many of the present populations are large and protected by their relative inaccessibility' (Perring & Farrell 1977).

METHODS

Old records were extracted from the Biological Records Centre at Monks Wood Experimental Station and from the appropriate county Floras. Local botanical recorders were contacted for more recent information.

The field survey of the southern English sites was carried out in the months of April and May between 1974 and 1978. A rubber boat was used in 1977 to visit several of the more inaccessible islands in the River Thames. At each site a population estimate and habitat notes were made and the associated species listed.

RESULTS

DISTRIBUTION

It was found that in England there are now at least 48 probably native populations of *L. aestivum* (Table 1). The populations vary from thousands on one of the Thames islands to a single clump by the river margin. Many of the sites are now islands, whereas in the past the plant was probably found by the riverside towpaths.

TABLE 1. RECENT RECORDS OF *LEUCOJUM AESTIVUM* FROM NATIVE SITES IN ENGLAND

Vice-county	Locality	Grid Ref.	Last Record	Recorder
7	Chilton Foliat	41/330·701	1976	Farrell
8	Upper Woodford	41/126·373	1976	Farrell
8	Ford	41/163·323	1976	Hornby
22	Moulsford	41/595·849	1974	Farrell
22	Abbey Mead, Abingdon	41/50·97	1963	Palmer
22	Sutton Courtenay	41/502·942	1977	Farrell
22	Long Wittenham	41/543·937	1977	Farrell
22	Clifton Hampden	41/547·954	1977	Farrell
22 & 23	Little Wittenham	41/567·934	1977	Wells
22	Nr Shillingford	41/593·932	1967	Bowen
22	Basildon Grotto	41/60·79	1968	Trembath
22	S. Wallingford	41/60·87	1963	Bowen
22	N. Wallingford	41/614·908	1974	Farrell
22	Loddon Bridge (a)	41/766·713	1969	Wakeley
22	Loddon Bridge (b)	41/769·719	1969	Wakeley
22	Shiplake Aits (a)	41/766·771	1976	Farrell
22	Shiplake Aits (b)	41/766·772	1976	Farrell
22	Shiplake Aits (c)	41/768·775	1976	Farrell
22	Sandford Mill	41/779·730	1975	Farrell
22	Winnersh	41/767·713	1973	Wells
22	Sandford Manor	41/782·735	1974	Wells
22	Whistley Park	41/785·737	1974	Farrell
22	Whistley Park Farm	41/788·748	1975	Bowen
22	Wargrave (a)	41/783·785	1976	Farrell
22	Wargrave (b)	41/785·791	1976	Farrell
22	Remenham	41/777·802	1977	Farrell
22	Bolney Court	41/779·808	1977	Farrell
22	N. of Wargrave Marsh	41/779·810	1977	Farrell
22	S. of Wargrave Marsh	41/781·801	1977	Wells
22	Hambleton Mill	41/784·849	1974	Wells
22	Quarry Wood	41/861·858	1976	Farrell
22	Marlow (a)	41/869·863	1977	Farrell
22	Marlow (b)	41/870·863	1977	Farrell
22	Marlow (c)	41/874·866	1977	Farrell
23	Shillingford	41/594·923	1975	Farrell
23	Culham	41/509·965	1975	Farrell
23	Radley	41/534·976	1975	Farrell
23	Nr Cleeve (a)	41/603·820	1974	Farrell
23	Nr Cleeve (b)	41/601·826	1974	Farrell
23	Nr Cleeve (c)	41/599·814	1974	Farrell
23	White Gates, Sonning	41/746·762	1977	Farrell
23	Sonning	41/754·756	1975	Pankhurst
23	Shiplake Court	41/771·783	1976	Farrell
23	Shiplake	41/779·787	1976	Farrell
23	Bolney Court	41/777·802	1977	Farrell
24	Medmenham	41/803·836	1975	Bevan
24	Temple Lock	41/834·844	1976	Farrell
24	Stoney Ware	41/845·854	1976	Farrell

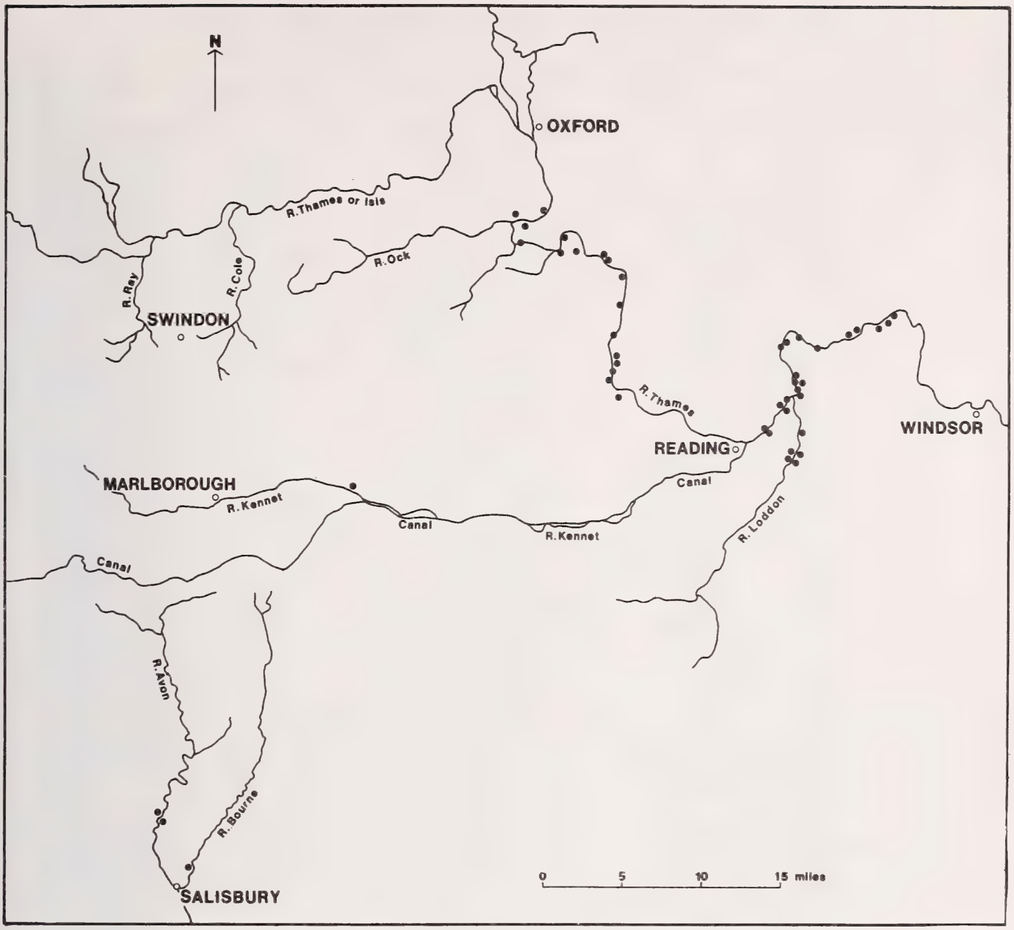

FIGURE 1. Map of the Thames Basin, showing the main areas of distribution of *Leucojum aestivum* in England.

There are two main districts where the species is frequently found in England (Fig. 1). One is the stretch of the Thames between Reading and Windsor, and the other, again on the Thames, is further upstream between Goring and Abingdon. As the English name of the plant suggests, there are several sites on the lower reaches of the River Loddon. These appear to be the only native localities for *L. aestivum* in England except for the isolated occurrences in Wiltshire, which are somewhat anomalous. The two colonies in the south of that county at Upper Woodford and Ford, on the Rivers Avon and Bourne respectively, appear to be entirely native situations, whilst that at Chilton Foliat, on the River Kennett, although again in a willow thicket, looks as though it may have spread naturally from one originally planted clump.

In Scotland, two clumps of *L. aestivum* were discovered near the east bank of the River Leven, Dunbarton, v.c. 99, in 1975. Two years later, a large population was found by the River Endrick in the south-eastern corner of Loch Lomond, Stirling, v.c. 86. Three more Scottish localities are known to exist in Kirkcudbright, v.c. 73, Wigtown, v.c. 74, and Easterness, v.c. 96. None appears to be native. The non-native populations in Britain and the Channel Islands are listed in Table 2. 29 localities are listed for Ireland (Table 3); those in southern Ireland are believed to be native.

TABLE 2. INTRODUCTIONS OR ESCAPES OF *LEUCOJUM AESTIVUM* IN BRITAIN AND THE CHANNEL ISLES

Vice-County	Locality	Grid Ref.	Last Record	Recorder
S	Guernsey	90/1·5	1975	McClintock
S	Jersey	90/4·2	1975	McClintock
S	Alderney	90/4·8	1972	McClintock
1	Falmouth district	10/7·3	1961	Margetts
2	Menabilly Wood	20/1·5	1931	Thurston
2	Landulph	20/4·6	1935	Adams
3	Tor Moss	20/822·423	1954	Walters
3	Littlehempston	20/81·62	1931	—
3	Knighton Heath	20/842·771	1959	Howitt
3	Exmouth	30/0·8	1956	Frankis
6	Frome	31/7·4	1957	Hunt
9	Woodsford	30/763·906	1978	Farrell
9	Charlton Marshall	31/900·042	1978	Farrell
9	Bourton	31/772·311	1975	Graveson
9	Kingston Lacy	31/986·016	1978	Farrell
9	Nr Wimborne Minster	40/0·9	1930	Leather
9	Wimborne St Giles	41/0·1	1951	Graveson
11	Wick Ferry	40/1·9	1949	Proctor
11	Titchfield Haven	41/533·028	1962	Bowman
11	Southwick	41/61·08	1933	Welch
18	Rochford	51/8·9	1956	Jermyn
20	Ware district	52/3·1	1958	—
22	Frilford	41/40·95	1965	Bowen
27	Cringleford Wood	63/196·066	1974	Hornby
30	Tingrith Park	52/0·3	1950	—
30	Bokhurst	52/0·6	1950	—
30	Great Barford	52/12·54	1950	Norman
31	Tilbrook	52/08·69	1954	Bishop
37	Park Wood	32/765·462	1955	Day
41	Caswell Cwm	21/5·8	1940	Webb
45	Milton	22/0·0	1933	Griffith
69	Nr Newby Bridge	34/365·864	1978	Livermore
69	Nr Middle Low Wood	34/425·862	1974	Livermore
69	Ambleside	35/372·033	1966	Williamson
73	Low Bridge of Tariff	25/685·541	1975	Stewart
74	Ardwell Mill	25/0·5	1938	Sprott
86	Endrick Mouth	26/436·886	1977	Mitchell
96	Drumnadrochit	28/5·3	1942	Campbell
99	Dumbarton-Bonhill	26/3·7	1976	Stirling

HABITAT

Of the 35 sites in England from which detailed records have been taken, 14 are on islands, usually with some form of tree cover, 12 are in dense willow carr, eight in woodland or under hedges, and only one in open grassland. Very few associated species were found growing with *L. aestivum*. Species lists from 26 English localities (Table 4) show that the main associates are *Urtica dioica*, *Salix* spp., *Symphytum officinale*, *Carex riparia* and *Alnus glutinosa*, all species which occur in damp places beside streams or rivers and in woods.

Only two of the localities visited showed a fairly rich flora. The first, on the bank of the River Thames at Shillingford, is a grassy promontory grazed by cattle, whilst the second, at Wargrave Marsh, is a dense *Salix* carr. Although many of the localities are on the river bank they are usually overhung to some extent by trees, and it is unusual to find the plant growing in the open as it is at Shillingford.

TABLE 3. IRISH RECORDS OF *LEUCOJUM AESTIVUM*

Vice-County	Locality	Grid Ref.	Last Record	Recorder
H1	Dingle	00/41·99	1975	Long
H3	Bandon Estuary	10/5·5	1975	Keyes–McDonnell
H6	River Clodiagh	21/4·1	1900	Knowles
H6	Kilbarry Bog	21/6·1	1972	Browne
H8	River Maigue	11/4·4	1909	Praeger
H8	Ballinacurra Creek	11/548·562	1974	Farrell
H8	Limerick	11/58·59	1909	Praeger
H8	Whitehall Creek	11/5·5	1909	Knowles
H9	Parteen	11/6·6	1909	Praeger
H10	Little Brosna River	12/9·0	1934	Praeger
H10	Thurles	21/0·5	1934	Praeger
H11	Erkina River	21/3·8	1934	Praeger
H12	Macmine	31/0·2	1909	Knowles
H14	Nr Durrow	21/4·7	1909	Knowles
H14	Kilmorony House	21/699·893	1945	Brunker
H18	Little Brosna River	12/9·0	1939	Praeger
H22	Oldbridge	22/9·7	1969	Synnott
H25	Lough Key	13/8·0	1970	Scannell
H30	Coalpit Lough	23/399·080	1973	Farrell
H30	Lough Mentis	23/358·004	1970	Lamb
H30	Annalee River	23/3·1	1930	Faris
H33	Lisgoole	33/2·4	1909	Praeger
H36	Dungannon (Coalisland)	23/8·6	1906	Bingham
H39	Masserne Deerpark	33/0·8	1972	Harron
H39	Brankinstown	33/1·6	*c*1930	Wright
H39	Langford Lodge	33/1·7	1972	Harron
H39	Lough Neagh (a)	33/1·8	1936	Praeger
H39	Lough Neagh (b)	33/1·8	1909	Tomlinson
H39	Mouth of Six-Mile River	33/1·8	1926	Sayers

DISCUSSION

STATUS

There has been considerable discussion about the status of *L. aestivum* in the British Isles. Only a few opinions are mentioned here, as a more detailed examination will be presented at a later date.

Of the early English botanists, Curtis (1788), Marshall (1896–1897), Druce (1896), Hind (1889) and Dunn (1905) thought it to be a native species. Curtis, the discoverer of the plant in England, stated '*Leucojum aestivum* is found undoubtedly betwixt Greenwich and Woolwich about half a mile below the former, close by the Thames side, just above high-water mark, growing (where no garden, in all probability, could ever have existed) . . .'. Watson (1849) defined his 'denizen' as a plant 'At present maintaining its habitats as if a native species, without direct aid of man, but liable to some suspicion of having been originally introduced by human agency, whether by design or accident'.

Marshall, who first recorded the plant in Ireland at Macmine Junction in 1897, saw nothing in the surroundings to make him doubt its being indigenous there. Praeger (1937) thought that there was no doubt that the species was truly native in many or most of its Irish stations. An excellent paper summarizing the early views on the status of *L. aestivum* (Knowles & Phillips 1910) attempted to show that the habitat and distribution of the plant on the Continent, where it is admitted to be native, agree with its occurrences in England and Ireland. Much more recently, Webb (1977) has commented on its status in Ireland: 'Often an escape, but probably native in South'.

The two Irish localities which I have personally visited, at Coalpit Lough, Cavan, v.c. H30, and Ballinacurra Creek, Limerick, v.c. H8, lead me to believe that *L. aestivum* is probably native in Ireland. At Coalpit there is a large colony growing amongst *Phalaris arundinacea* on the edge of a willow carr

TABLE 4. SPECIES ASSOCIATED WITH *LEUCOJUM AESTIVUM* AT 26 SITES IN ENGLAND

	Chilton Foliat	Upper Woodford	Moulsford	Long Wittenham	Clifton Hampden	N. Wallingford	Shiplake Aits (a)	Sandford Mill	Sandford Manor	Whistley Park	Whistley Park Farm	Remenham	N. of Wargrave Marsh	Hambledon Mill	Shillingford	Culham	Radley	Nr Cleeve (a)	Nr Cleeve (b)	Nr Cleeve (c)	White Gates, Sonning	Sonning	Shiplake Court	Bolney Court	Temple Lock	Stoney Ware	Number of occurrences
Urtica dioica	+	+	+	+	+	+	+	+		+		+	+	+			+	+	+	+	+				+	+	19
Salix spp.	+		+					+	+	+		+	+	+		+	+		+	+		+					13
Symphytum officinale			+		+	+	+		+	+		+	+	+	+	+				+			+				13
Carex riparia	+	+										+	+						+				+		+	+	8
Alnus glutinosa								+			+	+	+				+	+						+			7
Crataegus monogyna		+								+			+	+										+			5
Iris pseudacorus								+				+	+		+								+				5
Galium aparine											+		+			+					+						4
Glechoma hederacea											+				+	+		+									4
Phalaris arundinacea				+									+		+										+		4
Ribes sylvestris													+			+					+		+				4
Caltha palustris												+	+		+												3
Dactylis glomerata						+	+								+												3
Filipendula ulmaria										+					+	+											3
Poa trivialis						+												+	+								3
Rumex sanguineus															+			+							+		3
Ulmus spp.		+														+						+					3
Acer pseudoplatanus													+										+				2
Aesculus hippocastanum																		+					+				2
Alopecurus pratensis									+						+												2
Carex acutiformis															+	+											2
Epilobium hirsutum													+		+												2
Fraxinus excelsior		+									+																2
Glyceria maxima		+																	+								2
Oenanthe crocata		+											+														2
Phragmites communis										+									+								2
Populus alba					+																			+			2
Ranunculus ficaria						+												+									2
Total number of species at each site (including those at one site only)	3	7	3	2	3	5	3	4	3	6	7	7	17	4	16	9	3	8	7	4	4	4	6	4	5	2	

Species occurring at only one locality are omitted from the Table; they are listed below with their locality. *Conium maculatum* (Shiplake Aits); *Corylus avellana, Endymion non-scriptus, Poa pratensis* (Whistley Park Farm); *Eupatorium cannabinum, Humulus lupulus, Viburnum opulus* (N. of Wargrave Marsh); *Anthriscus sylvestris, Deschampsia cespitosa, Festuca arundinacea, Lolium perenne, Ranunculus repens* (Shillingford); *Cardamine pratensis* (Culham); *Acer campestre* (Nr Cleeve (a)); *Taraxacum officinale* (Nr Cleeve (b)); *Chrysosplenium oppositifolium* (Nr Cleeve (c)); *Rhamnus catharticus* (White Gates); *Fagus sylvatica, Rubus fruticosus* (Sonning); *Scrophularia nodosa* (Bolney Court); *Lycopus europaeus* (Temple Lock).

TABLE 5. POPULATION ESTIMATES AT 33 SITES OF *LEUCOJUM AESTIVUM* INVESTIGATED IN ENGLAND

Locality	Estimated Number of Plants 0–10	11–100	101–999	1000+
Chilton Foliat	10			
Ford	1			
Sutton Courtenay	10			
Winnersh	2			
Sandford Manor	7			
Marlow (a)	6			
Temple Lock	2			
Stoney Ware	1			
Sub total	45			
Clifton Hampden		20		
N. Wallingford		20		
Loddon Bridge (b)		30		
Shiplake Aits (a)		50		
Quarry Wood		100		
Radley		30		
Nr Cleeve (a)		50		
White Gates		12		
Medmenham		100		
Sub total		462		
Moulsford			400	
Long Wittenham			200	
Whistley Park			400	
Wargrave (a)			250	
Remenham			200	
Hambledon Mill			200	
Shillingford			300	
Nr Cleeve (b)			200	
Sonning			150	
Shiplake Court			200	
Sub total			2500	
Upper Woodford				2000
Sandford Mill				1000
Wargrave Marsh				2000
Culham				2000
Nr Cleeve (c)				2000
Bolney Court				1000
Sub total				10000
Grand Total				13000
% total population	0·35	3·55	19·22	76·88

which is often inundated. The station south of the city of Limerick is precariously perched at the confluence of two rivers, where several large clumps are hidden amongst the willow bushes and reeds. The area is very muddy, indicating regular submersion.

The recent discoveries in Scotland add further problems as to the status of the species. A. McG. Stirling (pers. comm. 1978) is tempted to consider the Endrick colony as native, whilst indicating that the Loch Leven plants may have resulted from water-borne seeds.

THREATS

This species is protected in part by the relative inaccessibility of most of its sites. Many of the remaining colonies are on islands, but such is the popularity of cruising these days that more and more mooring places are needed for the water traffic and several sites have been threatened by planning applications for moorings and marinas.

One object of the present survey was to discover the largest colonies in order to recommend them to conservation bodies. Estimates of the number of plants (clumps) in each of the 33 English populations are given in Table 5. This shows the great importance of the last six named sites, which contain approximately 77% of the total population of *L. aestivum* (estimated at 13,000 clumps) in the 33 sites investigated.

As the main stronghold for the species is along the River Thames from Reading to Marlow and at the head of the River Loddon near Twyford, it is obviously this area which needs protecting if *L. aestivum* is to continue to survive. Those wishing to see the plant should do so from public footpaths by the river and not by entering private land. Aggravation of the landowners and farmers could jeopardize the survival of the plant at many of its stations.

ACKNOWLEDGMENTS

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Short Notes

DIPHASIASTRUM ALPINUM (L.) HOLUB IN HARRIS

It is strange that the alpine clubmoss, *Diphasiastrum alpinum* (L.) Holub, which is widespread in neighbouring parts of the Scottish mainland and Inner Hebrides, should be hitherto unrecorded for v.c. 110. A search for it and other rarities covering ten years and many miles led to the discovery in July 1977 of a small thriving colony at an altitude of 480m, GR 19/163.081, just below the outlet of the lochan which lies on the col between Sgurr Scaladale and Tomnaval. The plants were in short turf on the gently inclined grassy slope a little above the steep plunge into Scaladale. They were found near the end of a day spent searching the Clisham range, and the little time left to negotiate the drop down to the track prevented prolonged search for further colonies. A voucher specimen is in **LTR.**

J. T. B. & D. Bowman

SENECIO CINERARIA DC. × *S. ERUCIFOLIUS* L. IN E. KENT

Senecio cineraria DC. (recently reduced by Chater (1974) to a subspecies of *S. bicolor* Tod., but for convenience referred to here by the more familiar specific name) is well known as a naturalized alien in Britain and Ireland. Most localities are near coastal resorts where it has spread from gardens to adjacent cliffs. In some of these, hybrids with the native *S. jacobaea* L. have arisen (Benoit *et al.* 1975). However, there do not appear to be any reports of hybrids between *S. cineraria* and other native species closely related to *S. jacobaea*. This is hardly surprising as the localities are all too dry to support *S. aquaticus* Hill and are outside the areas where *S. erucifolius* L. is of frequent occurrence. These three native species all have $2n = 40$, the same number as *S. cineraria*, and are placed in Sect. *Jacobaea* (Miller) Dumort. *S. cineraria* belongs to Sect. *Incanae* (DC.) O.Hoffm., but sectional differences are no barrier to hybridization in the genus: the commonest hybrid *Senecio* in south-eastern England is *S. squalidus* L. (Sect. *Jacobaea*) × *S. viscosus* L. (Sect. *Senecio*), another instance of an opportunity for hybridization created by the spread of an alien species into the area already occupied by a native one.

The extensive population of naturalized *Senecio cineraria* south of Deal in E. Kent, v.c. 15, is exceptional. The habitat is not a cliff but a level area of pebbles lying inland of the present-day shingle beach, and the native species present include *S. erucifolius*. *S. cineraria* × *S. jacobaea* is already well known there, although v.c. 15 is not among the vice-counties listed for this hybrid by Benoit *et al.* (1975).

The first discovery of *S. cineraria* × *S. erucifolius* was made in this vicinity by B. Wurzell on 19th June, 1978, south of Walmer. He found a population including *S. cineraria*, *S. erucifolius*, *S. jacobaea* and plants with both whitish tomentum, a character which could only be inherited from *S. cineraria*, and short stolons, indicating that *S. erucifolius* must be the other parent. At that date the plants were not flowering. Mr Wurzell mentioned his discovery to me briefly in a letter, without indicating the precise locality. On 11th August, 1978, I happened to be in the same general area and searched for the new hybrid in what subsequently turned out to be a different place. Here *S. cineraria* and *S. erucifolius*, but not *S. jacobaea*, were present and I soon found a single flowering hybrid specimen, one branch of which was collected. This plant lacked stolons but is demonstrably of the same parentage as Wurzell's; further observation will be necessary before it can be stated either that stolons die back early or that the hybrid exists in nothomorphs both with and without them.

In spite of this uncertainty I believe it practicable to describe the new hybrid, typifying it by my August gathering. I propose to name it in honour of A. P. Paterson, curator of the Chelsea Physic Garden, whose article (Paterson 1978) in praise of the exotic plants established on this beach, including *S. cineraria* and unspecified hybrids, was published coincidentally in August 1978.

Senecio × patersonianus hybrida nova e *S. cineraria* DC. et *S. erucifolio* L. exorta. Ab illo corymbo strictiore, bracteis exterioribus multum longioribus, achaeniis in costis pilosis, ab hoc tomento et foliis obtusilobis differt.

Planta stolones aut breves aut nullos emittens. Caudex aliquantum lignosus tantummodo in parte inferiore ramosus tomento albido munitus. Folia caulinaria ovato-oblonga parva (5 × 2 cm) profunde regulariterque pinnatifida, infra albido-tomentosa supra alboviridia araneo-hirsuta, lobis inferioribus reductis caulem amplectentibus ceteris ovatis tenuiter pinnatifidis lobulis obtusis. Corymbi plani densi ramis inferioribus arcte ascendentibus modo apicem versus ramosis. Involucra 5 mm tomentosa cinerea crassa campanulata, bracteis lanceolatis, exterioribus plerumque 3, quam interioribus circa triplo brevioribus. Ligulae circa 12, laete flavae. Achaenia in costis breviter pilosa.

HOLOTYPUS: England: E. Kent: near Kingsdown, on shingle west of present-day beach, with *S. cineraria* and *S. erucifolius*. 11th August, 1978. *R. M. Burton* (**BM**)

The tomentum makes the hybrid closer in general appearance to *S. cineraria*, although when the two plants are placed side by side it is obviously less dense than that of the latter species. The two have leaves of similar shape but those of the hybrid are of a much thinner texture. The achenes of the hybrid have hairy ribs, like those of *S. erucifolius*; in *S. cineraria* they are glabrous. Separation from *S.* × *albescens* Burbidge & Colgan (*S. cineraria* × *S. jacobaea*) is more difficult and is best effected by an examination of the outer bracts. In *S. erucifolius* these are about half as long as the inner bracts, a character which in combination with the very small outer bracts of *S. cineraria* produces a length about one-third of that of the inner bracts in the new hybrid. In *S. jacobaea* the outer bracts are also about one-third as long as the inner, so that those of *S.* × *albescens* are proportionately smaller.

The achenes of the type specimen appear to be sterile, but this character would be better observed later in the year when they have had more time in which to mature.

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R. M. BURTON

CHROMOSOME NUMBERS OF BRITISH PLANTS, 6

		Grid Reference and locality
Galium boreale L.	$2n=44$	35/843.284 Cronkley Fell, Teesdale, N.W. Yorks., v.c. 65
	$2n=44$	35/814.302 Widdybank Fell, Teesdale, Durham, v.c. 66
	$2n=44$	35/904.279 Wynch Bridge, Teesdale, Durham, v.c. 66
	$2n=44$	27/590.411 Creag an Lochain, Mid Perth, v.c. 88

The only previous report of the chromosome number of the British material of this species gave counts of $2n=44$ for plants from Teesdale and Lough Derg, Eire (Rahn 1961). These counts agree with practically all those reported from Continental material.

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A. DALE

ANOTHER BRITISH LOCALITY FOR *CAREX MURICATA* L. *SENSU STRICTO*

Nelmes (1947) distinguished *Carex muricata* L. *sensu stricto*, of which the type-specimen is in **LINN**, from the sedge known as *C. pairaei* F. W. Schultz. The former is a calcicolous plant of northern and eastern Europe; the latter largely replaces it in the south and west and is calcifuge. *C. pairaei* is frequent in Britain wherever there are acid sands or gravels, but especially in south-western England and in western Wales, whereas *C. muricata* appears to be extremely rare. Nelmes found herbarium specimens from only four British localities: from near Woodchester, W. Gloucs., v.c. 34, collected by G. C. Druce in 1900; from the top of a limestone hill near Wrexham, Denbigh, v.c. 50, gathered by J. E. Bowman in 1840; from limestone screes at Gordale, Mid-W. Yorks., v.c. 64, gathered by E. Milne-Redhead in 1934 and by J. E. Lousley in 1935; and from the grounds of the castle at Lauder, Berwick, v.c. 81, gathered by A. Brotherston in 1878.

David & Kelcey (1975) described the discovery, by Mrs B. M. Mack in 1973, of a Gloucestershire colony of this plant that may well be the same as Druce's: but searches elsewhere have been unsuccessful. The Gordale screes have, since the Second World War, been trampled bare by visitors' hobnails; there are so many limestone hills near Wrexham that to search for the plant there is like looking for a needle in a hundred haystacks; while at Lauder there seems to be no calcareous ground at all.

In November 1977, however, F. J. Roberts asked my opinion of a plant that he had found near Ribblehead, Mid-W. Yorks., v.c. 64, in 1974. He had had no reason to think that his find might be of importance, and the specimen was a poor one; but it seemed to me to show some of the characters of *C. muricata*, and it grew on limestone. In May and June 1978 I was able to examine the plant in the field, and there is no doubt whatever that it is the rarer taxon. Its distinctive characters are: the erect and rigid habit; the spikes, which are orbicular rather than ovoid as in *C. pairaei*, the lowest being often distinctly separated from the others; the glumes, which are dark and much shorter than the utricles from which, until the latter ripen and darken, they are marked off by a strong colour-contrast; and the outline of the utricle, which is more rounded than in *C. pairaei*, has a more distinct wing or flange, and is more suddenly contracted into the beak. A fifth character, the much earlier flowering time of *C. muricata*, was somewhat masked by the abnormal lateness of the spring in 1978.

The differences between the two taxa are precise and constant but they are not, in the opinion of A. O. Chater and of myself, sufficiently great to justify more than a subspecific distinction. The northern and eastern plant should then be known as *Carex muricata* L. subsp. *muricata*. I had hoped that Schultz's, and his friend Paira's, association with the western plant might be preserved in the name *C. muricata* L. subsp. *pairaei* (F. W. Schultz) Čelak. (Čelakovsky 1881), but J. Holub has drawn to my attention an earlier publication by Čelakovsky (1879) in which the plant is named *C. muricata* L. subsp. *lamprocarpa* Čelak., which is therefore its correct name.

At Ribblehead I found only four plants of the sedge, growing in slight shade on mossy limestone ledges at the edge of a limestone pavement. There is, however, some doubt as to whether my colony is the same as that originally seen by Mr Roberts, and there may well be more of the plant in the area.

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R. W. David

THE DISTRIBUTION OF *CAREX RUPESTRIS* ALL. IN BRITAIN

Carex rupestris All. is the most widely distributed of the four species of *Carex* Section *Petraeae* (O. F. Lang) Kük. Unlike its allies, which are steppe plants of dry sandy or rocky ground in North America (one of them, *C. obtusata* Liljebl., in north-eastern Europe as well), *C. rupestris* is arctic-alpine, extending from the circumpolar region down the chain of the Rockies to Colorado; in Europe it reappears in the Pyrenees, Alps, northern Balkans and Carpathians. Further east it occurs in the Caucasus and the highlands of central Asia. It is strongly calcicole.

In Britain this sedge is confined to Scotland, and there to four areas: the Durness-Inchnadamph limestone, that of Kishorn, and the mica-schists of Breadalbane and of the Cairngorms-Clova region. In the first two it occupies large areas of exposed limestone; in the others it may be restricted to calcareous pockets in a chaos of rocks otherwise species-poor. Its presence in many of these places, and its abundance in some others, have until comparatively recently been over-looked. This is partly due to its small size (the tufts of leaves are likely to be less than 10 cm high and each leaf is less than 2 mm broad), and to its tendency to be shy-flowering. Even when it flowers the simple spikes, narrowly and smoothly cylindrical, may be missed; in the vegetative state it may easily be passed over as a small *Festuca*, and some erroneous records have been due to the same confusion in reverse. Yet to a botanist who is specifically looking for it the characteristically rigid carriage of the leaves, their greyish or brownish colouring, and their habit of corkscrewing at the tips will quickly signal its presence. Where it occurs it is likely to cover several yards, and in one Sutherland station it is more or less dominant for a third of a mile.

Carex rupestris favours ledges and outcrops of fissured limestone, into which its long rhizomes can penetrate, sending up multiple tufts through the cracks. It may also be found in damp rendzina. In both habitats it is very frequently associated with *Dryas octopetala*, although in some stations, for example the first two quoted below for Easterness, the two plants occupy quite separate areas. *Carex rupestris* is not a plant of very high altitudes: in Scotland its upper limit appears to be below 3000 feet, while it descends almost to sea level in West Sutherland.

Every British station that I have been able to trace is listed below, with grid-references. With the exception of four of the more remote (Meall na Samhna, Glen Einich, Loch Loch, Glas Tulaichean), all have been personally visited since 1970, and as age must now limit my explorations it seems best to publish the findings and so encourage others to extend them. The sizes of the populations that I have myself surveyed are indicated by the letters A = 1 to 20, B = 21 to 100, C = 101 to 1000, D = over 1000. Where I have failed to refind the sedge, the date of, and authority for, the last sighting are given. The authenticity of the herbarium specimens quoted has been confirmed by me.

Mid Perth, v.c. 88: 27/4.3, Ben Heasgarnich, 1886 (White 1898); Meall na Samhna, 1960 (M. E. D. Poore field record); 27/5.3, Meall Ghaordie, 1893, **BM**, **E**, **GL**; Coire Fionn Lairige, 1963 (J. G. Roger field record); Meall nan Tarmachan, 1963 (J. G. Roger field record); 27/5.4, Creag an Lochain, 2 places (A, B); 27/6.4, Coire nam Buidheag (C); 27/6.5, Carn Gorm and An Sgor (B).

E. Perth, v.c. 89: 27/9.6, Ben Vrackie (B); 27/9.7, Ben Vuirich (C); Loch Loch (Ratcliffe 1977); 37/0.7, Glas Tulaichean, 1971 (Roger 1972); 37/1.7, The Cairnwell (C).

Forfar, v.c. 90: 37/1.7, Caenlochan (B); 37/2.7, Glen Fiagh, 1976 (Mrs J. Pitt field record); Glen Doll (B).

S. Aberdeen, v.c. 92: 37/1.8, Coire Kander (C); 37/1.9, Creag an Dail Bheag (C).

Easterness, v.c. 96: 27/6.7, Allt Coire Chuirn (B); 27/8.9, Coire Garbhlach (B); 27/9.9, Glen Einich, 1967 (J. G. Roger field record).

Main Argyll, v.c. 98: 27/2.2, Coire Fionn Choirain, 1963 (S. Ward field record).

W. Ross, v.c. 105: 18/8.4, Sgurr a Gharaidh (D); above Loch an Loin (B); 18/8.5, Mheallaidh Wood, field record at Biological Records Centre unconfirmed and most unlikely (off the limestone); 18/9.2, Mam Ratagan (Druce 1929), doubted by Druce himself and unlikely; 29/1.0, Knockan (B).

W. Sutherland, v.c. 108: 29/1.1, Knockan (B); 29/2.1, Beinn an Fhuarain (D); Beinn nan Cnaimhseag (C); 29/2.2, Inchnadamph (D); 29/3.1, Breabag (B); 29/3.6, Loch Borralie (B); 29/4.5, Ard Neackie (A); 29/4.6, Smoo (C); Heilam (D).

Outer Hebrides, v.c. 110: 08/8.3, Beinn Mhor (S. Uist), 1930 (Harrison 1941), unconfirmed and probably an error.

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R. W. David

OPHRYS APIFERA HUDS. IN ARTIFICIAL HABITATS

Hill (1978) has described the annual variation, from 1971 to 1977, in the number of plants and in the number of flowers per inflorescence in two closely situated colonies of *Ophrys apifera* Huds. on gravel and sand near the edge of a pool in disused gravel workings in W. Gloucs., v.c. 34. The habitat was unusual in that most of it was dominated by *Betula* and *Salix* scrub, and the water table was high.

Of the eleven stations for *O. apifera* known to me in Denbigh, v.c. 50, Flint, v.c. 51 and north-western Cheshire, v.c. 58, all but one have been derived from man's activities, and one is similar to Hill's site. Although more natural sites exist despite heavy grazing of the limestone areas of Clwyd, I have not recorded the orchid from them. It seems reasonable to suggest that the survival of *O. apifera*, and perhaps other plants in the British flora, now somewhat ironically depends to a significant extent on the conservation of man-made habitats.

At most of the sites the soil contained both clay and comminuted limestone and the most frequent associates were *Blackstonia perfoliata, Dactylorhiza fuchsii* and *Linum catharticum*. Where the peripheral terrain was suitable, the association included many components of the rich, regional limestone flora. Some of the most interesting, at different sites, were *Hypericum montanum, Linum bienne* and *Scabiosa columbaria*. The individual characteristics of some of the other sites are mentioned briefly in the following notes.

1. Minera, Denbigh (GR 33/2.5). Six orchids were found on a mound of fine limestone and marly clay detritus in the older part of a still active quarry on 2nd August, 1972, and possibly the same six plants on 6th July, 1974. This locality is remarkable for the variety and abundance of Orchidaceae. There were *Coeloglossum viride, Gymnadenia conopsea, Listera ovata* and *Orchis mascula* in the immediate vicinity with numerous *Dactylorhiza purpurella, Epipactis helleborine* and *Anacamptis pyramidalis* not far away.
2. Gresford, Denbigh (GR 33/3.5). A scattered colony of 20 plants was seen on 27th June, 1971, on a weathered, mixed dump of boulder-clay and sand in a corner of a sand and gravel quarry. The colony seemed to be much the same on subsequent visits, about every other year, up to 20th June, 1978. A larger compact colony, about 100 m from the first, on a flushed, clay-rich slope, was destroyed by quarrying in 1977, but in June, 1978 another hundred or so plants were seen close by in groups of 4 to 12 over a 100 m square of low ridges in a waterlogged area. They had presumably reached the flowering stage between 1971 and 1978. An adjacent wet clay level was dominated by *Festuca arundinacea* and encroaching *Salix viminalis*. This station evidently bears some resemblance to that described by Hill.
3. Bodfari, Flint (GR 33/0.7). 30 plants were seen on 1st July, 1972, on a 20 m length of thin, stony soil flushed by seepage from the high, fissured quarry face.
4. Prestatyn, Flint (GR 33/0.8). A single plant was noticed on inner coastal dunes on 15th July, 1972, but the locality was not searched further.
5. Whitford, Flint (GR 33/1.7). Three fine plants were found in bare, shallow soil on the edge of lightly flushed slabs below a quarried limestone face on 17th July, 1971.
6. Holywell, Flint (GR 33/1.7). About a dozen plants were seen on 31st July, 1977, on a grassed rubble slope, but no note was taken of associates in the species-rich vicinity.
7. Rhydymwyn, Flint (GR 33/2.6). A small colony, including four plants just coming into flower, was seen on 23rd June, 1971, on coarse limestone rubble on a high terrace above an operational quarry. The plants were small and the situation apparently dry, although the proximity of *Dactylorhiza* suggested occasional flushing.
8. Ffrith, Flint (GR 33/2.5). At this site the fissured, irregular limestone outcrop has been haphazardly worked, presumably for local building. About 25 plants were seen on 19th June, 1973, on a considerable barren bank of fragmented rock and slipped clay.
9. Llanfynydd, Flint (GR 33/2.5). Here a quarry, now disused, has been cut back into the hillside creating a roofless cavern of considerable size, with a moist floor relatively bare save for a few

abandoned blocks and low mounds of fine debris. A colony of *c* 65 plants was found on the mounds on 27th June, 1974, and another 30 or so were seen on debris tipped down the hillside. On 19th June, 1975, only five or six plants were found at each site, and in 1978 none could be seen. Sheep had invaded the peripheral zone and the quarry had been heavily used for clay-pigeon shooting.

10. Ledsham, Cheshire (GR 33/3.7). A compact colony of 17 plants was found on 27th July, 1968, on gritty, calcareous clay moistened by seepage from an adjacent bank and previously covered by a stone platform. On 20th June, 1968, six good plants (but only one opening flower) and seven basal rosettes were seen.

11. Stanlow, Cheshire (GR 33/4.7). A scattered colony of *c* 20 plants on the grassy banks of the containment bunds around a group of tanks in an oil storage depot was shown to me on 1st July, 1974. The tank foundations were laid on limestone aggregate and the earth bunds were composed of clay and limestone chips. The orchids had been seen by the depot-manager in earlier years. The plants were small but healthy, evidently benefitting from the scything carried out at the site, especially before and after the main growing season, in order to reduce fire risks.

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T. Edmondson

PUCCINELLIA CAPILLARIS (LILJEBL.) JANS. × *P. MARITIMA* (HUDS.) PARL. ON NORTH RONA, OUTER HEBRIDES

In 1972 *Puccinellia capillaris* (Liljebl.) Jans. was found on North Rona, a small island to the north of the Outer Hebrides, v.c. 110 (Gilbert *et al.* 1973). The plants appeared very variable, and it was thought at the time that other species or hybrids might be present. On a further visit to North Rona in 1976 two species were recognized: *Puccinellia capillaris* on bare ground on the low-lying peninsulas, and *P. maritima* (Huds.) Parl. in crevices in and grassland above low cliffs. In several places on Fianuis, the northernmost peninsula, the two species were growing together. Neither plant had been recorded from the island up to 1958 (McVean 1961), and we conjecture that *P. maritima* was overlooked whereas *P. capillaris*, a species which appears to be spreading in northern Scotland, is probably a recent arrival.

The *P. capillaris* plants were morphologically distinctive, taking the form of green adpressed rosettes with relatively few tillers and numerous flowering culms. The lemmas were 2.3–2.7 mm long, often enclosing the developing grain, and the short anthers (0.8–0.9 mm) dehisced to liberate abundant spherical pollen. The species appears to be a short-lived perennial adapted to a habitat which is heavily disturbed by gulls and seals. By contrast, the plants of *P. maritima* were tufted, with green or greyish leaves and rather stiff tillers and flowering culms radiating from the central stock. The lemmas and anthers were 3.3–4.0 and 1.5–2.0 mm long respectively, and developing grain and good pollen were again regularly present. This biotype of *P. maritima*, which is characterized by a lack of stolons, is quite common on the mainland of Scotland.

A collection of both dried and living material from Fianuis was submitted to Dr C. E. Hubbard who reported that one of the live plants was more or less intermediate between *P. capillaris* and *P. maritima* and, judging from spikelet characters, was a hybrid between the two species. The plant was tufted in habit, with spreading, green leaves, loose, ovoid panicles, lower lemmas 3.3–3.5 mm long, and indehiscent anthers 1.0–1.8 mm long in which over 90% of the pollen grains were imperfect (irregular in shape and size, and colourless). The plant has been kept alive at Hampton but failed to flower in 1977. Its chromosome number has not been determined. The hybrid should have $2n = 42$; Dr K. Jones (*in litt.* 1977) found that Caithness material of *P. capillaris* had the chromosome number $2n = 28$, while $2n = 56$ is the main number reported for *P. maritima* (Scott & Gray 1976).

This hybrid, which was described as *P.* × *mixta* by Holmberg (1920), has been recorded from Denmark, Holland, Iceland, Norway and Sweden (Jones & Stace 1975), so that its occurrence in Britain is not unexpected. Herbarium specimens have been deposited in **K**.

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O. L. Gilbert & P. M. Holligan

ULTRAVIOLET PHOTOGRAPHY OF THE COLOURS AND PATTERNS OF FLOWERS

The colours and patterns of insect-pollinated flowers include ultraviolet components that are visible to many insect pollinators but not to the human eye. Many if not most insect pollinators – bees, hoverflies, moths and butterflies – probably have trichromatic colour vision with ultraviolet as one of their three primary colours. Thus the (to us) hidden ultraviolet patterns of flowers, and ultraviolet colour differences between the flowers of different species or genotypes, are likely to be important adaptive characters.

Surveys of ultraviolet (UV) absorption and patterning in flowers have been published by Daumer (1958) and Kugler (1963), and several new investigations have been published recently, but there is still a serious lack of information about the UV characteristics of the flowers of the great majority of species, even those of many otherwise well-known members of the British flora. Flowers are still commonly described only in terms of the colours and patterns that are visible to the human eye.

The photographic techniques that were used by Daumer involved quartz optics and special films for UV photography, but Kugler used unmodified Leica optics and ordinary Perutz monochrome film, which were quite satisfactory for the long UV wavelengths that are visible to bees. Kugler used a Schott UG1 filter to exclude visible light and an electronic flash-gun to provide UV light. Similar techniques were described by Silberglied (1976) and Hill (1977), but all these techniques require the use of a fixed camera or at least a tripod, which is often impossible and usually inconvenient and undesirable in the field. The field technique described by Eisner *et al.* (1969), using a hand-held television camera, is potentially useful for rapid surveys of UV colouration in the field but requires bulky and expensive equipment and does not provide permanent records of satisfactory quality.

I have found that it is relatively easy to photograph the UV image of flowers by a modified version of Kugler's technique, using a hand-held 35 mm single-lens reflex camera. I have used this modified technique quite extensively in the field since 1976. No special lenses are required. Visible light is excluded by a hand-held filter (Schott UG1 or Kodak Wratten 18A) that effectively transmits light only between about 300 and 400 nm; an ordinary monochrome film (Ilford FP4 or Kodak Tri-X) that is not sensitive to the small amounts of far-red and infra-red light that are also transmitted by these filters is used. A small electronic flash provides sufficient UV light. The procedure is very simple: the flower is brought into focus in the viewfinder and then the camera is held in position while the filter, also hand-held, is placed over the lens. The UV exposure is then made, the filter is removed, and a paired full-spectrum (visible-light) exposure is made on the next frame. It is advisable to make a second UV exposure.

The chief difficulties of this hand-held technique are caused by the small depth of focus that is obtained in close-up photography at the wide apertures (f1.4–4) that are needed for the UV exposure, combined with the impossibility of using the viewfinder after the filter has been placed over the camera lens. A steady hand is necessary. When colour photographs are required in addition to the paired UV and full-spectrum monochrome exposures, they can be taken using the same lens transferred to a second camera body that is loaded with colour film.

There are, from the point of view of the UV-blind human observer, two particularly striking and unexpected features of the UV colours and patterns of flowers:

a) The common occurrence of UV patterning in yellow flowers (and capitula of composites) in which a

UV-absorbing centre is surrounded by UV-reflecting outer parts. To the human eye, such flowers appear uniformly yellow, or almost so; to a UV-sensitive insect, they have a conspicuous pattern with a central insect-red area in an otherwise insect-purple flower (e.g. *Potentilla anserina*). In other cases yellow flowers are wholly UV-absorbing (e.g. *Potentilla fruticosa*). Yellow flowers that look very similar to us are often sharply distinct in UV, either because they have different UV patterns or because they differ in UV reflectance (e.g. *Brassica* species).

b) The extreme rarity of UV-reflecting white flowers. Although a few white flowers with strong UV reflectance (insect-white flowers) do exist, Daumer (1958) did not report finding any flowers of this type in a survey of 204 species. I have investigated 126 British species with white flowers and found only four species with insect-white flowers (*Bryonia dioica* and white variants of *Raphanus raphanistrum*, *R. maritimus* and *Verbascum lychnitis*).

The great majority of flowers that appear white to the human eye are strongly UV-absorbing (insect-yellow). These flowers reflect light strongly and uniformly in our visible spectrum from about 700nm to 425nm; below *c* 425–405nm their reflectance falls sharply and only a few show significant reflectance below 390nm. In order to quantify the different shades of UV colour shown by flowers it is necessary to obtain reflectance spectra (Kay 1978). In every case that I have investigated in detail UV absorption in white flowers is caused by flavone or flavonol pigments. Patterning, with a more strongly UV-absorbing central region, is much less well developed in white flowers than in yellow flowers, and when it does occur relatively small differences in R^{50} (the wavelength at which 50% of peak reflectance is shown) are involved: *c*12nm in the case of *Calystegia silvatica*, for example, compared with differences of 120nm or more in similarly UV-patterned yellow flowers. The UV-absorbing white flowers of different species are probably differentiated from one another in many cases, to the insect eye, by comparably small differences in R^{50} over the range of wavelengths between *c* 380nm (e.g. *Hesperis matronalis*, R^{50} 382 nm) and *c* 430nm (*Arabis hirsuta*, R^{50} 418nm; *Trifolium repens*, R^{50} 426nm); I have found very few flowers with petal R^{50}s between *c* 430nm and the lower end of the yellow range at *c* 490nm. Photography using UV-transparent filters can only give a qualitative indication of the occurrence of this type of differentiation among white flowers, and quantitative photometric studies are necessary to characterize it precisely.

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Q. O. N. Kay

RUBUS DENTATIFOLIUS (BRIGGS) W. C. R. WATS. AND *R. VECTENSIS* W. C. R. WATS.

Watson (1937) gave a new name, *Rubus vectensis*, to a bramble which Rogers (1892, 1900) had illegitimately called *R. borreri* Bell-Salter. Watson's last (1958) opinion was that this is synonymous with *R. retrodentatus* Muell. & Lefèv., but reference to the holotype of the latter species (herb. Mueller, 2410, **LAU**) shows that this view cannot be sustained; *R. vectensis* is therefore currently used as the valid name for this bramble, which is widespread and frequent in many southern and western counties of England and Wales. Since it also occurs in southern Ireland and south-western France, it is a species of wide geographical range and major rank.

That *R. vectensis* exhibits rather a broad spectrum of variation (particularly in the intensity of stem armature) is evident from Sudre's remarks on specimens from Tarn, France (Bat. Eur. 429), which I translate: 'I have come to the conclusion that my *R. pauciglandulosus* var. *montisparsus* of which I have seen only one example was nothing more than an open ground and well-developed form of *R. borreri*. This seems to be identical with the English Set 38.' These latter specimens were collected in Dorset and are *R. vectensis*. Sudre also issued Bat. Eur. 428 (also from Tarn) as *R. schmidelyanus* var. *breviglandulosus* and thought it (transl.) 'intermediate between type and *R. borreri*'. In my opinion this is an example of the less intensely prickled variant but should also be called *R. vectensis*.

Rogers (1894) stated 'further study of living bushes . . . has convinced me that we have a well-marked variety of the true *R. borreri* Bell-Salt. in the form described and named *dentatifolius* by the late Mr Briggs in Fl. Plym. 121 . . . I know it to be a locally abundant and constant form . . . from Plymouth and Launceston to Okehampton and Haldon Hill near Exeter . . . the typical plant being thus far unknown in the province'. [*R. borreri sensu* Rogers ≡ *R. vectensis* W. C. R. Wats.]

During 1977 I examined large numbers of bushes in the field in Brecon, W. Gloucs., Wight and S. Devon (the Exeter district, Haldon Hill and western Dartmoor from Plymouth to Okehampton) growing in various conditions (open to shady) and on various soils. The plants throughout these areas exhibited virtually a continuous range of variation from sparsely prickled almost eglandular stems to strongly prickled, aciculate examples; panicles tended to vary similarly in intensity of armature and glandulosity, and terminal leaflet shapes varied from narrowly obovate with cuspidate tips through broadly obovate with cuspidate-acuminate tips to elliptic-obovate with attenuate tips. Throughout these areas, however, the floral characters, e.g. petal size and shape, sepal clothing and disposition, panicle shape and leaf indentation, were constant. The less intensely armed variant tends to be more evident in damp, shady situations in S. Devon than elsewhere, but the complete range of variation is present there also. A batch of '*R. borreri*' from **BM** (herb. Barton & Riddelsdell nos. 736, 1294, 4580, 4636, 3834–6, 10468–71, 10490–2/3/6/7, 10595), gathered from a number of localities between W. Gloucs. and W. Kent, exhibits similar characteristics. All the evidence, therefore, points to the existence of one taxon only. The type of variation observed is to be found in other *Rubus* species, e.g. *R. infestus* Weihe ex Boenn., *R. anisacanthos* G. Braun and *R. leyanus* Rogers, for which H. E. Weber (pers. comm. 1978) has recently proposed the Section name *Anisacanthi*; I conclude that *R. vectensis* should be included in this group.

What then is the correct name for this bramble? Visits to Briggs' localities and reference to the large number of syntypes of his *R. sprengelii* Weihe var. *dentatifolius* (**CGE**, **K**) reveal the full range of variation; Briggs' (1880) original description includes 'extreme forms with panicles with longer and less uniform prickles intermixed with numerous aciculi' and his concept was clearly of one taxon with varying armature. It was Rogers' view that two taxa, '*R. borreri*' and '*R. borreri* var. *dentatifolius*', are to be sustained.

After careful consideration I conclude that, *pace* Rogers, we are here dealing with one somewhat variable species, which should be known as:

Rubus dentatifolius (Briggs) W. C. R. Wats., in *Lond. Nat.*, **1930**: 73 (1931)
R. sprengelii var. *dentatifolius* Briggs, in *Fl. Plymouth*, p. 121 (1880)
R. vectensis W. C. R. Wats., in *J. Bot., Lond.*, **75**: 197 (1937)
R. borreri auct.

LECTOTYPUS: Ringmoor Down near Sheepstor, S. Devon, v.c. 3, T. R. A. Briggs, 14th August, 1869, as *R. borreri* var. (**K**); isolectotype (**CGE**)

Set of British Rubi nos. 38 & 63, present in many herbaria, exemplify the limits of variation to be observed in this species.

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A. NEWTON

RUBUS DREJERI G. JENSEN IN SCOTLAND

Rubus drejeri G. Jensen has hitherto been a doubtfully British bramble. Although Rogers (1900) described it accurately (apart from the omission of pilose anthers) and possessed specimens sent to him by Gelert and Focke, he applied the name somewhat broadly to several British species, e.g *R. anisacanthos* G. Braun. I have not, however, seen any of Rogers' sheets from the Stirling district (including Lochs Earn and Vennachar), v.c. 86, referred to in his article (Rogers 1897); these may well have been the true *R. drejeri*. The brambles of Surrey and S. Somerset referred to by Watson (1952) are both unnamed local taxa and his description and figure (Watson 1958) present a composite of these; they differ from *R. drejeri* in significant respects.

In 1978 I collected specimens exactly matching Danish and German examples of *R. drejeri* in **MANCH** and my own herbarium from two places near Blairgowrie, E. Perth, v.c. 89 (GR 37/1.4). One bush was growing by the riverside walk just north of the town bridge, and a clump of several bushes was found on the west side of the A 923 at the edge of an old birch wood about a mile south of the town. Further examples of the same bramble have been sent to me by G. H. Ballantyne from Fife, v.c. 85: east of Lochgelly (GR 36/1.9), and Cluny, east of Cardenden (GR 36/2.9). *R. drejeri* is evidently well established in eastern central Scotland and should be looked for elsewhere in the area, particularly in Rogers' localities.

This is an addition to the list of *Rubus* species growing on both sides of the North Sea given by Newton & Weber (1977).

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A. NEWTON

THE ALTITUDINAL RANGE OF *CATABROSA AQUATICA* (L.) BEAUV.

Catabrosa aquatica (L.) Beauv. is generally regarded as a plant of lowland streamsides, ditches and ponds, and, chiefly in north-western Britain, of damp sandy sea-shores. In Westmorland, v.c. 69, where it is a rare and declining species, Wilson (1938) gave its habitat as 'Pool sides and watery places in the low country' and its altitudinal range as '20–400ft or higher'. In his *Comital Flora*, Druce (1932) gave the altitudinal limit as 1000ft.

It came, therefore, as a considerable surprise when one of us (F. J. R.) discovered it in July 1978 at 2300ft (710m) on the east side of Little Fell, Westmorland (GR 34/78.21; **LANC**). Two colonies were found, 40m apart, growing in gently sloping, east-facing flushes, lightly trampled by sheep and associated with:

Agrostis stolonifera	*Leontodon autumnalis*	*Saxifraga stellaris*
Cochlearia officinalis	*Montia fontana*	*Veronica beccabunga*
Chrysosplenium oppositifolium	*Ranunculus flammula*	*V. scutellata*
Epilobium alsinifolium		

According to the *Atlas of the British flora, C. aquatica* has been recorded from only four 10km squares in which there is no land below 500ft. Two are pre-1930 records: one from Talbotstown, Wicklow, v.c. H20, and the other from near Clatt, N. Aberdeen, v.c. 93. These two sites lie at about 800 and 680ft respectively. Of the two post-1930 sites, one is from boggy ground by the River Greta west of Bowes, N. W. Yorks., v.c. 65, and probably between 1000 and 1100ft. The other locality, near Malham Tarn, Mid-W. Yorks., v.c. 64, is well known. Here it grows in several sites on cattle-trampled, silty stream-banks up to 1225ft and associated with:

Carex flacca	*Eleocharis uniglumis*	*Poa trivialis*
C. lepidocarpa	*Juncus articulatus*	*Ranunculus flammula*
Eleocharis palustris	*Poa annua*	*Veronica beccabunga*

The Little Fell locality is therefore 1100ft higher than Malham and 1300ft higher than Druce's limit. Although *C. aquatica* occurs only in the lowlands in northern Norway (Benum 1958), it occurs in 'many places in the central highlands' in Iceland (Gröntved 1942) and Suessenguth (1936) gave its upper limit as 2200m (7200ft) in the Engadine.

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F. J. Roberts & G. Halliday

LYCOPODIELLA INUNDATA (L.) HOLUB AT FOX TOR MIRES, SOUTH DEVON

Fox Tor Mires is a large topogenous valley bog at the head of the catchment of the River Swincombe, which flows into the West Dart River on Dartmoor, S. Devon, v.c. 3. I carried out a floristic survey of the Mire in 1971, as it was proposed as a reservoir site to supply water to Plymouth, and any inundation of the area would have markedly altered the vegetation. (The proposal was eventually rescinded in favour of another site). Part of the Mire, known as Whiteworks, where the Strane River flows into the River Swincombe, at GR 20/618.709, has been disturbed by past surface-mining for tin. The name 'White' works indicates kaolinization of the granite around the tin lodes (Worth 1953). The operations started about 1800, reached a peak in the 1880s and ceased in about 1905. They were temporarily revived during the First World War. The presence of water and china clay prevented tunnel mining, resulting in 'tinner's furrows' (Worth 1953), which were deep gullies (1–4m) following the tin lodes. These gullies are now filled with *Sphagnum* bog with associated *Juncus* species and *Polytrichum commune*. The excavated waste material was piled into mounds 1–3m high on the ridges between the gullies. The surface of these mounds (still a regolith rather than a soil) supports a xerophytic community of *Calluna vulgaris* (with *Hypogymnia physodes* as an epiphyte on the larger plants), *Vaccinium myrtillus, Cladonia* species (notably *C. impexa*) and *Dicranum bonjeanii*. There is thus a marked microtopographical and moisture gradient between the very dry mounds and the wet bog. The intermediate communities, which grade from the xerophytic heath to a *Juncus effusus/Polytrichum commune* community at the base of the mound, contain mainly *Agrostis setacea, Potentilla erecta, Galium saxatile, Polygala serpyllifolia, Pleurozium schreberi* and *Rhytidiadelphus loreus*. In this community on one mound I discovered a large plant of *Lycopodiella inundata* (L.) Holub. A careful search of the other mounds revealed three additional plants. In the autumn of 1974, after a prolonged wet summer, I discovered one further specimen, but it is possible that this was missed on the first occasion.

It is interesting to speculate on the source of these plants. The mounds are completely man-made and are at most 150 years old, and the final disturbance did not cease until between 1905 and 1918. I have searched the surrounding mire for specimens of *L. inundata* in more 'natural' habitats, but have not discovered any local source for colonization of these mounds. The nearest S. Devon records in the *Atlas of ferns of the British Isles* (Jermy *et al.* 1978) are from valley bogs on the pebble-bed heaths, near Aylesbeare, 50km to the east.

Unfortunately the plants suffered severely in the drought of 1976; all but one plant dried up and there has been no recovery to date.

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D. L. Wigston

NOTHOFAGUS BLUME IN BRITAIN

There is growing interest in species of *Nothofagus* in this country as it is possible that there will be widescale plantings of some species in the near future by both public and private forestry organizations, and one species, *N. obliqua* (Mirbel) Blume, the Roble, has been suggested as a possible replacement for elm. I have received a number of enquiries about *Nothofagus* from B.S.B.I. members, particularly those who saw a young specimen of *N. procera* (Poeppig & Endl.) Örsted, the Rauli, in the Chelsea Physic Garden after the 1978 Annual General Meeting.

The following is a list of all *Nothofagus* species known by me to have been planted in Great Britain; they are placed under their area of origin.

AUSTRALIA
N. moorei (F. Mueller) Krasser

TASMANIA
N. cunninghamii (Hooker) Örsted

NEW ZEALAND
N. fusca (Hooker fil.) Örsted
N. menziesii (Hooker fil.) Örsted
N. solandri (Hooker fil.) Örsted
var. *cliffortioides* (Hooker fil.) Poole
N. truncata (Colenso) Cockayne

SOUTH AMERICA
* *N. alessandrii* Espinosa
* *N. antarctica* (G. Forster) Örsted
N. betuloides (Mirbel) Blume
N. dombeyi (Mirbel) Blume
* *N. glauca* (Philippi) Krasser
N. nitida (Philippi) Krasser
* *N. obliqua* (Mirbel) Blume
* *N. procera* (Poeppig & Endl.) Örsted
* *N. pumilio* (Poeppig & Endl.) Krasser

* deciduous species

There are one deciduous Tasmanian species, *N. gunnii* (Hooker fil.) Örsted, 19 evergreen New Guinea species and 5 New Caledonian species (Van Steenis 1953), which to my knowledge have not yet been introduced into Britain.

Hybrids between New Zealand species are well known (Cockayne 1926), but hybrids which apparently have not been recorded in the native range of the genus occur in Britain. For example, the allopatric species *N. menziesii* (New Zealand) and *N. obliqua* (Chile) have hybridized at Weston-under-Lizard, v.c. 39 and 40. *N. obliqua* and *N. procera* are partially sympatric in their native Chile, but no native hybrids have been reported. *N. obliqua* × *N. procera* is present in Westonbirt Arboretum, W. Gloucs., v.c. 34, and at Alice Holt Lodge, N. Hants., v.c. 12, where it set seed in 1978, although it is not yet known if this is viable.

The majority of the species listed above only occur in gardens and arboreta, but three, *N. dombeyi*, the Coigue, *N. obliqua* and *N. procera*, have been planted as pure stands in England, Scotland and Wales. The first widespread Forestry Commission plantings took place in 1936 and 1937, mainly of *N. procera*, although one very fine *N. obliqua* stand of this age occurs at Kingswood Warren, Mendip Forest, N. Somerset, v.c. 6. A further set of plantings was made in 1956. Supply of seed in the past has been variable and of suspect identification; at Ladyswood, Kernow Forest, W. Cornwall, v.c. 1, in adjacent 1956 plantings of *N. obliqua* and *N. procera* there is a specimen of *N. menziesii*. Also, all Forestry Commission specimens I have seen determined as *N. betuloides* are undoubtedly *N. dombeyi*. *N. nitida* is of doubtful status, probably only a variety of *N. dombeyi*. The specimens I have seen in this country labelled *N. truncata* have none of the characteristics of this species (Bean 1976) and are probably *N. fusca*.

Since 1956, many private forestry estates have included *Nothofagus* species, mainly *N. obliqua* and *N. procera*, in their planting regimes (Bradford 1971), but Lord Bradford's estates at Weston-under-Lizard and Tavistock, S. Devon, v.c. 3, have included mixed and pure stands of *N. dombeyi*, and the Forestry Commission lists stands of this species in Wales. Undoubtedly, their most attractive economic feature is a very fast rate of growth (e.g. 75 ft in 13 years) producing a good quality hardwood timber. I suspect that foresters also feel that their use will satisfy a demand for hardwoods in forest landscapes, particularly in respect of the recent 'small-wood grant' legislation which requires a proportion of hardwoods among conifers if grants are to be awarded.

N. obliqua and *N. procera* can both be coppiced, although growth of the coppice-shoots is light-demanding (particularly for *N. procera*) and can be totally suppressed under dense canopy. It is possible that the use of these species in the landscape will lead to a partial revival of coppicing; the Forestry Commission have experimental *N. procera* coppice plots at Flaxley, Forest of Dean, W. Gloucs., v.c. 34. Because of its ability to be coppiced it has been suggested that *N. obliqua* could be used in hedgerow management as a fast-growing replacement for elms ravaged by Dutch elm disease. However, both *N. obliqua* and *N. procera* are shallow-rooting and susceptible to windthrow, and their use in open positions, particularly as fast-growing trees in gardens or close to buildings, should be viewed with caution.

Pure stands of the deciduous *N. obliqua* and *N. procera* support a good native woodland ground flora and understorey, although, being relatively smooth-barked, epiphyte cover can be poor. The evergreen *N. dombeyi* appears to suppress ground cover, producing a deep litter which remains undecomposed for a long time. By contrast, the litter of *N. obliqua* and *N. procera* breaks down more rapidly than that of native beech.

N. antarctica, N. obliqua and *N. procera* were seeding freely in the summer of 1978, and the latter two species are certainly regenerating from seed in many of their sites in Britain. Introduced trees which produce substantial, easily-dispersed, seed-crops, can cause problems for conservation management of woodlands. The sycamore, *Acer pseudoplatanus* L., is an example, and careful observation of *N. obliqua* and *N. procera* regeneration is needed to see if they may present similar problems.

Nothofagus is closely related to the genus *Fagus*. Of all the species, *N. obliqua* and *N. procera* have the closest (if superficial) resemblance to our native hardwoods. These two are, however, unlikely to be confused with *Fagus sylvatica* L., but *N. procera* foliage resembles that of *Carpinus betulus* L. and the canopy resembles that of the fastigiate hornbeam, *C. betulus* 'Fastigiata'. *N. obliqua* can resemble the English elm, *Ulmus procera* Salisb., in form, but the foliage is unlikely to be confused.

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D. L. WIGSTON

Plant Records

Records for publication must be submitted in the form shown below to the appropriate vice-county Recorder (*List of members* (1979)), and *not* to the Editors.

Records are arranged in the order given in the *List of British vascular plants* by J. E. Dandy (1958) and his subsequent revision (*Watsonia*, **7**: 157–178 (1969)), but *Taraxacum* is arranged according to A. J. Richards (*Watsonia*, **9**, Suppl. (1972)). With the exception of collectors' initials, herbarium abbreviations are those used in *British herbaria* by D. H. Kent (1958).

The following signs are used:

* before the record: to indicate a new vice-county record.
† before the species number: to indicate that the plant is not a native species of the British Isles.
† before the record: to indicate a species which, though native in some parts of the British Isles, is not so in the locality recorded.
[] enclosing a previously published record: to indicate that the record should be deleted.

2/1. SELAGINELLA SELAGINOIDES (L.) Link *__46__, Cards.: Twyi valley, GR 22/7.5. J. P. Savidge, 1968, field record. (*Nature Wales*, **16**: 215 (1979)). **47**, Montgomery: N. of Llyn Coch-hwyad, GR 23/9.1. R. G. Woods, 1978, field record. 2nd record. (*Nature Wales*, **16**: 217 (1979)).

2/2. SELAGINELLA KRAUSSIANA (Kunze) A. Braun *__101__, Kintyre: Kilberry Castle lawn, GR 16/71.64. A. G. Kenneth, 1978, **CGE**. ·

3/2. ISOETES ECHINOSPORA Durieu **73**, Kirkcudbright: Loch Ken viaduct, GR 25/68.70. R. Stokoe, 1978, **herb. R.S.** 2nd record.

4/1 × 4. EQUISETUM HYEMALE L. × E. VARIEGATUM Schleich. ex Weber & Mohr *__104__, N. Ebudes: bank of R. Hinnisdal, Skye, GR 18/38.57. C. W. Murray, 1974, **E**, det. C. N. Page.

4/4. EQUISETUM VARIEGATUM Schleich. ex Weber & Mohr *__104__, N. Ebudes: between An Garbh-choire and Loch Coruisk, Skye, GR 18/47.19. J. & D. Bowman, 1978, **herb. C. W. Murray**. 1st definite record.

4/8. EQUISETUM PRATENSE Ehrh. *__99__, Dunbarton: High Craigton, GR 26/52.77. A. McG. Stirling, 1978, **E**.

4/10. EQUISETUM TELMATEIA Ehrh. **69b**, Furness: Ireleth, GR 34/22.77. D. Hartley, 1976, field record. 2nd extant record.

7/1. HYMENOPHYLLUM TUNBRIGENSE (L.) Sm. **70**, Cumberland: Eskdale, GR 34/1.9. D. A. Ratcliffe, 1957, field record. 1st post-1930 record.

15/5a. ASPLENIUM TRICHOMANES L. subsp. TRICHOMANES *__67__, S. Northumb.: Hotbank Crags, GR 35/77.68. G. A. & M. Swan, 1973, **herb. G.A.S.**, det. J. A. Crabbe.

21/1 × 2. DRYOPTERIS FILIX-MAS (L.) Schott × D. PSUEDOMAS (Woll.) Holub & Pouzar *__44__, Carms.: near Cwmduad, GR22/37.31. B.S.B.I. Field Meeting, 1978, field record, det. H. Vannerom. (*Nature Wales*, **16**: 212 (1979)).

21/3. DRYOPTERIS ABBREVIATA (DC.) Newm. *__73__, Kirkcudbright: near New Galloway station, GR 25/6.7. (collector unknown), 1960, **BM**.

21/8. DRYOPTERIS AEMULA (Ait.) Kuntze **46**, Cards.: Devil's Bridge, GR 22/7.7. R. H. Roberts, 1977, field record, 2nd record. (*Nature Wales*, **16**: 215 (1979)). *__47__, Montgomery: near Aberllefenni, GR 23/7.1. P. M. Benoit, 1978, **NMW**. (*Nature Wales*, **16**: 217 (1979)). **70**, Cumberland: Eskdale, GR 34/1.9. D. A. Ratcliffe, 1959, field record. 1st post-1930 record.

21/9. Dryopteris expansa (C. Presl) Fraser-Jenkins & Jermy *73, Kirkcudbright: Carruchen Moss, GR 25/94.73. O. M. Stewart, 1976, **E**, det. M. Gibby & A. C. Jermy. ***104**, N. Ebudes: Dun Fiadhairt, near Dunvegan, Skye, GR 18/23.50. M. Coulson, 1971, field record, det. A. C. Jermy.

22/1. Polystichum setiferum (Forsk.) Woynar **80**, Roxburgh: Monksford Glen, Newton St Boswells, GR 36/58.32. J. Blance, 1975, **herb. R. W. M. Corner**. 1st localised post-1930 record.

22/2. Polystichum aculeatum (L.) Roth **93**, N. Aberdeen: Laithers, 3 miles W. of Turriff, GR 38/67.49. D. Welch, 1978, **ABD**. 1st definite post-1930 record.

22/3. Polystichum lonchitis (L.) Roth **70**, Cumberland: Cross Fell, GR 35/6.3. D. A. Ratcliffe, 1957, field record. 1st post-1930 record.

24/5. Thelypteris robertiana (Hoffm.) Slosson **70**, Cumberland: Scarrowmanwick Fell, Croglin, GR 35/59.46. D. A. Ratcliffe, 1956, field record. 1st post-1930 record.

25/1/2. Polypodium australe Fée **57**, Derbys.: Hagg Rock, Matlock Bath, GR 43/29.57. A. Willmot, 1978, field record, det. **BM**. 1st record since 1860, rediscovery at same locality.

†27/1. Azolla filiculoides Lam. ***48**, Merioneth: near Talgarth Lodge, Pennal, GR 22/6.9. K. M. Stevens, 1978, **NMW**. ***59**, S. Lancs.: St Helens, GR 33/51.95. Liverpool Botanical Society, 1976, field record. Near Rufford, GR 34/46.15. E. M. Stephenson, 1978, field record. 1st and 2nd records.

34/1b. Juniperus communis L. subsp. nana Syme **99**, Dunbarton: Ben Vane, GR 27/27.09. A. McG. Stirling, 1976, **E**. 2nd record.

46/7. Ranunculus sardous Crantz ***106**, E. Ross: near Gordon's Mills, Udale Bay, Black Isle, GR 28/70.65. U. K. Duncan, 1966, **RNG**, det. E. J. Clement. 1st definite record.

46/10. Ranunculus auricomus L. ***104**, N. Ebudes: R. Stenscholl, Staffin, Skye, GR 18/48.67. C. W. Murray, 1976, **CGE**. 1st definite record.

46/20. Ranunculus circinatus Sibth. **85**, Fife: Lochmill Loch, Newburgh, GR 37/22.16. G. H. Ballantyne, 1972, field record. 1st post-1930 record.

46/24b. Ranunculus ficaria L. subsp. bulbifer (Marsden-Jones) Lawalrée ***104**, N. Ebudes: Lynedale House, Skye, GR 18/36.54. Coolin Hills Hotel, Portree, Skye, GR 18/48.43. Both records C. W. Murray, 1978, **herb. C.W.M.**, conf. P. Harrold. 1st and 2nd records.

48/1. Myosurus minimus L. **34**, W. Gloucs.: Hartpury, GR 32/78.21. C. R. Cuthbert, 1977, field record. 2nd record, 1st since 1796.

50/1. Thalictrum flavum L. **44**, Carms.: near Drefach, Velindre, GR 22/34.39. B.S.B.I. Field Meeting, 1978, field record. 2nd record. (*Nature Wales*, **16**: 212 (1979)).

†53/3. Berberis buxifolia Pers. ***28**, W. Norfolk: East Walton Common, GR 53/73.16. E. L. Swann, 1960s, field record, det. D. E. Coombe.

†54/1. Mahonia aquifolium (Pursh) Nutt. ***73**, Kirkcudbright: near Black Water of Dee, GR 25/65.69. O. M. Stewart, 1977, field record.

56/1 × 2. Nuphar lutea (L.) Sm. × N. pumila (Timm) DC. ***70**, Cumberland: Blea Tarn, Armboth, GR 35/29.14. R. Stokoe, 1978, **herb. R.S.**, det. Y. Heslop-Harrison. 2nd English record. **85**, Fife: Black Loch, Cleish Hills, GR 36/07.96. G. H. Ballantyne, 1975, field record, confirms records of 1910 and 1919.

†64/f. Dicentra formosa Walp. ***46**, Cards.: Allt Henbant-fawr, N.W. of Capel Dewi, GR 22/44.43. Capel Dewi, GR 22/45.42. Both records A. O. Chater, 1978, **NMW**. 1st and 2nd records. (*Nature Wales*, **16**: 215 (1979)).

†65/4. Corydalis lutea (L.) DC. ***104**, N. Ebudes: Portree, Skye, GR 18/48.43. M. Henriksen & P. Burke, 1974, **herb. C. W. Murray**.

66/6b. FUMARIA MURALIS Sond. ex Koch subsp. BORAEI (Jord.) Pugsl. †***104**, N. Ebudes: Uigshader, N. W. of Portree, Skye, GR 18/42.46. P. Burke, 1974, **herb. C. W. Murray**, det. F. H. Perring.

67/1. BRASSICA OLERACEA L. **50**, Denbigh: Minera, near Wrexham, GR 33/25.51. Limestone cliff. T. Edmondson, 1974, field record. 2nd record. (*Nature Wales,* **16**: 220 (1979)).

†67/j. BRASSICA JUNCEA (L.) Czern. ***57**, Derbys.: S. of Ford Bridge, Allestree, GR 43/35.40. E. A. Pratt, 1978, **DBY**.

†68/1. ERUCASTRUM GALLICUM (Willd.) O. E. Schulz **17**, Surrey: Stoat's Nest pit, GR 51/30.59. W. A. P. Small, 1977, field record, det. E. J. Clement. 1st post-1930 record.

†69/3. RHYNCHOSINAPIS CHEIRANTHOS (Vill.) Dandy ***70**, Cumberland: Workington, GR 25/99.29. C. C. Haworth, 1978, **LANC**.

†74/3. RAPHANUS SATIVUS L. **96**, Easterness: Tomatin, GR 28/80.29. E. Bullock, 1978, **E**. 2nd record.

†86/2. CAPSELLA RUBELLA Reut. ***35**, Monm.: Newport, GR 31/30.85. Rubbish tip. T. G. Evans, 1978, **NMW**, conf. E. J. Clement. (*Nature Wales,* **16**: 208 (1979)).

†90/2. BUNIAS ORIENTALIS L. **67**, S. Northumb.: North Blyth, GR 45/31.82. G. A. Swan, 1978, **herb. G.A.S.** 2nd record. ***70**, Cumberland: The Swifts, Carlisle, GR 35/40.56. R. Groom, 1978, **LANC**.

94/2. DRABA NORVEGICA Gunn. **104**, N. Ebudes: Bidein Druim na Ramh, Skye, GR 18/45.24. J. H. Penson, 1964, **E**, det. S. M. Walters. 2nd record.

97/2. CARDAMINE AMARA L. ***48**, Merioneth: Trystion Glen, Cynwyd, GR 33/0.4. P. M. Benoit, 1977, **NMW**.

98/2. BARBAREA STRICTA Andrz. ***50**, Denbigh: Pulford Brook, Rosset, near Wrexham, GR 33/40.58. T. Edmondson, 1975, **NMW**. (*Nature Wales,* **16**: 220 (1979)).

†98/4. BARBAREA VERNA (Mill.) Aschers. **70**, Cumberland: 1 mile N. of Alston, GR 35/71.48. Sir Charles Willink, 1977, **LANC**. 1st post-1930 record.

†AUBRIETA DELTOIDEA (L.) DC. ***46**, Cards.: Llandysul, GR 22/41.40. Well-naturalised. A. O. Chater, 1978, **NMW**. (*Nature Wales,* **16**: 215 (1979)).

102/2. NASTURTIUM MICROPHYLLUM (Boenn.) Reichb. ***99**, Dunbarton: near the Fruin Water, Callendoun, Helensburgh, GR 26/33.84. A. McG. Stirling, 1978, field record.

102/3. RORIPPA SYLVESTRIS (L.) Bess. **46**, Cards.: Teifi, 1.5km N.W. of Cenarth, GR 22/25.42. A. O. Chater, 1978, field record. 2nd record. (*Nature Wales,* **16**: 215 (1979)).

102/4. RORIPPA PALUSTRIS (L.) Besser subsp. PALUSTRIS ***99**, Dunbarton: Hardgate, Clydebank, GR 26/49.73. W. E. Evans, 1910, **E**, det. B. Jonsell. 1st definite record.

†108/v. SISYMBRIUM VOLGENSE Bieb. ex E. Fourn. ***27**, E. Norfolk: Caistor St Edmunds, GR 63/22.04. P. G. Lawson, 1978, **BM**, det. E. J. Clement.

112/2. RESEDA LUTEA L. **80**, Roxburgh: Melrose railway station, GR 36/54.33. R. W. M. Corner, 1978, **herb. R.W.M.C.** 1st record this century.

113/4b. VIOLA RIVINIANA Reichb. subsp. MINOR (Gregory) Valentine. ***99**, Dunbarton: near the Red Burn, Camis Eskan, Helensburgh, GR 26/32.81. A. McG. Stirling, 1978, field record.

115/6 × 5. HYPERICUM MACULATUM Crantz × H. PERFORATUM L. ***73**, Kirkcudbright: Crossmichael, GR 25/72.67. O. M. Stewart, 1977, **E**, det. N. K. B. Robson. Creetown station, GR 25/47.59. O. M. Stewart, 1977, **BM**, det. N. K. B. Robson.1st and 2nd records.

115/12. Hypericum hirsutum L. **93**, N. Aberdeen: Laithers, 3 miles W. of Turriff, GR 38/67.49. D. Welch, 1978, **ABD**. 1st post-1930 record.

122/1. Elatine hexandra (Lapierre) DC. ***69**, Westmorland: Grasmere, GR 35/34.06. J. D. Allonby, 1977, **herb. Freshwater Biological Ass., Windermere**, det. J. Lund. Loughrigg Tarn, GR 35/34.04. R. Stokoe, 1978, **herb. R.S.** 1st and 2nd records.

†124/c. Lychnis coronaria (L.) Desr. ***94**, Banff: Nether Dallachy, GR 38/36.64. M. McC. Werster, 1978, **E**. ***106**, E. Ross: Munlochy, Black Isle, GR 28/64.52. M. McC. Webster, 1978, **E**.

†129/o. Saponaria ocymoides L. ***35**, Monm.: Newport, GR 31/30.85. Rubbish tip. T. G. Evans, 1978, **NMW**, conf. E. J. Clement. (*Nature Wales*, **16**: 208 (1979)).

137/1. Minuartia verna (L.) Hiern ***46**, Cards.: Goginan lead mine, GR 22/6.8. J. P. Savidge, 1972, field record. (*Nature Wales*, **16**: 215 (1979))

141/2. Arenaria leptoclados (Reichenb.) Guss. ***99**, Dunbarton: between Craigendoran and Ardmore, Helensburgh, GR 26/32.80. A. McG. Stirling, 1972, **E**.

†141/6. Arenaria balearica L. ***27**, E. Norfolk: Overstrand, GR 63/20.40. E. A. Ellis, 1977, field record.

143/1. Spergularia rubra (L.) J. and C. Presl †**104**, N. Ebudes: near Kinloch Lodge Hotel Skye, GR 18/70.16. M. McC. Webster, 1978, **herb. C. W. Murray.** 1st definite record for Skye.

149/1b. Montia fontana L. subsp. chondrosperma (Fenzl) Walters ***73**, Kirkudbright: Castlehill Point, GR 25/85.52. O. M. Stewart, 1978, **E**. Mossyard, GR 25/55.51. O. M. Stewart, 1978, **E**. 1st and 2nd records.

154/14. Chenopodium rubrum L. **70**, Cumberland: near Abbeytown, GR35/1.5. G. Halliday, 1978, **LANC**, det. J. P. M. Brenan. Only extant record.

156/1 × 2. Atriplex littoralis L. × A. patula L. ***95**, Moray: Findhorn, GR 38/04.63. M. McC. Webster, 1978, **E**, det. P. M. Taschereau.

156/lon × 3. Atriplex longipes Drejer × A. prostrata Boucher ex DC. ***73**, Kirkcudbright: Creetown, GR 25/47.58. O. M. Stewart, 1978, **MANCH**, det. P. M. Taschereau. ***94**, Banff: Spey Bay, GR 38/35.65. M. McC. Webster, 1978, **E**, det. P. M. Taschereau. ***106**, E. Ross: Munlochy Bay, Black Isle, GR 28/66.53. M. McC. Webster, 1978, **E**, det. P. M. Taschereau.

156/4 × lon. Atriplex glabriuscula Edmondst. × A. longipes Drejer ***106**, E. Ross: Black Isle, GR 28/—. Nigg Ferry, GR 28/79.68. Both records M. McC. Webster. 1978, **E**, det. P. M. Taschereau. 1st and 2nd records.

156/lon. Atriplex longipes Drejer ***73**, Kirkcudbright: between Newton Stewart and Creetown, GR 25/47.58. P. M. Taschereau, 1975, **MANCH**.

156/p. Atriplex praecox Hülphers ***104**, N. Ebudes: Loch Slapin, Skye, GR 18/57.21. M. McC. Webster, 1978. **MANCH**, det. P. M. Taschereau. Loch na Dal near Kinloch Lodge, Skye, GR 18/70.15 M. McC. Webster, 1978, **E**. 1st and 2nd records. ***106**, E. Ross: Munlochy Bay, Black Isle, GR 28/66.53. M. McC. Webster, 1978, **E**, det. P. M. Taschereau.

160/2. Salicornia dolichostachya Moss ***70**, Cumberland: Grune Point, GR 35/14.56. C. W. Muirhead, *c*1963, field record. Newton Arlosh, GR 35/19.56. R. Groom, 1978, **LANC**, det. K. Ferguson. 1st and 2nd records.

160/4. Salicornia ramosissima Woods ***70**, Cumberland: Grune Point, GR 35/14.56. C. W. Muirhead, *c*1963, field record. Newton Arlosh, GR 35/19.56. R. Groom, 1978, **LANC**, det. K. Ferguson. 1st and 2nd records.

160/f. Salicornia fragilis P. W. Ball & Tutin ***69b**, Furness: Roosecote, Barrow-in-Furness, GR 34/21.68. G. Halliday, 1978, field record, det. K. Ferguson.

†168/3. GERANIUM ENDRESSII Gay **70**, Cumberland: Whitehaven-Egremont road, GR 25/98.15. C. C. Haworth, 1978, **herb. C.C.H.** 2nd record.

168/9. GERANIUM PYRENAICUM Burm. f. **44**, Carms.: Pembrey Country Park, GR 22/4.0. F. H. Webb, 1978, field record. 1st localized record. (*Nature Wales,* **16**: 212 (1979)).

169/4. ERODIUM GLUTINOSUM Dumort. ***46**, Cards.: Gwbert, GR 22/16.48. A. O. Chater, 1978, field record. (*Nature Wales,* **16**: 215 (1979)).

171/1. IMPATIENS NOLI-TANGERE L. **59**, S. Lancs.: Pleasington, Blackburn, GR 34/64.26. P. Jepson, 1978, field record. 1st post-1930 record.

187/1 × 2. ULEX EUROPAEUS L. × U. GALLII Planch. ***47**, Montgomery: S.W. end of Llanymynech Hill, GR 33/2.2. P. M. Benoit, 1978, **NMW**. (*Nature Wales,* **16**: 217 (1979)).

189/3. ONONIS RECLINATA L. **45**, Pembs.: Stackpole, GR 11/99.95. D. S. Ranwell & S. B. Evans, 1971, field record. 2nd record. (*Nature Wales,* **16**: 213 (1979)).

†190/1 × 2. MEDICAGO FALCATA L. × M. SATIVA L. ***67**, S. Northumb.: Seaton Burn, GR 45/23.73. E. R. Meek, 1978, **herb. G. A. Swan**. det. A. J. Richards.

†191/3. MELILOTUS ALBA Medic. ***73**, Kirkcudbright: Kirkbean, GR 25/97.59. O. M. Stewart, 1978, **E**.

206/2. VICIA TETRASPERMA (L.) Schreb. ***99**, Dunbarton: near R. Leven, Dillichip, Bonhill, GR 26/39.78. A. McG. Stirling, 1978, **E**.

206/15. VICIA ANGUSTIFOLIA L. ***104**, N. Ebudes: Kinloch Lodge, Skye, GR 18/72.15. M. McC. Webster, 1978, **herb. C. W. Murray**. 1st definite record. Durringell Hotel, Kyleakin, Skye, GR 18/74.26. C. W. Murray, 1978, **herb. C.W.M.** 2nd record.

207/10. LATHYRUS JAPONICUS Willd. subsp. MARITIMUS (L.) P. W. Ball ***49**, Caerns.: Bardsey Island, GR 23/1.2. A. P. Conolly, 1978, field record. 2nd Welsh record. (*Nature Wales,* **16**: 219 (1979)).

†207/g. LATHYRUS GRANDIFLORUS Sibth. & Sm. ***35**, Monm.: Penpergwm station, GR 32/32.10. T. G. Evans, 1978, **NMW**. (*Nature Wales,* **16**: 209 (1979)). ***70**, Cumberland: near Whitehaven, GR 25/99.12. C. C. Haworth, 1978, **LANC**.

†207/i. LATHYRUS INCONSPICUUS L. ***59**, S. Lancs.: Prestwich, GR 34/79.03. J. J. Zawadski, 1978, field record, det. E. J. Clement.

†209/a. SPIRAEA ALBA Duroi ***73**, Kirkudbright: Townhead of Greenlaw, GR 25/73.64. O. M. Stewart, 1978, **E**, det. A. J. Silverside.

211/2. RUBUS SAXATILIS L. **93**, N. Aberdeen: Aberdour, GR 38/86.65. D. Welch, 1978, **ABD**. 1st post-1930 record.

211/11/2. RUBUS SCISSUS W. C. R. Wats. ***85**, Fife: W. of Saline, GR 26/9.9. G. H. Ballantyne, 1973, **herb. G.H.B.**, det. E. S. Edees.

211/11/3. RUBUS SULCATUS Vest ex Tratt. **13**, W. Sussex: Amberley Wild Brooks, GR 51/03.14. R. J. Pankhurst, 1978, **BM**, det. A. Newton. Rediscovery of only locality, last recorded in 1917.

211/11/7. RUBUS FISSUS Lindl. ***85**, Fife: S. of Crossgates, GR 36/1.8. G. H. Ballantyne, 1970, **herb. G.H.B.**, det. E. S. Edees.

211/11/18. RUBUS LATIFOLIUS Bab. ***85**, Fife: Abden, Kinghorn, GR 36/2.8. G. H. Ballantyne, 1962, **herb. G.H.B.**, det. E. S. Edees.

211/11/27. RUBUS TUBERCULATUS Bab. ***85**, Fife: Dysant, Kirkcaldy, GR 36/3.9. G. H. Ballantyne, 1977, **herb. G.H.B.**, det. A. Newton.

†211/11/54. Rubus laciniatus Willd. ***85**, Fife: Raith, Kirkcaldy, GR 36/2.9. G. H. Ballantyne, 1962, field record.

211/11/59. Rubus lindleianus Lees ***85**, Fife: Kinshaldy, Tentsmuir, GR 37/4.2. G. H. Ballantyne, 1978, **herb. G.H.B.**, det. A. Newton.

211/11/99. Rubus septentrionalis W. C. R. Wats. ***85**, Fife: Edentown, Ladybank, GR 37/2.0. G. H. Ballantyne, 1978, **herb. G.H.B.**, conf. A. Newton.

211/11/113. Rubus polyanthemus Lindeb. ***85**, Fife: Annsmuir golf-course, Ladybank, GR 37/3.1. G. H. Ballantyne, 1978, **herb. G.H.B.**, det. A. Newton.

211/11/126. Rubus errabundus W. C. R. Wats. ***85**, Fife: Lochmill, S. of Newburgh, GR 37/2.1. G. H. Ballantyne, 1978, **herb. G.H.B.**, conf. A. Newton.

211/11/129. Rubus ulmifolius Schott ***85**, Fife: Kilmany, GR 37/3.2. G. H. Ballantyne, 1973, **herb. G.H.B.**, conf. E. S. Edees.

†211/11/139. Rubus procerus P. J. Muell. ***85**, Fife: Newburgh, GR 37/2.1. G. H. Ballantyne, 1978, **herb. G.H.B.**, conf. A. Newton.

211/11/165. Rubus vestitus Weihe & Nees ***85**, Fife: Raith. Kirkcaldy, GR 36/2.9. G. H. Ballantyne, 1962, **herb. G.H.B.**, det. E. S. Edees.

211/11/213. Rubus echinatoides (Rogers) Sudre ***85**, Fife: Tillyochie, 3 miles W. of Kinross, GR 33/1.0. G. H. Ballantyne, 1975, **herb. G.H.B.**, det. A. Newton.

211/11/354. Rubus infestus Weihe ex Boenn. ***85**, Fife: Cairney hill, GR 36/0.8. G. H. Ballantyne, 1978, **herb. G.H.B.**, conf. A. Newton.

211/11/356. Rubus dasyphyllus (Rogers) Rogers ***85**, Fife: Kilmany, GR 37/3.2. G. H. Ballantyne, 1973, **herb. G.H.B.**. det. E. S. Edees.

211/11/d. Rubus danicus Focke ***85**, Fife: Lappyburn, E. of Kirkcaldy, GR 36/3.9. G. H. Ballantyne, 1962, **herb. G.H.B.**, det. E. S. Edees.

211/11/s. Rubus scoticus (Rogers & A. Ley) E. S. Edees ***85**, Fife: W. of Oakley, GR 26/9.9. G. H. Ballantyne, 1978, **herb. G.H.B.,** det. A. Newton.

212/14 × 13. Potentilla anglica Laichard. × P. erecta (L.) Räusch. **44**, Carms.: near Cwmduad, GR 22/37.31. B.S.B.I. Field Meeting, 1978, field record, det. H. Vannerom. 2nd record. (*Nature Wales,* **16**: 212 (1979)).

216/3 × 1. Geum rivale L. × G. urbanum L. ***46**, Cards.: Nant y March dingle, nr Capel Betws Leucu, GR 22/60.57. A. O. Chater, 1978, **NMW**. (*Nature Wales*, **16**: 215 (1979)) **79**, Selkirk: Peel Hospital near Galashiels, GR 36/43.35. R. W. M. Corner, 1978, **herb. R.W.M.C.** 1st localized record.

218/2. Agrimonia odorata (Gouan) Mill. ***80**, Roxburgh: South Greenholm, Newcastleton, GR 35/49.90. R. W. M. Corner, 1978, **herb. R.W.M.C.** S. of Bowland, GR 35/45.39. R. W. M. Corner, 1978, **herb. R.W.M.C.** 1st and 2nd records.

220/1. Alchemilla alpina L. ***93**, N. Aberdeen: Plaidy, GR 38/73.55. M. McC. Webster, 1956, field record. Now probably extinct.

220/3/1. Alchemilla glaucescens Wallr. [***69**, Westmorland. The record in *Flowering plants and ferns of Cumbria* (1978, p. 15) was based on a misidentification, G. Halliday fide M. E. Bradshaw.]

220/3/3. Alchemilla filicaulis Buser ***67**, S. Northumb.: N. of Great Swinburn, GR 35/93.76. G. A. & M. Swan, 1978, **herb. G.A.S.**, det. S. M. Walters. ***68**, Cheviot: Hen Hole, Cheviot, GR 36/89.20. G. A. & M. Swan, 1978, **herb. G.A.S.**, det. S. M. Walters.

†220/3/12. Alchemilla mollis (Buser) Rothm. ***67**, S. Northumb.: near Seaton Burn, GR 45/23.73. G. A. & M. Swan, 1975, **herb. G.A.S.**, det. S. M. Walters. Near Carvoran, GR 35/66.65. G. A. & M. Swan, 1977, **herb. G.A.S.**, det. S. M. Walters. 2nd record.

220/3/7. Alchemilla acutiloba Opiz *67, S. Northumb.: N. of Baybridge, GR 35/95.50. G. A. & M. Swan, 1976, **herb. G.A.S.**, det. S. M. Walters.

225/1 × 8. Rosa arvensis Huds. × R. canina L. *73, Kirkcudbright: Kirkconnel Drive, New Abbey, GR 25/97.68. O. M. Stewart, 1977, **E**, det. R. Melville.

225/12 × 4. Rosa pimpinellifolia L. × R. sherardii Davies *52, Anglesey: Rhoscefnhir, GR 23/52.76. R. H. Roberts, 1978, **K**, det. R. Melville. 1st definite record. (*Nature Wales*, **16**: 222 (1979)).

225/8 × 4. Rosa canina L. × R. pimpinellifolia L. *52, Anglesey: Talgwynedd, Dwyran, GR 23/46.64. R. H. Roberts, 1976, **K**, det. R. Melville. (*Nature Wales*, **16**: 223 (1979)).

225/8 × 12. Rosa canina L. × R. sherardii Davies *49, Caerns.: Y Maes, Bangor, GR 23/57.71. R. H. Roberts, 1974, **K**, det. R. Melville. Near Treborth, Bangor, GR 23/56.71. R. H. Roberts, 1976, **K**, det. R. Melville. 1st and 2nd records. (*Nature Wales*, **16**: 219 (1979)).

225/8 × 14. Rosa canina L. × R. rubiginosa L. *28, W. Norfolk: East Walton, GR 53/74.16. B. Burt, 1976, **K**, det. R. Melville.

225/9 × 8. Rosa afzeliana Fr. × R. canina L. *52, Anglesey: Penmynydd, GR 23/52.73. R. H. Roberts, 1978, **K**, det. R. Melville. (*Nature Wales*, **16**: 223 (1979)). *73, Kirkcudbright: Barrhill, New Abbey, GR 25/96.66. N. F. & O. M. Stewart, 1978, **K**, det. R. Melville.

225/9 × 12. Rosa afzeliana Fr. × R. sherardii Davies *52, Anglesey: Penmynydd, GR 23/52.73. R. H. Roberts, 1978, **K**, det. R. Melville. (*Nature Wales*, **16**: 223 (1979)).

225/15 × 14. Rosa micrantha Borrer ex Sims × R. rubiginosa L. *28, W. Norfolk: Morston, GR 53/90.40. E. L. Swann, 1978, **K**, det. R. Melville.

†226/5. Prunus cerasus L. *106, E. Ross: Easter Kinkell, Black Isle, GR 28/56.53. M. McC. Webster, 1977, field record.

229/1. Crataegus laevigata (Poir.) DC. *45, Pembs.: Pencelly Forest, GR 22/1.3. S. B. Evans, 1978, **NMW**. (*Nature Wales*, **16**: 213 (1979)).

†232/4/1. Sorbus intermedia (Ehrh.) Pers. 70, Cumberland: Eskmeals, GR 35/08.94. A. Warburton, 1972, field record, det. G. Halliday. 2nd record. *73, Kirkcudbright: Falbae, GR 25/73.70. O. M. Stewart, 1978, **E**.

232/5/7. Sorbus rupicola (Syme) Hedl. *70, Cumberland: Falcon and Walla Crags, Derwentwater, GR 35/2.2. D. A. Ratcliffe, 1956, field record. Raven Crags, Thirlmere, GR 35/3.1. D. A. Ratcliffe, 1962, field record. 2nd record.

235/10a. Sedum forsteranum Sm. subsp. forsteranum 73, Kirkcudbright: Carsluith, GR 25/48.54. C.S.S.F. Field Meeting, 1977, field record. 2nd record.

†237/h. Crassula helmsii (T. Kirk) Cockayne *17, Surrey: Baron's Pond, Epsom, GR 51/20.59. W. A. P. Small, 1976, field record. Moat Pond, Thursley Common, GR 41/89.41. S. Wenham, 1977, field record, det. **BM**. 1st and 2nd records. *95, Moray: Lossiemouth, GR 38/26.69. M. S. Marshall, 1978, **E**, det. R. Pankhurst & E. J. Clement.

239/2. Saxifraga stellaris L. 50, Denbigh: Craig Berwyn, GR 33/07.33. R. G. Woods, 1978, field record. 2nd record, 1st post-1930 record. (*Nature Wales*, **16**: 221 (1979)).

239/3. Saxifraga hirculus L. *70, Cumberland: Black Burn slopes of Cross Fell, GR 35/7.3. D. A. Ratcliffe, 1959, field record.

239/6. Saxifraga hirsuta L. †*69, Westmorland: Rather Heath, Crook, GR 34/48.95. G. Halliday, 1975, **LANC**, det. D. A. Webb. 1st definite record. *73, Kirkcudbright: near Drum park bridge, GR 25/87.79. O. M. Stewart & M. Martin, 1978, **E**.

†240/1. Tellima grandiflora (Pursh) Dougl. ex Lindl. *69b, Furness: Blawith, Grange-over-Sands, GR 34/41.78. J. M. Lock, 1978, **LANC**.

†241/1. TOLMIEA MENZIESII (Pursh) Torr. & Gray *69, Westmorland: Rather Heath, Crook, GR 34/48.95. G. Halliday, 1975, **LANC**. *73, Kirkcudbright: by Garrock Burn, Hanaston Wood, GR 25/59.82. N. F. Stewart, 1978, field record.

254/4. EPILOBIUM LANCEOLATUM Seb. & Mauri *43. Radnor: Llanelwedd. GR 32/05.52. F. Rose, 1978, field record. (*Nature Wales,* **16**: 211 (1979)).

254/6. EPILOBIUM ADENOCAULON Hausskn. *70, Cumberland: Carlisle, GR 35/4.5. C. W. Muirhead, 1973, **herb. C.W.M.**

†256/3. OENOTHERA STRICTA Ledeb. ex Link **44**, Carms.: Pembrey Burrows, GR 21/41.99. F. H. Webb, 1978, **NMW**, conf. E. A. Ellis. 2nd record. (*Nature Wales,* **16**: 212 (1979)). *46, Cards.: Gwbert, GR 22/16.48. A. O. Chater, 1978, **NMW**. (*Nature Wales,* **16**: 215 (1979)).

†256/c. OENOTHERA CAMBRICA Rost. *13, W. Sussex: West Wittering, GR 40/76.99. M. B. Mallinson, 1953, **LTR**, det. K. Rostański.

262/3. CALLITRICHE OBTUSANGULA Le Gall **69b**, Furness: Mere Tarn, Aldingham, GR 34/26.71. R. Stokoe, 1978, **herb. R.S.** 2nd record.

262/6. CALLITRICHE TRUNCATA Guss. *57, Derbys.: Melbourne Pool, GR 43/39.24. K. M. Hollick, 1978, **DBY**.

277/3. TORILIS NODOSA (L.) Gaertn. **85**, Fife: Crail, GR 37/61.07. G. H. Ballantyne, 1977, field record. 1st post-1930 record.

288/1. CICUTA VIROSA L. *50, Denbigh: E. side of Hanmer Mere near Whitchurch, GR 33/45.39. J. M. Brummitt,1978, field record. Llyn Bedydd, Hanmer, near Whitchurch, GR 33/47.39. J. M. Brummitt, 1978, field record. 1st and 2nd records. (*Nature Wales,* **16**: 221 (1979)).

318/2. MERCURIALIS ANNUA L. *95, Moray: Kinloss, GR 38/05.61. E. M. Legge, 1978, **BM & E**, det. E. J. Clement.

†320/18. POLYGONUM BALDSCHUANICUM Regel *70, Cumberland: near St Bees, GR 25/96.12. C. C. Haworth, 1978, field record.

†320/20. REYNOUTRIA SACHALINENSIS (Friedrich Schmidt Petrop.) Nakai *46, Cards.: Falcondale Lake, GR 22/57.50. A. O. Chater, 1978, **NMW**. S.W. of Cribyn, GR 22/51.50. A. O. Chater, 1978, **NMW**. 1st and 2nd records. (*Nature Wales,* **16**: 216 (1979)).

325/8. RUMEX LONGIFOLIUS DC. **73**, Kirkcudbright: Water of Deugh, GR 26/55.01. O. M. Stewart, 1978, **E**. 1st post-1930 record. *99, Dunbarton: N. of Bearsden, GR 26/53.74. P. Macpherson, 1968, **herb. P.M.** Mountblow, Dalmuir, GR 26/47.71. A. McG. Stirling, 1970, field record. 1st and 2nd records.

325/11 × 12. RUMEX CRISPUS L. × R. OBTUSIFOLIUS L. *99, Dunbarton: Milton, Dumbarton, GR 26/41.74. A. McG. Stirling, 1977, field record. Ardpeaton Cove, GR 26/21.85. A. McG. Stirling & E. C. Wallace, 1978, field record. 1st and 2nd records.

325/14. RUMEX SANGUINEUS L. **104**, N. Ebudes: Armadale Castle woods, Skye, GR 18/63.04. C. W. Murray, 1976, **herb. C.W.M.** 2nd record.

343/2 × 4. SALIX ALBA L. × S. FRAGILIS L. *73, Kirkcudbright: Challoch, GR 25/39.67. C.S.S.F. Field Meeting, 1977, **E**, det. R. C. L. Howitt.

343/5. SALIX TRIANDRA L. **50**, Denbigh: Llwyn Celyn, Llanrhaedr near Denbigh, GR 33/08.64. J. M. Brummitt, 1978, **NMW**. 2nd record. (*Nature Wales,* **16**: 221 (1979)).

343/13 × 11 × 9. SALIX AURITA L. × S. CAPREA L. × S. VIMINALIS L. *73, Kirkcudbright: near Castlefairn, GR 25/72.87. O. M. Stewart, 1976, **E**, det. R. C. L. Howitt.

343/12 × 14. SALIX CINEREA L. × S. MYRSINIFOLIA Salisb. *73, Kirkcudbright: Lotus Loch, GR 25/90.68. O. M. Stewart. 1977, **E**, det. R. C. L. Howitt.

343/13 × 16. SALIX AURITA L. × S. REPENS L. *46. Cards.: Tryal-bach. Llannon. GR 22/52.65. A. O. Chater & D. G. Jones, 1978, **NMW**, conf. R. D. Meikle. (*Nature Wales,* **16**: 216 (1979)).

343/14. SALIX MYRSINIFOLIA Salisb. ***73**, Kirkcudbright: Milton Loch, GR 25/84.71. R. J. Pankhurst & T. K. Power, 1975, field record, 1977, **E**.

343/14 × 15. SALIX MYRSINIFOLIA Salisb. × S. PHYLICIFOLIA L. ***73**, Kirkcudbright: Milton Loch, GR 25/83.71. R. C. L. Howitt, 1977, **E**.

†343/e. SALIX ELAEAGNOS Scop. ***28**, W. Norfolk: Bawsey, GR 53/21.65. E. L. Swann, 1978, **herb. R. C. L. Howitt**, det. R.C.L.H.

†345/2. RHODODENDRON LUTEUM Sweet ***73**, Kirkcudbright: Kirkconnel Moss, GR 25/97.69. O. M. Stewart, 1976, field record. Hannaston Wood, GR 25/59.82. O. M. Stewart, 1978, field record. 1st and 2nd records.

350/1. ANDROMEDA POLIFOLIA L. ***99**, Dunbarton: Blairbeich, Gartocharn, GR 26/43.83. E. Bignal & J. Christie, 1978, **E**.

353/1. ARBUTUS UNEDO L. †***35**, Monm.: Chepstow, GR 31/53.93. T. G. Evans, 1978, **herb. T.G.E.** (*Nature, Wales,* **16**: 209 (1979)).

359/1. PYROLA MINOR L. **104**, N. Ebudes: Dunvegan Castle woods, Skye, GR 18/24.49. Lady Anne Brewis, 1975, **herb. C. W. Murray**. 1st record for Skye.

360/1. ORTHILIA SECUNDA (L.) House **104**, N. Ebudes: Gorge on Allt nan Con, S. of Kylerhea road, Skye, GR 18/71.22. C. W. Murray, 1978, **herb. C.W.M.** 1st record for Skye.

†367/f. PRIMULA FLORINDAE Ward **96**, Easterness: Lower Glendoe, Fort Augustus, GR 28/40.09. R. W. M. Corner, 1977, **E**, det. M. McC. Webster. 2nd record.

†370/5. LYSIMACHIA PUNCTATA L. ***70**, Cumberland: by R. Ehen, between Ennerdale Bridge and Cleator Moor, GR 35/04.15. S.E. of Whitehaven on Egremont road, GR 25/98.15. 1st and 2nd records. Both records C. C. Haworth, 1978, field record. ***106**, E. Ross: Foulis Castle, Dingwall, GR 28/58.64. M. McC. Webster, 1978, field record.

372/1. ANAGALLIS TENELLA (L.) L. **99**, Dunbarton: S. side of Carman Muir, Cardross, GR 26/36.78. A. McG. Stirling, 1976, field record. 2nd record.

372/4. ANAGALLIS MINIMA (L.) E. H. L. Krause [**99**, Dunbarton: *Watsonia,* **12**: 173 (1978) editorial error for 372/1.]

†375/1. BUDDLEJA DAVIDII Franch. ***96b**, Nairn: Auldearn, GR 28/9.5. M. McC. Webster, 1978, field record.

383/1. BLACKSTONIA PERFOLIATA (L.) Huds. ***46**, Cards.: Ynyslas, GR 22/6.9. J. P. Savidge, 1972, field record. (*Nature Wales,* **16**: 216 (1979)).

†392/2. SYMPHYTUM ASPERUM Lepech. ***106**, E. Ross: Fortrose, GR 28/72.56. M. McC. Webster, 1948, field record, conf. F. H. Perring, 1978.

†394/1. TRACHYSTEMON ORIENTALIS (L.) G. Don ***57**, Derbys.: Graves Park, Sheffield, GR 43/35.82. J. Hodgson, 1977, field record.

†395/1. PENTAGLOTTIS SEMPERVIRENS (L.) Tausch ***104**, N. Ebudes: Dunvegan, Skye, GR 18/24.49. C. W. Murray, 1974, **herb. C.W.M.**

399/1. PULMONARIA LONGIFOLIA (Bast.) Bor. †***73**, Kirkcudbright: by Urr Water near Tottleham Glen, GR 25/76.69. O. M. Stewart, 1977, **E**.

†399/2. PULMONARIA OFFICINALIS L. ***73**, Kirkcudbright: near Polharrow Bridge, GR 25/60.84. S. of Balmaclellen, GR 25/65.78. 1st and 2nd records. Both records O. M. Stewart, 1978, field record.

400/10. MYOSOTIS RAMOSISSIMA Rochel *99, Dunbarton: Dumbuck Hill, Dumbarton, GR 26/4.7. A. McG. Stirling, 1978, **E**.

†AMSINCKIA INTERMEDIA Fischer & C. A. Meyer *68, Cheviot: Spittal, GR 46/00.51. G. A. & M. Swan, 1978, **herb. G.A.S.**, det. H. J. M. Bowen. Junction of R. Till and R. Tweed, GR 36/87.43. D. H. Burnett, 1978, **herb. G.A.S.**, det. H. J. M. Bowen. 1st and 2nd records.

†406/3. CALYSTEGIA SILVATICA (Kit.) Griseb. *93, N. Aberdeen: Rothienorman, GR 38/72.35. D. Welch, 1978, **ABD**.

†407/c. CUSCUTA CAMPESTRIS Yuncker *95, Moray: Forres, GR 38/05.58. On beetroot. C. Underhill, 1978, **E**.

†413/s. SOLANUM SARRACHOIDES Sendt. *95, Moray: Kinloss, GR 38/05.61. E. M. Legge, 1978, **E**.

416/10. VERBASCUM VIRGATUM Stokes †44. Carms.: Pembrey Country Park, GR 22/41.00. F. H. Webb, 1978, field record. 2nd record. (*Nature Wales*, **16**: 212 (1979)).

417/1. MISOPATES ORONTIUM (L.) Raf. 59, S. Lancs.: Liverpool, GR 33/36.89. A. J. Coombes, 1976, **LIV**. 2nd record.

†420/2 × 3. LINARIA PURPUREA (L.) Mill. × L. REPENS (L.) Mill. *35, Monm.: near Severn Tunnel junction, GR 31/46.87. T. G. Evans, 1978, **herb. T.G.E.** (*Nature Wales*, **16**: 209 (1979)).

420/3. LINARIA REPENS (L.) Mill. †104, N. Ebudes: Dunringell Hotel, Kyleakin, Skye, GR 18/74.26. M. McC. Webster, 1978, **E**. 2nd record.

424/3. SCROPHULARIA UMBROSA Dumort. 70, Cumberland: by R. Eden near Nunnery Walks, GR 35/53.42. F. J. Roberts, 1978, field record. 2nd record.

426/1. LIMOSELLA AQUATICA L. *88, Mid Perth: R. Eam near Forteviot, GR 37/03.17. A. W. Robson, 1977, field record.

430/3. VERONICA CATENATA Pennell 70, Cumberland: near Abbeytown, GR 35/1.5. R. Stokoe, 1978, **herb. R.S.** Rediscovery of pre-1930 site, only extant record. 73, Kirkcudbright: Girthon, GR 25/60.54. O. M. Stewart, 1978, **E**. 2nd record.

430/10. VERONICA FRUTICANS Jacq. *98, Main Argyll: Coire a' Ghabhalach, Beinn an Dothaidh, GR 27/33.40. A. G. Kenneth, 1978, **CGE**, conf. S. M. Walters.

†430/14. VERONICA PEREGRINA L. 69, Westmorland: Kirkby Lonsdale, GR 34/61.78. J. M. Lock, 1978, field record. 2nd record. *99, Dunbarton: Ross Priory, GR 26/41.87. P. Macpherson, 1978, **herb. P.M.**

†430/17. VERONICA ACINIFOLIA L. *13, W. Sussex: Brooklands Park, Worthing, GR 51/16.03. G. Bishop, 1978, field record, det. D. McClintock.

430/20. VERONICA HEDERIFOLIA L. 104, N. Ebudes: Dunringell Hotel, Kyleakin, Skye, GR 18/74.26. C. W. Murray, 1978, **herb. C.W.M.** 1st localized record.

434/3. MELAMPYRUM PRATENSE L. 85, Fife: 2½ miles N.E. of Saline, GR 36/05.94. G. H. Ballantyne, 1971, field record. 1st record this century.

439/1. LATHRAEA SQUAMARIA L. *85, Fife: 1½ miles N.E. of Saline, GR 36/04.94. G. H. Ballantyne, 1978, field record. 1st definite record.

442/1. UTRICULARIA VULGARIS L. *34, W. Gloucs.: Chamomile Green, Ruspidge, Forest of Dean, GR 32/65.10. K. G. Preston-Mafham, 1977, **K**, det. P. Taylor. 1st definite record.

445/3 × 5. MENTHA ARVENSIS L. × M. SPICATA L. *45, Pembs.: 2km N.E. of St David's, GR 12/76.26. J. W. Donovan & T. A. W. Davis, 1978, field record. (*Nature Wales*, **16**: 214 (1979)).

†445/5 × 7. Mentha spicata L. × M. suaveolens Ehrh. ***93**, N. Aberdeen: Premnay, GR 38/63.24. D. Welch, 1978, **ABD** & **K**, det. R. M. Harley.

458/1. Betonica officinalis L. **85**, Fife: 1½ miles N.E. of Thornton, GR 36/30.99. G. H. Ballantyne, 1976, field record. 1st record this century.

462/2. Lamium moluccellifolium Fr. **57**, Derbys.: Ashbourne, GR 43/17.46. K. M. Hollick, 1978, field record. 1st post-1930 record.

†475/r. Campanula rhomboidalis L. ***72**, Dumfries: Langholm, GR 35/3.8. R. C. L. Howitt, 1978, **DFS**, det. E. J. Clement. 1st British record.

480/2. Lobelia dortmanna L. **47**, Montgomery: Llyn Coch-hwyad, GR 23/9.1. R. G. Woods, 1978, field record. 2nd record. (*Nature Wales,* **16**: 217 (1979)).

485/3. Galium mollugo L. **†104**, N. Ebudes: Prabost, Skeabost Bridge, Skye, GR 18/42.50. C. W. Murray, 1978, **herb. C.W.M.** 2nd record.

†487/3. Sambucus racemosa L. ***70**, Cumberland: S.E. of Hutton-in-the-Forest, GR 35/47.35. G. Halliday, 1975, field record.

†491/n. Lonicera nitida Wils. ***79**, Selkirk: Tweedside E. of Boldside, GR 36/50.33. R. W. M. Corner, 1978, **herb. R.W.M.C.**, det. **E**. ***80**, Roxburgh: by A7, Torwoodlee, N. of Galashiels, GR 36/48.38. R. W. M. Corner, 1978, field record. ***106**, E. Ross: Munlochy, GR 28/6.5. M. McC. Webster, 1978, field record.

494/2. Valerianella carinata Lois. **46**, Cards.: St Peter's churchyard, Lampeter, GR 22/57.48. J. R. Palmer & C. W. Bannister, field record. 2nd record. (*Nature Wales,* **16**: 216 (1979)).

†495/2. Valeriana pyrenaica L. ***93**, N. Aberdeen: Auchleven, GR 38/62.24. D. Welch, 1978, **ABD**.

†503/2. Galinsoga ciliata (Raf.) Blake ***69b**, Furness: High Fell Gate, Grange-over-Sands, GR 34/39.77. J. Harling, 1978, field record. ***70**, Cumberland: Carlisle, GR 35/4.5. C. W. Muirhead, mid-1970s, field record. Wetheral, GR 35/46.54. R. & C. Smith, 1977, field record. 1st and 2nd records.

506/2 × 1. Senecio aquaticus Hill × S. jacobaea L. ***28**, W. Norfolk: Castle Acre, GR 53/81.14. E. L. Swann, 1969, field record. ***70**, Cumberland: Ennerdale Bridge, GR 35/06.16. C. C. Haworth, 1978, **herb. C.C.H.**

†506/18 × 1. Senecio cineraria DC. × S. jacobaea L. ***46**, Cards.: Castle Grounds, Aberystwyth, GR 22/57.81. A. O. Chater, 1978, **NMW**, conf. P. M. Benoit. (*Nature Wales,* **16**: 216 (1979)).

506/4 × 7. Senecio squalidus L. × S. viscosus L. ***59**, S. Lancs.: Liverpool, GR 33/36.90. A. J. Coombes, 1976, field record, det. P. C. Crisp.

†509/2. Petasites albus (L.) Gaertn. ***73**, Kirkcudbright: near Irongray, GR 25/91.99. O. M. Stewart, 1977, field record.

†509/4. Petasites fragrans (Vill.) C. Presl **80**, Roxburgh: Charters Plantation crossroads, Smailholm, GR 36/67.35. R. W. M. Corner, 1978, **herb. R.W.M.C.** 1st post-1930 record.

512/4. Inula conyza DC. ***70**, Cumberland: Steel Green, Millom, GR 34/17.78. N. Nicholson, 1955, field record.

†519/9. Aster salignus Willd. **96**, Easterness: Dores, GR 28/57.31. M. McC. Webster, 1978, **E**, det. R. J. Pankhurst. 2nd record.

†533/3. Chrysanthemum maximum Ramond ***106**, E. Ross: Fortrose, GR 28/73.56. M. McC. Webster, 1978, field record.

†536/b. ECHINOPS BANNATICUS Rochel ex Schrader *96, Easterness: Gollanfield, GR 28/81.52. M. McC. Webster, 1978, **E**.

537/1. CARLINA VULGARIS L. **93**, N. Aberdeen: Slains, GR 48/05.29. D. Welch, 1978, field record. 1st post-1930 record.

539/3. CARDUUS NUTANS L. ***96**, Easterness: Boat-of-Garten, GR 28/93.17. D. Hayes, 1978, **E**.

540/8 × 3. CIRSIUM DISSECTUM (L.) Hill × C. PALUSTRE (L.) Scop. ***27**, E. Norfolk: Southrepps Common, GR 63/20.30. P. W. Lambley & F. Rose, 1975, field record.

542/1. ONOPORDUM ACANTHIUM L. ***48**, Merioneth: Tywyn, GR 23/58.00. K. M. Stevens, 1978, field record, conf. P. M. Benoit. (*Nature Wales,* **16**: 218 (1979)).

554/1. LACTUCA SERRIOLA L. ***57**, Derbys.: Megaloughton Lane, Derby, GR 43/39.35. S. Jackson, 1978, **DBY**.

†557/3. CICERBITA MACROPHYLLA (Willd.) Wallr. **35**, Monm.: Newport Docks, GR 31/31.85. T. G. Evans, 1978, **NMW**. 2nd record. (*Nature Wales,* **16**: 209 (1979)).

558/1/sev. HIERACIUM SEVERICEPS Wiinst. ***70**, Cumberland: Cleator Moor, GR 35/01.16. C. C. Haworth, 1978, **herb. C.C.H.**, det. P. D. Sell.

558/1/155. HIERACIUM SUBMUTABILE (Zahn) Pugsl. ***57**, Derbys.: near Parsley Hay, GR 43/13.63. R. Smith, 1978, **DBY**, det. C. E. A. Andrews. 1st definite record.

558/1/223. HIERACIUM VAGUM Jord. ***34**, W. Gloucs.: Westerleigh, GR 31/69.79. J. Bevan, 1978, **herb. J.B.**, det. P. D. Sell.

†599/3. CREPIS SETOSA Haller f. ***69b**, Furness: by Rosthwaite bridge, Cark, GR 34/36.76. K. A. Gunning, 1976, field record, 1978 specimen **LANC.**

559/4. CREPIS MOLLIS (Jacq.) Aschers. **70**, Cumberland: 1km S.E. of Alston, GR 35/72.45. Ayle Burn, N. of Alston, GR 35/71.49. Both records G. A. & M. Swan, 1965, field records. Only 2 extant localities.

560/3. TARAXACUM LACISTOPHYLLUM (Dahlst.) Raunk. ***59**, S. Lancs.

560/12. TARAXACUM LAETUM (Dahlst.) Dahlst. ***6**, N. Somerset

560/21. TARAXACUM SIMILE Raunk. ***6**, N. Somerset

560/27. TARAXACUM PROXIMIFORME van Soest ***70**, Cumberland

560/33. TARAXACUM UNGUILOBUM Dahlst. ***104**, N. Ebudes

560/35. TARAXACUM LANDMARKII Dahlst. ***70**, Cumberland ***104**, N. Ebudes

560/37. TARAXACUM SPECTABILE Dahlst. ***6**, N. Somerset ***70**, Cumberland ***104**, N. Ebudes

560/42. TARAXACUM EURYPHYLLUM (Dahlst.) M. P. Chr. ***3**, S. Devon ***59**, S. Lancs.

560/43. TARAXACUM MACULIGERUM H. Lindb. f. ***3**, S. Devon

560/44. TARAXACUM PRAESTANS H. Lindb. f. ***3**, S. Devon ***6**, N. Somerset

560/45. TARAXACUM PSEUDOLARSSONII A. J. Richards ***70**, Cumberland

560/61. TARAXACUM NORDSTEDTII Dahlst. ***6**, N. Somerset

560/64. TARAXACUM ADAMII Claire ***5**, S. Somerset ***104**, N. Ebudes

560/67. TARAXACUM SUBCYANOLEPIS M. P. Chr. ***5**, S. Somerset

560/69. TARAXACUM SELLANDII Dahlst. ***70**, Cumberland

560/75. Taraxacum pannucium Dahlst. *3, S. Devon

†560/76. Taraxacum linguatum Dahlst. ex M. P. Chr. & Wiinst. *5, S. Somerset

560/81. Taraxacum croceiflorum Dahlst. *5, S. Somerset

560/83. Taraxacum expallidiforme Dahlst. *5, S. Somerset

560/84. Taraxacum insigne Ekman ex Raunk. *70, Cumberland

560/85. Taraxacum subundulatum Dahlst. *17, Surrey

560/94. Taraxacum ekmanii Dahlst. *3, S. Devon *5, S. Somerset

560/95. Taraxacum porrectidens Dahlst. *5, S. Somerset

†560/98. Taraxacum pectinatiforme H. Lindb. f. *6, N. Somerset

560/99. Taraxacum aurosulum H. Lindb. f. *59, S. Lancs.

560/103. Taraxacum cordatum Palmgr. *5, S. Somerset *6, N. Somerset

560/105. Taraxacum longisquameum H. Lindb. f. *5, S. Somerset

560/106. Taraxacum dahlstedtii H. Lindb. f. *3, S. Devon *5, S. Somerset *70, Cumberland

†560/112. Taraxacum christiansenii Hagl. *5, S. Somerset

560/114. Taraxacum hamatum Raunk. *5, S. Somerset *6, N. Somerset

560/115. Taraxacum hamatiforme Dahlst. *5, S. Somerset

560/116. Taraxacum marklundii Palmgr. *5, S. Somerset *70, Cumberland

560/118. Taraxacum oblongatum Dahlst. *6, N. Somerset *70, Cumberland

560/121. Taraxacum duplidentifrons Dahlst. *3, S. Devon

560/125. Taraxacum polyodon Dahlst. *70, Cumberland

560/126. Taraxacum reflexilobum H. Lindb. f. *6, N. Somerset

560/127. Taraxacum crispifolium H. Lindb. f. *5, S. Somerset

570/3. Elodea nuttallii (Planch.) St John *28, W. Norfolk: Hilgay, GR 53/62.98. J. M. Lock & J. Huntley, 1978, field record.

†571/1. Lagarosiphon major (Ridl.) Moss *73, Kirkcudbright: Crossmichael, GR 25/73.66. R. Stokoe, 1978, **E**, det. F. H. Perring.

†575/1. Aponogeton distachyos L. f. *57, Derbys.: Firthwood, near Dronfield, GR 43/36.78. M. C. Hewitt, 1978, **DBY**.

577/3. Potamogeton coloratus Hornem. **69**, Westmorland: Barton Fell, GR 35/47.23. R. Stokoe, 1978, **herb. R.S.**, det. R. C. L. Howitt. Rediscovery in only locality, last recorded in 1883.

577/7 × 19. Potamogeton alpinus Balb. × P. crispus L. *70. Cumberland: R. Eden, between Carlisle and confluence with R. Irthing, GR 35/4.5. N. T. H. Holmes, 1978, **herb. N.C.C., Huntingdon**.

577/11. Potamogeton friesii Rupr. **73**, Kirkcudbright: Carlingwark Loch, GR 25/76.61. R. Stokoe, 1978, **herb. R.S.** Confirms record of 1882, 2nd extant record. *104, N. Ebudes: Loch na Creitheach, N. of Camasunary, Skye, GR 18/51.20. C. W. Murray, 1976, **herb. C.W.M.**, det. **BM**.

577/14. Potamogeton obtusifolius Mert. & Koch *46, Cards.: Falcondale Lake, GR 22/56.49. B.S.B.I. Field Meeting, 1978, **NMW**. (*Nature Wales,* **16**: 216 (1979)).

577/15. Potamogeton berchtoldii Fieb. *104, N. Ebudes: Loch Mor, Waterstein, Skye, GR 18/14.48. C. W. Murray, 1975, **BM**, det. J. E. Dandy. Loch Cuithir Skye, GR 18/47.59. C. W. Murray, 1976, **herb. C.W.M.**, det. **BM**. 1st and 2nd records.

577/16. Potamogeton trichoides Cham. & Schlecht. *34, W. Gloucs.: Frampton-on-Severn, GR 32/74.07. J. A. Moore, 1976, **BM**, det. A. C. Jermy.

577/20. Potamogeton filiformis Pers. *67, S. Northumb.: Rayburn Lake, GR 45/11.92. G. A. & M. Swan, 1969, **herb. G.A.S.**, det. J. E. Dandy. **104**, N. Ebudes: Allt na Uamha, Waterstein, Skye, GR 18/14.47. C. W. Murray, 1975, **herb. C.W.M.**, det. J. E. Dandy. 2nd record, 1st record for Skye.

579/2. Ruppia maritima L. *59, S. Lancs.: Southport, GR 34/33.18. A. J. Truscott, 1977, **LIV**. 1st definite record. **69b**, Furness: Roosecote, Barrow-in-Furness, GR 34/22.68. G. Halliday, 1978, **LANC**. Only extant record.

†586/2. Hemerocallis lilioasphodelus L. *73, Kirkcudbright: W. of station at Gatehouse of Fleet, GR 25/54.62. C.S.S.F. Field Meeting, 1977, field record.

†589/3 × 2. Polygonatum multiflorum (L.) All. × P. odoratum (Mill.) Druce *46, Cards.: 1km E. of Llanfair, GR 22/44.40. J. R. Palmer, 1978, **NMW**. (*Nature Wales,* **16**: 216 (1979)).

597/1. Gagea lutea (L) Ker-Gawl. **79**, Selkirk: Howden Burn, S.W. of Selkirk, GR 36/45.26. R. W. M. Corner, 1978, field record. 1st post-1930 record.

†601/2. Muscari comosum (L.) Mill. *44, Carms.: Pembrey, GR 22/42.01. O. Webb, 1978, field record. (*Nature Wales,* **16**: 213 (1979)). **70**, Cumberland: Eskmeals gun-range, GR 34/08.93. A. Warburton, 1976, field record. 2nd record.

605/8. Juncus inflexus L. *99, Dunbarton: near Rowmore, Faslane, GR 26/24.89. A. McG. Stirling, 1978, **E**. Near R. Lever, Dillichip, Bonhill, GR 26/39.78. A. McG. Stirling, 1978, **E**. 2nd record.

605/14. Juncus maritimus Lam. **85**, Fife: near Boarhills, GR 37/55.15. G. H. Ballantyne, 1977, field record. 1st record this century.

605/17. Juncus subnodulosus Schrank *69, Westmorland: Sandford Mire, Warcop, GR 35/72.17. Sir Charles Willink, 1978, field record, det. C. A. Stace.

605/f. Juncus foliosus Desf. **70**, Cumberland: St Bees, GR 25/97.09. C. C. Haworth, 1978, **LANC**. 2nd record.

†606/4. Luzula luzuloides (Lam.) Dandy & Wilmott *106, E. Ross: Brahan Castle, near Dingwall, GR 28/51.54. M. McC. Webster, 1978, **E**.

607/3. Allium scorodoprasum L. **95**, Moray: Dyke, 28/98.58. M. McC. Webster, 1978, **E**. 1st post-1930 record.

615/1. Sisyrinchium bermudiana L. †*46. Cards.: Ynyslas. GR 22/6.9. M. H. Bigwood, 1965, field record. (*Nature Wales,* **16**: 216 (1979)).

†618/1. Crocus nudiflorus Sm. *17, Surrey: E. side of A287, N. of Frensham Great Pond, GR 41/84.41. D. R. Rosekar, 1977, **SLBI**.

624/1. Cephalanthera longifolia (L.) Fritsch *47, Montgomery: near Kerry, GR 22/1.8. E. H. Wolfe, 1978, field record. (*Nature Wales,* **16**: 217 (1979)).

628/2. Listera cordata (L.) R. Br. **47**, Montgomery: S. of Carnedd Wen, GR 23/9.0. R. G. Woods, 1978, field record. 2nd record. (*Nature Wales,* **16**: 217 (1979)).

631/1. Hammarbya paludosa (L.) Kuntze *44, Carms.: Twrch Valley, GR 22/7.1. D. Davies, 1978, field record. (*Nature Wales,* **16**: 213 (1979)). **46**, Cards.: near Ponterwyd, GR 22/7.7. J. P. Savidge, 1968, field record. 2nd record. (*Nature Wales,* **16**: 216 (1979)).

643/1. DACTYLORHIZA FUCHSII (Druce) Vermeul. *93, N. Aberdeen: Aberdour, GR 38/86.65. D. Welch, 1978, **ABD**.

643/3a. DACTYLORHIZA INCARNATA (L.) Soó subsp. INCARNATA *99, Dunbarton: near the Dubh Lochan, Inveraran, GR 27/32.16. A. McG. Stirling, 1978, field record.

643/3b. DACTYLORHIZA INCARNATA (L.) Soó subsp. PULCHELLA (Druce) Soó **104**, N. Ebudes: between Bealach Udal and R. Kylerhea, GR 18/75.20. C. W. Murray, 1978, **herb. C.W.M.**, conf. M. McC. Webster. 2nd record.

645/3. ERIOPHORUM LATIFOLIUM Hoppe *46, Cards.: Glwydwern, 2km W.S.W. of Cribyn, GR 22/49.50. A. O. Chater & D. G. Jones, 1978, **NMW**. (*Nature Wales,* **16**: 217 (1979). *70, Cumberland: near Irthing Head, Gilsland moors, GR 35/61.77. D. A. Ratcliffe, 1956, field record. Armboth Fell, Thirlmere, GR 35/2.1. D. A. Ratcliffe, 1957, field record. 2nd record.

†646/1. ACORUS CALAMUS L. **69**, Westmorland: Holehird, Troutbeck Bridge, GR 35/40.00. R. Stokoe, 1978, field record. 2nd record.

649/2. ARUM ITALICUM Mill. †*42, Brecon: Glanusk Estate near Crickhowell, GR 32/19.19. R. Hewitt, 1978, field record. (*Nature Wales,* **16**: 210 (1979)).

650/2. LEMNA TRISULCA L. **70**, Cumberland: Braystones, GR 35/00.05. R. Stokoe, 1977, **herb. R.S.** Silloth golf-course, GR 35/10.52. R. & C. Smith, 1978, field record. Only 2 extant records.

650/4. LEMNA GIBBA L. *69, Westmorland: Lancaster-Kendal canal, Stainton, GR 34/52.85. M. Wigginton, 1978, field record.

656/2. ELEOCHARIS ACICULARIS (L.) Roem. & Schult. **70**, Cumberland: near Abbeytown, GR 35/1.5. F. J. Roberts, 1978, **LANC**. Confirmation of pre-1930 record, 2nd extant record.

656/6. ELEOCHARIS UNIGLUMIS (Link) Schult. **85**, Fife: Wormit, GR 37/39.26. M. Benstead, 1978, field record. 1st post-1930 record. *99, Dunbarton: Ardmore Point, Helensburgh, GR 26/3.7. A. McG. Stirling, 1978, **E**.

657/1. BLYSMUS COMPRESSUS (L.) Panz. ex Link **70**, Cumberland: Bowness-on-Solway, GR 35/20.61. D. A. Ratcliffe, 1957, field record. 1st post-1930 record.

657/2. BLYSMUS RUFUS (Huds.) Link *46, Cards.: Cors Fochno, GR 22/62.90. F. M. Slater, 1974, field record. (*Nature Wales,* **16**: 217 (1979)).

659/1. SCHOENUS NIGRICANS L. **59**, S. Lancs.: Farnworth, Bolton, GR 34/73.07. C. E. Shaw, 1977, field record. 2nd record.

663/1. CAREX LAEVIGATA Sm. **85**, Fife: 1½ miles N.E. of Saline, GR 36/04.94. G. H. Ballantyne, 1978, field record. 1st record this century.

663/9b. CAREX SEROTINA Mérat subsp. PULCHELLA (Lonnr.) Van Ooststr. *99, Dunbarton: Inch Moan, Loch Lomond, GR 26/37.90. P. Macpherson, 1969, **E**, det. A. O. Chater. *106, E. Ross: Loch Garve, GR 28/41.60. M. McC. Webster, 1978, field record.

663/13. CAREX CAPILLARIS L. *70, Cumberland: Tynehead Fell, Alston Moor, GR 35/7.3. D. A. Ratcliffe, 1957, field record.

663/16 × 17. CAREX ROSTRATA Stokes × C. VESICARIA L. *73, Kirkcudbright: Luskie Dam, GR 25/59.82. O. M. Stewart, 1978, **E**, det. R. W. David.

663/27. CAREX VAGINATA Tausch *79, Selkirk: Bught Hill, upper Ettrick Water, GR 36/18.10. R. W. M. Corner, 1978, **BM**, conf. J. G. Roger. White Shank, upper Ettrick Water, GR 36/17.08. R. W. M. Corner, 1978, **herb. R.W.M.C.** 1st and 2nd records.

663/28. CAREX LIMOSA L. **47**, Montgomery: Nant Ysguthan, GR 23/9.1. R. G. Woods, 1978, field record. 2nd record. (*Nature Wales,* **16**: 218 (1979)). *48, Merioneth: near Trawsfynydd, GR 23/7.3. P. M. Benoit, 1978, **NMW**. 1st definite record.

663/29. CAREX PAUPERCULA Michx *47, Montgomery: near Cerig Brithion, c2km N. of A458 at Nant-y-dugoed, GR 23/92.15. F. A. Currie, 1978, **NMW.** N. and E. of Llyn Coch-hwyad, GR 23/93.10. R. G. Woods & M. Davies, 1978, field record. 1st and 2nd records. (*Nature Wales,* **16**: 218 (1979)). **70**, Cumberland: Butterburn flow, GR 35/66.76. D. A. Ratcliffe, 1955, field record. 1st post-1930 record.

663/33. CAREX LASIOCARPA Ehrh. **47**, Montgomery: E. of Llyn Coch-hwyad, GR 23/9.1. R. G. Woods, 1978, field record. 2nd record. (*Nature Wales,* **16**: 218 (1979)). **99**. Dunbarton: Dubh Lochan, Inveraran, GR 27/32.16. J. Mitchell, 1978, field record. 2nd record.

663/48. CAREX AQUATILIS Wahlenb. **80**, Roxburgh: R. Tweed near Trows, Makerstoun, GR 36/68.32. R. W. M. Corner, 1978, **BM**, det. A. C. Jermy. 1st record since 1882, rediscovery at same locality.

663/57 × 71. CAREX OTRUBAE Podp. × C. REMOTA L. ***45**, Pembs.: Cilgerran, GR 22/18.43. R. W. David, 1978, **NMW**, conf. A. O. Chater. (*Nature Wales,* **16**: 214 (1979)).

663/61. CAREX ARENARIA L. ***57**, Derbys.: Rowsley, GR 43/25.65. Old railway sidings. M. C. Hewitt, 1978, field record, det. J. Hodgson.

663/68. CAREX MURICATA L. subsp. LAMPROCARPA Čelak. (*C. pairaei* F. W. Schultz) ***59**, S. Lancs.: 1km N. of Clitheroe, GR 34/74.43. P. Jepson, 1974, field record, det. R. W. David.

†ARUNDINARIA JAPONICA Sieb. & Zucc. ex Steud. ***46**, Cards.: Trawscoed, GR 22/66.72. Lodge Park, GR 22/66.93. Both records A. O. Chater, **NMW**, det. D. McClintock. 1st and 2nd records. (*Nature Wales,* **16**: 217 (1979)).

670/2. FESTUCA ARUNDINACEA Schreb. **46**, Cards.: Nant y Ferwig, GR 22/16.48. A. O. Chater, 1962, field record. 2nd record. (*Nature Wales,* **16**: 217 (1979)).

670/3. FESTUCA GIGANTEA (L.) Vill. **104**, N. Ebudes: Torrin, Skye, GR 18/57.20. C. W. Murray, 1974, **herb. C.W.M.** 2nd record.

670/4. FESTUCA ALTISSIMA All. **73**, Kirkcudbright: Dunieoch Glen, Garroch, New Galloway, GR 25/59.81. J. Martin, 1976, field record, det. F. Rose. 2nd extant record.

†670/5. FESTUCA HETEROPHYLLA Lam. ***27**, E. Norfolk: Roydon near Diss, GR 62/09.80. A. C. Copping, 1978, field record, det. E. L. Swann.

670/6c. FESTUCA RUBRA L. subsp. LITORALIS (G. F. W. Meyer) Auquier ***41**, Glam.: Afon Kenfig, Kenfig Burrows, GR 21/78.82. T. G. Evans, 1978, **NMW**, conf. C. E. Hubbard. (*Nature Wales,* **16**: 210 (1979)).

670/6d. FESTUCA RUBRA L. subsp. MEGASTACHYS Gaud. ***35**, Monm.: Newport, GR 31/30.85. Rubbish tip. T. G. Evans, 1978, **NMW**, det. C. E. Hubbard. (*Nature Wales,* **16**: 210 1979)).

670/10. FESTUCA VIVIPARA (L.) Sm. **47**, Montgomery: N. of Llyn Coch-hwyad, GR 23/9.1. R. G. Woods, 1978, field record. 2nd record. (*Nature Wales,* **16**: 218 (1979)).

673/2. PUCCINELLIA DISTANS (Jacq.) Parl. ***94**, Banff: Tugnet, Spey Bay, GR 38/34.65. M. McC. Webster, 1978, **BM**, **CGE**, **E** & **K**.

676/9. POA COMPRESSA L. **46**, Cards.: Glwydern, 2km W.S.W. of Criby, GR 22/50.50. A. O. Chater, 1978, **NMW**. 2nd record. (*Nature Wales,* **16**: 217 (1979)). ***104**, N. Ebudes: Ardvasar, Sleat, Skye, GR 18/63.03. M. McC. Webster, 1978, **E**.

†676/14. POA PALUSTRIS L. ***50**, Denbigh: Trefnant, 4km N. of Denbigh, GR 33/06.70. J. M. Brummitt, 1978, **NMW**. (*Nature Wales,* **16**: 222 (1979)). ***99**, Dunbarton: Rhu, GR 26/26.83. A. McG. Stirling, 1978, **E**.

†676/15. POA CHAIXII Vill. ***46**, Cards.: Llanfihangel-ystrad churchyard, GR 22/52.56. A. O. Chater, 1978, **NMW**. (*Nature Wales,* **16**: 217 (1979)).

683/1. Bromus erectus Huds. *44, Carms.: Pembrey Burrows, GR 22/41.00. Q. O. N. Kay, 1978, **NMW**. (*Nature Wales,* **16**: 213 (1979)).

†683/4. Bromus inermis Leyss. **17**, Surrey: Stockbridge Pond, GR 41/87.42. C. T. Prime, 1977, field record, det. C. E. Hubbard. 2nd record.

†683/20. Bromus unioloides Kunth **35**, Monm.: Newport, GR 31/30.85. Rubbish tip. T. G. Evans, 1978, **NMW**, 2nd record. (*Nature Wales,* **16**: 210 (1979)).

684/2. Brachypodium pinnatum (L.) Beauv. †*44, Carms.: Pembrey Burrows, GR 22/40.00. Q. O. N. Kay, 1977, **NMW**. (*Nature Wales,* **16**: 213 (1979)). **46**, Cards.: St Peter's churchyard, Lampeter, GR 22/57.48. B.S.B.I. Field meeting, 1978, **NMW**. 2nd record. (*Nature Wales,* **16**: 217 (1979)).

687/1. Hordeum secalinum Schreb. *46, Cards.: St Peter's churchyard, Lampeter, GR 22/57.48. B.S.B.I. Field Meeting, 1978, **NMW**. (*Nature Wales,* **16**: 217 (1979)).

687/2. Hordeum murinum L. †*104, N. Ebudes: Isle Ornsay, Skye, GR 18/70.12. M. McC. Webster, 1978, **E**.

†692/3. Avena strigosa Schreb. *106, E. Ross: Cromarty, GR 28/77.66. M. McC. Webster, 1976, field record.

†697/3. Aira multiculmis Dumort. *95, Moray: Little Tearie, Darnaway, GR 28/98.55. M. McC. Webster, 1977, **E**, conf. C. E. Hubbard. *96b, Nairn: Nairn, GR 28/88.56. M. McC. Webster, 1978, field record. *104, E. Ebudes: near Claigan, Skye, GR 18/2.5. M. McC. Webster, 1975, **E**. Broadford, GR 18/65.23. M. McC. Webster, 1978, field record. 1st and 2nd records.

700/1. Calamagrostis epigejos (L.) Roth *46, Cards.: Coedmore, GR 22/20.43. S. B. Evans & D. G. Jones, 1977, field record. (*Nature Wales,* **16**: 217 (1979)).

700/2. Calamagrostis canescens (Weber) Roth *50, Denbigh: Llyn Bedydd, Hanmer, near Whitchurch, GR 33/47.39. J. M. Brummitt, 1978, **NMW**. (*Nature Wales,* **16**: 222 (1979)).

701/4. Agrostis gigantea Roth **52**, Anglesey: near Bodwrog Church, Gwalchmai, GR 23/39.77. R. H. Roberts, 1978, **NMW**. 2nd record. (*Nature Wales,* **16**: 223 (1979)). *104, N. Ebudes: Dunringell Hotel, Kyleakin, Skye, GR 18/74.26. M. McC. Webster, 1978, **E**.

706/1. Lagurus ovatus L. †*95, Moray: Elgin, GR 38/23.63. M. McC. Webster, 1978, **E**.

714/2. Parapholis incurva (L.) C. E. Hubbard *68, Cheviot: near Warkworth, GR 46/26.05. G. A. & M. Swan, 1978, **herb. G.A.S.**, 1st definite record.

716/a. Spartina anglica C. E. Hubbard *72, Dumfries: Powfoot, GR 35/14.65. E. J. Perkins, 1970, field record as *S.* × *townsendii*, redet. 1976, C. E. Hubbard. (*Trans. J. Proc. Dumfries. Galloway nat. Hist. Antiq. Soc.*, **48**: 64 (1971)).


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Book Reviews

Flowering plants of the world. Consultant editor V. H. Heywood. Pp. 336, with numerous coloured and monochrome plates. Oxford University Press, Oxford. 1978. Price £7·95.

This very unusual publication might, from a superficial glance, appear to be yet another straw to break the overladen backs of our coffee tables, since, by its generous dimensions and elegant format, it would seem to be aimed at this section of the market. However, the browser soon becomes aware of the serious purpose behind the gracious facade: that of providing a broad, balanced picture of the diversity, relationships and economic uses of the flowering plants for all those prepared to acquire minimal familiarity with the technical terminology used by botanists in the course of their work. In short, it fills the wide gap between the ultra-popular and the professional literature, an important function since the latter is so often unavailable and conceptually inaccessible to the interested, intelligent layman. It is difficult to draw parallels, but the reviewer remembers time spent as a young botanist browsing in Le Maout & Decaisne's *General system of botany*, generally familiar to British readers through Mrs Hooker's translation under the editorship of J. D. Hooker (1876). It may well be that the present volume will form a similar painless means of instruction for aspiring botanists and, at the same time, be a valuable source of reference in the gap between the outline family details in works like Willis's *A dictionary of the flowering plants and ferns* and the full range of professional monographs.

Following a general introduction, which draws attention to the significance of this group of plants and outlines some principles of classification, comes an illustrated glossary which should meet the needs of users unfamiliar with botanical jargon. Then come treatments of the families in the sequence, with minor variations, of Stebbins (1974), itself based closely on Cronquist (1968). At a time when we are still remarkably ignorant of the relationships of the major flowering plant groups, this choice of arrangement seems a wise one. At all events it is better to further wean British minds from the enshrined provisions of the Bentham & Hooker system, without confusing them by using that of Engler & Prantl, which, despite its many drawbacks, comes as second nature to botanists trained outside the influence of British botanical traditions. Each family account starts with a brief general statement, followed by a distribution map and outline tabulation of estimated numbers of genera and species, distribution and economic uses. Next comes a more extended statement of distribution and paragraphs on diagnostic features and classification which cover both relationships within the family and external relationships with other groups. Finally there is a section on economic uses, ranging from those which affect us all to more esoteric considerations, like good poisons for arrow-tips and obscure herbal remedies, which are currently only of interest to limited groups of humanity but, with our advancing knowledge of plant drugs, may yet concern us all.

The book is very generously illustrated and the accounts of most families have half-page plates; but some of the more familiar families, e.g. Compositae, Cactaceae and Umbelliferae, are provided with one or more full-page plates in full colour. The plates include both drawings of whole plants and details of flowers and fruit, often with dissections. Usually four species per plate are illustrated, selected to demonstrate something of the morphological diversity found in the family. The half-page plates are in sepia monochrome, with one drawing, usually a flower or fruit, highlighted in full colour. In the opinion of the reviewer, they are much more satisfactory than those in full colour, being vigorously three-dimensional and informative, in contrast to the full-colour plates, which in comparison seem flat, lacking in detail and rather tired. The plates greatly supplement the text and are, in general, satisfactorily reproduced; but in a few cases, e.g. Pyrolaceae, the impression is so faint that the rather ethereal *Monotropa* seems in some danger of fading right away. Although faults can be found, as in the sketches of whole trees, which are uniformally very poor, the artists can be congratulated on a mammoth task successfully accomplished.

What then can be said about the text? Here we come up against the problem of a considerable degree of unevenness in the various family treatments. In order to get the work done in a reasonable time, the editors recruited a body of no less than 44 contributors. In some cases, e.g. Jeffrey (Compositae and Cucurbitaceae), Clayton (Gramineae), Cook (various families of hydrophytes), Robson (Guttiferae), Whitmore (Palmae) and Heywood (Umbelliferae), the accounts are by acknowledged masters of the group concerned; but for many families specialists are not available, and the accounts were compiled by a botanist with no specialised knowledge. This strategy was no doubt inevitable; but it is doubly unfortunate, since the stimulatingly high quality of some accounts highlights the defects of some of the others.

Perhaps the maps are the least satisfactory feature of the book. Accurate distributional data are notoriously difficult to obtain; but British botanists will be surprised, for example, to note that their flora lacks any members of the Plumbaginaceae and, in common with north-western Europe as a whole, any representation of the Chenopodiaceae. However, they will at the same time be encouraged to note that *Paeonia* appears to have spread right across southern Britain and Ireland. Our European colleagues will be startled to see the spread of the Xyridaceae across North Africa and into Spain. If such troubles have arisen so close to home, what about less familiar parts of the world? Our fears are heightened by the map of the Cyperaceae, which indicates its absence from northern parts of Alaska and Siberia, where it must be one of the few families which make a major contribution to the vegetation of those inhospitable regions.

Many points of detail could be criticized. For instance, aficianados of the Umbelliferae will be surprised to find Sea Holly listed under the Acanthaceae, while the economic uses of the bulrush (*Scirpus*) are hopelessly confused with the reedmace (*Typha*) and the text and plate caption are at variance as to whether *Spirodela* is recognized as a genus distinct from *Lemna*. The selection of families to be provided with plates is generally sound, but I should have liked a plate for the Zygophyllaceae (25 genera, 240 species including the important tropical timber tree Lignum Vitae) and the Loasaceae (15 genera, 250 species). This could have been done within the same number by not illustrating some small families like Achariaceae (3 genera, 3 species of no particular interest). There are, however, some small families, like the monotypic Cephalotaceae, which have such extraordinary morphology and biology as to merit illustration.

The publishers in their 'blurb' on the dust cover state without qualification that 'The main text . . . has been written by a panel of internationally recognized authorities'. and unfortunately this is echoed by Sir George Taylor in his Preface, where he refers to a 'team of acknowledged international experts'. The list of contributors on the opposite page shows that this is only partly true, as will be apparent to anyone familiar with the botanical community. The list does indeed include a large number of distinguished botanists, some of whom have already been noted in relation to their specialist contributions. It also includes others who contributed much of the text on a piecework basis and without the advantage of any deep background in the groups concerned. Clearly their work was conducted conscientiously; but industry and honest intentions are not always enough to guarantee success in topics like those involved here, where a comprehensive knowledge of the specialist literature is essential to ensure that statements on matters like relationships reflect the best state of our present knowledge. What then should have been done? The reader can hardly expect a contributor star system like that used in hotel guides, but a forthright introductory statement to the effect that while some families were by experts, others were the result of honest compilation by non-specialists, would have both put the book in its true setting and won the respect of the many informed readers who will recognize tares lurking amongst the rich harvest of wheat.

This has been a long review, but recognition of this order is appropriate to a major work which will be widely consulted as a standard reference. In short, it can be commended as a rich source of attractively presented information on a group on which we are totally dependent for our food and which contributes so much to the interest and variety of our lives, both through gardens and in the incredible richness of the world's natural communities. It will provide almost endless scope for botanical browsing and, if used with caution, act as a fertile source of reference data. As the reviewer's thoughts turn towards the impending Christmas festivities, its potential role as an excellent gift for botanical friends or relatives is obvious.

At £7·95 it seems a near miracle, and in these days, when every review seems to end with a moan about the soaring price of books, it is a pleasure to salute the publishers, and to hope that their enterprise will be rewarded, and that their competitors will be encouraged to attempt similar feats of economic agility.

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J. F. M. Cannon

An illustrated guide to pollen analysis. P. D. Moore & J. A. Webb. Pp. ix + 133, with 48 plates. Hodder & Stoughton, London. 1978. Price (soft cover) £4·95.

The way vegetation has changed during the course of time is a fascinating subject and it is not surprising that many students are attracted to it. It is also, however, one of the most complex aspects of botany because it requires a deep understanding of many other botanical disciplines, both technical and interpretative. It is particularly important, therefore, that anybody being introduced to pollen analysis should be well aware of both the strengths of the subject and its uncertainties. Good text books on pollen analysis are few and far between.

The authors have set themselves the task of writing a laboratory manual for pollen analysts and have, on the whole, been very successful in achieving their aim. This is essentially a practical book although it also covers such topics as the interpretation of pollen diagrams and the wider aspects of palynology. The intended readership seems to be undergraduate students, although the authors are keen that pollen analysis should also be taken up in school sixth-form projects. To this end they have attempted to present their material as simply as possible and to avoid unnecessary terminology and jargon.

The main topics covered in this useful book include the collection and treatment of pollen-bearing samples, the range of structure of pollen grains and spores in northern Europe, a key for their identification, and pollen diagrams. Much of the material included here has been published elsewhere in research papers but is brought together for the first time. The authors acknowledge a heavy debt to Faegri & Iversen and their classic *Textbook of pollen analysis* (1975). Readers who know that work will recognize a number of the diagrams and much of the key. The essentially pragmatic approach borrowed from Faegri & Iversen has a great deal to recommend itself but can be taken too far. The definition of the pollen classes in the key is a case in point: to class the pollen grains of the Compositae (Liguliflorae) as fenestrate rather than tricolporate can be confusing to the student since the grains are indeed tricolporate despite their distinctive ornamentation. The syncolpate pollen class is also anomalous because it contains a very heterogeneous selection of types. On the other hand, the use of the term monocolpate to cover single-furrowed examples of both pollen and spores seems sensible. There is a comprehensive glossary of terms.

One of the main advantages of this book over that of Faegri & Iversen is the long series of photographs of different types of pollen and spores which can be used in conjunction with the key. Light micrographs are supplemented by a scattering of scanning electron micrographs. The general standard of the photographs is high and they will be very useful, although it is a pity that the universally accepted system for the orientation of illustrations has not been followed.

To explain how pollen diagrams are prepared and, especially, what they mean is not an easy task, and this is where Moore and Webb have been least successful in their aim of being simple in concept and expression. Nevertheless, they have given a very useful introduction to this complex subject which repays careful reading.

It would be idle to pretend that students presented with this book will suddenly find pollen analysis plain sailing. It is, however, a welcome addition to the literature which goes a long way to fulfilling its aims. It is well produced (although the soft cover may not survive long in laboratory conditions) and by modern standards very reasonably priced.

G. C. S. Clarke

Upper Teesdale: its area and natural history. Edited by A. R. Clapham. Pp. 238, with 8 coloured and 24 monochrome plates, 37 text-figures and maps on the inside covers. Collins, London. 1978. Price £7·50.

The storm that arose in botanical circles over the decision to inundate one of the classical Teesdale sites has more or less abated. This book will compensate to some extent for the loss of a portion of the Teesdale flora. It is a tangible end-product of many years of research, in many branches of natural history, which was largely supported by funds supplied by Imperial Chemical Industries (the main beneficiary of the Cow Green reservoir) and administered by the Teesdale Trust. It presents, in very readable form, much information and learned discussion that would otherwise remain hidden away in university archives or be scattered in scientific journals.

The book is a compilation of ten chapters, the work of several different authors, which cover different aspects of the natural history of the Upper Teesdale National Nature Reserve. In addition, there is a preface by Lord Nugent of Guildford, an editorial foreword and introduction by A. R. Clapham, a summary by D. H. Valentine and a useful list of references. Since the fame of Upper Teesdale has rested on its unique assemblage of rare plants, which has made the site a 'mecca' for botanists for about three centuries, it is not surprising that more space is given to floristic than to faunistic aspects. Few intensive studies of invertebrates had been published before 1960, and possibly the Upper Teesdale fauna may be found not to differ significantly from that of other upland regions of Britain. In contrast, recent studies on the vascular flora have emphasized the peculiarity of Upper Teesdale, not only adding further rarities to an already impressive list, but demonstrating some of the results of genetic isolation of the Teesdale populations. At their most popular, cryptogams have never been given the amount of attention received by phanerogams; and partly because of this, partly because they are usually less restricted in their distribution patterns, and also because they are less amenable to study under cultivation, they do not figure prominently in the book. A few interesting bryophytes are mentioned (e.g. *Grimmia agassizii* (now *Schistidium agassizii* Sull. & Lesq.)) and a few algae (e.g. chapter 10), but only passing reference is made to lichens (e.g. *Verrucaria* sp., p. 194).

Although the threat to the Cow Green plant populations provided the stimulus for a concentrated research programme which began in 1967 and led up to the book's appearance in 1978, the contents are wide-ranging and include references to most of the Teesdale rarities. To do this it draws on the earlier researches, carried out by staff of the Nature Conservancy and postgraduate students (especially of Durham University, situated within easy reach of the Upper Teesdale N.N.R. and the adjacent Moor House N.N.R.), and data from other sources. The authors, all experts within the fields of natural history included, have intimate knowledge of the region. Their combined erudition, brought together under able editorship, presents Upper Teesdale as a dynamic system resulting from, and subject to, the various influences of climate, geology, soils, fauna and land use. It makes compulsive reading for anyone interested in natural history, and is essential reading for those likely to be involved in the Teesdale flora. The book is liberally illustrated with line drawings and photographic plates, the latter including aerial and general views and a fair number of plant portraits (animals include two birds, sheep, one fish and an emperor moth, all monochrome). The photographs are of high definition and have lost little in reproduction, although the colours of *Primula farinosa* (Pl. VI) seem a little lurid. The captions to the mosses (Pl. 16) are misleading: *Sphagnum imbricatum* (not identifiable in monochrome) does not have 'slender pointed stem-tips', and I remember being impressed by the blackish green, not dark brown, tufts of *Gymnostomum recurvirostrum*.

The note on the cover gives the impression that the book is primarily concerned with the effects of the Cow Green Reservoir. This is true as regards aquatic fauna and flora (chapters 9 and 10) but the bulk of the book is much more wide-ranging in its approach. This enhances rather than detracts from its usefulness. It is an attractive and relatively inexpensive volume which fills an important gap in the readily available literature on British natural history.

A. Eddy

The moss flora of Britain & Ireland A. J. E. Smith. Pp. viii + 706, with 333 figures of line-drawings by Ruth Smith. Cambridge University Press, Cambridge. 1978. Price £27·50.

Fifteen years ago I heard Dr E. F. Warburg declare impatiently that Dixon (the last (3rd) edition of whose *The student's handbook of British mosses* appeared in 1924) had had his way far too long: this superb Flora is the answer. At long last, in a single volume are all those critical comments, revisions, new species' descriptions and corrections to Dixon which we have had continually to search for in the pages of the *Transactions of the British Bryological Society* and, latterly, in the *Journal of Bryology*.

Although there is only a relatively modest increase in the number of species (692 compared with 625 in Dixon) – 18 of these are in the genus *Bryum*, there is considerable splitting of old, familiar genera (175 compared with 115). While accepting the need for this, it is a pity that the author has not taken the opportunity to depart from Dixon by introducing family-by-family keys to genera, or of making much more use of keys to related genera, for example the genera which comprised *Brachythecium, Eurhynchium, Plagiothecium* and *Mnium* sensu Dixon. *Mnium* is now split into four genera, and to identify a specimen one has either to find the appropriate part of the lengthy artificial key to *all* the genera or to look for the relevant differences in the generic descriptions.

A few subspecies make their appearance, e.g. *Tortula ruralis* subsp. *ruraliformis*, but most of the infraspecific variation is still treated at the varietal level. I wonder how many taxonomists would accept his definition of a variety (p. 2) to cover the situation 'where there are two or more reasonably well marked peaks in the range of morphological variation . . . and where these appear to have a sound genetical basis'. I was pleased to see *Ulota bruchii* relegated to a variety of *U. crispa* and I share the author's own doubts at raising *Hypnum cupressiforme* var. *ericetorum* to specific rank (as *H. jutlandicum*).

Three genera, notably *Sphagnum* by Dr M. O. Hill, are contributed by other authors. All the species are extraordinarily well illustrated by line-drawings, virtually all done by the author's wife. The appropriate drawings are not difficult to find; but it is a pity that the number of the figure is not given in the text, and also that the page number is omitted from the place of publication of the species' name. The book is extremely well produced in a clear format; the only misprints which have been brought to my attention are the spellings of *Dicranum elongatum* (p. 3) and *Bryum dunense* (p. 420).

This, then, is a milestone for British bryology and a most worthy successor to Dixon. Its significance is comparable to the appearance in 1952 of the first edition of Clapham, Tutin & Warburg. The author and his wife deserve our heartfelt thanks for bringing to such a successful conclusion what must have been a long and daunting task.

G. Halliday

I fiori della montagna. Silvio Stefenelli. Pp. 239, with 206 coloured plates. Priuli & Verlucca, Ivrea. 1977. Price not stated.

This is a popular book clearly intended for those with little knowledge of the Italian mountain flora. 190 species are illustrated and identification is primarily by flower colour – plants with flowers of the same colour being grouped together and with the edge of the page correspondingly coloured. Associated with each large colour photograph is information on distribution and an elaborate table of symbols for a variety of characters – leaf-shape, inflorescence, phenology, altitude, habitat etc. These symbols are marked appropriately for the individual species, and this serves as some check on the visual identification.

The choice of species must necessarily be highly arbitrary, particularly since Italy is fortunate in having the richest mountain flora of any European country. There is token representation of ferns and gymnosperms (one species each) and only a few monocotyledons (orchids excepted); nevertheless the inclusion of only one grass, and the choice (*Phleum phleoides*), is surprising. As one would expect, most of the species are conspicuous, colourful and photogenic – eleven gentians for example.

The illustrations are those of the author (currently on the staff of the botanic garden of the Gran Paradiso National Park) and are generally of a high quality; some might take a little finding – *Carex caryophyllea*, for example, in yellow, *Larix europaea* in purple and *Sedum rosea* in pink. A commentary to a series of 16 evocative photographs of the Italian mountain scene serves as an introduction.

Provided one is aware of its restricted coverage, this is certainly a book worth putting in the rucksack when setting off for the Italian Alps.

G. Halliday

Origin and relationships of the Californian flora. P. H. Raven & D. I. Axelrod. Pp. viii + 134, with 4 colour photographs, 11 maps and 15 tables. University of California Publications in Botany, vol. 72. University of California Press, Berkeley & Los Angeles, California. 1978. Price not stated.

The Californian flora occupies a key role in the study of plant biosystematics. The researches of Clausen, Keck and Hiesey in the 1940s laid a sound foundation on which much of the later work seems a natural progression. Today, no other area has been so energetically studied in terms of those evolutionary processes occurring in plant populations and communities which have given rise to its modern flora.

The authors of the paper here under review begin by considering the floristic make-up of California, which they treat in two parts: Cismontane California, or the Californian Floristic Province, and the area to the east of the mountains. Transmontane California, consisting of desert regions to the north and south with the rich central Inyo region lying between them.

The focus of attention, particularly within the Floristic Province, is undoubtedly the high proportion of endemic species: 47·7 per cent of the total 4452 native species recorded. As the authors point out, this is very high for a continental area, and some of the reasons for it become clear as the climatic, orogenic and vegetational history of the area is described. A gradual but fluctuating xeric trend through mid- and late-Tertiary times resulted in an interplay between the rich Arcto-Tertiary forest flora, with northern affinities, and the drier sclerophyllous Madro-Tertiary flora from further south. Palaeoendemics such as *Lyonothamnus*, that curious member of the *Rosaceae*, now restricted to the Californian Islands but recorded from the mainland Tertiary, form a proportion of the endemism and indicate the continuing equable climate prevailing in some areas since Tertiary times. The majority of endemics, however, are of more recent origin and are an expression of the enormous environmental diversity (the product of Late Pliocene mountain building), ranging from subtropical desert to above the timberline on the one hand, and the recurrent fluctuating climate on the other. Many of these endemics probably arose in the ever-changing ecotone between the two floristic elements, and one aspect of this is the high proportion of annual endemics with Madro-Tertiary affinities.

One intriguing problem is the floristic link between California and the climatically similar Mediterranean region – genera such as *Arbutus, Cupressus* and *Lavatera* and even the species *Styrax officinalis*. Apart from some examples which may be introductions, it is difficult to see them except as relics of a former wide-ranging, ancient northern flora.

The remainder of the paper is devoted to narrower topics. Six prominent families in the Californian Floristic Province, namely Amaryllidaceae, Boraginaceae, Hydrophyllaceae, Onagraceae, Polemoniaceae and Polygonaceae, are discussed. A further section considers endemics in more detail, with a recognition of relict areas and regions of high endemism, and there is an extended discussion of edaphic endemism with special reference to the role played by serpentine areas.

The major patterns of evolution characteristic of the Californian flora are summarized briefly, but some of the points raised are important, having implications for other Mediterranean and semi-arid floras. Final sections review the introduced flora, consider the vital and pressing need for conservation, and make suggestions on promising future lines of research. The text closes with a short summary.

In view of the floristic richness and scientific significance of this relatively well-documented region, this review by two acknowledged authorities in the field will for long remain a key work. As one not as familiar with the Californian flora as I could wish, I only regret the lack of a detailed map showing some of the places mentioned.

R. M. Harley

Plant communities. Anne Bülow-Olsen, illustrated by Susanne Larsen. Translated by Joan Tate and edited and adapted by Francis Rose. Pp. 128, with numerous illustrations. Penguin Nature Guides, London. 1978. Price £1·95.

When reviewing a book of this kind it is difficult, without reading the original language edition, to know to whom criticism, if indeed criticism is called for, should be directed. I will start however with praising the illustrator and those that have designed this attractive book. The plant portraits are accurate and life-like and the photographs well-chosen. This standard is not reflected in the text, however, and, assuming the translator has done her job well, I will apportion my criticisms equally between author and editor.

The first 96 pages are devoted to plant communities, such as beech and oak forests, or ecosystems, such as high- and low-nutrient lakes. The text is chatty and loose and therefore often misleading or ambiguous, e.g. it is the deep roots of dune pansy, not the well-developed rootstock, that 'fetches water from the deeper levels'; and '*all* [my italics] fenland plants have adapted to haymaking, grazing and the culling of reeds'. Some statements are bald and leave the reader in the air, e.g. 'water lobelia has a single functionless stoma'; others show loose thinking, e.g. 'in water plants there is no real evaporation from the surface of the leaf' – those submerged will not have and the emergents may have considerable evaporation, but the reviewer knows none which have *un*-real evaporation! And again, take the opening sentence on raised bogs: 'If a river or stream deposits material in a lake or a hollow without good natural drainage, a peat bog may be formed'. If a river, or a stream, deposits material in a lake or a hollow without good natural drainage there will eventually be a flood and a wide distribution of silt-nutrients, etc. With time and the interaction of living and decayed plants there may be a peat community, which may then most likely be a mire rather than a bog.

The remaining 30 pages give a few anecdotes on 'Requirements for plant life', where one is led to believe that 'tissue formation takes place in the green parts of a plant', and that variegated plants are 'due either to specialized breeding by horticulturists or to a virus that prevents the formation of chlorophyll in the diseased patches'.

This is an amusing book but not a book for the budding ecologist. Dr Rose's interest in lichens comes out to his credit in his 'adaption', but he appears to have done little editing; though, in fairness, his terms of reference may have prevented him from re-phrasing large tracts of the text, and this book needs re-writing.

A. C. JERMY

Nature's use of colour in plants and their flowers. John & Susan Proctor. Pp. 120, with numerous coloured illustrations. Eurobook Ltd: Peter Lowe, London. 1978. Price £3·95.

It makes a pleasant change to see a nature book on the market which does not represent yet another colour-guide for the identification of a circumscribed plant group but deals with one of the most mysterious aspects of plant biology. Both authors and publisher have steered clear of the temptation to produce a spectacular coffee-table book and have succeeded in rendering a highly complex scientific topic in a language which anyone, without academic training, will easily comprehend.

It is clearly the sort of book one would have craved for as a young aspiring naturalist, and it should certainly find a place on the shelf of every school library. But it should also yield plenty of information for the gardener, both professional and amateur, and it will answer many of the questions which the plant lover in general may ask.

Following a concise introduction about plant structure the authors discuss in well-organized sections the nature of colours and how they are produced within the plant, the process of photosynthesis, the importance of colour for the plant in general, the role of colour in attracting insects, birds, bats and other animals, colour as a means of mimicry and camouflage and, finally, how man has changed, used or influenced colour in plants for his own purpose.

The book is lavishly illustrated with beautifully reproduced albeit sometimes garish colour photographs, and a few diagrammatical representations. To the reviewer's delight, however, the finest picture in the whole book is based not on a photograph but on an original botanical illustration (p. 65), although the authors fail to acknowledge and pay tribute to the artist.

Referring to what appears to be a *Loranthus* as 'Mistletoes' (p. 37) may be a little puzzling to a British reader; surely it would have been more appropriate to illustrate the native species and this to a much greater effect. Although scientific names are given in some instances, their omission in others is irritating; this applies *mutatis mutandis* also to the names of insects and birds. This inconsistency should perhaps be rectified in future editions.

But all these are only minor blemishes in an otherwise commendable book.

E. LAUNERT

River plants. S. M. Haslam. Pp. xii + 396, with 27 photographs and numerous line illustrations. Cambridge University Press, Cambridge. 1978. Price £27·50 (boards); £7·95 (paper).

The plants and vegetation of rivers are fascinating subjects which have been studied all too little. Dr Haslam's book is the first full-length work on this topic. The introductory chapter is, in part, a summary of material treated in greater detail in later chapters and, in part, an account of important British river plants. Much of this latter material seems unnecessary; there is no key, and the illustrations are too small to help in identification – for instance, the drawings of the leaf sections of *Eleogiton fluitans* and *Juncus bulbosus* are so much reduced that it is almost impossible to see that the leaves of the former are solid and that those of the latter are tubular. Anyone wanting to identify river plants would be wise to use *British water plants*, by Haslam *et al.* (1975). There is, however, a useful summary of the ecology of each species. This section also serves to introduce the species symbols which are a feature of the book and which appear subsequently whenever a plant name is used in a list or diagram. My feeling is that these symbols will not be particularly helpful; they must also have added substantially to the cost of the book.

The next seven chapters deal with habitat factors. There is a good deal of overlap between chapters – although the author points out, reasonably, that such overlap is often useful and necessary. While these chapters contain much interesting information – the figures for hydraulic resistance and uprooting strength of different species should be mentioned here – there is also a great deal of material presented so vaguely as to be difficult to interpret. Could not stream flow-rates and substrate particle-sizes be defined more precisely, for instance? The most serious difficulty, however, is the lack of information on sampling techniques. Nowhere is there an account of how the sample sites were chosen, except that in Chapter 2, when considering plant distribution in whole river systems, it appears that sites were recorded from bridges. Do bridges necessarily provide sites typical of the river system?

After a very brief review of work on the productivity of river plants, the next five chapters deal with vegetation in relation to habitat. The usefulness of these chapters, particularly that dealing with streams on hard rocks, is reduced by the author's decision not to distinguish the many bryophyte species of these streams. There is also no comparison made between the plant communities of chalk and limestone and those described from similar habitats on the continent of Europe. In the next three chapters, however, some interesting parallels are drawn between river vegetation in the British Isles and eastern North America.

The final five chapters deal with the relationships between river plants and man – the flood hazards that plants may cause, their aesthetic value, and the effects on them of pollution and man-induced changes. Canals and drainage dykes are also included, and these chapters contain information and recommendations which could be useful to anyone concerned with the management of waterways.

The line illustrations by P. A. Wolseley often help to clarify the text. There is a glossary, a substantial list of relevant literature and a comprehensive index. The design of the book is attractive but the very generous layout, and the use of symbols, mean that there is a great deal of unused page space which must surely add to the cost. There are also too many misprints, many of them in the Latin names. Sadly one is left with an impression of a missed opportunity to clarify the neglected and interesting field of river plants.

J. M. Lock

Flora of the Isle of Wight. J. Bevis, R. Kettel & B. Shepard. Pp. 114. Isle of Wight Natural History and Archaeological Society, Newport. 1978. Price: £3·35 incl. p. & p. Obtainable from Mr B. Shepard, 87 Elm Grove, Newport, I.O.W.

I like this first complete account of the wild flowers of this island of, exactly, 100 tetrads to appear for 120 years. Obviously much assiduity has gone into its preparation.

The work was started by A. W. Westrup in 1956. He died in 1964, and Mrs Yule took over until 1968, since when the island Society has been in charge, with numerous members making recordings. Their efforts were coordinated by the three authors and the whole edited by O. H. Frazer. The authors are grateful to 'the BSBI specialists in every genus, of whom we took full advantage'.

All the same, the result gives the impression of a local production with little outside help. For some of the gaps, even non-specialists or recent basic papers could have produced at least clues – 'The cytotypes *Polypodium australe* and *P. interjectum* are reputed to occur'–'reputed', when all three such taxa are mapped for the island; no attempt has been made to name even one species of *Taraxacum*, although our *Taraxacum Flora* came out in 1972; and there is an almost complete *non possumus* over *Hieracium* sensu stricto: the four species in the *Critical Supplement* are unmentioned and the only one named is not in it.

Very few first records are given, very few names of recorders are cited (but that of J. W. Long occurs quite often, although it does not appear in the introductory pages), and there are very few references to literature or herbarium specimens – no indication that any herbarium at all has been searched. So following up records is almost impossible without recourse to the island.

Names are as in Dandy: none is up-dated. One or two raise eyebrows – *Alyssum alyssoides* as a garden escape, and also *Iberis amara* (no *I. umbellata*); *Potentilla anglica* in 10 tetrads, *P. reptans* in 100, but no hybrids at all. Very few hybrids are given and nearly all these are only mentioned *en passant* and unnamed. Surprisingly 'Hybrids between species of *Glyceria* often occur': none is down for the island in any Atlas or in *Hybridization and the flora of the British Isles*. Very few variants or even subspecies are given either – not even *Epipactis vectensis*, which at one time brought fame to the island, and to the young Francis Rose. And, to get it off my chest, there is no proper map.

But I started by saying that I liked this book – and the fact is that there is much to be pleased with. I know no other that gives six pages to a 'botanical calendar', with numerous dates showing when to see what where. The account of each species ends with 'information of local interest'. Here are to be read such matters as how best to pick blackberries, but also the remarkable story of the spread of *Quercus ilex*; where to see 'veritable cascades' of *Antirrhinum majus*; that the spur length of *Linaria vulgaris* varies from 5 to 13 mm; that the records for *Jasione* in the *Atlas* for the north of the island are in error; that 'any revision of Dandy's List . . . would undoubtedly result in the inclusion' of *Lonicera nitida*; the sad stories of *Salsola kali* and *Potentilla palustris*; that *Myosurus* and *Oxalis europaea* are yet more weeds being spread by nurseries; and a summary of the remarkable *Gaudinia* story. There is good news of the refinding of lost species and of new discoveries. In addition to the well-known island rarities, *Chenopodium urbicum* is down for three tetrads and *Euphorbia platyphyllos* for six; and *Campanula portenschlagiana* is firmly given its rightful place as 'commonly found on walls' – abundant on one.

Over 1000 species are said to be listed, casual aliens being for the most part excluded. The intention was 'to leave an accurate yardstick'. I think this has been done, for at least it is clear what is and what is not known about any given plant. This may be the work of amateurs, and they would claim no critical expertise (despite the remarks on five species of *Salicornia*), but there is evidence of much diligence and care, and there is a mass of detail set out, in almost too small type, unrelieved by illustrations. I hope this great effort will attract people to the island to give encouragement and build on the good work already done.

D. McClintock

Flora of Bedfordshire. John G. Dony. The Corporation of Luton Museum and Art Gallery, Luton. 1953. Reprint. Pp. 532, with 25 plates, 1 map and 22 figures. New preface by author. E. P. Publishing Ltd, Wakefield. 1978. Price £10·00.

A Flora of Shropshire. W. A. Leighton. John van Voorst, London & John Davies, Shrewsbury. 1841. Reprint together with reprint of the Filices, Lycopodiaceae, Marsiliaceae and Equisetaceae of Shropshire. William Phillips. Shropshire Archaeological Society, 1877. Pp. xii + 573 + 6, with 21 figures. E. P. Publishing Ltd, Wakefield. 1978. Price £8·00.

The flora of Perthshire. Francis Buchanan W. White. Introduced and edited by James W. H. Trail. Perthshire Society of Natural Science. William Blackwood & Sons, Edinburgh. 1898. Reprint. Pp. lxx + 407, with one portrait plate and one map. E. P. Publishing Ltd, Wakefield. 1978. Price £8·00.

All those who had despaired of obtaining a copy of an out-of-print, scarce and consequently expensive local Flora will congratulate the E.P. Publishing company for making available reprints of county Floras in a continuing series. Selected by Dr Franklyn Perring, most titles are published in a uniform format of 26 × 17cm, with a 4-page-to-1 compression. This is a laudable plan to keep down costs but one no doubt subject to much criticism due to the resultant very small print, which is quite surprisingly clear, however, and easily read by those with good eyesight.

The three titles above continue this series of, to date, eight reprints of important local Floras. Content however, unlike format, is not uniform. Opportunity has been taken to include a new Foreword or introduction in certain of these reprints, but such is lacking in two of the above titles. Dr Dony has, however, contributed a new (1978) Preface to his *Flora of Bedfordshire* reprint, noting changes in the flora of that county since 1953. In one respect, however, the publisher has quite failed this author. Photographic reproduction has suffered markedly; the excellent plates of the first edition are here very badly reproduced with all fine detail lost. This seems extraordinary in view of the otherwise high-quality printing, and one awaits reprint publication in this series of another well-illustrated classic (Praeger's *The botanist in Ireland*) with some trepidation. The original map of Bedfordshire botanical districts has been redrawn but drastically simplified, losing much of its value. Other maps are simply reduced in size but have reproduced well.

Also redrawn (in black and white only) for its reprint is the 5-colour map of the Perthshire botanical districts, again with much fine detail omitted and a complete absence of contours. Otherwise this reprint of *The flora of Perthshire* is a facsimile with no additions.

An additional reprint of William Phillips's short 1877 paper on the Pteridophyta of Shropshire (a group omitted by Leighton in his Flora) adds to the interest of this otherwise only full account of the flora of that county. Here, the black and white drawings distributed throughout the text of the 1841 Flora are reproduced very well indeed; in fact they are clearer in reprint than in original!

Apart from the disappointing photographic reproduction, the quality of the reprints is high and prices seem not unreasonable when £20 was a catalogued price for a Leighton first edition in 1976 and £15 is now asked for a copy of the *Flora of Bedfordshire*.

G. A. Matthews

Key works to the fauna and flora of the British Isles and northwestern Europe. Edited by G. J. Kerrich, D. L. Hawksworth & R. W. Sims. Pp. xii + 179. Systematics Association Special Volume no. 9. Academic Press, London, New York & San Francisco. 1978. Price £7·80.

The *Bibliography of key works for the identification of the British fauna and flora* ran to three editions, of which the last was published in 1967. The Systematics Association has now published a fresh version of this selective bibliography. The references have been brought up to date with the substantial amount of new literature which has appeared in the meantime, and are carefully chosen to be relevant and useful, and to cover all organisms. One may rightly understand the word 'key' in the title to mean that the principal references are included, and that this book will help you to look up an identification key to the plant or animal group of interest.

If one were interested in vascular plants only, then there are only eight pages which would be relevant. The 1967 version provided 34 pages, since references to particular genera were then given. Nevertheless, neither version is comprehensive, and most readers will probably prefer to consult this book in a library, rather than purchase a copy.

R. J. Pankhurst

Applied plant anatomy. D. F. Cutler. Pp. 103, with 75 black and white plates and figures. Longman Group Ltd, London & New York. 1978. Price £4·95.

The author is head of the plant anatomy section of the Jodrell Laboratory of the Royal Botanic Gardens, Kew. This laboratory has for many years had an international reputation for research in plant anatomy, particularly directed towards increasing knowledge of comparative anatomy on a world-wide basis and applying this to systematics and to the identification of plant materials.

The book has been written with the express purpose of demonstrating the application of plant anatomical information to other branches of botany and to 'everyday problems'. The relevance to taxonomy emerges most clearly , and the book provides a valuable elementary guide which should be especially helpful to amateur botanists working in taxonomy but without a formal training in botany. The author illustrates a wide variety of structures, rather than using types, and the book includes a useful chapter on techniques of investigation and an excellent glossary of terms. There are a number of guides to families, genera and species which possess particular anatomical features: these would also be most valuable to anyone teaching plant anatomy. In all these respects the book can be strongly recommended.

The application to physiology and ecology is unevenly treated and much less satisfactory. Even at an elementary level it would be possible to give simple quantitative treatments of such matters as the flow of water through tracheids and vessels in relation to their diameter, length and structure of end-walls, or leaf anatomy in relation to the absorption of solar radiation and diffusion into and out of gases. In contrast, there is a fascinating account of the anatomy of grafts, which is not normally treated even in advanced textbooks.

The chapter on adaptive features is notably weak and sometimes misleading. It is not simply that the evaporating surfaces of the shoots of xerophytes may be reduced, but that they are reduced relative to the absorbing surface of the roots. In fact, in the same environmental conditions and in the absence of other differences, small or narrow leaves will lose more water, and incidentally more heat, per unit area of surface than broad leaves. The heat balance of leaves is also affected by anatomical features which reflect radiation or interfere with movement of air over the surfaces. In the discussion of succulence of halophytes no mention is made of osmotic regulation, which largely offsets the supposed 'physiological drought' of saline soils.

The final chapters deal with applications to archaeology, adulteration of foods, identification of timbers and forensic science. The treatment, though readable and lively, is largely anecdotal. Surprisingly, the application to timber technology, where knowledge of anatomy is relevant to understanding mechanical properties and impregnation with preservatives, is scarcely mentioned.

The book is concisely written and illustrated with several excellent photographs and numerous diagrams. Although the diagrams serve their immediate purpose many are crude and very small; one must hope they will not be imitated by students.

C. D. Pigott

A nature conservation review. Edited by Derek Ratcliffe. Volume 1, pp. xvi + 401, volume 2, pp. viii + 320. Cambridge University Press, London. 1977. Price: Vol. 1, £35; Vol. 2, £25.

Perhaps inevitably, this book sets the reviewer reaching for the clichés. 'Long-awaited', 'monumental' and 'magnificently produced' spring instantly to mind. *A nature conservation review* is all of these and much more. The origins of these two volumes are closely bound up with the history of nature conservation in Britain since the Second World War. When the Nature Conservancy was established in 1949, its programme for the acquisition of a series of National Nature Reserves stemmed directly from the report of the Special Committee on Wildlife Conservation (1947; Cmd. 7122), set up to advise the Ministry of Town and Country Planning in 1945 under the chairmanship of Sir Julian Huxley and, later, Sir Arthur Tansley. The original list of proposed reserves was a remarkable achievement of its time, but exploration of the British countryside, and the work of the staff of the Conservancy itself, quickly showed it to be inadequate. New sites were discovered, and, with changing practices in land use, new threats to British wildlife developed where none could have been envisaged before the War. The Conservancy's site conservation programme was periodically reviewed, and a major reappraisal was launched in 1965. The *Review*, which has issued from this, is the product of a formidable body of expertise, and the distillation of an immense amount of work. The many contributions have been skilfully edited into a coherent whole by the chief scientist of the Nature Conservancy Council, Dr Ratcliffe, who himself wrote the introductory and general chapters as well as substantial parts of the text.

The early chapters set out the philosophy and methodology of the *Review*, which is, in effect, an essay in 'zoning' the land of Britain in relation to its nature conservation interest. The basic concept has been the selection of 'key areas' to cover the spectrum of habitat and community types; it is assumed explicitly that vegetation is an expression of site factors, and a major determinant of the animals. The key areas seek to represent the typical as well as the exceptional, and to embrace the major reference points in the total field of variation of British vegetation. The choice between individual sites has been governed by a balance of many criteria – size, diversity of habitat and richness in species, recorded history, proximity to related sites, and in some cases potential (rather than present) value and intrinsic appeal. Site boundaries have taken due account of practical considerations, the need for buffer zones, and the particular conservation value of large continuous areas.

There follow a series of seven chapters covering the major habitat types. In each chapter an extended ecological outline of the habitats and their vegetation is followed by a summary and discussion of the more characteristic plant and animal species that occur in them, notes on the distribution of the habitats and communities in Britain, and a list of key sites – a pleasant format, but with some tendency to repetitiveness. For many readers these chapters will be the most interesting and useful part of the *Review*, because they constitute the first attempt at a comprehensive summary of British vegetation since Tansley. They underline how far knowledge and understanding have advanced in the last 30–40 years. Thus in the chapter on coastal vegetation, the accounts of saltmarshes, dunes and shingle vegetation have a coherence, and are based on a wealth of physiographic and floristic detail that would have been unattainable 30 years ago; the account of cliff vegetation (which takes into account the work of Dr A. J. C. Malloch) fills a major lacuna in Tansley's books. The account of woods emphasises the role of man in shaping their present form and structure, and gives due recognition to Dr Oliver Rackham's researches in this field. The effects of atmospheric pollution on epiphytic bryophytes and lichens, and the importance of long-term continuity for the persistence of some epiphytic lichens and woodland flowering plants and bryophytes, are considered. There is a good discussion of western and Scottish acid woodlands of sessile oak and other species, with their often rich bryophyte floras – a vegetation type notably characteristic of the British Isles, as is ashwood on the more base-rich soils.

'Lowland' heaths are summarized briefly, with some emphasis on the western parts of the country and transitions to coastal and upland heath in such areas as the South-West peninsula, West Wales and the Marches. The much-studied and species-rich calcareous grasslands are also tersely and neatly summarized, along with calcicolous scrub. There is a good outline of the ecology and floristics of the East Anglian Breckland 'heaths' (dare one say it, out of proportion to their importance in the context of such other riches?). Academic plant ecologists (and, until recently, conservationists) have tended to neglect the 'neutral grasslands'; here – defined in a broad sense which includes a number of marsh communities – they are given a useful systematic treatment. There is a nicely rounded account of open-water communities in which the major directions of variation are well brought out. Integration of the accounts of the plant and animal communities in this chapter will be welcomed by many, even though, as the authors concede, it may make reading hard work for those unfamiliar with the invertebrates and algae. It is interesting that several of the major examples of marl lakes are artificial reservoirs or derelict gravel workings in southern England. Speleologists may be surprised to find caves included in this chapter – though a wet-suited caver might be ready enough to agree that Swildon's Hole or Ogof Ffynnon Ddu are 'open water sites'! The account of peatlands follows a fairly traditional scheme in which acid to alkaline is equated with an 'oligotrophic' to 'eutrophic' direction of variation. This is a pity because, as the authors point out, these two directions of variation are *not* the same, and in my view failure to separate them has greatly impeded the understanding of British peatland vegetation. However, the present account, if conservative, goes a long way beyond the accounts of Tansley's day. 'Upland grasslands and heaths' is an understatement, if not a misnomer, for a very tightly packed chapter on upland and mountain vegetation. Much of it summarizes information available in more extended form in McVean & Ratcliffe's *Plant communities of the Scottish Highlands* (1962), but here it is placed in a broader context embracing Wales and England too. A little more might have been said about the floristically important mountain cliffs and corries. What we have here is laconically minimal.

The chapter on 'artificial ecosystems' – man-made habitats – is welcome, though rubbish-tip and wool-alien devotees among the readers of *Watsonia* will not need to be reminded of the part Man has played in enhancing the biological diversity of our island. This chapter records the declining wildlife content of arable farmland, the (probably limited) decrease in our half-million miles of hedges, and the disappearance of farm ponds. But road and railway verges are still very much with us, to provide an extensive and sometimes rich if often rather uniform habitat, and derelict quarries, mines and gravel pits continue to generate new habitats which sometimes develop diverse and interesting communities of plants and animals.

The first volume concludes with chapters on conservation of flora and fauna, and a brief overall appraisal. A few points are worth abstracting. 'Common and widespread species . . . tend to be well represented in the key site series, and aggregations of rare and local species, as . . . in Upper Teesdale, are also adequately dealt with.' 'No attempt has been made to include rare species which occur singly in localities undistinguished for other features, e.g. *Diapensia lapponica*.' 'It is of concern . . . that adequate samples of the range of genetic variation be maintained . . . but it is hoped that, in representing the British flora according to other criteria, a wide range of genotypic variability has incidentally been included.' Given the context, I find myself in close agreement with the philosophy and the intentions expressed in the *Review*; I am sure the priorities are essentially right. However, it is clear that, even if all these intentions materialize, there will still be no lack of worthwhile conservation projects left for members of the B.S.B.I. and the county naturalists' trusts.

Volume 2 of the *Review* is made up of brief site descriptions. These vary in length and style, but they include many admirable thumbnail sketches, including lists of the more characteristic and interesting species. This volume is a mine of information which will surely be much consulted by conservationists, planners – and by those simply going on holiday or planning botanical trips in unfamiliar parts of the country!

Looking at the *Review* as a whole, three general comments come to mind. First, as the editor points out early in the book, any account of this kind is 'greatly handicapped by the lack of a standard countrywide description and classification of British vegetation types.' This robs much of the descriptive material of a clarity and incisiveness it might otherwise have had, and I fear the loss is practical as well as intellectual. For me, the communities (or their British counterparts) spring vividly from the pages of Westhoff & den Held's *Plantengemeenschappen in Nederland* (1969); too often that is not so here. I think we are paying dearly for the fragmentation of the tradition of descriptive plant ecology in Britain since the War, and the preoccupation of so many with the methodology of description and analysis rather than with the vegetation that is ostensibly their interest. One hopes that the Conservancy's 'National Vegetation Classification' project will serve to re-establish a continuing and developing tradition of studying vegetation for its own inherent interest.

The *Review* is so monumental that it is bound to stand as a landmark, and will be regarded by many as definitive. I hope it will *not* be regarded as definitive, or at least, not for too long. All is flux, and this is nowhere more true than in biology and biological conservation (as, indeed, the preface of the *Review* makes clear). Continuity and stability are vital ingredients of conservation policy, but this is no place for the monumental turn of mind and it would be quite wrong to nurture the idea that conservation can ever reach a safe and administratively tidy finality. We should look forward to a new *Nature conservation review*, probably not long after A.D. 2000.

Third, the price invites comment. It is a catastrophe. No doubt the C.U.P. could justify it up to the hilt. Perhaps their hands were tied by the requirements of the Nature Conservancy Council. But this is not an isolated instance, even if it is one of the more extreme. The embittered book buyer fears they may have joined with some Dutch and German publishers in a cynical calculation that, since no university or major public institution can afford *not* to buy a book of first rank importance, they need print no more copies than will satisfy that guaranteed market, and can charge what they like for them. The resulting splendid volumes can stand for decades on the library shelf as a monument to the Press's 'high standards' when everybody has forgotten about the price. But prestige is derived from *praestigium*. Is this really the best way to serve conservation or scholarship, and are there really not alternatives which would equally have served the commercial imperatives of a publishing house? Frankly, I would have preferred to see a less polished production, in a paperback binding, intended for a much larger circulation at a much lower price. This is a book which merits and needs a wide circulation. It should be in every county naturalists' trust office, and in every public library. It should be possible for a keen postgraduate (or even undergraduate) student or keen amateur naturalist to regard a copy of his own as a realistic, if far-stretched, ambition. But at £60? No way!

A nature conservation review combines the characters of a textbook on British vegetation and its associated fauna, a major Nature Conservancy Council policy document, and a *Baedeker* or *Botanist in Ireland* for British wildlife. And it is illustrated with some very fine photographs of sites and vegetation. By any standards it is an impressive achievement, and one upon which the editor, the contributors, and the Conservancy are to be congratulated. And whatever one may say about the price, it is matched by a very high standard of production. I hope the *Review* will be as widely read as it deserves.

M. C. F. Proctor

The island of Mull. A survey of its flora and environment. Edited by A. C. Jermy & J. A. Crabbe. Pp. xxxvi + 631, with 130 text-figures. British Museum (Natural History), London. 1978. Price £28·00.

This latest local Flora covers Mull and its adjacent small islands (notably Iona, Staffa, Ulva and the Treshnish Islands), comprising all of vice-county 103, Mid Ebudes, apart from the more westerly islands of Coll and Tiree. It is in many respects a Flora with a difference and with very high standards. It was largely written and compiled by the staff of the Botany Department of the Natural History Museum, and their professional expertise shows through on nearly every page of the book. Most of the field work was concentrated into the five years 1966–1970.

The book is divided into three parts and 19 chapters. Part 1, *Prologue*, contains a short chapter on the history of plant-recording in Mull and a longer chapter entitled 'Patterns of distribution within the flora of Mull'. This is a well-written survey of distribution patterns of vascular plants, bryophytes and lichens, and freshwater algae, including dot-maps (dots on actual localities, not in grid squares) of 45 representative vascular plants. The authors of the vascular plant section have used the geographical elements of J. R. Matthews, while those of the bryophyte and lichen section followed D. A. Ratcliffe.

Part 2, *The environment*, contains eight chapters on the topography, geology, geomorphology and soils, climate, marine physical environment, marine ecosystems, brackish and freshwater ecosystems, and terrestrial ecosystems. These comprise about 146 authoritative, informative and interesting pages which amply justify the carefully worded title of the book and together constitute one of the two main features setting it apart from other local Floras. These chapters are liberally provided with diagrams, tables, numerical analyses and, especially in the ecosystems chapters, well chosen and clearly reproduced photographs. Very sensibly, outside expertise (e.g. J. S. Bibby of the Macaulay Institute for Soil Science) has been brought in to add authority to some of the chapters.

Part 3, *The flora*, is divided into nine chapters: seed-plants, pteridophytes, bryophytes, lichens, fungi, fresh-water algae excluding diatoms, freshwater diatoms, marine diatoms, and marine algae excluding diatoms. In the first two chapters a good deal of information on each species is compressed into a small space. The English (not Gaelic) name, status in Mull, phytogeographical element, first record, present habitat, and present frequency and distribution all appear before a summary of the field records. For species with eight or fewer records all of them are given, while commoner species are designated by the districts of the island in which they occur. These districts, of which there are 17, are illustrated by a very clear map on the back and front end-covers. The districts are partly defined by 10 km grid squares, but the grid-lines have been liberally departed from wherever convenient. Indeed, due to the irregular shape of the island, no district contains as much as 100 km^2 of land, and some of the marginal districts (e.g. Ulva) bear no relation whatsoever to grid squares. The net result is sensible, practical and thoroughly pleasing. In the bryophyte and lichen chapters the information provided is scarcely less complete, but in the remaining chapters fewer data are forthcoming, although the species lists are impressively long. The chapter on freshwater diatoms is rich in habitat details. It is, of course, this complete coverage of plants, including by tradition (though not logically) fungi and cyanophytes, which puts this Flora in a category of its own.

Despite its excellence, there are, in the opinion of the reviewer, a number of short-comings which, although of a relatively minor nature, should have been made good. The chapters are paged separately, a very annoying and quite pointless system; the reviewer was supplied with the above total of figures by the editors, there being none given in the book. On the last page of the book one is informed starkly 'There is no general index'. This is a bad mistake, for the indices at the beginning of the book and at the start of some chapters are in no way a substitute. The bibliography would also have been far better placed in one continuous unit at the end of the book, instead of separately for each chapter. There is overall, it must be admitted, a general lack of integration caused by many separate authors. This has become a real drawback in parts of the systematic accounts. The separation of the algae into four chapters, and the separation of the fungi and lichens, is unjustifiable and counter-productive, especially as there are several families and genera which appear in more than one chapter and, in the case of diatoms, even species which do so. There is obviously every gradation between fresh-water and salt-water, and the disposition of species in this book reflects this problem.

Some features which are not well covered, but which would have been welcome additions, include a list of collectors' names (several are identified by surname only, without a date), a closer appraisal of the national status of the rarer species (e.g. a simple list of species known in Britain only from Mull), and more details of land-use (what crops are grown?).

As might be expected, the taxonomic treatment is of a high standard, and there is a long list of outside experts who have been consulted on critical groups. The editors did, however, miss out in the case of *Juncus* for, while *J. bulbosus* and *J. kochii* are kept separate, the well-defined segregates of *Juncus bufonius* are ignored. Hence the occurrence in Mull of *Juncus ambiguus* and *J. foliosus* is missed (see maps in *Watsonia*, **12**: 125 (1978)).

My copy of the book was provided with two errata slips, one printed and the other photo-copied, neither of which contains all the errors on the other. Unfortunately some of these errors are important – the wrong abbreviations of Matthews's elements in Chapter 12, and the description of the frontispiece landscape as Pleistocene rather than Palaeocene (60 million years difference). On the other hand one is relieved to learn that 'for technical reasons' this ghastly reconstruction was printed on the title page rather than twice-over on the end-papers. Its relevance to the book is mystifying; a modern landscape would have been far more appreciated. On page 11.26 *Saxifraga stellaris* has two entries; the first should read *S. nivalis*.

The island of Mull does great credit to the B.M. staff involved, and it sets a standard in local Floras which will be rarely bettered. It certainly provides a welcome change from some of the recent production-line Floras consisting of a short introduction, a vast array of dot-maps, and a couple of lines entry for each species. It is to be hoped that future Flora-writers will set their sights higher having consulted this book.

C. A. STACE

Bibliographie über die Orchideen Europas und der Mittelmeerländer 1744–1976. Barbara & Ekhardt Willing. Pp. 325. *Willdenowia*, Beiheft 11. Botanischer Garten und Botanisches Museum, Berlin-Dahlem. 1977. Price not stated.

In this compilation the Willings have set themselves a formidable task. After a brief preface, in both German and English, there follows the bulk of the work, which consists of 3556 entries by author gathered from over 800 periodicals. The latter are listed in a second chapter. Further chapters index the main entries under four headings – species and subspecies (with indications of where the taxon is illustrated), hybrids, geographical location and subject (anatomy, biochemistry, taxonomy, etc.). Coverage of the British literature seems to be rather patchy, and, although I was disappointed (but not surprised) to find no mention of 'Wild Orchids of Bedfordshire' (*Bedfordshire Magazine*, 1948) by John Dony and illustrated in part by myself, there are other more important omissions. *Epipogium aphyllum* has the largest number of entries in the species index; but there is no mention of the note recording its original discovery in Britain (Crotch 1855) nor of Druce's famous double find of this species (1892 and 1923) (Druce 1924, 1925), although the periodical in which it appeared at least appears in the source index. However the authors freely admit that their work must be incomplete, and it is nevertheless certainly a most useful reference book for the large number of persons who interest themselves in this small group of plants.

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P. TAYLOR

Biological identification. R. J. Pankhurst. Pp. 104, with 19 text-figures. Edward Arnold, London. 1978. Price £3·20.

This book is concerned with the principles and practice of identification methods in biology. In the preface, the author quite correctly points out that most biologists need to identify specimens as part of their work, and the book puts much emphasis on the practical aspects of identification methods.

The first chapter is a general introduction to the identification and classification of plants and animals. As far as the practising biologist is concerned, there is little new here except a brief account of pattern recognition, a general term for the application of computers to problems of identification. The second chapter deals with conventional identification methods, namely the diagnostic key, the multi-access key and the comparison method. Reference is also made to the use of the multi-access key on punched cards. Again, the material in this chapter should be well known to the practising taxonomist.

The third chapter is concerned with automatic identification methods, which usually require the use of a computer. This chapter occupies almost half the length of the book and is probably the most exciting part of the present work. It includes information on a number of aspects of the application of computers to problems of identification, such as key-constructing programs, punched-card keys, matching methods and on-line identification programs. Obviously some mathematics and statistics are required for an understanding of this chapter.

Historical aspects of the subject are briefly reviewed in the fourth chapter. The fifth and final chapter deals with the applications of the various identification methods, described in the book, in various biological disciplines (botany, zoology, palaeontology, microbiology, pharmacognosy, medical diagnosis). As far as botany is concerned, there seems to be ample scope for the development of automatic identification methods.

There is a good reference list. This book can be recommended to those interested in plant and animal identification as a concise account of the traditional and newer methods available and should be most valuable for the undergraduate student.

J. G. Vaughan

Nature, day and night. Richard Adams, illustrated by David Goddard, science text by Max Hooper. Pp. 108, with numerous coloured illustrations and diagrams. Kestrel Books, Penguin Books, Harmondsworth, Middlesex. 1978. Price £3·95.

The note on the cover of this book informs us that it is 'very much more than a simple information book'. Apart from the scientific text for each habitat there is a descriptive essay by Richard Adams, who takes a personalized look at the habitat.

The system whereby each habitat is looked at in two different ways, by night and by day, is particularly interesting and emphasises how a relatively small habitat can support quite a large fauna. The habitats dealt with include meadows, moorlands, streams and ponds, and the seashore. Each is treated in a similar format, with a descriptive essay followed by a scientific text which takes one or two features or specializations found in that habitat as its theme.

The book makes one aware of the use made of the same habitat by the diurnal and nocturnal animals. It deals with aspects of the environment which, while fundamental, are often overlooked (such as the weather and weather charts, clouds and cloud formation) and has an interesting section, called 'Hot and cold air', about air movements and rainfall. The range of natural history topics covered in a relatively slim volume is surprising, and the author makes a conscious effort to answer some of the commoner questions which seem to be rarely answered. For example there is a section dealing with how birds make their nests – something rarely given in bird books. The emphasis in this book is on the explanation of a few of the activities or the functional significance of various structures associated with the day or night in the plants and animals of the habitat – questions such as why butterflies fly by day and moths by night or why birds have a dawn chorus. We may all have ideas on this and they may not agree with the suggestions made; but full marks should be given for this type of approach.

A few errors have crept in. For example it looks as though the heading 'Water Insects' applies equally to the bluebottle and grasshopper on the page. The figure of the female glowworm feeding on a snail is probably a larva; adult glowworms generally do not feed. I was not so keen on the stylized drawings of habitats with animals 'stuck' on them. In particular the keys to these pictures, which may contain up to 60 numbered items, are very complicated and not easy to use.

The book will stimulate readers to consider the implications of their natural history observations, to look and see, not just to glimpse, the events around them.

P. S. Whalley

Obituary

JOHN WESTLEY CARR
(1911–1978)

John Carr died in hospital in Algeciras on 3rd November, 1978, after a short illness, while on a visit to Spain. His funeral was attended by his wife Dorothy and family, and he lies peacefully in the cemetery at Rinconcillo (near Algeciras, where he spent many happy days), looking across the Bay of Algeciras to the Rock of Gibraltar. He first came to know this part of the world while stationed at Gibraltar during the war.

He came back to the south of Spain in 1957 with a bird-watching group, but on subsequent annual visits to Algeciras he soon switched his attention to the flora and Dorothy used to paint fine water-colour illustrations of the more showy plants. He never claimed to be a plant taxonomist:

> 'I am not a botanist. I graduated in French and Spanish in 1933 and though I am now quite deaf I can still read and write my languages and answer questions in the idiom of the Siglo de Oro . . . My botany is confined to recognizing the unmistakable; but I have a good memory for Latin names . . .' (in litt. 4.2.73).

He was, however, very interested in recording the distribution of plants, and joined the B.S.B.I. in 1954. He is included (as 'J. Carr') in the list of recorders in the *Flora of Essex* (1975) by S. T. Jermyn, a life-long friend, and he is also listed as a recorder in the B.S.B.I.'s *Atlas of the British flora*. So far as we know his recording was confined to Essex, apart from one sally to Guernsey to help D. McClintock.

The successful completion of the B.S.B.I.'s *Atlas* suggested to him the idea of trying to map, in the 10 km squares of the U.T.M. grid, the very rich flora of his holiday ground in south-western Spain. After discussing the idea with the then president, Dr S. M. Walters, and others he decided to invite members of the B.S.B.I. to co-operate. Thus originated the series of expeditions to Spain, on each of which a dozen or so members took part, as follows:

Year	*Date*	*Centre*	*Leader*
1974	7–21 April	Algeciras	J. W. Carr & E. J. Clement
1975	23 March–6 April	Algeciras	J. W. Carr
	19 May–2 June	Ronda	E. J. Clement
1976	11–25 April	Arcos de la Frontera	D. McClintock
	23 May–6 June	Torre del Mar	E. J. Clement
1977	3–17 April	Jerez de la Frontera	A. Copping
	24 April–8 May	Antequera	R. Mill
	15–29 May	Lanjaron	E. J. Clement

The data for the specimens in the private herbarium of Mrs Brinton-Lee of San Roque were entered on the maps, and a few squares were mapped by botanists living in that part of Spain (Mrs Molesworth-Allen, B. E. Smythies, S. Holmdahl) or by visiting botanists (notably R. M. Burton).

The survey eventually covered nearly the whole of the provinces of Cádiz and Málaga, and the western half of Granada, but, as most squares could be visited once only, the number of species plotted is probably less than half the total number of species present in each square. John was unsuccessful in obtaining the official collaboration of Spanish botanists, which would have resulted in more complete coverage.

He was a superbly efficient organizer, and each party was provided with maps mounted on hardboard, printed recording cards, collecting equipment, microscopes, etc. The comprehensive library included nearly every book or publication with illustrations of Spanish plants, even valuable and esoteric items such as the *Flora Atlantica* by Desfontaines. To supplement these he arranged for one or more botanical artists to accompany each group, and priority was given to painting endemic or rare species for which no illustration was readily available in the literature. Artists who contributed to this work include (in alphabetical order) Hilary Broad, Jill Condy, Sean Edwards, Robert Heppel, Elizabeth Luard, Jill Smythies and Rosemary Wise. The final result is a collection of over 500 paintings of professional standard, drawn from life, mostly with enlargements of diagnostic characters, all the same size. This is a very valuable addition to the iconography of Spanish plants, and many of the paintings have been displayed at B.S.B.I. Exhibition Meetings.

Some of the plants collected each day were put into presses, and a herbarium that totalled about 1300 species was eventually assembled. This was intended primarily as a matching herbarium, and exact locations and field notes are mostly lacking. An alphabetical index of plants known to occur in the area covered by the survey was also compiled; it gave references to illustrations in the literature, to drawings done by the artists, and to herbarium specimens.

Those members of the B.S.B.I. who joined his parties had a unique opportunity to learn something of the Mediterranean flora with a good botanical leader and facilities not offered by any botanical package tour. In his later years John spent all his spare time and effort and a great deal of money (each party he took out was to some extent subsidized by him) in trying to make a worthwhile contribution to the knowledge of the flora of southern Spain. The B.S.B.I. Exhibition Meeting of 1978 did not seem quite the same, with no massive Spanish exhibit taking up the whole of the far end of the General Herbarium. Our deepest sympathies are offered to his wife Dorothy, to his daughter Hilary Broad (both of whom joined him on so many of his Spanish expeditions) and to other members of his family.

B. E. Smythies & E. J. Clement

Reports

AQUATIC AND MARSH PLANTS SYMPOSIUM, BRATHAY CENTRE FOR EXPLORATION AND FIELD STUDIES, AMBLESIDE, CUMBRIA

27th–29th OCTOBER, 1978

INTRODUCTION

Some 80 participants in the Aquatic and Marsh Plants Symposium assembled on the evening of 27th October, 1978, at Brathay Centre for Exploration and Field Studies, Ambleside, Cumbria. Sherry and dinner were followed by an introductory talk, given by the Director of Studies at Brathay, Mr M. A. E. Mortimer. He welcomed the B.S.B.I. symposium to 'Old Brathay' and gave an account of the Brathay Trust.

The very full programme for the symposium consisted of nine talks, exhibits and displays, an illustrated lecture on Cumbrian aquatic and marsh plants and two afternoons of field excursions.

SATURDAY, 28TH OCTOBER

C. D. K. Cook. *Distribution of aquatic macrophytes.*

Aquatic macrophytes are defined as higher plants whose photosynthetically active parts are either permanently, or at least for several months of the year, submerged in water, or floating on the water surface. Cook *et al.* (1974) compiled an account of all genera with freshwater species, but the following genera were omitted from this work, either through ignorance or their having been described since 1974: Araceae – *Amauriella, Gymnostachys, Jasarum, Urospatha*; Compositae (Asteraceae) – *Gymnocoronis, Jaegeria, Sclerolepis*; Cyperaceae – *Elgeria*; Haloragaceae – *Vinkia*; Zannichelliaceae – *Vlesia*. Today, world-wide, it is estimated that there are about 5,000 aquatic species in about 360 genera. For higher plants about 2% of the species are aquatic, and about 3% of the genera and about 20% of the families contain aquatics. With the exception of the larger woody groups (Gymnospermae and Hamamelidaceae), aquatics are fairly evenly distributed throughout the vascular plants. Of the ten largest families, only the Orchidaceae has no aquatic species. (Species of *Spiranthes* will withstand short periods of submergence but can hardly be called aquatic). The Dicotyledones and Monocotyledones contain about the same proportion of aquatic species.

Clayton (1972) studied the numbers of species in the genera of several plant families, generally finding a quasi-logarithmic distribution, but with rather too many monotypic genera and too few very large genera. A similar analysis with aquatic plants by the speaker gave figures almost fitting those of the Acanthaceae published by Clayton (1972). However, aquatics have, unexpectedly, proportionally fewer monotypic genera (total 112). It is frequently cited that there are proportionally more monotypic aquatics than other types of plants, but this statement is apparently not true. There are relatively few large aquatic genera. The largest predominantly aquatic genera are: *Potamogeton c*100 species, *Bacopa c*100 (not exclusively aquatic), *Isoetes c*75 (of which *c*60 are aquatic), *Marsilea c*65, *Cryptocoryne* 52, *Najas c*50, *Apinagia c*50, *Echinodorus* 47, *Rotala* 44 (reduced from 97 by Cook), *Ottelia* 40, *Nymphaea c*40.

It is often said that aquatic environments are relatively stable and that consequently aquatic plants occupy large geographical areas. This is perhaps true for a few species, such as *Potamogeton pectinatus*, but some species, such as *Phragmites australis, Lemna minor, Typha latifolia* and *T. angustifolia*, are less widely distributed than is frequently believed; these species are largely replaced by vicariads in the tropics. Sculthorpe (1967) pointed out that aquatic species, like terrestrial ones, show a high degree of endemism, a view which the speaker's investigations support. Even in Europe, which has relatively few aquatic species (*c*1·5% of the flora), there are two endemic genera (*Luronium* and *Thorella*) and about 31 endemic species.

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Cook, C. D. K. *et al.* (1974). *Water plants of the world.* The Hague.
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B. A. Seddon. *The lake flora of Wales: studies on depth-distribution and zonation.*
Within all bodies of still or slowly moving water, zonation, related to depth, of water-plants is a conspicuous feature. For the lake flora survey of Wales information on zonation was obtained from measured line-transects, plotting species occurrence at regular intervals from the shore, and noting the depth of water at each point. Six such zonation profiles were shown.

In addition, the depth at which each species occurred, for many points within each lake, was measured, from which the greatest depth obtained by any species within a lake could be seen. Records for a single species from all lakes give a general picture of the plant's capability for growth in a range of

TABLE 1. MAXIMUM DEPTH RECORDED FOR MACROPHYTES IN WELSH LAKES

Life form	Species	Depth in ft
Submerged rosette habit	*Isoetes lacustris*	30
	Littorella uniflora	18
	Isoetes setacea	10
	Luronium natans	10
Submerged broad-leaf habit	*Potamogeton perfoliatus*	15
	P. obtusifolius	15
	P. lucens	15
Submerged dissected-leaf habit	*Myriophyllum alterniflorum*	18
	Ceratophyllum demersum	16
	Myriophyllum spicatum	12
	Utricularia sp.	12
Submerged filamentous habit	*Potamogeton berchtoldii*	16
	Juncus bulbosus	15
	Callitriche hamulata	12
Floating leaf habit	*Nuphar lutea*	12
	Nymphaea alba	12
	Potamogeton natans	10
	Polygonum amphibium	10
Erect emergent habit	*Schoenoplectus lacustris*	7
	Phragmites australis	6
	Typha angustifolia	6
	Equisetum fluviatile	6

depths and conditions. Depth-diagrams were presented for 24 species. Table 1 compares the depth ranges of species of both similar and contrasting life-forms. There appears to be no difference in maximum depth between submerged life-forms, or any correspondence between depth tolerance and zonation.

Lakes can be listed in order of the maximum depth at which a particular species occurs. For example, *Myriophyllum spicatum* has the following maximum depths in five lakes: Llyn Penrhyn, 2ft; Llangorse Lake, 5ft; Llyn Hendref, 6ft; Kenfig Pool, 9ft; Llyn Du Meifod, 12ft. From this it can be deduced that the plant is limited to the shallowest waters in nutrient-rich lakes (the first three) and penetrates to greater depths in the clear, hard-water dune lake at Kenfig. Similarly, *M. alterniflorum* occurs down to only 2ft in eutrophic lakes, to 5ft in lakes of moderate nutrient status, and only at greater depths in nutrient-poor lakes.

Although tendencies in aquatic plant distribution and zonation can be recognized, there are no consistent arrangements associated with a particular type of lake. Indeed, variation in floristic diversity can lead to variation in depth distribution in different places within the same lake.

It is concluded that zonations are the result of competitive interactions between species under water; light penetration at any depth only determines the relative vigour, and therefore only indirectly affects the spatial arrangement.

R. J. Driscoll & M. J. Jackson. *Recent work on the aquatic macrophyte flora of the Norfolk Broads.* The Norfolk Broads are renowned for their rich flora and fauna, and together with the adjacent marshes and fens the area provides an ideal habitat for a wide variety of aquatic plants. One of these plants, *Najas marina* L., is found nowhere else in the British Isles and Broadland is one of the few strongholds in this country for several other species, such as *Stratiotes aloides* L.

By the early 1970s those with interests in Broadland's wildlife were convinced that the aquatic flora of the Broads had deteriorated considerably, although little systematic work had been carried out to provide a factual basis for this assertion. Since this time, however, our understanding has much improved and a recent summary of Broadland Research produced by the Nature Conservancy Council (NCC) included nearly thirty major research projects. In 1978 the NCC financed a field survey of the distribution of aquatic macrophytes in the Broads and a retrospective study of the changes that had taken place in the past based on published and unpublished records and herbarium material (Jackson, M. J., 1978. *Trans. Norf. Nor. Nat. Soc.*, **24** (4): 137–152). The results of this work show that since the 1930s the rich aquatic flora of most of the Broads has become increasingly impoverished although the changes have not taken place simultaneously in all of the Broads affected. The decline usually involved an initial decrease in the number of species present followed by a gradual reduction in the productivity of those remaining.

The water lilies *Nuphar lutea* (L.) Sm. and *Nymphaea alba* L. are often among the last plants to be lost and these were the commonest species found in the 1978 survey. Among the species that have been recorded from the Broads in the past and which are now thought to have disappeared are:

Azolla filiculoides Lam.	*Potamogeton lucens* L.
Fontinalis antipyretica Hedw.	*Potamogeton obtusifolius* Mert. & Koch.
Hottonia palustris L.	*Potamogeton perfoliatus* L.
Hydrocharis morsus-ranae L.	*Potamogeton praelongus* Wulf.
Potamogeton compressus L.	*Ranunculus circinatus* Sibth.
Potamogeton friesii Rupr.	*Stratiotes aloides* L.

A few of the Broads, however, still retain a diverse flora. For example over ten species of aquatic macrophyte were recorded from Ormesby Broad in 1978 including: *Ceratophyllum demersum* L., *Myriophyllum spicatum* L., *Potamogeton berchtoldii* Fieb., *Zannichellia palustris* L. and *Najas marina*.

The reclaimed marshes associated with the Norfolk Broads are drained by an extensive network of dykes. In the early 1970s it was realized that at least some of these dykes supported a rich aquatic flora and during the period 1972–1978 the NCC financed several dyke surveys. Initially this work was concerned with comparing the flora of the dykes with that which used to exist in the Broads as it was thought that the dyke systems might provide a refuge for some of the species that had been lost. In later years more emphasis was placed on factors that might influence the diversity and species composition of the dyke flora.

All the species listed above as having disappeared from the Broads, with the exception of *P. praelongus*, were found to be thriving in the dykes. The diversity and species composition of the dyke flora were found to be influenced by three main factors:

1. *Adjacent land use.* Dykes draining arable land support a much less diverse flora than those draining pasture as in the absence of cattle grazing the marginal vegetation and damaging the banks the dykes become overgrown by *Phragmites australis* (Cav.) Trin. ex Steud.
2. *Dyke management.* Frequent and/or intensive dyke cleaning results in a general impoverishment of the dyke flora.
3. *Salinity.* Brackish dykes support a less diverse flora characterized by the presence of *Potamogeton pectinatus* L., *P. perfoliatus*, *Hippuris vulgaris* L. and *Myriophyllum* spp.

Several areas of marshland still retain a diverse dyke flora, including species that have never been recorded from the Broads, e.g. *Potamogeton acutifolius* Link. However, the conversion of grazing pasture to arable use and the improvement of land drainage pose a serious threat to such areas, and in the absence of an active conservation policy their long term future remains very much in doubt.

S. M. Haslam. *Identification of watercourse habitats.*
Watercourse plants are very sensitive to the environment in which they live, and the plant communities can be used as indicators of their habitats. Little use has been made of this relationship up to now, mainly because the controlling factors differ from those on land, and are not easily recognized by those without experience in these habitats. There are four main controlling factors for stream vegetation: rock-type, flow-regime, downstream variation, and the activities of man. The last is not used in the basic classification, as it is considered as modifying an existing order.

Rock-type and flow-regime are both of primary importance. Flow-type is intrinsically the most important, but since it is also the more difficult to assess, rock-type is used for the basic classification. Thus a stream is described as a clay stream, or a chalk stream, etc. The categories of rock-type that are used are: soft and hard limestone, soft and hard sandstone, clay, coal measures, resistant rocks (schists, slates, etc.) and alluvium.

In Britain there is a rough correlation between topography and rainfall. Flow-regime depends mainly on these two factors, and can, in a simple way, be classified on the types of landscape surrounding the streams. These landscape categories are: plains, lowlands, uplands, mountains, and very mountainous regions. This is the second classification, allowing a stream to be termed, for example, a lowland clay stream. The changes along a river's length from source to mouth – downstream variation – can be most easily estimated by its width, which corresponds satisfactorily with the vegetation, provided: 1, its use is confined to streams of one rock-plus-flow-type; and 2, it is accompanied by a habitat description which includes the normal stream depth, so that streams which are unusually deep for their width can be reclassified, in vegetation terms, into a larger size category, and *vice versa.*

With this information, descriptions can be given of the typical plant communities of each habitat, for example, large, lowland chalk streams. Conversely, the habitats can be deduced from descriptions of the vegetation (excluding those communities damaged by man's activities). However, in some cases the same plant community can occur in more than one habitat type. Each species has its own range of probable and possible habitats, and the combination of species present leads to either one, or a limited number of possible habitats, provided that either the community is diverse, or the species present have a narrow habitat range. The species list is the most important diagnostic feature but, for more accurate work, species abundance, vegetation cover and, sometimes, species habit, are also used.

J. A. Moore. *Charophytes.*
Most of this talk is incorporated in the first part of the paper in this issue, pp. 297–309.

P. M. Wade. *The flora of drainage channels.*
Areas of reclaimed land, such as the Somerset Levels and the Norfolk river valleys, are drained by networks of permanent drainage channels (dykes, drains, rhines, reens etc.), forming artificial bodies of water which support a large number of aquatic plant species including national rarities such as *Azolla filiculoides* and *Potamogeton acutifolius*. The total length of drainage channels in England and Wales is estimated at 128,000km, draining $1{\cdot}3 \times 10^6$ha of low-lying land.

In order to maintain their drainage efficiency, the channels are periodically managed, usually being mechanically excavated. On the 'moors' or levels of Mon., v.c. 35, the drainage channels are excavated to maintain a network of large main, or arterial channels and smaller subsidiary channels. The aquatic floras are different in the two types of channel. After being dredged, the channels pass through a modified hydroseral succession. The main channels are dredged out as soon as emergent communities appear (once every 5 years) whereas in subsidiary channels this stage is prolonged, being dredged once every 10–20 years. Submerged plant communities are rare or completely absent from subsidiary channels. The maintenance of this modified hydroseral succession is the most important factor in ensuring a diverse aquatic flora. In the drainage channels of the Monmouthshire Levels, as in other similar areas, the succession is modified by cattle trampling and grazing the margins, fluctuations in the salinity of the water, and, in main channels, the use of herbicide sprays.

Fears have been expressed that the increased intensity of dredging since the Second World War and the introduction of herbicide sprays might have impoverished the aquatic flora of the drainage channels. However, research into the past aquatic flora of the channels of the Monmouthshire Levels, based on herbarium and literature records, has shown that the flora of these channels has remained much the same since the mid-1800s, no changes being attributable to improved maintenance.

The continued existence of these rich aquatic communities is dependent upon the channels draining grazing land, in which case the channels have a secondary function of providing field boundaries and water for stock. However, major improvements in drainage are taking place resulting from the installation of new or improved pumps and the provision of underdrainage, as flood defences are rebuilt and the existing drainage systems renovated. The water levels are therefore lowered, the cattle are watered from troughs and the fields can be enlarged, the disused channels drying out and becoming overgrown. These 'improvements' herald the introduction of arable farming. This has already occurred in such areas as Romney Marsh and the Lincolnshire Fens. There is then further abandonment of channels; those that remain are often only temporary and support few aquatic plant species.

G. Halliday. *Slides of Cumbrian wetland habitats and species.*
Slides were shown of the wide variety of Cumbrian wetland habitats, including the main rivers, upland and lowland tarns, lakes, ponds, canal and brackish ditches. Their characteristic species were illustrated, and also rare and declining species such as *Bidens cernua, B. tripartita, Eleocharis acicularis* and *Pilularia globulifera.*

SUNDAY, 29TH OCTOBER

D. F. Westlake. *The ecology of chalk streams.*
Chalk stream plants are adapted to waters which are hard, rich in nitrogen and phosphorus, and very clear. Their flows and temperatures are relatively stable and moderate. At the upstream, or winterbourne end, the communities are adapted to a period in the summer when there is no flow. At the down-stream end the waters become less stable and more turbid, and change in chemical character, so that the animals and plants are no longer typical of chalk streams.

At a fen site near East Stoke, Wareham, Dorset, v.c. 9, stratigraphic and pollen analyses have shown that for over 10,000 years since the Ice Age, the catchment was dominated by forest. During this period it is very probable that the dominant aquatic vegetation was reed-swamp, containing species such as *Phragmites australis* and *Sparganium erectum*, and that submerged water plants were scarce. Subsequently man drastically altered the river and its catchment by felling forests, constructing water-mills, developing water-meadows, installing land-drains, opening sewage works, constructing flood prevention schemes, cutting water-weed, ploughing land and applying fertilizers. The dominant vegetation now is typically tidy beds of submerged water plant species, tolerant of interference by man.

Throughout most of a chalk stream, species of *Ranunculus* subgenus *Batrachium* (water crowfoots) are dominant. Near the source there are short-leaved species such as *R. aquatilis* and *R. peltatus.* Further downstream *R. penicillatus* var. *calcareus* is usually the most important. In the smaller streams, the emergent plants *Rorippa nasturtium-aquaticum* and *Apium nodiflorum* can often smother neglected reaches. Associated species characteristically change along the rivers, *Myriophyllum spicatum* and *Potamogeton lucens* being typical of the plants appearing downstream.

Ranunculus species overwinter as small plants and grow rapidly in the early spring, reaching a maximum in late spring or early summer, or even earlier nearer the river source. If left alone, the plants then die down, but they are usually cut about this time and this provokes vigorous regrowth. The maximum biomass found at sites which are regularly cut is therefore greater than that at undisturbed sites.

At many sites *Rorippa* only grows by means of floating fragments which invade the beds of *Ranunculus* in May. Once established, *Rorippa* spreads rapidly and maintains a fairly constant biomass for several months, adding a large amount of easily decomposed leaves to the river. The *Ranunculus* beneath is killed off. In the autumn floods the *Rorippa* is washed away and the *Ranunculus* regrows from surviving plants around the edges of the *Rorippa* stands. Thus the beds of *Ranunculus* tend to move each year and the two plants are interdependent. An early flood leads to greater *Ranunculus* survival and the vigorous beds produced the following year allow *Rorippa* to establish early, spread widely and suppress the *Ranunculus.*

Even in chalk streams, flow is one of the major factors affecting plant growth. The distribution of many associated species is related to stream width and slope, which tend to be correlated with depth and velocity. Another major factor is light. The maximum biomass at a site is a linear function of the light received and the dominant species change in shade. The cutting regime is important and, if changed, the dominant species may change. Grazing can have similar effects. All these factors are affected by man's activities and chalk stream plants are strongly influenced by man.

J. W. G. Lund. *The mystery of* Elodea *Michx in Britain.*
Until recently even the non-specialist could scarcely mistake *Elodea canadensis* Michx for any other aquatic plant in the English Lake District, where other species of this genus, or species of *Egeria* Planchon, *Lagarosiphon* Harvey or *Hydrilla* L. C. M. Richard, were very rare, unrecorded or extinct. It was therefore a surprise when Dr J. H. Marcus brought to me what appeared to be either a modification of this supposedly well-known plant, or even another species. For many years there had been a dense bed of *E. canadensis* in the bay behind our laboratory [Ferry House, Windermere]. Dr Marcus had been sampling this bed frequently for the past two years and had never seen such a plant. In this period, the same or a similar plant appeared in a pool in the Great Stour, E. Kent, v.c. 15, which I had visited each year for the previous 9 years, and which Mr P. Bolas had visited or fished-in frequently for the previous 10 years, and which throughout this period had contained *E. canadensis*. Within a year, both in the Windermere bay and the Great Stour pool, the invader had either replaced *E. canadensis* or was predominant. Information obtained from publications of the B.S.B.I., other bodies, professional botanists and naturalists, showed that an unknown taxon, or taxa, of *Elodea* were becoming more and more common in Britain.

Though I have done no research on this new form of *Elodea*, numerous specimens have now been collected or received. Plants collected from rivers or canals have sometimes been in flower, and appear to be *E. nuttallii* (Planchon) St John, judging by standard Floras; those in standing waters have not yet been seen to flower. It is not clear to me whether these riverine and lacustrine plants represent two taxa or one. I doubt that these are all modifications of *E. canadensis*.

Whatever may be decided concerning the taxonomy of this new and often explosive *Elodea* invasion, it shows a remarkable similarity to the famous invasion of *E. canadensis* into Britain in the last century. Since the reason for the decline of *E. canadensis* in later years to a less 'aggressive' status is unknown, the new invasion (or invasions) offers a challenge to, and an opportunity for ecologists which should be grasped.

It is of interest that, as yet no 'new' *Elodea* has been seen in Esthwaite Water, the richest, most eutrophic, lake in the Lake District, though typical *E. canadensis* is present. The new lacustrine plant has been found in Brothers Water by Mr R. Stokoe. This is a poor, oligotrophic, water. It is now known that the vegetatively similar plant, sometimes called *Hydrilla verticillata* (L. fil.) Royle and sometimes *E. nuttallii*, found by the late Professor W. H. Pearsall in Esthwaite Water over 60 years ago, is indeed a *Hydrilla*. I believe this plant to be extinct, having searched for it on many occasions since 1945.

M. J. Liddle & H. R. A. Scorgie. *The effects of recreation on aquatic habitats.*
There is concern that increasing use of aquatic habitats for recreation is producing changes that are not really understood, even in a qualitative way. Very little research is being carried out except in one or two isolated situations, such as the Norfolk Broads. The changes have been brought about by many different uses, but may be classified as either due to shore-based or water-based activities. The most important of these are fishing and boating.

Fishing is, perhaps, the most popular shore-based activity and there are some three million anglers in Britain. The amount of change they cause will vary, at least in part, according to the nature of the marginal vegetation. At one site it was found that up to 30% of the taller vegetation had been removed to provide access to the water. The removal of vegetation exposes the bank, and in some cases may lead to erosion, but it also provides a site for some species of plants not normally found in this habitat. Other shore-based activities may, of course, have the same effect.

The main effects associated with the use of boats are physical damage to submerged and floating macrophytes caused by wash, propeller action and direct impact. There may also be pollution from outboard motors and sewage. Those pollutants are likely to affect first the phytoplankton, but rooted macrophytes may be affected in turn by the increased turbidity. The extent of such changes depends on the nature of the habitat. This is particularly evident when comparing the effects of the addition of nutrients to oligotrophic and eutrophic waters. For example, a small increase in nutrient content in an oligotrophic lake in Snowdonia can cause substantial changes in the desmid flora, whereas a similar addition to the Norfolk Broads may well produce no detectable change.

Management of aquatic habitats for recreation use can also have profound effects. The most important are widespread activities such as dragline dredging, reinforcing the banks with piles, cutting, or the addition of aquatic herbicides. There is much need for further research, both into the fundamental changes produced by recreation and into techniques for the management of aquatic habitats which provide a satisfactory experience for the user, but which cause least disruption to the environment.

P. J. Brown. *Some aspects of the Alismataceae.*
No report of this talk was received.

EXCURSIONS HELD IN CONNECTION WITH THE AQUATIC AND MARSH PLANTS SYMPOSIUM

Three excusions were held on the afternoon of Saturday, 28th October. The largest group went by coach to the northern lakes, stopping by Derwentwater, Bassenthwaite, where *Callitriche hermaphroditica* was observed, and Ullswater, where luxuriant material of the rare *Potamogeton praelongus* was found at Glencoyne.

Two other groups left by minibus, one to the south-west of Cumbria, the other to the south-east. The former stopped by Coniston Lake before going on to the Subberthwaite mosses, where *Drosera anglica* was still recognizable. The last stop was at Shaws Moss on the west side of the Duddon estuary. Here an abundance of *Oxycoccus palustris* and *Dryopteris carthusiana* was admired on a largely wooded piece of raised bog. The third group visited Borwick Tarn above Staveley, observing *Potamogeton gramineus* and *P. obtusifolius*, and then a small valley mire and tarn near Winster, with *Drosera intermedia* and *Hypericum elodes* in its only Westmorland locality. At Stainton, the northern end of the Lancaster–Kendal canal, *Ceratophyllum submersum* was observed, luxuriant in its only Cumbrian locality, and also *Myriophyllum spicatum*.

Two of the groups were fortunate in being accompanied by wet-suited divers. All three groups were introduced to the long-leaved *Elodea* discussed earlier by Dr Lund, which was growing in profusion in several places.

On the Sunday afternoon, Professor C. D. Pigott conducted a party of 25 around the Esthwaite North Fen National Nature Reserve, by kind permission of the Nature Conservancy Council. Professor Pigott has studied the site over the last 13 years and has related the changes, which are still occurring, to the detailed survey by Pearsall, early in this century. These changes are the result both of the inevitable plant succession and of increasing eutrophication. The former is far from predictable and occurs more by the stepwise and unphased advances of the various zones than by slow imperceptible advance. The effects of eutrophication are especially evident adjacent to the inflow stream. Members of the party were particularly pleased to see the prominent tussocks of *Carex elongata* in the willow carr.

EXHIBITION MEETING, 1978

The Annual Exhibition Meeting was held in the Department of Botany, British Museum (Natural History), London, on Saturday, 25th November, 1978, from 12.00 to 17.30 hours.

G. E. SMITH'S DRAWINGS OF BRITISH PLANTS

In 1933 the Department of Botany, British Museum (Natural History), acquired a collection of watercolour drawings and pencil sketches, bearing dates from 1827 to 1860, of British plants, many including the locality, mainly from Sussex and Kent. The library catalogue attributed the collection to a 'Gerard Edwards'. Recent study of botanists of that period has failed to reveal any such person. There was, however, a Rev. Gerard Edwards Smith (1804–1881) who was notably active in those years. Study of the collection has revealed that the surname of Smith was omitted from the library catalogue.

G. E. Smith produced just one publication, a slight local list, but he was one of the outstanding field botanists of his generation. He was responsible for first describing *Filago apiculata* G. E. Sm., *Epipactis phyllanthes* G. E. Sm. and *Limonium binervosum* (G. E. Sm.) C. E. Salmon.

Most of the drawings giving localities date either from ten years he spent in and around Chichester, shortly after his ordination, or from his earlier period in south-eastern Kent. They complement his herbarium specimens from these two areas, which are now in **BM** and **OXF**.

D. E. Allen

METEOROLOGICAL ORIGINS OF THE B.S.B.I.

The Botanical Society of London, an ancestor to the B.S.B.I., flourished from 1836 to 1856. The reports of its meetings are brief and austere and an address list of members was published once only, not long after its founding. It had been supposed that the London medical schools were largely responsible for its existence, reflecting the prominent place that botany occupied in their curricula. However, four of the fifteen original officers and Council were meteorologists, and were also at that time office-holders in the Meteorological Society of London. This Society had been in existence since 1823 but for some years had been moribund. In November 1836 it underwent a marked revival after a meeting at which one William Henry White was appointed Hon. Secretary. Significantly, W. H. White had chaired the inaugural meeting of the Botanical Society of London only a week or so earlier. Two other leading members of the Meteorological Society of London also belonged to the Botanical Society from the start. One of these, John Green, acted as printer to both Societies.

In 1850, following the founding of the British (now the Royal) Meteorological Society, the Meteorological Society of London was dissolved, and the links between the sciences of meteorology and botany at that time came to an end. Had they continued, the extensive work on phenology later conducted under the auspices of the Royal Meteorological Society might have helped to introduce British botanists to the potential of 'network research', for purposes other than distribution mapping, a good two generations earlier.

D. E. Allen

RECENT RECORDS OF *PUCCINELLIA* PARL. IN E. KENT

Heavy salting of main roads in E. Kent, v.c. 15, in winter has resulted in the destruction of vegetation nearest to the roadside, leaving a strip of soil 5–30cm wide almost completely bare of vegetation. Saltmarsh plants thrive in this man-made saline environment. The roadside verges along the A249 from Sheppey over Detling Hill (198m) to Maidstone have been colonized by *Puccinellia fasciculata* (Torr.) Bicknell and *P. distans* (L.) Parl. All the evidence suggests that this migration inland has occurred within the last eight years. Passing cars act as ideal vectors for disseminating seed as they produce sudden gusts of wind which are likely to detach and carry seed for several metres. Road surveys show that seed-dispersal in late summer coincides with maximum traffic-flow.

J. S. Badmin

PLANTS, PUBLIC RELATIONS AND FUND-RAISING FOR CONSERVATION

Original watercolours of rare plants, painted from live material, were exhibited, together with cards, notelets and table-mats decorated with prints from the watercolours. The printed material is sold to raise funds for a Naturalists' Trust, and helps to make the public familiar with species needing conservation.

R. J. Banks

PUCCINELLIA × *PANNONICA* (HACKEL) HOLMBERG IN BRITAIN

Living and herbarium specimens were displayed of a *Puccinellia* discovered in 1975 by Mr R. P. Libbey at Reedham, E. Norfolk, v.c. 27, together with photographs of meiotic and mitotic chromosomes. In morphological details the plant is exactly intermediate between *P. distans* (Jacq.) Parl. and *P. rupestris* (With.) Fernald & Weath.: spikelet 4·5–6· mm, lower glume 1·2–1·7 mm, upper glume 2–2·4 mm, lowest lemma 2·6–3 mm. The chromosome number ($2n = 42$) is the same as that of the parents, but meiosis is irregular (6–11 bivalents) and pollen fertility and seed-set nil. The plant bears some resemblance to the type specimen of *P.* × *pannonica* (Hackel) Holmberg, which is said to be of the same parentage. This is the first record of a cytologically-confirmed *Puccinellia* hybrid in Britain.

C. M. Barker & C. A. Stace

THE FLORA OF PONDS IN THE LONG EATON AND SAWLEY DISTRICT OF DERBYSHIRE

A series of ponds in the Long Eaton and Sawley district of Derbys., v.c. 57, provide a unique opportunity to study the development of aquatic macrophyte communities. These ponds, created in the late 19th Century, were the subject of an ecological investigation carried out by Godwin (1923). Current ecological studies are being undertaken to determine changes which have taken place since then. The diverse aquatic plant communities supported by these ponds gives them a high conservation value and it is hoped that an understanding of their ecology will enable effective conservation measures to be formulated. The exhibitors would like to contact any members who have ever made records of the flora of these ponds.

REFERENCE

Godwin, H. (1923). Dispersal of pond floras. *J. Ecol.*, **11**: 160–164.

J. E. Beresford & P. M. Wade

SECRETARY'S MISCELLANY , 1978

A selection of photographs from Amberley Wild Brooks, W. Sussex, v.c. 13, was shown. An application for a grant for draining Amberley Wild Brooks was not approved by the Minister following a Public Inquiry in 1978.

Also exhibited were: conservation badges of the Flora's League, 1928, photographs of the Kew Conservation Conference 'Survival or Extinction?', 1978, and designs for a B.S.B.I. emblem.

M. Briggs

VERONICA ACINIFOLIA L.

Specimens from British herbaria, and photographs by R. J. Pankhurst, of *Veronica acinifolia* L. were exhibited, with an account of records for the plant from five vice-counties. First recorded in Surrey, v.c. 17, in 1920, and in Dorset, v.c. 9, since 1937, in 1978 there were new records from N. & S. Somerset, v.c. 5 and 6, and W. Sussex, v.c. 13. The early records were as a cornfield weed, but all recent records have been introductions with shrubs from nursery gardens.

M. Briggs & R. J. Pankhurst

BIDENS CONNATA MUHL.

Collections of achenes of *Bidens connata* Muhl., *B. cernua* L., *B. frondosa* L. and *B. tripartita* L. were exhibited to show comparison of diagnostic characters. A map showed records of all known localities for *B. connata* in Britain which are by, or near, the Grand Union Canal, in Middlesex, v.c. 21, just extending into Bucks., v.c. 24, and Herts., v.c. 20. The map was compiled from searches made by R. M. Burton, Dr J. H. Chapman and Mrs M. V. Marsden. Mrs Marsden, who first found the plant in 1977 (see *B.S.B.I. News*, **18**: 15–16), was responsible for the Bucks. records and Dr Chapman for the Herts. records; all three recorders found the plant in Middlesex.

R. M. BURTON

A SPECIES OF *PICRIS* L. NEW TO EUROPE

A coloured drawing by Mrs H. Broad of *Picris cupuligera* (Durieu) Walpers found near Salobreña (Granada, Spain) in the spring of 1978 was exhibited. The species was previously only known from North Africa. The specimen from which the drawing was made is now at the Universidad de Sevilla, and details of its discovery have been accepted for publication in *Lagascalia*.

R. M. BURTON

TWO SPECIES OF *SENECIO* L. FROM E. KENT

Herbarium specimens of *Senecio inaequidens* DC., *S. cineraria* DC., *S. erucifolius* L., and *S. cineraria* × *S. erucifolius*, new to science (see also Short Notes, pp. 333–334), were exhibited. They were collected from a shingle beach at Walmer, E. Kent, v.c. 15, by B. Wurzell in 1978.

Previous records of the South African *S. inaequidens* in Britain have all been undoubted wool-aliens. However, the Walmer plant is more likely to have originated from a seed carried by wind from Calais, 40km to the southeast, where it is abundantly naturalized. Similar dispersal from established colonies in north-eastern Belgium is considered responsible for numerous widely scattered plants in the Rhineland, further east (see GERSTBERGER, P. (1978). *Decheniana*, **131**: 136–138). A colony recently discovered near Ghent (see ROBBRECHT, E. (1977). *Dumortiera*, **6**: 33–34) is perhaps derived from the one at Calais 130km to the west. The species may therefore be expected to become naturalized in Kent.

R. M. BURTON

BARDSEY – AN ISLAND FLORA

Maps of species locations on Bardsey island, Caerns., v.c. 49, and, for comparison, the Lleyn peninsula, Caerns., and their British distributions, were exhibited. Rare species include *Lathyrus japonicus* and *Ranunculus parviflorus*, unknown or scarce elsewhere in Wales, and *Trifolium subterraneum* and *Juncus acutus*, both near their northern British limits. Other restricted species are *Limonium binervosum, Thalictrum minus, Schoenus nigricans, Spiranthes spiralis* and *Hymenophyllum wilsonii*. Trees and shrubs are sparse on Bardsey and mostly introduced. *Prunus spinosa* is a rare cliff-plant. *Geranium robertianum* and *Hedera helix* are restricted to the mountain, and *Silene dioica* and *Oenanthe crocata* to single sites. Changing land-use accounts for the rarity of many arable weeds (e.g. *Spergula arvensis* and *Polygonum persicaria*) but *Lamium amplexicaule* and *Coronopus didymus* are frequent in gardens, although *C. squamatus* is rare. Herbal and medicinal species are conspicuous, including *Conium maculatum, Artemisia absinthium, Ballota nigra, Inula helenium* and *Malva sylvestris*, perhaps of ancient monastic cultivation.

A. P. CONOLLY

THE CAMBRIDGE UNIVERSITY BOTANIC GARDEN CONSERVATION SECTION

The Conservation Section of the Cambridge University Botanic Garden started in 1974, when a contract with the Nature Conservancy Council allowed for the appointment of a conservation propagator. The section is housed in the private research area of the Garden, but is responsible for the displays of British plants in the public Ecological Area. The primary responsibility of the section is to keep stocks of those perennial species which are nationally rare and still growing wild in eastern England. These stocks are available for research and education, and provide a reserve for any eventual re-introduction which may be necessary if a species becomes extinct. The existence of the living collection reduces the pressure on the surviving wild populations, since for many research purposes, guaranteed cloned material of known wild origin is perfectly adequate.

D. Donald & S. M. Walters

DESCHAMPSIA DANTHONIOIDES (TRIN.) MUNRO EX. BENTH. IN BEDFORDSHIRE AND BUCKINGHAMSHIRE

This north-western American annual was recorded by Miss K. M. Hollick from Derbys., v.c. 57, in 1977, and found in the same year at Woburn, Beds., v.c. 30. It could not be found at either station in 1978. However, it was found in 1978 at an additional site in Beds. and in two sites in Bucks., v.c. 24. In all cases there was sowing or re-seeding with grass-seed (in the Beds. and Bucks. stations on golf-courses) supplied by Mommersteeg International Seed Company. *D. danthonioides* is a rare impurity in the grass-seed and, being an annual, is not likely to persist and become a regular member of the British flora. A specimen, maps and Miss Hollick's original drawing were exhibited.

C. M. Dony

MARITIME SPECIES IN BEDFORDSHIRE

A map was exhibited showing that *Puccinellia distans* (L.) Parl. is now present on the verges of the A1 trunk road in Beds., v.c. 30, for a distance of 20km, the nearest distance to the coast being 100km. Salt has been used to de-ice this stretch of road since 1950. Another map showed *Cerastium diffusum* L. to be still widespread on railways now in use in Beds., having been observed on the whole of the railway system in the war years when the permanent way was not regularly maintained. The railways came to Beds. between 1837 and 1868. *Cochlearia danica* L. was found to be frequent on the railway between 1945 and 1950, but has subsequently disappeared.

C. M. Dony & J. G. Dony

OENOTHERA L. IN WALES

Following a visit to Britain by Dr Krzysztof Rostański, the European expert on the genus *Oenothera* L., it is known that ten species and two hybrids of *Oenothera* have been found in Wales. Specimens of all these were exhibited, with descriptions and notes on their distribution in Wales. A key to the British species of *Oenothera* was also shown.

G. Ellis

WATERCOLOUR PAINTINGS OF GARDEN WEEDS

The original watercolours for the *Amateur Gardening* (June, 1978) weed guides were exhibited. There are 54 pictures in all of the commonest garden weeds. On the reverse of each printed weed guide there are full details of the appearance, habitat and general characteristics of each weed, and measures for eradication.

B. Everard

RECORDING THE FLORA OF CUMBRIA

The exhibit described the progress made during the first five years of a ten-year recording programme. A map showed the distribution of the 1050 tetrads so far started, together with an indication of the number of species recorded from each. Species shown included rarities such as *Carex aquatilis* and *Eleocharis austriaca*, and naturalized species such as the handsome Mediterranean pea *Lathyrus grandiflorus*.

G. HALLIDAY

LACTUCA SALIGNA L. AND *PULICARIA VULGARIS* GAERTN. IN BRITAIN

The ecology of some rare species, particularly *Lactuca saligna* L. and *Pulicaria vulgaris* Gaertn., is the subject of research being carried out at Queen Mary College, University of London. *L. saligna* is mainly confined to sea-walls in the Thames Estuary, although old records indicate that it was previously found in a wider range of habitats. The New Forest contains the main sites of *P. vulgaris* in western Europe. Although it seems to have always been a rare plant, it was previously found in many places in south-eastern England and the Severn Valley. Suitable habitats for both plants appear to be widespread and the reasons for their current very localized occurrences are being investigated. The exhibit featured maps of the past and present distribution of both species, photographs, and information on the research project, including ways in which B.S.B.I. members could help.

A. D. R. HARE & S. D. PRINCE

ORIGINAL FLOWER DRAWINGS BASED ON DISSECTIONS OF LIVING SPECIMENS

The exhibit showed a selection from a total of 111 plants which have been illustrated as examples for 100 selected flowering plant families. Each drawing illustrates a dissection of an individual flower which has been taken from fresh specimens and without any influence by, or reference to, past drawings or diagrams. Checking is only carried out after the drawings have been completed. Each portion of the flower has been carefully measured and recorded. The drawings are to be used as book illustrations for a Cambridge University Press publication, on flowering plant families, by the artist and Clive King, Assistant Taxonomist and Librarian of the Cambridge University Botanic Garden. The Director of the Garden, Dr S. M. Walters, has acted as advisor on the project.

M. HICKEY

A GUIDE TO THE IDENTIFICATION OF SPECIES OF *RANUNCULUS* L. SUBGENUS *BATRACHIUM*

A new tabular key to water buttercups was presented with an exhibit based on the use of photocopying actual plants as an aid in identification. A tabular key is particularly useful for species exhibiting great morphological plasticity. Often identification must be based on a large number of characters together and a subsequent process of elimination. It is preferable to group together species with similar characteristics to facilitate ease of comparison. Silhouettes of all ten British species and one extra variety were displayed together with descriptions of each.

N. T. H. HOLMES

A PRACTICAL LOOK AT THE NORTH-WEST EUROPEAN POLLEN FLORA

In 1975 the Pollen Section in the Botany Department, British Museum (Natural History) and colleagues at the State University, Utrecht, Netherlands, began work on the *Northwest European pollen*

Flora. Individual accounts, consisting of detailed pollen descriptions, keys and micrographs of each family, appear initially in the *Review of Palaeobotany and Palynology* and are later collected into volumes. Volume 1 has been published. An explanation of the techniques used in the preparation of the *pollen Flora* was exhibited together with microscope slides, light micrographs and scanning electron micrographs.

M. R. Jones

THE ULTRAVIOLET COLOURS AND PATTERNS OF FLOWERS

Matched pairs of ultraviolet and colour or full-spectrum monochrome photographs of the flowers of 19 species were exhibited. The photographs included examples of most major types of UV colour and pattern, as follows:

a) Yellow flowers in which the central parts (usually the inner petal lamina, stamens and gynoecium) are UV-absorbing (insect-red) and the outer parts are UV-reflecting (insect-purple). *Blackstonia perfoliata, Caltha palustris, Leontodon hispidus* and *Potentilla anserina* show no visible differentiation of the petal lamina corresponding with the UV pattern, but in *Ranunculus acris* (inner petal dull yellow) and *Rhynchosinapis cheiranthos* (inner petal white) the UV-absorbing parts are differentiated.
b) Yellow flowers which are wholly UV-absorbing (insect-red). Examples are *Diplotaxis tenuifolia, Lysimachia nummularia* and *Potentilla fruticosa.*
c) White or mainly white flowers or inflorescences which are wholly UV-absorbing (insect-yellow) including any areas of other colours (e.g. yellow stamens or petal bases) which may occur. *Calystegia silvatica, Crocus sieberi* var. *sieberi, Potentilla rupestris, Silene alba, Trifolium uniflorum* and *Arum creticum* are in this category.
d) White flowers which reflect UV strongly (insect-white). This is a rare type, exemplified by *Bryonia dioica*, in which the white outer lamina reflects UV strongly and the visible pattern coincides with the UV pattern.
e) Flowers with anthocyanin colouration in which the visible markings of petal bases and veins generally coincide with the UV markings. *Geranium sanguineum* and *Malva sylvestris* are examples.

See also Short Notes, pp. 339–340.

Q. O. N. Kay

CHENOPODIUM BOTRYODES SM. IN W. KENT

Chenopodium botryodes Sm. appears to be confined almost entirely to the Thames estuary. A small colony disappeared from a site near Faversham, W. Kent, v.c. 15, where it had long been known, during 1977. On the night of 11th January, 1978, a severe storm swept the north coast of Kent. The seawalls were breached and there was widespread flooding of the marshlands. A line of mud, rubble, flotsam and clumps of vegetation was left behind the breached seawall when the floodwaters receded. Eight months later, a colony of *C. botryodes* was found on mud, among the debris flung inland, some four miles west of its former site. Seed may well have travelled with the stormwaters.

W. M. Keens

FRAGARIA MOSCHATA DUCHESNE AND OTHER STRAWBERRIES

The exhibit comprised herbarium sheets and living plants of a number of strawberries: 1. A comparison of *F. moschata* Duchesne and *F. vesca* L. 2. A selection of varieties of *F. vesca*. 3. *F. viridis* L. and *F. vesca* × *F. viridis*. 4. The garden strawberry, *F.* × *ananassa* Duchesne, and its parents. A key was provided to the species and hybrids exhibited.

A. C. Leslie & J. F. Leslie

SOME OBSERVATIONS ON *OXALIS* L.

The exhibit illustrated several species of *Oxalis* L. native in the Americas and S. Africa, now established as weeds in the British Isles. The importance of heterostyly for seed production in the rhizomatous species *O. articulata* Savigny was emphasized. In sect. *Ionoxalis*, the often profuse production of bulbils compensates for the absence of capsules. The number of nerves per bulb scale was shown to be an important taxonomic character. A species new to the British Isles, thought to be *O. bulbifera* R. Knuth, was also displayed.

R. P. LIBBEY

THE FLORA OF THE AVON GORGE

The Avon Gorge is well known for its rare and local plants. Its flora was illustrated with photographs, herbarium specimens and live plants, raised from seed.

Sir Joseph Banks was one of the many famous botanists who visited the Gorge and a photocopy of his manuscript Journal describing his visit in 1767 was displayed. The manuscripts of J. W. White's *Flora of the Bristol coalfield* (1881–1886) and *The flora of Bristol* (1912) have been discovered in Bristol University, and extracts concerning *Allium sphaerocephalon* L. were shown.

A series of photographs illustrated the recent development of scrub and woodland in Walcombe Slade, which has reduced the area occupied by some of the rare plants, such as *Carex humilis* Leyss.

A card index of historical records was shown, which will form the basis of a Historical Flora of the Avon Gorge.

C. M. LOVATT

DABOECIA CANTABRICA (HUDS.) C. KOCH WITH A SPLIT COROLLA

Specimens of *Daboecia cantabrica* (Huds.) C. Koch with all their corollas split into four equal segments were exhibited. They stemmed from the original plant, now called 'Covadonga', which was found at a place of that name in northern Spain in July, 1973, by Mr T. Underhill of Dartington. Analagous forms, including var. *schizopetala* of *Erica cinerea, Kalmia latifolia* var. *polypetala, Convolvulus arvensis* var. *stonestreetii, Calystegia sepium* f. *schizopetala* and *E. tetralix* var. *fissa*, were commented upon.

D. MCCLINTOCK

SAXIFRAGA HYPNOIDES L. AND *S. ROSACEA* MOENCH IN BRITAIN

Saxifraga hypnoides L. in the British Isles is a plant of upland districts in the north and west, mostly on wet, calcareous sites. The species has two chromosome races: plants from western Ireland and Wales are diploid ($2n = 26$), while plants from northern England and Scotland are tetraploid ($2n = 52$). The two cytotypes are not always morphologically distinct and both have a similar range of growth-forms and habitats in the wild. It is to be hoped that further work will show consistent morphological differences that can be used by field botanists. Living plants of both cytotypes were exhibited.

S. rosacea Moench in the British Isles is centred on western Ireland with an outlying station in North Wales – a population rediscovered this year after 80 years. In Manchester Museum Herbarium there is a specimen of *S. rosacea* collected by Druce in 1883 from Glen Doll, Forfar, v.c. 90, that was the first record of the species for Scotland. It would be of great interest to refind the species in Glen Doll. Living plants of *S. rosacea* and *S. cespitosa* L. were exhibited with the Druce herbarium specimen to show how *S. rosacea* differs from other dactyloid (mossy) saxifrages.

D. M. PARKER

FUTURE MAP-MAKING AT THE BIOLOGICAL RECORDS CENTRE

The exhibit demonstrated new types of map which will be made either on the 'geagraph' plotter at the Experimental Cartography Unit of the Natural Environment Research Council or on the FR80 microfilm recorder at the Rutherford Laboratory of the Science Research Council. Both will provide a faster and more visually satisfactory product than hitherto. A *Provisional atlas of the bryophytes of the British Isles* plotted by the Experimental Cartography Unit was displayed.

F. H. PERRING

AN APPEAL TO ENSURE THE FUTURE OF *LATHYRUS PALUSTRIS* L. IN WALES

Since its discovery in 1971, the only known Welsh site of *Lathyrus palustris* L. has been threatened by over-grazing, drainage and industrial development. The site, near Pembrey, Carms., v.c. 44, also supports *Ornithopus perpusillus, Oenanthe fistulosa, Menyanthes trifoliata, Hydrocharis morsus-ranae* and *Scirpus fluitans*, all of which are locally rare plants. Attempts to purchase the fen with its associated drainage ditches and low dune ridges have to date been frustrated, but recently the owner agreed to sell about 3 acres of the area. The Llanelli Naturalists' Society has launched an appeal for the £3,000 required for the purchase and subsequent management of the proposed reserve. To date more than £1,500 has been raised.

The location of the site and an account of its flora were displayed, together with appeal material, and donations were gratefully received from B.S.B.I. members.

R. D. PRYCE

THE GUERNSEY BAILIWICK, 1978

Specimens of new records for the islands were exhibited:

GUERNSEY: *Scorpiurus muricatus, Sedum hybridum, Cotula coronopifolia, Dipsacus fullonum* subsp. *sativus, Populus nigra, Glyceria maxima,* and the first record since 1928 of *Scandix pecten-veneris.*

SARK: *Diplotaxis tenuifolia, Rorippa × sterilis, Ulmus laevis, Arctotis stoechadifolia, Carex sylvatica,* and the second record after 50 years of *Glyceria declinata.*

P. RYAN

THE CYTOLOGY OF *HYDRILLA VERTICILLATA* (L. FIL.) ROYLE

Plants of *Hydrilla verticillata sensu lato* from two widely separated areas, Renvyle, Galway, v.c. H16, and Suwalki, Poland, were found to be diploid with $2n = 16$ chromosomes. The morphology of the chromosomes was studied in conjunction with those of *Elodea nuttallii* (Planchon) St John, now spreading in Britain and Europe. *E. nuttallii* has $2n = 48$ chromosomes.

M. J. P. SCANNELL & R. CZAPIK

S. ROSAMOND PRAEGER (1867–1954)

S. Rosamond Praeger was born in Hollywood, Co. Down, Ireland. She studied art in Belfast and at the Slade, London. She is best known for her studies, in stone, of children, but plant studies to illustrate works by her brother, Robert Lloyd Praeger, were published in *Weeds* (1913) and in *Open air studies in botany* (1897). The originals are in the archives of the Herbarium (**DBN**), National Botanic Gardens, Glasnevin, Dublin.

M. J. P. SCANNELL

MIMULUS L. IN BRITAIN

Photographs were displayed of species and hybrids of *Mimulus* L. which occur in naturalized populations in Britain, together with herbarium material and a provisional key to the taxa concerned. A distinctive taxon of horticultural origin, well naturalized in central and northern Scotland, is *M. guttatus* DC. × *M. variegatus* Lodd. However, *M. variegatus* is not itself known to be naturalized in Scotland.

A. J. SILVERSIDE

THE PROBLEM OF *ELODEA* MICHX

The recent appearance of longer and narrower-leaved plants of *Elodea* Michx has raised problems concerning the genus in Britain and Europe. Records of such plants go back to 1914, when Pearsall found 'an elongate form of *Elodea canadensis*' in Esthwaite Water, Furness, v.c. 69b. These long-leaved plants have since been identified as *E. nuttallii* (Planchon) St John. However, they may be more closely related to *E. ernstiae* St John, or even to *Hydrilla verticillata* (L. fil.) Royle. Herbarium specimens were exhibited to illustrate this possibility. The long-leaved plant appears to be spreading rapidly and a taxonomic and ecological study of the plant is currently being undertaken at Lancaster University.

D. A. SIMPSON

GETTING TO GRIPS WITH THE UMBELLIFERAE

The exhibit presented a progress report on the fourth year of a study of the Umbelliferae in Europe. Live specimens of over 30 species were exhibited, together with herbarium specimens and colour transparencies. Means of germinating and sustaining southerly species in a cold climate without expensive heating were discussed. Classification and identification using cotyledons and fruits were illustrated. Rapid progress in the next four seasons appears to depend on finding further Continental locations rich in Umbelliferae species.

M. J. SOUTHAM

RECORDS AND DRAWINGS OF PLANTS FROM SCOTLAND

Specimens of species of *Atriplex* L., including hybrids, from Kirkcudbright, v.c. 73, were exhibited. Two other records were *Trifolium aureum* from E. Ross, v.c. 106, and *Crassula helmsii* new to Moray, v.c. 95.

Drawings of flowers to illustrate Miss M. McC. Webster's *Flora of Moray, Nairn and East Inverness* by Mrs O. M. Stewart were shown, and also various watercolours of roses and alien grasses.

O. M. STEWART & M. McC. WEBSTER

EXPERIMENTAL HYBRIDS IN THE GENUS *ATRIPLEX* L.

During 1977–78 the following diploid hybrids were synthesized at Manchester: *Atriplex littoralis* L. (female parent) × *A. praecox* L. (pollen parent), and *A. littoralis* (female parent) × *A. longipes* L. (pollen parent). Several seedlings of the F_1 hybrid *A. littoralis* × *A. longipes* were treated with colchicine to induce chromosome doubling, to test the hypothesis that the widespread tetraploid species, *A. patula* L., originated from this diploid hybrid. Pollen fertility in the F_1 hybrid plants varied from 20–60% stainable grains. The grain size within each individual was extremely irregular. In the colchicine-treated plants pollen fertility varied from 80–100% stainable grains, a range equal to that of the parent species. Most of the grains were about the same size. All the plants set plenty of well-formed seed. Herbarium specimens of the hybrid plants and the parent species were displayed. The colchicine-induced allopolyploid was represented by a second-generation living potted plant in flower. None of these hybrids have been found in nature and this is the first report of their artificial synthesis. The attempt to synthesize *A. patula* produced plants vaguely similar to this species but different in many morphological characters. Such plants would never be identified as *A. patula* if found in nature, and further work will be done to test the ability of *A. patula* to cross with this synthetic species.

P. M. TASCHEREAU

THE AQUATIC FLORA OF LLYN GWYNANT, CAERNS.

During a recent survey of the aquatic flora of Llyn Gwynant, Caerns., v.c. 49, underwater photographs were taken of some of the submerged species, such as *Isoetes lacustris, Littorella uniflora, Juncus bulbosus* and *Callitriche hamulata*. The photographs show such features as the growth form of the species, extent of stands, and epiphytic algal growth. The survey was carried out in conjunction with the Loughborough Underwater Research Unit.

P. M. WADE

EPILOBIUM LANCEOLATUM SEB. & MAURI – A PLANT TO LOOK FOR IN YOUR GARDEN

Epilobium lanceolatum Seb. & Mauri is a willow-herb apparently confined, until recent years, to the south of England. Since 1930, however, numerous records north of the Thames and Severn have greatly enlarged its known British distribution. Many of these more recent records, such as the first record for Cambs., v.c. 29, in 1953, are on disturbed ground, and seem to indicate small populations of recent origin.

In June 1978 I recorded the species, previously apparently unknown in Ireland, as a weed in the garden of Prof. D. A. Webb's house in Oughrim, Wicklow, v.c. H20, together with *E. montanum* L., *E. obscurum* Schreb. and *E. adenocaulon* Hausskn. The latter was also seen in a nearby nursery from which garden plants had from time to time been bought by Prof. Webb. It seems likely that both *E. adenocaulon* and *E. lanceolatum* were derived via nurseries and with garden plants from English sources.

It would be very interesting to have more records for *E. lanceolatum*, which is not difficult to recognize. It is the only sub-glabrous willow-herb with a four-cleft stigma and clearly petiolate, elliptic-lanceolate lower leaves with cuneate bases. The likely confusion is with small forms of *E. montanum*, but with a little practice even these two species can be distinguished quite easily. The character given in the *Flora of the British Isles* of having all the upper leaves alternate is not reliable to distinguish *E. lanceolatum* from *E. montanum*, and seems to apply only to well-grown specimens.

S. M. WALTERS

A VARIANT OF *DACTYLORHIZA FUCHSII* (DRUCE) SOÓ IN N. LINCS.

A variant of *Dactylorhiza fuchsii* (Druce) Soó was discovered by I. Weston on a drain bank between Belton and Crowle, N. Lincs., v.c. 54, in 1975. Four plants were seen distributed over a length of about 200 yards. Many hundreds of plants of typical *D. fuchsii* were growing on the side of the drain. The variant has been seen each year since 1975. Five plants were recorded in 1978, but one of these was subsequently, unwittingly destroyed by fishermen. The variant has dark purple leaves and stems. The labellum is unmarked and is of a very dark rich purple with a velvety texture. The other perianth parts are pale pink. The coloration is striking and can be picked out at a distance. The new form appears to have a high overall anthocyanin content. Nothing similar has been found in the literature. No specimen was taken as there are now only four such plants in the area.

The exhibit featured a series of photographs of the plants taken in 1977 and 1978 by Mr & Mrs G. L. Phillips and the exhibitor.

I. WESTON

A *NOTHOFAGUS* HERBARIUM

Foliage specimens of all species of *Nothofagus* Blume (except *N. moorei*) now represented in the British Isles were exhibited. For a full account of this exhibit see Short Notes, pp. 344–345.

D. L. WIGSTON

The following also exhibited:

K. J. ADAMS & P. J. WANSTALL. An introduced *Lemna* in Essex?
E. J. CLEMENT. More adventive news.
E. R. T. CONACHER & P. MACPHERSON. *Coriandrum sativum* L. in Glasgow.
R. W. DAVID. (a) The distribution of *Carex humilis* Leyss. in Britain.
(b) Another British station for *Carex muricata* L. *sensu stricto*.
C. M. DONY. Officers of the B.S.B.I. 1947–1978.
J. M. EDMONDS. B.S.B.I. Black Nightshade Survey.
A. N. GIBBY. Postage stamps of botanical interest.
A. P. HAMILTON. Which helleborine?
T. HINITT. Wild flowers in close-up.
D. W. JEFFREY & W. WALSH. Ireland's first floral stamps.
A. J. SILVERSIDE. *Pulmonaria rubra* Schott naturalized in Scotland
ST CHRISTOPHER'S SCHOOL, BURNHAM-ON-SEA. Operation orchid.

In the lecture hall the following members gave short talks illustrated by colour slides:

C. J. DOYLE. Why herbaria?–a camera can take a closer look.
L. FARRELL. Recent research on the Military Orchid.
J. L. MASON. Water-weeds.
E. MILNE-REDHEAD. Fox fritillary meadow, Framsden.
L. H. PINKESS. Some plant galls found within the City of Birmingham.
R. D. PRYCE. *Muscari comosum*–naturalized at Pembrey, Dyfed.
J. REED. Ohio plants through the seasons.
A. G. SIDE. Plants of Tenerife.
R. C. STERN. B.S.B.I. meetings in Skye and Barra, 1978.

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's *British herbaria*. Line drawings should be in Indian ink, preferably on good quality white card, but blue-lined graph paper or tracing paper is acceptable. 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 Lettraset 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. Manuscripts will be scrutinized by the editors and a referee and a decision communicated as soon as possible. Authors receive a galley proof for checking, but only errors of typography or fact may be corrected. 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 C. A. Stace, Botanical Laboratories, Adrian Building, The University of Leicester, LE1 7RH. Books for review should be sent to Dr N. K. B. Robson, Dept. of Botany, British Museum (Natural History), Cromwell Road, London, SW7 5BD. Plant records should be sent to the appropriate vice-county recorders.

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