BOTANICAL SOCIETY OF THE BRITISH ISLES

WELSH REGION BULLETIN

Editor: T.A.W.Davis

No. 13 JULY, 1970 Price: One Shilling

Contents

Annual General Meeting:
Programme and Agenda 1

Photographic Competition 3

The Calcifuge-Calcicole Concept:
a Botanical Approach 4

Geological-Pedalogical Aspects of
the Calcifuge-Calcicole Concept 12

Review: A List of the Flowering Plants
and Ferns of Carmarthenshire 17

Cardiff, July, 1970

ANNUAL GENERAL MEETING OF THE WELSH REGION, BOTANICAL SOCIETY of the BRITISH ISLES, to be held at GREGYNOG HALL near NEWTOWN, MONTGOMERYSHIRE on Saturday 3rd October 1970.

PROGRAMME

10.45	Coffee
11.00-11.40	Talk by Dr. Peter Moore, B.Sc., Ph.D., of the Dept. of Botany, King's College, London, on the light thrown on recorded history by Palynology.
11.40	Discussion
12.00-12.40	Talk by Dr. Franklyn Perring, M.A., Ph.D., F.L.S., of the Biological Records Centre, Monkswood Experimental Station, on some aspects of conservation in 1970.
12.40	Discussion
13.00	Lunch
14.00	Meeting of the Welsh Region Committee
14.30	Talk by Mr. J.M.L.Zeremayr, Conservator of Forests, South Wales, on Forestry and Conservation.
15.15	Discussion
15.30	Tea
16.30	Annual General Meeting (Agenda over)
18.30	Dinner
19.30	Photographic Competition (Rules and details over). Discussion on the proposals for the development of the Montgomery Canal in the light of Conservation.

Sunday October 4th : Field Meeting.

Meet outside Gregynog Hall at 11.00 to visit the areas of the Montgomeryshire Canal recommended for conservation following the survey of the canal by the Field Meeting on July 4th. Bring lunch and Wellingtons. Members are asked to book early for this meeting as the difficulty of parking in narrow lanes may make it necessary to hire a mini bus to avoid obstructing the highway.

Accommodation at Gregynog Hall is limited and members are requested to book early, otherwise it may not be available.

AGENDA for the ANNUAL GENERAL MEETING

1. Chairman's Address

2. Hon. Secretary's Report

3. Election of members to serve on the Welsh Region Committee. The following members retire and offer themselves for re-election:-
Messrs. D.Davies., J.W.Donovan., S.G.Harrison.,
Dr. W.S.Lacey.
Other nominations are invited, proposed and seconded by members resident in Wales and with the written consent of the nominee: Nominations can be accepted at the meeting.

4. Election of a Regional Representative to serve on the Council of the B.S.B.I. for four years.
Nominations must be submitted to the Hon. Sec., B.S.B.I. two months before the A.G.M. Any two B.S.B.I. members resident in Wales may make a nomination which must have the written consent of the nominee. The Regional Representative is elected for four years. Council normally meets twice annually in London and once at the time of the A.G.M. which is held in different places. Representatives may claim a 2nd class return railway fare when attending Council meetings. Nominations should therefore reach the Hon. Sec., Welsh Region by the end of July.

WELSH REGION PHOTOGRAPHIC COMPETITION, 1970

The Photographic Competition is open to all members of the B.S.B.I. for photographs taken in Wales. There will be three classes. The Rules are :-

1. Classes:

   a) 35mm colour transparancy of a close up of part or the whole of a plant or group of plants.

   b) 10" x 8" black and white print of a close up of part or the whole of a plant or group of plants.

   c) 10" x 8" black and white print or a 35mm colour transparency of a habitat or plant association.

2. Photographs must have been taken in Wales.

3. The competition is confined to B.S.B.I. members.

4. The winner of each class will receive a New Naturalist book of his/her own choice.

5. Entries will be judged on their botanical, photographical and topographical merits as well as their suitability for reproduction in a New Naturalist book.

6. The Welsh Region reserves the right to publish blocks obtained from suitable entries should a book on Plant Distribution in Wales be produced by the Welsh Region. Due acknowledgement will be made and the owners of photographs will retain their copyright and will be eligible for royalties.

7. Entries should be submitted with a completed entry form (enclosed) to the Hon. Sec., Welsh Region to reach her not later than 30th September, or they may be handed to her immediately after the A.G.M.

The Calcifuge-Calcicole Concept; a Botanical approach.

by

Dr. William J. Lacey

Foreword

In 1968 our Meetings Secretary asked me for ideas on a theme for the Annual General Meeting to be held in Bangor in September 1969. When I suggested "The Calcifuge-Calcicole Concept" and agreed to introduce the subject by reference to a few selected species, illustrated with colour transparencies, I hardly expected to be asked later to produce for publication an article on my personal reminiscences and modest musings.

But here it is, very rapidly prepared, because during the talk I had but a list of headings for my guidance and pressure of other work since has prevented me from preparing a respectable manuscript; and given in the first person singular because it was, indeed, a statement of personal experience over more than forty years of interest in plants and because such a style may serve to remind those who were present of a very pleasant weekend meeting.

Introduction: a biographical background

I owe my interest in Botany to both of my parents; to my mother, who was a teacher in the village school and an artist of modest ability, a love of flowers as things of beauty; to my father, a nurseryman and fruitgrower by force of circumstance (but not by inclination), an interest in the conditions that control the growth of plants.

Up to the age of eighteen I lived on the southwestern edge of the Charnwood Forest in Leicestershire; the familiar childhood surroundings were the heather and bilberry-clad hills, formed of hard acidic Pre-Cambrian rocks, that form this delectable part of Central England.

In 1920 my father bought a car and the family often took trips to visit relatives in the Melton Mowbray area of East Leicestershire, on what I now know to be Liassic beds. Often also we took picnics in the country to the west and northwest, on Breedon-on-the-Hill, or, more daring, in the Derbyshire Dales, both familiar to me now as areas of Carboniferous Limestone. In these areas to east and west I met a flora different from that at home and joyed in my first discovery of orchids, only Early Purple Orchid (Orchis mascula) as I realise now, but at the time just as exciting to me as my first find of Sword-leaved Helleborine (Cephalanthera longifolia) in North Wales many years later.

At the Wyggeston Grammar School in Leicester I had a Classical education and did not study Biology until the age of sixteen. From that age my mentor in Biology - and namesake, but no relation - was a late Sizar of St. John's College, Cambridge and primarily a zoologist. He was a good biologist, indeed, but I suspect that his real interests lay in the order (1) small-scale working model railways (which he constructed himself with great skill and superb craftsmanship), (2) zoology, and finally (3) botany. At any rate, we had no botanical field classes and the differences between the vegetation of acid and of limestone soils, which I had seen even as a child in the Elementary School, but not understood, were not specially covered in our London Higher School Certificate courses.

In due course I became a Botany student in the University of Reading and there met the terms 'calcifuge', 'calciphobe', 'calcicole' and 'calciphile' for the first time. And at this point it is appropriate to define the meaning of these terms, as generally understood, by quoting from a selection of well-known publications. The terms will also be exemplified by reference to a selection of commonly-quoted plant species and by reference to soil Hydrogen ion concentration or 'pH'.

Some published definitions

1. From "Wild Flowers of Chalk and Limestone" by J.E. Lousley (Collins):

   Calcifuge - "plants which avoid lime"
   Calcicole - "those plants which show not only the positive characteristics of thriving on calcareous soils but also the negative attribute of avoiding soils deficient in lime"

I do not myself like the use of the word "avoid" in these two definitions, as it would seem to imply some active process on the part of a plant to move into or out of an environment, as an animal might. Lousley himself suggests that probably a better definition would be one given earlier by Hope Simpson.

2. J.F. Hope Simpson, 1938, in Journal of Ecology.

   "Calcicoles are regarded as species affecting the more important types of calcareous soils and rare or absent from acid soils and calcifuges are the reverse"

3. From "A Dictionary of Biology" by M. Abercrombie, C.J. Hickman, and M.L. Johnson (Penguin Books):

"Calcifuge - (of plants) growing best on acid soils, e.g. sheep's sorrel"
"Calcicole - (of plants) growing best on calcareous soils, e.g. salad burnet"
"Calciphobe" and "calciphile" are rather less commonly used alternative terms for "calcifuge" and "calcicole" respectively.

In his book "Mountains and Moorlands", (Collins, 1950) the late Professor Pearsall gives a detailed account of acid and lime-rich soils and adopts the following classification:

a. lime-saturated. pH above 6.0

b. lime-deficient.

c. base-deficient, iron oxide becoming mobile and relatively more important than lime.

d. acid, with podsolic profile in stable soils; often marked by peat accumulation. pH below 3.8.

In this scheme category b. and c. are often classed as "Brown Earths" and what are called "Natural Soils" are those about half-saturated with bases and with a pH of about 5.0.

Species lists

At this point I illustrated with colour transparencies the following selected species, which, in my experience in various parts of the British Isles, appear to be reliable 'indicators' or characteristic species at the extreme ends of the calcifuge - calcicole range.

Calcifuge (pH about 3.5 - 4.5, less than 3.8, Pearsall)	Calcicole (pH about 6.0 - 7.5)
Erica tetralix	in dry habitats
Erica cinerea	Clematis vitalba
Calluna vulgaris	Helianthemum chamaecistus
Vaccinium myrtillus	Geranium sanguineum
Narthecium ossifragum	Poterium sanguisorba
Gentiana pneumonanthe	Veronica spicata ssp. hybrida
Rhynchospora alba	Carlina vulgaris
Drosera rotundifolia	Neckera crispa
Blechnum spicant	Ctenidium molluscum
Polytrichum commune	in wetlands
Leucobryum glaucum	Cladium mariscus
Sphagnum (most, but not all species)	Schoenus nigricans
	Juncus subnodulosus

Doubtless other species could be added to these lists.

Many plants, of course, clearly have a wide range of tolerance and can be found growing successfully on soils with a wide range of pH. Two such, a little surprising when one first meets them, are the Harebell (Campanula rotundifolia) and Wood Sage (Teucrium scorodonia), both as much at home, it seems, on the Chalk Downs of Southern England as on heather-clad hills in North Wales.

The Seeds of Doubt

After the Second World War, when I took up my first biology teaching post in 1944 at the Wigan and District Mining and Technical College, I perpetuated uncritically the ideas about calcifuges and calcicoles gained at Reading and summarised by the lists given above. Indeed, I drew freely from the examples given in Wheldon and Wilson's "Flora of West Lancashire" (1907) to illustrate my lectures. (Although I admit to being somewhat uncritical in those days, I do claim as one redeeming feature of my short sojourn in Wigan the fact that I introduced field classes and excursions as part of the botany teaching, unknown in Wigan until then and, indeed, not a common practice in Technical Colleges anywhere at that time).

And then in 1946 I came to Bangor and met Norman Woodhead, who sowed the "seeds of doubt"! He did not believe, he told me, in the generally-accepted separation of calcifuge and calcicole plants. He had many times seen, both in Britain and on the Continent, so-called calcifuge plants growing in the "wrong place" according to the text-book, but no matter what the book might say, for him "the plant is always right".

I might have believed Woodhead more readily on the calcifuge-calcicole question if he had not also stoutly maintained that chromosomes do not exist (except as an artefact produced by man), but that is another topic which I must not become involved with here. But Woodhead's dictum that "the plant is always right", familiar to very many former Bangor students of Botany does merit attention.

Let us consider a few selected examples, drawn from various parts of Britain and known personally to me, where the concept appears to break down, as Woodhead might claim that it does, and see what explanation we can find, if any, in each case.

Some Examples of Mixed Calcifuge-Calcicole Floras

(in the following list examples from Wales and from Eire were illustrated by means of colour transparencies)

England

1. Derbyshire Dales In a number of localities bracken covers the plateaux to either side of the water-worn gorges and narrow valleys in the Carboniferous Limestone.

2. Mendips Similar situations may be found in localities on the Carboniferous Limestone south of Bristol, where, for example, Salad Burnet (Poterium sanguisorba) can be found growing vigorously through heather.

3. Box Hill, Surrey Heather and bracken occur on Juniper Top. above the Chalk grassland.

4. Kingley Vale, Sussex Similarly, heath vegetation can be found growing on the top of the South Downs in this area.

Wales

5. Llanddwyn Island, Anglesey Bloody Cranesbill (Geranium sanguineum) flourishes on the landward side of this rocky Pre-Cambrian outcrop, which elsewhere on the island supports a heath flora.

6. Cors Goch Escarpment, Anglesey and

7. Bwrdd Arthur, Anglesey both carry in places an intimate mixture of such species as Erica cinerea, Ulex gallii, Molinia caerulea, Poterium sanguisorba, Helianthemum chamaecistus, Carlina vulgaris, Leucobryum glaucum, Ctenidium molluscum, Neckera crispa.

8. Breidden Hill, Montgomeryshire Geranium sanguineum, Helianthemum chamaecistus, Veronica spicata, Potentilla rupestris, Lychnis viscaria grow mixed with Erica cinerea on the steep faces of this massive igneous outcrop.

Eire

9. Upland bogs in County Mayo Not uncommonly Schoenus nigricans may be found flourishing and abundant, growing in intimate mixture with Erica tetralix, Erica cinerea, Eriophorum angustifolium, Drosera rotundifolia and Rhynchospora alba.

10. Achill Island Here Schoenus nigricans can be found growing with Erica tetralix at sea level on sandy soil of Pre-Cambrian origin.

11. Connemara, County Galway In several localities Cladium mariscus grows in pools in the peat bogs, whose surface vegetation includes Erica tetralix, Rhynchospora alba and Drosera intermedia.

Possible Explanations

Most of the examples of mixed calcifuge-calcicole floras cited above are susceptible of fairly straightforward explanation.

The situation in Derbyshire and in "limestone heaths" of the Mendips can be explained by the occurrence of a capping deposit of boulder clay or other glacially-derived material or of a leached soil overlying the limestone. Sometimes the capping layer bearing a heath vegetation is thin enough for such plants as Poterium sanguisorba to be rooted in more base-rich layers beneath. This is the situation on Mendip limestone heaths where, presumably, the Poterium sanguisorba, believed to be a lime-demanding species, spreads vegetatively in the lower layers of the soil and not by seed. Not only would any seed set have to germinate in the acid upper layers of the soil, but also young seedlings would have to compete in the early stages of their growth with a dense stand of heather.

Similar explanations apply on the North and South Downs, where the Chalk is capped locally by a layer known as "Clay-with-flints" derived by weathering of the Upper Chalk, and akin to glacial Boulder Clays in some of its properties.

On Llanddwyn Island Geranium sanguineum grows on banks of blown sand, rich in calcareous shell fragments.

On the escarpments of Cors Goch and Bwrdd Arthur the local geology provides some explanation as here the Lower Carboniferous rocks shew a rapid alternation of layers of limestone interleaved with layers of conglomerate and grit. It is thus possible to have typical heath vegetation and limestone grassland in close juxtaposition on dip slopes weathered to varying depths and to have an intimate mixture of representative species from the two contrasting types of vegetation on the escarpment slopes, where screes composed of both limestone and grit fragments provide a mosaic of soil microhabitats.

The Breidden Hill situation is probably also to be explained in a way similar to that suggested for the Anglesey examples. The calcite content is distributed unevenly through the dolerite and could provide a mosaic of soils, not only in niches in the solid rock outcrops but also on the scree slopes below. The ecology of this

fascinating area is currently being studied by C.A. Sinker and S.C. Jarvis from Preston Montford Field Centre.

Turning now to the occurrence of Schoenus nigricans in acid bogs in County Mayo and in relatively dry sandy situations at sea level in Achill Island, no such easy explanations in terms of different or soil types are forthcoming. Here recent work by Sparling (1962,1968) suggests that the anomalous position of the fen plant Schoenus nigricans can be explained to some degree by its extreme sensitivity to aluminium ions. Sparling suggests that S. nigricans is excluded from other ombrotrophic bogs in the British Isles by the presence of high concentrations of aluminium ions, a situation apparently not obtaining in the bogs of Western Ireland and Western Scotland. The source of the aluminium in ombrotrophic bogs is said to be from atmospheric dust particles and the western approaches with their prevailing westerly winds and higher humidity receive less dust than the rest of the British Isles. Thus the occurrence of S. nigricans in the bogs of Western Ireland and Scotland and its absence in such situations in Wales and in England is climatically controlled. This amounts to saying that Schoenus is not distributed solely in relation to the occurrence of calcareous soils and is clearly not controlled by a pH factor alone. Should I take the Black Bog Rush off my list of calcicoles?

Sparling's work would also appear to imply that where Schoenus nigricans does grow in those calcium-rich fens of Britain which could nevertheless receive a supply of air-derived aluminium ions, the calcium in some way inhibits the toxicity of the aluminium. This should be capable of fairly easy testing by an extension of Sparling's work, using added Ca ions in synthetic blanket bog water to which the lethal dose of Al ions was already added.

Before leaving Schoenus nigricans, it is worth noting in passing that this plant, said to be the same as the Northern Hemisphere species, grows in Rhodesia near the Zambesi River. I have myself seen it there growing in quantity in the vicinity of highly mineral-rich hot springs.

So far I have no explanation to offer for the occurrence of Saw Sedge (Cladium mariscus) in the acid-peat-fringed pools of Connemara bogs. I know of no published work on these occurrences. In his "Natural History of Ireland" Lloyd Praeger noted that Schoenus and Cladium "are not everywhere calcicole".

Conclusions

If we consider only the two extremes of low pH (acid) soils and high pH (base-rich or calcareous) soils, then I think that there may well be some species which will only flourish in such soils. For them the names "calcifuge" and "calcicole" appear to be justified. But we know that a large number of plant species tolerate a wide range of soil conditions, especially when this is coupled with different climatic conditions, and to them the calcifuge-calcicole concept does not readily apply.

The case of Schoenus nigricans, assuming Sparling's explanation to be the correct one, shows us that we must keep an open mind and not try to "compartmentalise" plant behaviour too much. If a plant grows in a particular area other than that expected from text-book knowledge or from previous experience elsewhere, and if it can be seen to grow well, to flourish, to flower, to set seed, to maintain itself and perhaps to spread, then we should remember Woodhead's dictum - "the plant is always right" - and be prepared to look for explanations other than or in addition to a simple calcifuge-calcicole concept.

References

"Wild Flowers of Chalk and Limestone" J.E.Lousley. Collins 1950.

"A Dictionary of Biology" M.Abercrombie, C.J.Hickman, M.L.Johnson. Penguin Books 1951.

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GEOLOGICAL-PEDOLOGICAL ASPECTS OF THE CALCIFUGE/ CALCICOLE CONCEPTS

by

Dr. D. F. Ball, The Nature Conservancy,
Bangor, Caernarvonshire

(Abridged version of a talk given to the Annual General Meeting of the Welsh Region, Botanical Society of British Isles at Bangor, 27.9.69)

Introduction.

Initially we can define the concept, although the definition is now known to be over-simplified, as stating that there are discrete groups of plant species particularly adapted to conditions of low soil calcium (calcifuges) and to conditions of high soil calcium (calcicoles). Dr. Lacey has just shown from his experience and the literature further attests, that such a division is not clear-cut but for ease of discussion, I will assume it as generally true. I intend to summarise the following considerations in the problem:

1) Relevant aspects of geology

2) Soil profile characteristics associated with extreme calcifuge and calcicole situations and with zones of complex association

3) Significant factors of soil chemistry.

Geological and Pedological Aspects.

1) The major geological consideration must be the chemical composition of the rock from which soils are formed and I am concentrating here on the simple case in which soils are formed directly on weathered rocks. It would be expected that a rock containing more calcium would give a more lime-rich soil of higher pH value (other soil-forming factors being equal) than would a rock of lower calcium content. However, the way in which the calcium is combined with other elements in the rock is important. Calcium can occur widely either in complex alumino-silicates or in carbonates, the rate of release of the element by weathering being generally much more rapid in the latter than in the former. Secondly, even if two rocks contain equal quantities of calcium in the same mineral form, one rock if it is massive and composed of closely interlocking crystals is much less susceptible to weathering than a more fissile or porous rock. Thus, although extreme "calcifuge" and "calcicole" rocks (e.g. quartzite and chalk) can readily be put into categories, there is a wide intermediate range of rock types and it is impossible to generalise that a specific level of calcium or of a particular calcium mineral will form and maintain a soil suitable for one or other group of plants.

2) In the consideration of soil profile characteristics, illustration by slides was used to assist discussion. Examples of extreme "calcifuge" soils include deep acid hill peat on the Snowdonian mountains and well-developed heath podzols on quartz sands in Dorset. At the other extreme, the typical "calcicole" soils include basic Fen peats and the shallow organic soils over chalk classifiable as rendzinas, illustrated from Hampshire and Sussex. Extremes in soil categories are perhaps less interesting ecologically than are the soil complexes of alternate greater and lesser lime richness in the surface horizons. These can result from complex geological origin in which variable thicknesses of non-calcareous material overlie a calcareous substratum, for example where relic or wind-blown deposits overlie chalk or where thin glacial drift overlies buried or partially exposed limestone pavement.

Due to the leaching caused by rainfall in Britain, soils can only remain lime-rich near the surface here if :-

a) Parent materials contain so little non-calcareous insoluble residue that no significant cover of leached material can accumulate, or alternatively that erosive processes continue to remove such accumulated residue as it accumulates;

b) Physiographic situation allows a soil to be continually flushed by lime-rich waters or a high-water table prevents solution of calcium carbonate and its removal from plant rooting depths.

3) In general, high contents of soil calcium in a form readily available to plants, and high pH values, go together, as do low available calcium quantities and low pH values. This again however is not a simple issue, there being no more than a general correlation of calcium with pH, so that a simple statement that a measured pH implies a particular quantity of available calcium is not possible. Russell (1961) has pointed out that the relationship of plants to soil pH involves:-

a) Direct sensitivity of plant roots to the hydrogen ion content of the soil solution.

b) Secondary effects resulting from pH.

In general, water culture experiments have shown (b) to be dominant. In soils of low pH, the effects, as well as an actual shortage of available calcium and sometimes also of phosphate, are an excess of soluble aluminium and manganese (the aluminium accumulating in roots and interfering with phosphate transport). In soils of high pH, the limiting effects are an inability to take up enough iron, manganese and boron which are poorly soluble at high pH.

A valuable recent review by Burstrom (1968), for drawing my attention to which I am indebted to Dr.R.Elfyn Hughes, deals comprehensively with the topic of calcium and plant growth.

He points out that although calcium is present in large amounts in plants and generally considered to be a major nutrient, there remains doubt as to the precise biochemical role it plays, although this may be to assist passage of diffusible cell constituents, such as potassium, through cell walls. He notes that for a long period calcium itself was thought to play little part in the calcicole/calcifuge problem compared to the secondary effects of soil calcium levels but there is now a return to interest in fundamental calcium relationships. Although the absolute calcium requirement of most species is too low for any total deficiencies in nature, it has been found that calcifuge species may have low calcium optima for growth; show growth inhibition at high calcium concentrations and are resistant to aluminium toxicity, while in contrast calcicoles have high optima for growth. However only tentative explanations have so far been put forward to explain apparent differences in calcium uptake by plants.

An Unsolved Problem.

The point made in the last sentence shows that the chemistry of soils related to calcifuge/calcicole plant distribution is not properly understood, even accepting the concept that there really are distinct plant groups, This is doubtful in view of the points made by Dr. Lacey and by other contributors to discussion today indicating that the same species falls into different categories in different localities.

In the most widely publicised association of calcifuge with calcicole species on the so-called "chalk heaths", it has been generally stated that this association depends on shallow rooted calcifuges rooting in leached upper soil horizons and deep rooted calcicoles rooted in lower calcareous horizons. However recent work on Lullington Heath, Sussex, by Grubb, Green and Merrifield (1969) has suggested that this concept too must be treated with caution as a general explanation since they find root growth satisfactory there for both calcifuge and calcicole species at pH 5-6 and both groups have almost certainly regenerated from seed in soils at that pH range.

The problem therefore, though there is doubtless some truth in most of the generalisations made about it, remains unsolved and requires further study from both ecological and pedological approaches.

References.

Burstrom, H. G.	1968	Calcium and Plant Growth. Biol. Rev. 43, 287-316
Grubb, P.J. Green, H.E. and Merrifield, R. C. J.	1969	The ecology of Chalk Heath - its relevance to the calcicole-calcifuge and soil acidification problems. J. Ecol. 57, 175-212
Russell, E. J.	1961	Soil Conditions and Plant Growth. Longman's, London (9th Ed. revised by E.W. Russell).

A List of the Flowering Plants and Ferns of Carmarthenshire compiled by R.F. May, F.L.S. pp. 88. Published by the West Wales Naturalists' Trust, Ltd. 1967.

Botanists throughout Wales, and especially those who reside in Carmarthenshire, are indebted to Mr. May for this list. In the absence of a published flora, it serves as a very useful source of reference and will prove invaluable to anyone undertaking the work of writing a flora of Carmarthenshire. The bulk of the records for the species listed emanate from Mr. May himself and from Mrs. I.M. Vaughan; without the records of these two tireless field-workers the list would have been much reduced and its value much diminished. Collating the records for the flowering plants and ferns of the county from widely scattered sources in various books, journals, catalogues and magazines must have proved an onerous task and we are grateful to Mr. May for undertaking it.

The contents include a description of the topography of the county together with a broad, general account of plant distribution, a poorly defined and unexplained geological map of Carmarthenshire and an interesting account of the history of botanical exploration in the county from John Ray onwards. There then follows the list of 1,117 species following the nomenclature used in the Excursion Flora of Clapham, Tutin and Warburg (1964) and based on the plan used in Dandy's List of British Vascular Plants (1958). English common names are also given.

Knowledge of the county's plant distribution will continue to expand and new discoveries will be made. A species not found anywhere in the lists, for instance, is the Wild Service Tree (Sorbus torminalis), discovered in 1969 in Gallt y Fforest (otherwise known as Poor Man's Wood) near Llandovery; a voucher specimen has been deposited in the herbarium of the National Museum of Wales at Cardiff. A plant which appears in Appendix 2 to the list under the title Species presumed lost or extinct is the Bird's Nest Orchid (Neottia nidus-avis), recorded near Llandovery c. 1908. Unknown to Mr. May, a little girl on her way to school at Gelli Aur in June 1954 picked this plant and brought it to school. It was sent to Mr.A.E.Wade at the National Museum who confirmed the determination and returned the specimen. Mr. Wade's letter survives and is now in the hands of Mr. May. Additional stations for the less common plants on the list are being continually discovered and the sites of others are disappearing due to some development or change of land-use; the situation is in a state of flux so that the need for recording by field botanists will continue.

Our knowledge of the constitution of the flora and of the distribution of the plant species in the county is now more extensive than it has ever been thanks to this list. It should be an essential companion to anyone interested in the county's flora and should be on the bookshelves of every naturalist and school in Wales. It is hoped that the publication of this list will stimulate others to take an interest in our native plants so that they will go out to the field to discover the beauty and variety of our county's flora.

(Copies may be obtained from Dr. Dillwyn Miles, Hon. Secretary West Wales Naturalists' Trust, 4 Victoria Place, Haverfordwest, Pembs., price 10/- which includes packing and posting.)

David Davies