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(THE FERN GAZETTE Volume 13 Part 2 was published on 29th September 1986)
This number is dedicated to

PROFESSOR DOCTOR TADEUS REICHSTEIN,

eminent pteridologist,

on the occasion of his Ninetieth Birthday

20th July 1987

Photograph courtesy of H. & K. Rasbach
Further papers submitted to honour Professor Reichstein will appear in the next number of the Fern Gazette.
T. REICHSTEIN : A PERSONAL APPRAISAL

There can be no doubt that, in Tadeus Reichstein, now entering his 90th year, we have among us one of the most outstanding personalities of the 20th century. I am not erudite enough to discuss his chemical achievement per se except to note that in 1968 he was awarded the highest accolade in the gift of the Royal Society of London (the Copley Medal). Other aspects of his life and scientific interests can perhaps best be introduced in an anecdotal manner based on my own personal experience of how I first became involved with him.

This happened early in the 1950s when he wrote to me from the Chemistry Department in Basel to follow up some information that I had recently published in my book (Problems of Cytology and Evolution in the Pteridophyta, 1950, CUP). This book had been drawn to his attention by a Swiss colleague and he wanted to know how best to confirm the putative hybrid nature of some of his local ferns. In reply, I offered to visit him to look at them provided only that he could lay on any kind of a student's microscope. He replied by telegram saying “Splendid. Come this weekend”. This message reached me at 12 noon on Whit Saturday and if one can effectively think back to that time there will be no doubt regarding the impossibility of flying to Switzerland at Whitsun if you don’t know that you want to go before noon on Whit Saturday. I had to explain this also by telegram but having secured a flight as soon as possible at a later weekend (in term time I could not easily be absent from Leeds except at a weekend) I took the precaution, before setting off, of consulting our then professor of organic chemistry for information about my unknown correspondent. The reply I received was surprising, and at first alarming. I was told “Oh, Reichstein. He is a very well known mountain climber with many difficult traverses named after him”. This rather frightening prospect was toned down by one additional fact, namely that he was now old and therefore might not want to dangle me on a rope over a precipice. Somewhat comforted by that I set off and was received with the most incredible hospitality and kindness. I had no difficulty in sorting out his problematical hybrids by showing him how to recognise bad spores under a microscope. I also took the opportunity of taking fixings of several plants that he had growing in his greenhouse from local gatherings and some of these, when looked at chromosomally after my return to Leeds proved to be new — diploids where tetraploids were to be expected or the converse. Herewith began an active collaboration that has lasted until the present day.

Even at the first encounter I was so much impressed with his ready intelligence as well his botanical expertise that I made more enquiries as soon as I got back to Leeds, this time from a student in the Chemistry Department. This lad’s eyes opened wide as soon as I mentioned the name Reichstein. I was assured that he was a tremendous chemist and indeed the holder of a Nobel Prize (awarded in 1950). What a difference from the previous concentration on mountain climbing as a major credential, true as this doubtless is!

To a professional chemist, the very simple reagents needed (acetic acid and absolute alcohol) to take fixations for aceto-carmine squash preparations offer no problems and I was soon receiving new fixations of additional Swiss specimens. At first I dealt with these myself but soon began to pass them on to John Lovis (a member of my staff) who benefitted greatly by the experience. Since Reichstein himself owned a powerful car and was willing to apply his alpine expertise in any part of Europe (France, Spain, Germany, Italy etc.) as required, knowledge of European ferns rapidly increased. Certain key genera, notably Asplenium, Polypodium, Dryopteris etc., are now as fully known as they are likely to become, at least with respect to this part of the world. For this alone, I was able, in 1974, to propose Reichstein as an honorary foreign member of the Linnean Society of London, when I became president (1974-76) of that well known biological society.
Reichstein has now been able to stimulate his own local group to become experts both in cytology and in taxonomy thereby virtually eliminating any former dependence on Britain. Moreover, the Swiss group has recently turned the tables on Britain by giving invaluable help towards finalising a long drawn out project on the fern flora of Madeira begun by the Leeds group in 1949 but published only in 1986 (see Bull. Brit. Mus. (Nat. Hist.) Bot. 15: 123-161). By that time four authors had necessarily become involved namely I. Manton (Leeds), John Lovis (now permanently resident in New Zealand), G. Vida (Budapest) and Mary Gibby (London). Such a geographical spread among authors posed a major obstacle to communication and the text took two years to complete. Indeed, without Reichstein’s constant help in co-ordinating nomenclature and literature and in detecting errors sometimes involving the typescripts of one or other author finality might never have been reached.

A pioneer as effective as this in so many different fields of human activity is rare indeed and anyone privileged to have known him personally can scarcely fail to be both proud and grateful for the experience.

Irene Manton
**ASPLENIUM X REICHSTEINII (= ASPLENIUM FONTANUM X A. MAJORICUM; ASPLENIACEAE: PTERIDOPHYTA), A NEW ENDEMIC FERN HYBRID FROM MALLORCA, BALEARIC ISLANDS**

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**ABSTRACT**

An *Asplenium* hybrid that was found near the town of Sóller, Mallorca, is described and the name *Asplenium x reichsteinii* Bennet & Rasbach is proposed for it. It is a triploid plant exhibiting 36 bivalents and 36 univalents at meiosis. These cytological results as well as its morphology strongly suggest that it originated from a cross between *Asplenium fontanum* and *A. majoricum*. Further support in favour of this interpretation was obtained by comparing it with hybrid plants of this combination artificially produced by Sleep (1967); an almost complete agreement in morphology and an identical cytological pattern were both observed. The occurrence of *Asplenium fontanum* on Mallorca and earlier reports in literature of a single plant obviously also representing *Asplenium x reichsteinii* are discussed.

**INTRODUCTION**


Obviously *Asplenium majoricum* hybridizes with other species of Aspleniaceae rather easily. Three described and named hybrids involving *Asplenium majoricum* are presently known, all of them found near Sóller: *Asplenium majoricum* x *A. trichomanes* subsp. *quadrivalens* D.E. Meyer (= *Asplenium x orellii* Lovis & Reichstein, Lovis & Reichstein 1969), *Asplenium majoricum* x *A. petrarchae* (Guerin) DC. subsp. *petrarchae* (= *Asplenium x sollerense*, Lovis, Sleep & Reichstein, Lovis & al. 1969), and finally the intergeneric hybrid *Asplenium majoricum* x *Ceterach officinarum* DC (= x *Asplenoceterach barrancense* Bennet & D.E. Meyer, Bennet & Meyer 1972).

During an excursion to the olive groves above Biniaraix near Sóller, Mallorca, in April 1986 two plants were found that were believed to represent the cross between *Asplenium fontanum* and *A. majoricum*. The area was revisited in October 1986 and another four hybrid plants were discovered. Results of further studies, especially the cytological examinations, confirmed the assumed origin of this hybrid. It is described here in detail and named *Asplenium x reichsteinii*.

**MATERIALS AND METHODS**

The two plants of *Asplenium x reichsteinii* found in April 1986 were collected and taken into cultivation in the greenhouse of Prof. Reichstein at Basel and at Bochum for further studies. In October 1986 another plant (out of a group of three plants growing closely together) was taken into cultivation at Basel. Of the fourth plant found in
October 1986 fixations were made in the field. The meiosis was investigated applying the classical acetocarmine method (Manton 1950). For the final analysis and the photographs of the spore mother cells a magnification of 1,000 x and a phase microscope were used. In the case of the type plant 18 cells in the stage of diakinesis/metaphase 1 were counted.

**DIAGNOSIS**

*Asplenium x reichsteinii* Bennert et Rasbach *hybr. nov.* (= *Asplenium fontanum* (L.) Bernh. x *Asplenium majoricum* Litard.).


Holotype: *Asplenium x reichsteinii* Bennert et Rasbach. On a limestone wall above Biniaix near Sóller, Mallorca, Balearic Islands, Spain: c. 180m alt.; with *Asplenium majoricum*, *A. petrarchae*, *A. trichomanes*, and *Ceterach officinarum* growing in the near vicinity; leg.: H.W. Bennert et U. Peters, 17 April 1986; WBSP43/86; plant later cultivated in Basel under reference number TR-6477; whole plant pressed on 7 October 1986; holotype: B (see Fig. 1).

Dedicated to Prof. Dr. T. Reichstein, Basel, who has added very much to the knowledge of the ferns, especially of the genus *Asplenium*.

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**FIGURE 1.** *Asplenium x reichsteinii* Bennert et Rasbach (= *Asplenium fontanum* x *A. majoricum*); silhouette of the type plant (kept in B).
FIGURE 2. *Asplenium x reichsteinii*, its parents and the artificially produced hybrid *Asplenium majoricum* x *A. fontanum*: silhouettes of fronds: a: *Asplenium fontanum*; Gorge du Verdon, Dept. Var, France; WB 52/72, 3.4.1972; b, c: *Asplenium x reichsteinii*; Biniaraix near Sóller, Mallorca, Spain; Ras-535, 13.10.1986; d: *Asplenium majoricum*; Puig d'en Barrera near Sóller, Mallorca, Spain; WB 167/71, 10.4.1971; e, f: *Asplenium x reichsteinii*; Biniaraix near Sóller, Mallorca, Spain; WB 46/86, (= SP 24/86) 17.4.1986; g, h: Synthesized hybrid between *Asplenium majoricum* g (Sóller, Mallorca x *A. fontanum* d) Roche, Switzerland; AS 266 (i), 30.5.1962. The arrows indicate the position where the color of the rachis or of the stipe changes from brown below to green above. As this position is different on both surfaces solid arrows were used as markers for the upper surface and broken arrows for the lower surface.
Paratypes: A second plant of Asplenium x reichsteinii was discovered on the same day (17.4.1986; leg.: H.W. Bennet et U. Peters) somewhat above (c. 200m alt.) the locality of the holotype. This plant is in cultivation in Bochum (as SP 24/86); fronds of it will be deposited in the following herbaria: BM, G. K. MA and Z. A third plant collected on 13 October, 1986 (leg.: H.W. Bennet, H. Rasbach et K. Rasbach) was divided into two parts, both being cultivated in Basel (as TR-6540 a & b). Of a fourth plant (that remained in the field) fixations were made and fronds were collected on 13 October, 1986; these are kept in the private herbaria of H. and K. Rasbach (Ras-535) and H.W. Bennet (WB 71/86). The cytological examinations that were made of all paratype plants gave the same results as in the case of the holotype.

Hybrid plant with its gross morphology being intermediate between both parents, however rather similar to Asplenium fontanum from which it can be distinguished by the following characters. Pinnae more compact and less deeply cut: pinna segments less sharply toothed. Stipe and lower part of the rachis (especially on the abaxial surface) dark brown coloured. Scales of rhizome in their colour intermediate between the parent species (in Asplenium fontanum light brown, in Asplenium majoricum deep brown). Fronds of the wild growing plants up to 12cm long and 1.5cm broad. Spores abortive (Fig. 3). Plant triploid with 36 bivalents and 36 univalents at meiosis.

FIGURE 3. Ripe sporangia of Asplenium x reichsteinii containing aborted spores.

CYTOLOGY AND ORIGIN OF ASPLENIUM X REICHSTEINII

The morphology of Asplenium x reichsteinii clearly suggests a relationship to Asplenium fontanum and Asplenium majoricum (see Fig. 1 and Fig. 2). Further support for this interpretation comes from the cytological results. As Asplenium x reichsteinii is triploid it must have originated from a cross between a tetraploid and a diploid species. The pairing behaviour of chromosomes showing 36 bivalents and the same number of univalents at meiosis (Fig. 4) can be interpreted in two different ways. One possibility is that an autotetraploid (AAAA) and an unrelated diploid species (BB) were involved with the bivalents originating from the autotetraploid species exclusively (AABB). The same pairing behaviour may result, however, if an allotetraploid species (AABB) and a diploid species containing a related genome (AA or BB) hybridize; in this case each species contributes one set of chromosomes to the bivalents observed at meiosis (AABB or ABB).

Considering the first possibility Asplenium trichomanes, A. petrarchae and A. ruta-muraria are the autotetraploid species, Asplenium fontanum (see following chapter) and A. onopteris L. the diploid ones that occur in the vicinity of Soller thus representing possible candidates involved in hybridization. None of the hybrid
FIGURE 4. Cytology of *Asplenium x reichsteinii* (type plant WB SP 43/86): a: Photograph of spore mother cell during meiosis (diakinesis) showing 36 bivalents and 36 univalents; b: Explanatory diagram; bivalents black, univalents in outline; preparation by H.R.
combinations between these species would, however, result in a plant exhibiting such an *Asplenium fontanum*-like morphology as *Asplenium x reichsteinii* does. Even hybrids involving *Asplenium fontanum* should show closer morphological relationships to the tetraploid parent as the latter would contribute two sets of chromosomes which would dominate over the single set coming from *A. fontanum*.

When checking the second possibility of explaining the cytological results only one allotetraploid species has to be considered, namely *Asplenium majoricum*. Keeping in mind that it contains two genomes of *Asplenium fontanum* and *A. petrarchae* (FoFoPePe, see introduction) only a cross involving *Asplenium fontanum* (FoFo) or diploid *A. petrarchae* (PePe) would show the pairing behaviour observed. Apart from the fact that diploid *Asplenium petrarchae* is to date not known to occur on the Balearic Islands the hybrid involving this species (FoPePe) should be close to *A. petrarchae* in its morphology. The only hybrid combination to remain is that between *Asplenium majoricum* and *A. fontanum*. This hybrid must be triploid and have the genome formula FoFoPe with one genome Fo being derived directly from the diploid parent *Asplenium fontanum* and the other one being contributed by *A. majoricum*. This indeed explains both the morphological features (two genomes Fo dominate over one Pe) as well as the cytology (the bivalents being formed by the two genomes Fo) of *Asplenium x reichsteinii*.

Though this interpretation of the origin of *Asplenium x reichsteinii* hardly can be doubted it is, for reasons that will become obvious in the following chapter, of considerable value to obtain further support from independent investigations. In order to elucidate the origin and interrelationships of *Asplenium majoricum*, Sleep (1967) produced hybrids in various combinations. Within her hybridization programme she successfully synthesized the hybrid between *Asplenium fontanum* and *A. majoricum*. For this plant she reports exactly the same pairing behaviour of chromosomes as observed in *Asplenium x reichsteinii*. Furthermore, the morphology of this artificially produced hybrid is almost identical with that of *Asplenium x reichsteinii* from Mallorca (Fig. 2). The only obvious difference is that in the extension of the brown colour of the rachis (which especially in hybrids may vary to some extent). The two fronds of the synthesized hybrid that are shown in Fig. 2, g and h, will be deposited in B together with the holotype.

**ON THE OCCURRENCE OF ASPLENIUM FONTANUM ON MALLORCA**

*Asplenium majoricum* as one parent species of *Asplenium x reichsteinii* is rather frequent in the area where the hybrid plants were found. To our surprise not even a single plant of *Asplenium fontanum* could be discovered although several days were spent investigating the fern flora around Sóller with special attention given to the occurrence of this species. In modern literature *Asplenium fontanum* is consistently listed as a rare but undoubted member of the Majorcan flora (Jalas & Suominen 1972, Bonafè 1977, Duvigneaud 1979, Pichi Sermolli 1979, Greuter et al. 1981, Bolòs & Vigo 1984, Salvo et al. 1984, Smythies 1984, Castroviejo et al. 1986). Nevertheless, any authentic and reliable recent report that would confirm the present occurrence of *Asplenium fontanum* on Mallorca seems to be lacking. Judging from the information given by Bonafè (1977) all corresponding original reports date back to the time before 1920. The oldest source that mentions *Asplenium fontanum* from Mallorca seems to be the catalogue of vascular plants of the Balearic Islands by Marès & Vigineix (1880). At that time *Asplenium majoricum* had not yet been described as a separate species; this was done by Litardière in 1911. Therefore it seems doubtful whether really *Asplenium fontanum* and not *A. majoricum* was meant. In his chapter on *Asplenium fontanum* Bonafè (1977) also mentions the existence of herbarium specimens and
presents a photograph (p.34) showing a complete dried plant being kept in the "Herbarium Bianor de Palma". This voucher could indeed belong to *Asplenium fontanum*. Bonafè (1977) further reports that specimens obviously belonging to the same collection are kept in the herbarium of the Botanical Institute at Barcelona. The sheet with these specimens (no. 72095) was borrowed from Barcelona and thoroughly examined. On the basis of morphology (shape of pinnae, green colour of stipe and rachis) and the well developed (not aborted) spores with an exospore length of (29-)32-35(-41) μm it is obvious that these plants indeed represent true *Asplenium fontanum* (Fig. 5). The

![Figure 5](image_url)

**FIGURE 5.** Herbarium specimen of *Asplenium fontanum* from Sóller, Mallorca, kept in the herbarium of the Botanical Institute at Barcelona (no. 72095). Leg.: F.re Bianor-Marie; 15.11.1917. Silhouette of whole plant.

inscription on the label is as follows: "Plantes des Baleares *Asplenium Halleri*, R.Br. Murs des olivaires. Soller, Est. 1917, 15 Novembre. F.re Bianor-Marie". This find was obviously the basis for the report of *Asplenium Halleri* (a synonym for *Asplenium fontanum*) in the plant list of Bianor (1917). Although he does not mention *Asplenium majoricum* (which by that time had already been described as a separate species) Bianor’s statement must be accepted as correct. More recently collected specimens in the private herbarium of J. Orell, Palma de Mallorca, with a morphology close to *Asplenium fontanum* were checked and found to belong to *Asplenium x reichsteinii* (see following chapter).

If *Asplenium fontanum* still exists on Mallorca it must be a very rare species possibly restricted to one or very few localities, with only a small number of individuals. We are inclined to believe that it would not primarily grow on the walls of the olive terraces as *Asplenium majoricum* and *A. petrarchae* do but prefer more favourable microhabitats on limestone cliffs. These should be shady and moist to ensure a relatively good water supply especially during summer time when long lasting rainless periods appear which are typical of the Mediterranean climate. Such habitats are more likely to occur at higher elevations in the mountains where as a consequence of frequent cloud formation air humidity tends to be high and water may condensate thus improving plant water relations. *Asplenium fontanum* is certainly less drought
resistant than *Asplenium petrarchae* and *A. majoricum* or other members of this genus.

Although we could not establish the present occurrence of *Asplenium fontanum* on Mallorca there is good reason to believe that it was, and is, still there. One argument is that *Asplenium fontanum* is one parent species of *A. majoricum* and it is most probable that the latter originated on Mallorca where it is endemic. The second point is the rather frequent occurrence of *Asplenium x reichsteinii* (see following chapter). The normal situation for fern hybrids to arise is that both parent species are present often growing closely together. The tendency of *Asplenium x reichsteinii* to occur at somewhat higher elevations (around 200m alt., highest locality at 235m alt.) and its preference for natural limestone cliffs (only 2 out of 6 plants grew on walls), always at the base of steep and high projecting rock faces, are remarkable and may be indicators for the habitats where *Asplenium fontanum* can be expected on Mallorca.

**EARLIER REPORTS ON HYBRIDS BETWEEN *ASPLEN/UM FONTANUM* AND *A. MAJORICUM***

The oldest published report on hybrids between *Asplenium fontanum* and *A. majoricum* seems to be that by Sleep (1967). As already mentioned she produced this cross artificially within a hybridization programme to study the origin of *Asplenium majoricum*. Under the applied experimental conditions it formed rather easily (6.4% success).

Besides these artificially raised hybrids one wild plant that was found near Söller by Schulze, Orell and Bonafè in 1964 (det. 24. III. 1964) obviously represents the cross between *Asplenium fontanum* and *A. majoricum*. This plant is referred to in several publications (Jaquotot & Orell 1968, Lovis & Reichstein 1969, Bonafè 1977, Reichstein 1981, Castroviejo et al. 1986) but without having received a valid name. Reichstein who checked pressed fronds of it (kept in the private herbarium of J. Orell, Palma de Mallorca) did not come to a final conclusion in his earlier paper (Lovis & Reichstein 1969) where he considers it as *Asplenium fontanum* or the hybrid between *A. fontanum* and *A. majoricum*. Later (Reichstein 1981), however, he stated that the assignment of Jaquotot & Orell (1968) (*Asplenium fontanum* × *A. majoricum*) is most probably correct. The fronds in the herbarium of Orell were checked again in 1986 by the present authors and only sporangia with abortive spores were found. It is therefore obvious that this plant indeed represents *Asplenium x reichsteinii*. Very recently Antoni Rebassa, a biology student living in Söller, sent 2 fronds of another plant of *Asplenium x reichsteinii* collected in October 1986. He describes the locality where he found the hybrid as follows: "San Vencis", Ses Tres Creus, Söller. This is probably the same area where Schulze, Orell and Bonafè found their plant in 1964.

This means that until now at least 8 different individuals of *Asplenium x reichsteinii* have been found in nature. As the hybrid resembles *Asplenium majoricum* it may easily be overlooked unless it is examined closely. Therefore more hybrid plants are to be expected and may be discovered in the neighbourhood of Söller.

**ACKNOWLEDGEMENTS**

We thank Dr A. Sleep, Leeds, for providing us with two very valuable fronds of the artificially produced hybrid between *Asplenium fontanum* and *A. majoricum*, Mr J. Orell, Palma de Mallorca, for letting us examine his specimen of *Asplenium x reichsteinii*, Prof. Dr T. Reichstein, Basel, for careful cultivation of the type plant and Dr J. Montserrat, Barcelona, for sending us the voucher of *Asplenium fontanum* from Mallorca on loan. Furthermore we gratefully acknowledge the help of Prof. Dr H. Hauppler, Bochum, who not only gave some information on floristic literature of the Balearic Islands but also enabled one of us (W.B.) to spend two days in the Söller area during a students’ excursion to Mallorca in April 1986. Our thanks are extended to Dr
B.S. Parris, Kew, Prof. Dr K. U. Kramer and Dr J. J. Schneller, both Zürich, for reviewing the manuscript and correcting our English; Prof. Dr K.U. Kramer also improved the Latin diagnosis. We are also grateful to Mrs I. Künzel, Bochum, who assisted us with the photographic work.

REFERENCES


REVIEW

INDEX OF THELYPTERIDACEAE by J.W. Grimes and B.S. Parris. 50 pp. 154 x 243mm. Royal Botanic Gardens, Kew. ISBN 0947643036. 1986. Price £6.30 (over the counter) or £7.25 (incl. p. & p) from Dr B.S. Parris at R.B.G., Kew, Richmond, Surrey, TW3 3AE.

This slender book consists of an easily referable index, in the form of three columns across the page. The first column is an alphabetical arrangement of all the basionyms of species which are now included in the Thelypteridaceae. Column two gives the genus, author and date in which that epithet was originally described: column three gives the present (or proposed) disposition, with author and date when published, or in the case of synonyms, the accepted species name, which may then be looked up in column one. For full bibliographical references one must refer to Index Filicum; all modern taxonomic treatments, up to the end of 1985, have been covered.

Thelypteridaceae is a large and confusing group and such an index cannot be final. We are promised alterations and additions in the future in the form of Supplements. As pointed out in the Introduction, opinions will differ and there are doubtless some mistakes or omissions. I am sure they will be few. This little book, well bound in a soft, but durable, plastic-impregnated cover, is a sensible and very useful spin-off of herbarium curation.

A.C. JERMY
NOTES ABOUT ASPLENIUM I. ASPLENIUM QUEZELII, A PSEUDO-ENDEMIC SPECIES IDENTICAL WITH A. DAGHESTANICUM (ASPLENIACEAE : PTERIDOPHYTA)

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ABSTRACT
A comparative morphological study has shown that A. quezelii and A. daghestanicum are identical. A daghestanicum is a relic (caucasian) element of the Tibesti flora, with close relatives in the Himalayas and China.

With great pleasure I dedicate this article to Prof. T. Reichstein. We have been working together to get a better understanding of various "difficult" Asplenia. Reichstein's interest in this genus is illustrated by the 27 articles he wrote about it in the last 25 years. The discovery of some new species in the Himalayas and China, similar to Asplenium daghestanicum Christ and A. quezelii Tardieu-Blot, renewed our interest in this group. Several new species await description. This paper only deals with the identity of A. daghestanicum and A. quezelii.

INTRODUCTION
H. Christ described A. daghestanicum in 1906 from a single collection (5 plants) made by Alexcenko and Woronow (holotype : PI, isotype : BR !). The ferns were collected in 1902 near Kurag in Daghestan (NW Caucasus). Christ suggested some distant relationship with A. fontanum Bernh., but A. daghestanicum became almost forgotten until Reichstein et al. (1973) compared it with A. creticum Lovis, Reichst. & Zaffran. At Reichstein's request Askerov collected the species again, in the same area, in 1982. Spores of this collection were used to raise progeny (TR-6062) for cytological studies (Askerov et al. in prep.). Until now, A. daghestanicum was considered to be an endemic of Daghestan.

In 1956 P. Quezel collected the single plant that Mme. Tardieu-Blot (1958) described as A. quezelii. It came from Mt. Emi-Koussi in the Tibesti massif of northern Chad (Sahara desert). She compared her new species only with A. lepidum Presl, a distantly related south European fern. A. quezelii was also mentioned by Reichstein et al. (1973), and compared with A. creticum. Most later authors (Quezel (1971 : 448 & 1983 : 414), Ozenda (1977 : 524)) have followed Tardieu-Blot's species concept (= an endemic of the Tibesti plateau, related to A. lepidum).

Since A. daghestanicum and A. quezelii look very similar, a comparative morphological study, including macro- and micro-characters, was undertaken to establish whether they were closely related or conspecific.

MATERIALS AND METHODS
The following collections were studied:

A. daghestanicum – Alexcenko et Woronow 450, U.S.S.R., Daghestan, Kurinski District, near Kuraeg, 21-V-1902. (Holotype P !, iso BR !).

A. daghestanicum – Askerov s.n., U.S.S.R., Daghestan, 2200m. 1982 (LE !).


A. quezelii – Quezel s.n., Chad, Tibesti, Emi-Koussi, lappiaz volcaniques du flanc NW, 3300m, 1956. (Holotype P !).
FIGURE 1: A. *A. guezelii* (Quezel s.n., holotype, P!); B. *A. daghestanicum*, (B.: Alexenko et Woronow 450, holotype, P!); C. *A. Askarov s.n., LE*; Bar = 1 cm.
FIGURE 2. Paleae. A. daghestanicum [Alexcenko et Woronow 450; (a: holo-, b: isotype); Askerov s.n. (c,d,f-h); TR 6062 (e)], A. quezelii [Quézel s.n.-holotype (i-m)]. Bar = 1 mm.
Epidermis preparations were made and studied following standard procedures (Viane 1985). SEM investigations were done on untreated spores coated with gold. All micromorphological characters used are mentioned in Table 2. Stomatal terminology is according to Van Cotthem (1970).

RESULTS

Macromorphological analysis
The overall habit of the plants studied is the same (Fig. 1): all have a short oblique to upright rhizome, with several fronds close together at the top. The paleae (rhizome and stipe base) of both species are identical (Fig. 2); clathrate, without a central dark line, and with a few marginal outgrowths, there are no large size differences (1.5-3mm long x 0.4mm wide) between the specimens. The leaves (3-7cm long) have a stipe about twice as long as the lamina (1.5-2.5cm long x 1cm wide), which is bipinnate only at the base. The pinnae, gradually reduced towards the confluent apical segment, are a little longer than broad; their dorsal surface is often obscured with sporangia. The indusia (0.8-1.5mm x 0.4mm) have an entire to slightly undulating edge. Table 1 gives the mean values and ratios for the macroscopical characters studied; all collections closely agree. The only discordant element is the short stipe of the cultivated plant (TR-6062): the reduction of the stipe length is an apparently very common effect of cultivation (compare values from the original, wild (Askerov) collection with these of TR-6062 (its progeny)).

Micromorphological analysis
The pattern of the epidermis cells is so similar for all collections that only that of the holotypes is illustrated (Figure 3). Stomates, of the polocytic type, have guardcells 40-50μm long. The polocytic cell, this is the cell surrounding the guard cells distally, is always a little wider than long. The exospore length is 30-36μm, which indicates, just as the guard cell size, that the specimens are probably tetraploid. All microcharacters studied are on Table 2: it is clear that none of the collections can be separated from the set on microscopical grounds.

FIGURE 3. Epidermal cell patterns: A: A. daghestanicum (holotype); B: A. quezelii (holotype). Bar = 100μm; arrow indicates direction of vein towards leaf margin.
Scanning electron microscopy (SEM) of spores can often be used to distinguish closely related taxa (e.g. Asplenium adiantum-nigrum L. from A. cuneifolium Viv. and A. onopteris L.; A. fontanum ssp. fontanum from A. fontanum ssp. pseudofontanum (Koss.) Reichst. & Schneller; etc.). SEM of A. daghestanicum and A. quezelii spores (Fig. 4) revealed that these are so similar that they cannot be used to separate the species, not even on a subspecific or varietal level.

**FIGURE 4.** SEM spore picture of A. daghestanicum (A) and A. quezelii (B). Bar = 10\(\mu\)m.

**Conclusion**

The conclusion of this morphological study is that A. daghestanicum and A. quezelii are the same species. The correct name must then be A. daghestanicum, as Christ’s binomial is the oldest legitimate one; A. quezelii Tardieu-Blot is hereby reduced to a (taxonomical) synonym.

**DISTRIBUTION AND RELATIONSHIPS**

Until now, both A. daghestanicum and A. quezelii were considered endemics, the former of Daghestan and the latter of the Tibesti massif. Following Tardieu-Blot’s (1958) description and statements about the supposed affinities of A. quezelii with the south European A. lepidum, most later authors have copied her in their phytogeographic papers [a.o. Knapp (1973: 425); Ozenda (1977: 523); Quézel (1971: 448, 1983: 414) etc.]. In a critical article Lebrun (1983) showed that the number of true endemic species (12) from the Saharan mountains is considerably lower than had been estimated (85). Now A. quezelii can also be added to his list of so-called pseudo-species (= pseudo-endemic species).

The former considerable phytogeographic interest of A. quezelii is not lessened now that it is included in A. daghestanicum. At present it is only possible to consider the African population as a Caucasian element in the Tibesti flora; it (both) probably is (are) relic(s) of a flora that was present under much wetter conditions. The author does not know of any other plant with a similar disjunct (3800km) distribution.

A. daghestanicum is related to a number of (partly undescribed) small ferns, best represented in the Himalayas and China (a.o. A. kongashanense Ching, A. subdigitatum Ching, A. xinjiangense Ching). Some new species belonging here will be described in the near future (Reichstein et al. in press). In the meantime, plant collectors in the Mediterranean to S.E. Asia are asked to look out for these rather small, easily overlooked ferns.
### TABLE 1. Mean values (in mm) and ratios of macromorphological characters.

<table>
<thead>
<tr>
<th>Collection</th>
<th>Lt</th>
<th>S</th>
<th>La</th>
<th>La/S</th>
<th>Wl</th>
<th>N</th>
<th>Lpal</th>
<th>Wpal</th>
<th>Lpi</th>
<th>Wpi</th>
<th>Lso</th>
<th>Wso</th>
<th>Lso/Wso</th>
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<tbody>
<tr>
<td>Alexcenko &amp; Woronow 450 (BR)</td>
<td>44</td>
<td>28</td>
<td>16</td>
<td>0.6</td>
<td>7</td>
<td>2.3</td>
<td>5.2</td>
<td>2.4</td>
<td>0.4</td>
<td>6</td>
<td>3.9</td>
<td>3.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Alexcenko &amp; Woronow 450 (P)</td>
<td>64</td>
<td>44</td>
<td>20</td>
<td>0.5</td>
<td>9</td>
<td>2.2</td>
<td>5.2</td>
<td>2.4</td>
<td>0.4</td>
<td>6</td>
<td>4.0</td>
<td>3.9</td>
<td>1.0</td>
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<tr>
<td>Askerov s.n. (LE)</td>
<td>54</td>
<td>37</td>
<td>17</td>
<td>0.5</td>
<td>9</td>
<td>2.0</td>
<td>5.1</td>
<td>1.8</td>
<td>0.4</td>
<td>5</td>
<td>4.5</td>
<td>3.5</td>
<td>1.4</td>
</tr>
<tr>
<td>TR 6062 (GENT)</td>
<td>35</td>
<td>14</td>
<td>21</td>
<td>1.6</td>
<td>9</td>
<td>2.3</td>
<td>6.2</td>
<td>2.0</td>
<td>0.4</td>
<td>5</td>
<td>3.7</td>
<td>3.2</td>
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<tr>
<td>Quezel s.n. (P)</td>
<td>55</td>
<td>36</td>
<td>19</td>
<td>0.5</td>
<td>9</td>
<td>2.1</td>
<td>5.2</td>
<td>2.1</td>
<td>0.4</td>
<td>5</td>
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<td>3.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Overall mean ± stand. deviation</td>
<td>50</td>
<td>32</td>
<td>19</td>
<td>±11</td>
<td>±3</td>
<td>±0.1</td>
<td>±2</td>
<td>±0.4</td>
<td>±1</td>
<td>±0.5</td>
<td>±0.1</td>
<td>±2</td>
<td>±0.6</td>
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### TABLE 2. Mean values (in μm) and ratios of micromorphological characters.

<table>
<thead>
<tr>
<th>Collection</th>
<th>Lst</th>
<th>Wst</th>
<th>Lst/Wst</th>
<th>Lpolo</th>
<th>Wpolo</th>
<th>Lpolo/Wpolo</th>
<th>Lepc</th>
<th>Wepc</th>
<th>Lepc/Wepc</th>
<th>l</th>
<th>l/Wepc</th>
<th>Lexo</th>
<th>Wexo</th>
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<td>0.3</td>
<td>32</td>
<td>27</td>
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<td>1.4</td>
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<td>92</td>
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<td>0.4</td>
<td>33</td>
<td>25</td>
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<td>0.4</td>
<td>33</td>
<td>25</td>
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<td>70</td>
<td>1.0</td>
<td>104</td>
<td>51</td>
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<td>18</td>
<td>0.4</td>
<td>33</td>
<td>26</td>
<td>1.3</td>
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<tr>
<td>Quezel s.n. (P)</td>
<td>49</td>
<td>33</td>
<td>1.5</td>
<td>69</td>
<td>80</td>
<td>0.9</td>
<td>104</td>
<td>58</td>
<td>1.8</td>
<td>19</td>
<td>0.3</td>
<td>34</td>
<td>27</td>
<td>1.3</td>
</tr>
<tr>
<td>Overall mean ± stand. deviation</td>
<td>44</td>
<td>34</td>
<td>1.3</td>
<td>±4</td>
<td>±0.1</td>
<td>±7</td>
<td>±9</td>
<td>±0.1</td>
<td>±13</td>
<td>±9</td>
<td>±0.4</td>
<td>±3</td>
<td>±0.1</td>
<td>±2</td>
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</table>
ACKNOWLEDGEMENTS

I thank the Directors and Curators of BR and P for the loan of valuable type material. Prof. Reichstein supported and encouraged my work in many ways; he also cultivated and provided material of the Askerov collection. Ir. Bohyn made the SEM available. I thank Prof. Van Cotthem and Prof. Van der Veken for supporting my research at their laboratory. I am grateful to Dr. Mary Gibby for organizing this special anniversary issue and for revising the English text.

REFERENCES

REVIEW


This book is a welcome addition to the ranks of fern floras and certainly lives up to the claim on its dust cover to be of use to naturalists, botanists and gardeners. It is intended to be used primarily as an aid in the field identification of ferns and fern allies. Two keys to genera are provided. The first is a tabular key for fertile material which is conveniently printed on a single fold out page. The second is an illustrated dichotomous key for fertile and sterile specimens. Within each genus there is a key to species and these keys, together with detailed descriptions of each species, clearly indicated field characters and good black and white photographs or drawings of whole fronds or complete plants (and sometimes more detailed illustrations of rhizomes, scales and fertile parts of the frond) should enable anyone to make correct identifications. The colour plates provide additional important information on habit, habitat and frond colouration; they are of the same high quality we have come to expect from recent Australian fern books. Distribution maps are included for most of the species which occur in the state of Victoria and much useful ecological information is provided. For the gardener there are guidance notes on situation requirements and suitability for pot, basket or rockery cultivation, while the broader principles, both of propagation by vegetative means and by spores, and of fern growing in general, are dealt with in the final chapter by C.J. Goudey and R.L. Hill.

The authors are to be congratulated on their high standards of content and presentation. I highly recommend this book to anyone with an interest in Australian pteridophytes and indeed to any naturalist intending to visit south-eastern Australia. At £25.00 it is very reasonably priced.

B.S. PARRIS
HYBRIDISATION EXPERIMENTS BETWEEN

ASPLENIUM SEELOSII AND A. CELTIBERICUM

(= A. SEELOSII SUBSP. GLABRUM)

(ASPLENIACEAE: PTERIDOPHYTA)

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Christchurch, New Zealand*

ABSTRACT

Hybridisation experiments between Asplenium seeilosii Leybold from the Italian Dolomites and A. celtibericum Rivas-Martinez (= A. seeilosii subsp. glabrum (Litard. & Maire) Rothm.) from N.E. Spain are described. The F1 hybrids showed a regular meiosis (n = 36) and were fertile. F2 generations were raised from two of the F1 plants. These showed indications of recombination of factors affecting fitness. The decision by Reichstein to revert to subspecific status for the Iberian taxon is upheld.

Asplenium seeilosii sensu lato is one of the strangest and most distinctive elements in the very diverse European spleenwort flora (cf. Eberle 1959, p.66; Rasbach et al. 1968, fig.48, p.101). The only species to which it has even a remote resemblance is A. septentroniale (L.)Hoffm., with which it shares the feature of a highly reduced lamina. Indeed, it was initially regarded as a variety (var. tripartitum) of that species by Gustav Seelos, after whom the plant was subsequently named when described as a distinct species by Leybold (1855). (See Becherer 1962, p.55).

Although so distinctive, Asplenium seeilosii is nevertheless highly variable, not merely between and within populations, but also within one individual, fronds varying in morphology in response to environmental conditions, including climatic variation and season of the year. This variability is not suppressed by glasshouse culture. In these experiments, plants grew more luxuriantly in Basel than in Leeds, though the growth forms produced in Leeds were perhaps closer to those likely to be realised in the wild.

In its more luxuriant forms, the fronds of Asplenium seeilosii consist of a relatively long stipe, terminated by a very short lamina divided into three segments, which may themselves be incised to a greater or lesser extent. The frond is rarely quite symmetrical, one of the lateral segments usually joining the axis at an appreciably lower point than the other.

The characteristic habitat of Asplenium seeilosii is crevices of vertical limestone rock walls. Its distribution falls into two main highly disjunct areas. In central Europe, its range is based on the Italian Dolomites with outliers in Austria, N.W. Yugoslavia (Julian Alps) and Germany (just!). It occurs also in the N.E. quarter of Spain, where there are two centres — one in the eastern half of the Pyrenees (one locality here is actually in France) and the other south of the Ebro river in Guadalajara. The plant is not endemic to Europe; it occurs also in Morocco (cf. Jalas & Suominen 1972, p.77).

The type of Asplenium seeilosii Leybold is from the Tyrol. Unless depauperate, plants from the Dolomites (Figs. 1A-I) always have a tripartite lamina, and this lamina plainly bears numerous stalked glandular hairs. In contrast, plants from Spain are glabrous and have a less divided lamina, though it is now evident that populations vary in this latter character (Figs. 1J-S). These differences have resulted in Iberian plants being given separate taxonomic status, firstly as a variety, var. glabrum Litardiere & Maire (in Maire 1928), secondly as a subspecies, subsp. glabrum, by Rothmal (in

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Cadevall & Font Quer (1937) and lastly raised to full specific rank as *A. celtibericum* by Rivas-Martinez (1967). *A. celtibericum* is based on material of extreme morphology from Guadalajara. Progeny of isotype material raised in Leeds is diminutive, with a virtually undivided lamina, consisting of only a single serrated terminal segment (Fig. 1J-L).

Both taxa are, as far as is yet known, uniformly diploid (Meyer 1957, 1967; Lovis unpub.).

It is clearly a matter of some interest to establish the degree of genetical relationship persisting between these two taxa — their origin from a common ancestor surely cannot be doubted. Accordingly, two attempts were made to hybridise them, using a characteristic though not extreme form of the Spanish plant as the male parent. The overall success obtained was 50%.

<table>
<thead>
<tr>
<th>FEMALE PARENT</th>
<th>MALE PARENT</th>
<th>FEMALE PROTHALLI</th>
<th>HYBRIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>JDL 1439 <em>A. seelosii</em> Mazzin, Italy</td>
<td>X <em>A. celtibericum</em> Organa, Spain (TR 898)</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>JDL 1440 &quot;&quot;</td>
<td>X &quot;&quot;</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

The F1 hybrids were unexpectedly easy to discriminate from possible ‘female’ selfs (or stray selfed ‘male’ prothalli), being not only vigorous, but of distinctive morphology. They all retained the tripartite lamina of *Asplenium seelosii* sensu stricto, but were glabrous. Thus in the F1 hybrids division of the lamina was dominant, but glandulosity proved to be recessive. Chromosome pairing was regular, 36 bivalents being formed, as in the two parents. F2 generations were raised from two of the F1 hybrids. In contrast to the uniform morphology of the F1 hybrids (Figs. 2A-E, 3A-F), the F2 progenies (Fig. 3G-X) were variable in frond form, with some individual recombinants lying outside

![Figure 2](image-url)
the range of the parent taxa (e.g. Fig. 3M-P). Curiously, only the sparsest indications of glandular hairs were seen on the lamina of any of the F2 plants. The suppression of glandulosity in both hybrid generations suggests that this characteristic evolved in the Tyrolean plant subsequent to its separation and divergence from the Iberian taxon and was not present in their common ancestor. The F2 progenies also showed signs of recombination of factors affecting fitness, numerous sporophytes not surviving to maturity. Success in raising in the glasshouse a plant from so extremely specialised a habitat as that of A. seelosii is at best precarious, but nevertheless there is good reason to believe that, in practice, the F2 generation shows some reduction in vigour in comparison with the F1. The fertility of F2 plants was not tested.

In the light of this information, combined, I suspect, with his personal experience of the range of form present in Spanish populations, Reichstein, in his remarkable definitive review of hybrids in European Aspleniaceae (Reichstein 1981, p.105), opted for subspecific status for the Iberian plant. Taxonomic decisions of this type can be more a matter of taste, of personal preference, rather than a question of right or wrong, but nevertheless Reichstein's decision is plainly very appropriate. Although it is true that the two areas of distribution of these taxa are so disjunct that their interfertility can have no practical effect in nature, recognition of the two taxa as geographical subspecies has the clear merit of preserving, within the classification, an indication of the close relationship that undoubtedly exists.

A remarkable diversity of form exists within the diploid taxa present in European Aspleniaceae. Using the ability to pair chromosomes at meiosis as a criterion of relationship, the great majority of inter-specific diploid combinations so far studied show no evidence of affinity. This can be true (e.g. trichomanes x viride : 72 univalents) or virtually so (e.g. cuneifolium & onopteris : 0 - 6 bivalents*), even where some evidence of affinity might be expected on morphological grounds. In contrast, A. seelosii x celtibericum shows us a situation where geographical isolation exists, accompanied by some morphological differentiation, but divergence is not yet sufficient to affect chromosome pairing.

It would be of great interest to investigate certain other pairs of diploid species of Asplenium, namely 1) A. jahandiezii (Litard.) Rouy and A. bourgaei Boiss. ex Milde, and 2) A. aegaenum Lovis, Reichst. & Greuter & A. fissum Kit. ex Willd. A. jahandiezii is restricted to the vicinity of the Gorge du Verdon in S.E. France, whereas A. bourgaei is a plant of Asia Minor, principally Asian Turkey. Their morphology suggests a close relationship, though by no means as close as in the case of A. seelosii and A. celtibericum. Although A. aegaenum and A. fissum are unmistakeable in their most characteristic forms, a few collections are difficult to place. Their distributions are approximately contiguous in the Aegean region. All of these four species are difficult to cultivate, and it has not yet been possible to attempt successfully to hybridise them, using the technique employed in Leeds (Lovis 1968), for which a prothallial growth sufficiently dense and vital to show, when tested, some signs of spermatozoid liberation is necessary if an hybridisation attempt is to have a reasonable chance of success. For the synthesis of such hybrid combinations, the elegant 'nearest neighbours' transplant technique devised and exploited with success in recent years by Reichstein, wherein the opportunity for hybridisation is extended indefinitely rather than restricted to a brief span in a watchglass, may well offer much better prospects.

*Evidence from X Asplenophyllum jacksonii Alston (Lovis & Vida 1969), A. x bechereri D.E. Meyer and A. x dolosum Milde (Reichstein 1981, Appendix II, pp. 118 & 122). Note that tetraploid hybrids such as A. majoricum x adulterinum which show 144 univalents (Lovis & Reichstein 1969) in effect provide a demonstration of lack of ability to pair for no less than six different diploid combinations: PF, PT, PV, FT, FV & TV.
ACKNOWLEDGEMENT

It is a great pleasure and privilege to acknowledge the assistance of Prof. Dr. Tadrik Reichstein in this project, 1) in guiding me to localities of *A. seelosii* s.s., including that at Mazzin from whence the culture used as female parent was obtained, 2) for providing the material of subsp. *glabrum* subsequently utilised as male parent and 3) for cultivating in Basel, very successfully, one of the resultant F₁ hybrids.

The great increase in our knowledge of European Aspleniaceae in the last 25 years is in very large measure the achievement of one man, both directly by his own efforts, and otherwise by very materially assisting and inspiring others. This paper is dedicated to him with most grateful thanks by one who has been very fortunate in being an associate.

REFERENCES


OBSERVATIONS OF PROGENY OF *ATHYRIUM FILIX-FEMINA* (ATHYRIACEAE; PTERIDOPHYTA) FROM BREEDING EXPERIMENTS*

J.J. SCHNELLER
Institut für Systematische Botanik, Zollikerstr. 107, CH-8008 Zürich, Switzerland

ABSTRACT

Progeny of plants collected from natural Swiss populations have been grown for more than 8 years in a garden. The offspring resulting from intragametophytic selfing are on average much smaller and more variable in size than those from intergametophytic selfing or from crossing (out-breeding). The sporophytes originating from outbreeding were the tallest and most robust. This observation and earlier results (Schneller 1979) suggest that the genetic variability and genetic load may be very high. How is it possible to maintain so many recessive deleterious genes in natural populations? Because of the instability of the microhabitats in which the prothalli grow, soft selection may allow an accumulation of genetic load. The result of this investigation, however, can also be interpreted in light of genetic regulation, because leaf dimensions are normally controlled by polygenic complexes.

INTRODUCTION

In most homosporous ferns it is possible to breed sporophytes in three different ways: 1. intragametophytic selfing, 2. intergametophytic selfing, 3. intergametophytic crossing. In the first case completely homozygous sporophytes result, because the egg and spermatozoid are from the same prothallus and therefore genetically identical. Intergametophytic selfing implies mating gametes from two prothalli of the same parent plant. As a result totally homozygous or partially heterozygous progeny will originate depending on the mode of fertilization and the genetic composition of the parent plant. In intergametophytic crossing experiments prothalli from two different parent plants are used. In this case either homozygous plants (due to intragametophytic selfing) or heterozygous plants (degree of heterozygosity depending on the genetic constitution of the parents) result. In a study of the breeding system of *Athyrium filix-femina* (Schneller 1979) it was shown that outbreeding was most successful but intra- and intergametophytic selfing also led to progeny. The viability of the different kinds of progeny, however, was remarkably different. After 8-10 years some of the plants obtained in these earlier experiments are still alive and are growing under similar conditions. Progeny from the three different modes could be seen to be distinct. The reasons for the observed differences will be discussed.

MATERIALS AND METHODS

The parent plants were collected in Switzerland in natural populations at Horgenerberg, Horgen, Kt. Zürich (nr. A-1, A-2, A-3, A-29, A-31, A-33), at Scalasiten, Tamins, Kt. Grisons (nr. A-42, A-48, A-49, A-50), and at Göscheneralp, Göschenen, Kt. Uri (nr. A-51). The plants investigated here were experimentally produced in the years 1975-77. Since 1979 they have been grown under similar conditions in a shady garden bed in the Botanical Garden of the University of Zürich. Three classes of plants were evaluated: 1. progeny (18 plants) from intragametophytic selfing ('intra'), 2. progeny (21 plants) from intergametophytic selfing experiments ('inter'), and 3. progeny (12 plants) from crossing experiments ('cross'). In an earlier investigation

*Dedicated to Prof. Dr. T. Reichstein on his 90th birthday.*
FIGURE 1. Distribution of leaf lengths of the different types of progeny. intra = intragametophytic selfing, inter = intergametophytic selfing, cross = crossing, ◦ = progeny from plant A-1, ● = progeny from plant A-2, ○ = progeny resulting from crossing A-1xA-2, † = mean and standard deviation, blanks = progeny from plants other than A1, A2.
(Schneller & Schmid 1982) and again in this experiment it could be shown that the aspects of leaf size that determine shape are correlated. This explains why the size of the leaves was used for Figure 1. Methods for the statistical analysis of means and deviation tests follow Linder & Bechtold (1979) and Campbell (1971), SAS statistical programs (SAS Inst. 1982) were used.

RESULTS
Measurements given in Table 1 were used for the statistical comparison. The Kruskall-Wallis test showed significant differences between ‘intra’ and ‘cross’ and between ‘inter’ and ‘cross’ (SAS Inst. 1982) In Figure 1 the distribution of the leaf length is shown. The progeny of two plants (A-1 and A-2) are indicated. Principal component analysis shows significant differences between the different breeding-classes.

DISCUSSION
Earlier experiments (Schneller 1979) showed that Athyrium filix-femina is predominantly outbreeding. All the parent plants collected randomly from natural habitats and used for the breeding experiments were heterozygous. These original plants grew well in their original environment. They can be regarded as successful results of selection (in the past) because they survived and withstood competition. Earlier experiments (Schneller 1979) and the results presented here show that the original plants stored a remarkable amount of genetic variability. In this investigation (Fig.1) it was shown mainly in examples A-1 and A-2 (but is true also for other examples). Because progeny are growing under similar conditions much of the observed variability is due to genetic diversity (it is difficult or impossible to distinguish in nature between the genetic component of variation and phenotypic plasticity (Schneller & Schmid 1982) because they are intermingled). Genetic variability may be expressed by advantageous, neutral, or deleterious factors. The results of breeding experiments reveal some consequences of this genetic diversity. Intrigametophytic and to a lesser degree intergametophytic selfing show very different results. In many cases no sporophytes are formed. If sporophytes occur they differ strikingly. They may die at an early stage or vary in size and virility (Schneller 1979). When no sporophytes are observed this may be due to prezygotic mechanisms or to early lethal recessive genes (zygotic lethals). Dwarf or subvital sporophytes may be due to weaker recessive deleterious genes.

After nearly ten years it can be clearly seen that the three classes of progeny (‘intra’, ‘inter’ and ‘cross’; Fig. 1) are distinct considering standard deviation and means of length. The differences are statistically significant with the exception of the mean leaf-length of ‘intra’ and ‘inter’ (which is significant only at the 80% level). The class ‘intra’ shows the largest deviation and the greatest proportion of dwarf plants. It should be noted that intragametophytic selfings have the greatest number of deaths during early stages (Schneller 1979). From the 50 original “intra”-plants only 18 survived. Even the progeny of one plant (A 1) shows a wide range of different offspring. Because the plants are homozygous, recessive genes will always be expressed. The great variance reflects genetic diversity. Dwarf or small plants could then be the result of weakly deleterious recessive genes, that may influence the metabolism of these plants. The viability of the plant and the regulation of leaf size seem to be somewhat correlated.

In the class ‘inter’ the deviation is smaller and the mean is larger than in the class ‘intra’. This would support the hypothesis of increased heterozygosity. Heterozygosity in this case seems to have a stabilising effect on the development, i.e., some of the recessive deleterious alleles will be “masked” by dominant alleles. Some of the
recessive deleterious genes, however, will be found in homozygous condition. This would explain the still wide range of different phenotypes in this class. We can assume that the degree of heterozygosity is highest in the class 'cross'. Here we observe taller plants, a smaller variability and a greater viability. The difference between the other two origins can be explained again by the stabilising effect of heterozygosity.

In population genetics simplified models have often been used to explain the influence of genes on fitness (Sperlich 1973, Wallace 1970). The results of this investigation in my opinion cannot be explained satisfactorily by simple models.

It is obvious that genetic load (mutational and/or segregational) occurs in the gene pool of *Athyrium filix-femina*. It has to be regarded as a consequence of outbreeding. Thus, stored recessive genetic load will be a hindrance to inbreeding, mainly because lethal genes result in none or in subvital offspring that could not survive in natural conditions. Most inbred sporophytes could not compete with the crossbred ones. Fern geneticists like Lloyd (1974) and Klekowski (1982) argue that inbreeding is important for the establishment of new populations. Selection pressure for inbreeding would 'clean' the population of deleterious genes and would also have an influence on the genetic diversity. The genetic load observed in this example reflects a great genetic diversity. Is such a genetic load extraordinary for ferns (or other organisms)? We still do not know enough about how much of genetic diversity can be maintained in natural populations. The answers given by theoretical models range widely depending on the assumptions made. Looking at concrete results in ferns, Klekowski (1982) mentioned that *Osmunda regalis* has the highest load so far documented. For this species 2.39 lethal equivalents per zygote were calculated. A somewhat lower load was found in *Thelypteris palustris* (Ganders 1972). Based on my earlier results (Schneller 1979) and results of this investigation I estimate (method see Ganders 1972) a mean load of 4.87 lethal equivalents per zygote for *Athyrium filix-femina*. This is about double the load of *Osmunda regalis* (Klekowski 1982). A comparable amount of load can be found in human populations (Brues 1969).

Wallace (1970, 1975) showed that soft selection (which is density- and frequency-dependent) allows an accumulation of genetic diversity. The consequences of soft selection to genetic diversity and particularly to genetic load were calculated by Klekowski (1982). In my opinion it is the habitat of *A. filix-femina* (and of course other plants as well) that allows soft selection. It consists of a mosaic of microhabitats variable within some limits influenced by other organisms or by unpredictable physical events on the soil, such as erosion, disturbance by rain, snow, frost, cover of litter etc. The observed large genetic diversity may be partly due to the nature of the microhabitat and soft selection.

The conclusions or hypotheses made so far in this discussion were based on the assumption that the observed load is due to recessive lethal genes. We know for numerous plants that the regulation of size and shape is polygenic (Mather 1942). The different leaf sizes seen in the experiments (Fig. 1) could also be explained by the different combination of regulating genes and could be a consequence of epistasis. We still know little about either the interrelationship of structural and regulatory factors or the role of epistasis.

Finally, I am fully aware of the lack of a satisfactory explanation to the observed phenomena. But in my opinion we should focus our interest on the problems of gene regulation; some attributes we currently link with genetic load may have another cause.

**ACKNOWLEDGEMENTS**

I thank Larry Hufford for reading and correcting the manuscript, Mark Nicholls and Prof. C.D.K. Cook for comments.
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**TABLE 1.** Leaf dimensions of progeny from different breeding experiments. intra = intragametophytic selfing, inter = intergametophytic selfing, cross = crossing, Nr. = plant number, L = length of leaf, B = breadth of leaf, Ba = length of basal pinna, Pos = position of longest pinna (basal pinna = Pos 1).

**REFERENCES**


REVIEW


This work is a study of the spores of the 122 species and subspecies of Pteridophytes found in Italy. The text is in Italian. For each taxa, a detailed morphological description of the spore(s) is given (a helpful glossary of the terms used, illustrated with line-drawings, is provided), with the global and Italian distributions, habitat information and cytological data. Although the (untreated) spores of all the taxa are illustrated by scanning electron micrographs, the spore measurements given are taken from dry spores (i.e. observed in air, without any mounting medium) with a transmitted-light microscope. The accounts of many of the taxa have comments on such topics as their taxonomy, nomenclature, cytology or phytogeography. A comprehensive bibliography of some 350 references is given. The new combination *Polypodium cambricum* ssp. *serrulatum* (Sch. ex Archang.) Pic. Ser. is made.

J.M. CAMUS
**ASPLENIUM TADEI (ASPLENIACEAE : PTERIDOPHYTA), A NEW SPECIES FROM TURKEY**

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**ABSTRACT**

The discovery of a new *Asplenium* species, *A. tadei* Fraser-Jenkins & Schneller, is reported from Antalya province, south Turkey. Its possible relationships are briefly discussed in the light of its tetraploid cytotype, and it is concluded that it is probably an allotetraploid species, either involving *A. trichomanes-ramosum* L. and some other diploid species, possibly *A. bourgaei* Milde or that it is a member of the *A. exiguum* Bedd., or *A. daghestanicum* Christ aggregates.

**INTRODUCTION**

In June 1978, while examining specimens from western Asia at Kew (K), in connection with his work on "*Flora Iranica*" (Fraser-Jenkins, Khullar & Reichstein, in prep.), the first-named author came across an unusual specimen of an *Asplenium* from Turkey, which was generally similar to *A. viride* Huds., but with an unusual frond-apex where the segments had become fused together into a terminal blade with narrow side-lobes. The specimen was unlike any other *Asplenium* species from the European area (sens. lat.) with the possible exception of *A. daghestanicum* Christ, a rare species from the eastern Caucasus, then known only from the type specimens in Paris (P), and which he had previously spent some time attempting to obtain, both in the Caucasus and by correspondence, in connection with study on that species and the closely similar, Sino-himalayan *A. aitchisonii* Fraser-Jenkins & Reichstein, by Professor T. Reichstein of Basel. However the Turkish specimen was noticeably longer, narrower and less deeply dissected than the type material of *A. daghestanicum*, and had the sori crowded towards the base of the pinnae; subsequently new material of *A. daghestanicum* brought to the BM from Dr A.N. Askerov of Baku, with the help of Prof. A. Takhtajan of Leningrad, showed that it was not the same species. The specimen concerned had been cited in the "*Flora of Turkey*" (Davis (ed.) 1965) under *A. bourgaei* Milde, a slightly similar but nevertheless markedly distinct species; its label gives the locality etc. as: "Asplenium bourgaei, Turkey, Vil. Antalya (Isauria), Geyik Dag, 8000’, crevices of shady limestone rocks, rare. *P.H. Davis* 14513, 31/8/1947". It was with excitement that it was arranged for the specimen to be sent to Professor Reichstein for study as a possible candidate (at the time) for *A. daghestanicum*, or at least as something different from other European and western Asian species. On seeing it he was able to suggest that it was close to but not the same as *A. daghestanicum* and could well be a new species. However he suggested that there was also a possibility that it could be a distinctive but vicariant form of *A. creticum* Lovis, Reichstein & Zaffran, a rare allotetraploid species from Crete derived from *A. viride* and *A. aegaeum* Lovis, Reichstein & Greuter, differing from it mainly in having the distinctive fused frond-apex. In *A. creticum* the frond-apex is not normally fused but occasional small specimens can show some signs of slight fusion, though nothing like the extent that it is fused in the Turkish specimen. The latter also has a narrower and less dissected frond than *A. creticum* and the somewhat irregularly tripartite lower pinnae with the sori crowded near the base are again distinct. It was therefore reported as an *Asplenium* species near to (but distinct from) *A. creticum* by Parris & Fraser-Jenkins (1980).
In order to investigate the species further it was planned to visit the locality to search for more material, Professor Reichstein kindly agreeing to finance the excursion which was carried out in September 1979 by the first-named author along with Miss S.J. de C. Coombs.

**PHYTOGEOGRAPHICAL NOTE**

Geyik Dağ is part of the large area of high-level limestone shield comprising the Taurus Mountains (Toros Dağlari) extending shortly inland all along the southern Mediterranean coast of Turkey and including some remote and very splendid mountains, often hard of access, such as Ak Dağ (3073m) and Bey Dağlari (3086m) in the western, or Lycian, Taurus, west of Antalya, another Ak Dağ (c. 3100m), Bolkar Dağlari (3240m), Aydos Dağ (3488m) and Toros Dağ (3585) in the central, or Issarian, and eastern, or Cilician, Taurus east of Antalya and to the west and north of Adana. The shield also extends beyond the Taurus proper to Ala Dağlari (3910m) to the north-east. These mountains can often be seen from a great distance as towering pale or white masses, not only because of their long-lasting snows, but also because of the very pale colour of their extensive and rugged limestone exposures. The Bey Dağlari seen to the west from across the Gulf of Antalya (Antalya Körfezi), and the Bolkar Dağlari seen from the north towering up above the dusty plain of Konya province (Vilhayet) are two of the best-known spectacular views of the Taurus. As one enters the mountains themselves north of Alanya, some 120km east of Antalya, the long high limestone ridge of Ak Dağ (White Mountain) comes into view, just to the south-east of which lies the connected, sharp and rugged peak of Geyik Dağ (2890m). Phytogeographically the Taurus Mountains lie within Mediterranean Turkey (see Parris and Fraser-Jenkins 1980), and form the border-line between that region and Inner Anatolia, but they are in many respects a special region themselves due to their high altitude, and as far as both ferns and flowering plants are concerned they contain not only many endemic species but also a number of extensions of the ranges of European species, sometimes as a fragmented link between the flora of Greece (via the arc from the Peloponnese, through Crete and Rhodes, and thus to the western Taurus), and the flora of the limestone regions of the south-west Caucasus. An interesting example of this turned up during the trip concerned, with the surprise find of *Dryopteris submontana* (Fraser-Jenkins and Jermy) Fraser-Jenkins on the north side of Geyik Dağ, new to Turkey (see Parris and Fraser-Jenkins 1980), and otherwise known from Europe, reaching its nearest point to Turkey at Mt. Parnassos in Greece. It is also known from the western Caucasus in Abkhazia, U.S.R., where the first-named author has been fortunate enough to see it in 1976; it was long known erroneously under the name *D. villarii* (Bell.) Woynar ex Schinz et Thell., as in Britain, before the taxonomy of the group was worked out (Fraser-Jenkins 1977). The Turkish plants appeared to be slightly different from most of the European ones in their more adnate, less lobed pinnules with very long teeth at their apices (though similar plants also occur in Crna Gora (Montenegro), Yugoslavia, as, for example at the Čakor Pass, west of Peć), but they are clearly within the range of *D. submontana* and have the characteristic dense, sticky-glandularity of that species. A chromosome-count carried out by the second-named author on the plant from Geyik Dağ (CRFJ 9809, BM) has confirmed that it is tetraploid (n = 82), which, along with its morphology, demonstrates its distinctness from the other two species in the erstwhile *D. villarii* cytological complex, *D. villarii* and *D. pallida* (Bory) C.Chr. ex Maire et Petitm., which are both diploid. Recently the first-named author has also seen a further, previously unidentified, specimen of *D. submontana* from the Ala Dağlari (Nigde province), coll.: Findlay 227 (E), and it could therefore also be expected elsewhere in the Taurus, including the Bey Dağlari in the western Taurus. The
remoteness and lack of road access to many of the mountains in the Taurus range probably explains why it has not been found before and suggests the strong possibility of the existence there of other interesting and overlooked species of ferns.

FIGURE 1.
Holotype of *Asplenium tadei*

COLLECTION OF THE NEW SPECIES
On 9th September 1979 a first attempt was made to find the *Asplenium*, setting off by car well before dawn from a motel at Manavgat on the coast. The narrow and rough route to Geyik Dağ turns off the main road north from Manavgat to Konya to head eastwards to the village of Gündoğmuş, in the foothills of the mountains. In roadside limestone crevices in the *Pinus brutia* Ten. forest there occurred at c. 750m alt. numerous populations of *Dryopteris pallida* subsp. *libanotica* (Ros.) Nardi, a diploid taxon very close to subsp. *pallida*, differing only in having distinctively marginal sori with a wide gap between the two rows of sori on each pinnule. Interestingly, in this area of Turkey there is a transition between subsp. *pallida* in the west and subsp. *libanotica* in the east (and Cyprus, the Lebanon etc.), and the populations here contained some clearly transitional forms (with good spores, not hybrids) as well as both subspecies. Beyond Gündoğmuş the forestry road turns northward into the main range and becomes even more narrow, rough and tortuous, being used mainly by small trucks sadly carrying away quantities of the natural forest as timber, and passing along spectacular cliff-edges above the forest, winding up into extremely rugged, higher-level open limestone crags, where it passes the shepherds' village of Güzelbag.
and comes out, some four hours (by Range Rover) after the start, at the base of the peak of Geyik Dağ itself. On this first visit a direct and very hot and tiring ascent was made up the steep and dry west side of the mountain, over a ridge to the north-facing cirque, still containing snow-patches which last all through the summer, below the summit arête. At c. 2300m alt. plentiful Cystopteris alpina (Lam.) Desv.; lectotype in herb. Hort. Cliff. (BM!) is C. fragilis, (L.) Bernh., not Asplenium foreziense Le Grand as stated by Fuchs (1956 and 1980), with its very finely dissected fronds, was found, along with a hybrid, probably C. alpina × C. fragilis and also occasional Asplenium lepidum Presl. subsp. haussknechtii (Godot and Reuter) Brownsey, a species somewhat similar to A. ruta-muraria L.; but disappointingly there was no trace of the species being searched for. A second ascent was made on 12th September 1979 from the north side of the mountain after following a driveable shepherds’ track around the base. Above some shepherds’ huts at 2250m alt. a population of the correct Asplenium containing about 20 plants was discovered, with great delight, growing in crevices on some north-facing limestone cliffs. Unfortunately further investigation into the size and altitudinal extent of the population and into the presence of other species or hybrids suddenly became a great deal less interesting a proposition, and indeed was somewhat hastily abandoned due to the appearance of a gun-toting young man of somewhat wild appearance and ambiguous intentions, armed, as he demonstrated, with a fully loaded Czech pistol, and who, while waving his pistol in their direction, insisted on accompanying the collectors down the mountain in a state of slightly awkward tension to where the car was parked below. There, fortunately, traditional Muslim politeness was just able to be maintained, with a few expressions of Turkish, and it was possible to turn the car and depart somewhat speedily around the side of the mountain and back on to the road-track. In all, five specimens of the Asplenium were collected and pressed (CRFJ 9812-9816) and an offset of CRFJ 9812 was transported living, partly wrapped in moss, to Basel to be grown by Professor Reichstein. It was immediately obvious in the field that this species did not closely match any other, including A. daghestanicum; it appeared in morphology most like A. viride, but with more deeply lobed lower pinnae and the distinctive fused frond-apex mentioned above. Although difficult to grow, including from fresh spores, the plant lived long enough in culture at Basel for a fixing to be made by Professor Reichstein and sent to the second-named author, who in August 1981, obtained a tetraploid chromosome count on it, with \( n = 72 \), at meiosis. In our opinion the collection clearly represents a new species, and we describe it, named in honour of Professor Tadeus Reichstein, thus:—

**DESCRIPTION**

**Asplenium tadei** Fraser-Jenkins et Schneller, sp. nov.


Holotypus: Turkey; “Asplenium tadei, sp. nov. Holotype. N. side of Geyik Dag, above shepherds’ huts, N. of Gündogmus, N. of Alanya, Antalya Vil hayet, Turkey. N. facing shaded limestone cliffs. 2250m alt. C.R. Fraser-Jenkins (9815) and S.J. de C. Coombs, 12/9/1979” (BMI) (Fig. 1).

Isotypi: ditto (BMI Herb. T. Reichstein (5124 c), Basell). Paratypi: ditto 9812 (BAKUI CANVI BM) Herb. T. Reichstein (5123 A), Basell), 9813 (G1 Herb. T. Reichstein (5124 A), Basell), 9814 (KI PI PEI Herb. T. Reichstein (5124 B), Basell) and 9816 (BMI Herb. T. Reichstein (5124 D), Basell). Plant similar in morphology to A. viride but differing in its pinnae being more deeply lobed, with narrow extended lobes, and becoming pinnatifid-trilobate near the base of the lamina. Sori crowded near the base and centre of each pinna. The distinctive frond-apex is a lanceolate segment consisting of several fused pairs of pinnae and bears
several (c. 5-7) pairs of narrow lobes at the sides. Stipe often as long as the lamina, green, with a brown base extending up to 1/3 of its length; bearing minute filiform, dark scales at its base which become smaller but are scattered up the whole length of the stipe. Cytotype tetraploid sexual (CRFJ 9812, det. J.J. Schneller; T. Reichstein, pers. comm. 18 August 1981).

ORIGIN AND RELATIONSHIPS

As *Asplenium tadei* is a tetraploid species whose morphology does not fit any known diploid species it seems likely that it may be an allotetraploid (amphidiploid) species along with the great majority of other European and western Asian tetraploid species, and indeed the concept of a mixed morphology can probably explain most of the appearance of the species. From the narrowness of the frond, the undivided pinnae and mostly green stipe and rhachis it seems likely that *A. viride*, with which it grows sympatrically on Geyik Dağı, could very probably be one of its ancestral diploid species. The other ancestor is less clear, though it must be a species with more lobed and probably longer pinnae. As no other diploid species occur today in the European (*sens. lat.*) flora which have a fused frond apex similar to *A. tadei*, it is impossible to do more at this stage than make a vague guess as to the rest of its origin, and it should be borne in mind that there exist two groups of mainly Asian species, the *A. exiguum* and *A. daghestanicum* aggregates which all have such a feature, so that *A. tadei* may well belong to one of these groups as a markedly distinctive member, with a diploid ancestor in one of the groups, possibly shared with *A. daghestanicum*. There is also a possibility that its second ancestor could be the south Turkish, Lebanese and Greek Aegean islands (Rhodes, Kastellorizo and Karpathos) endemic *A. bourgaei*, another species present in the vicinity (see Greuter *et al.* 1983), but at much lower altitudes (up to c. 900m) nearer the coast. *A. bourgaei* has longer, narrower pinnae bearing lobes which are widely joined at their bases; it also has a tendency for the bases of the upper pinnae to fuse together near the frond apex, but not nearly as markedly or widely as in *A. tadei*. However, in an allopolyploid combination it is often difficult to predict which characteristics will be emphasised and which not. Greuter *et al.* (1983) mentioned Davis' record of his specimen (which they did not see) under *A. bourgaei*, but stated correctly that because of its "completely aberrant" altitude it needed confirmation and might be due to some confusion. *A. bourgaei* has not so far been treated as in any way close to *A. exiguum*, but we believe that both it and the rare and restricted south French endemic, *A. jahandiezii* (Litard.) Rouy are closer to the *A. exiguum* group (including the Sino-himalayan *A. nesii* Christ) than to any other European species, though on a larger, world-wide scale, such groups may not be so clearly applicable.

Further study of *A. tadei* including attempted hybridisation work will be carried out by Professor Reichstein at Basel.

ACKNOWLEDGEMENTS

The authors wish to thank Professor Reichstein for his help in studying this species, and the first-named author is most grateful for his kind financial grant in aid of his expedition to collect it. They also wish to congratulate him on the achievement of his 90th birthday.

REFERENCES


THE FERN HERBARIUM OF COL. F.J. HUTCHISON

JOHN EDMONDSON

Botany Department, Liverpool Museum, William Brown Street, Liverpool, L3 8EN

ABSTRACT

The history and composition of F.J. Hutchison's fern herbarium is given, based on a manuscript catalogue prepared by H. Stansfield, and extracts are quoted from relevant correspondence. The herbarium contains material from 24 collectors, including Edwin Atkinson, Lady Anne Barkly, Francis Brent, John Buchanan, Charles B. Clarke, John Day, Wilhelm Hillebrand, George F. Hose (Bishop of Singapore & Sarawak), F.J. Hutchison and his probable relative H. McLeod Hutchison, Phoebe Moss, Charles Parish, Thomas Powell, Richard Spruce, William Stout and George Wall. Hutchison's own collections were largely made between 1870 and 1872 in Ceylon (Sri Lanka); they came to Liverpool Museum via the Royal Albert Memorial Museum, Exeter.

HISTORY OF THE COLLECTION

One of the largest collections of tropical ferns in the herbarium of Liverpool Museum (LIV) was presented in 1947 by the Royal Albert Memorial Museum, Exeter. It had been acquired from the widow of Col. Frederick J. Hutchison, shortly after his death on December 2, 1981 at Stoke, Devonport, Devon. The collection amounts to some 1,800 mounted sheets, and is noteworthy because it is composed not only of material collected by Hutchison himself in Ceylon, but also of exchange herbarium material sent by some well-known pteridologists of the mid-Victorian period.

Three categories of material can be recognised. Firstly, there are specimens which Hutchison himself collected between 1870 and 1872 in Ceylon (and a few from Dartmoor and Bovisands (1875), Perthshire (1876) and Ascot (1879). The total number comes to 310 sheets. The principal collection localities in Ceylon are given in Table 1.

Secondly, specimens acquired by Hutchison from his pteridological contacts amount to some 1,553 sheets. A list of these collectors is given below. Both categories consist of material mounted on "fern-size" sheets (21 x 13 inches), are fully catalogued and numbered in taxonomic sequence from 1 to 1,863.

Lastly, there is a large and bulky series of unmounted material, much of which is only skimpily labelled. Some may duplicate Hutchison's collections. The number of unmounted and uncatalogued specimens was estimated at 9,000; this figure should be treated with caution, as some of the material consists of sequences of dismembered frond segments stored in separate paper folders which could be reassembled into a single frond.

The catalogue of the mounted material in the Hutchison fern herbarium was prepared by the Museum's former Keeper of Botany, Mr H. Stansfield, and was completed in 1958. No attempt was made to revise the nomenclature, which retains the taxonomic treatment adopted by Hutchison. This adheres closely to Synopsis Filicium (Hooker & Baker, 1974). Many of the statistical data in this article have been extracted from Stansfield's catalogue.

TABLE 1.

Gazetteer of collection localities in Ceylon (Sri Lanka) visited by F.J. Hutchison

(Spelling as on labels)

<table>
<thead>
<tr>
<th>Location</th>
<th>Date(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggelwatte</td>
<td>10.1871</td>
</tr>
<tr>
<td>Bullatotte Pass</td>
<td>7.1871</td>
</tr>
<tr>
<td>Colombo</td>
<td>8.9.1870, 7.1871, 9.1871</td>
</tr>
<tr>
<td>Condagailie Pass</td>
<td>1.1871</td>
</tr>
<tr>
<td>Dimboola Pass</td>
<td>3.1871</td>
</tr>
<tr>
<td>Galagana</td>
<td>4.1872</td>
</tr>
<tr>
<td>Galle</td>
<td>7.1871</td>
</tr>
<tr>
<td>Gonaganna</td>
<td>2.1872</td>
</tr>
<tr>
<td>Gongolla</td>
<td>4.1872</td>
</tr>
<tr>
<td>Hakgalla</td>
<td>1-2.1871, 5.1871</td>
</tr>
</tbody>
</table>
Although Hutchison’s own collecting activities in Ceylon were carried out privately while he was stationed there (with the rank of Major), it is clear from correspondence held at Liverpool Museum that he collaborated closely with the principal pteridologists of the period in Ceylon. One of these was Thomas W. Naylor Beckett (1839-1906), a coffee planter, whose herbarium and correspondence is kept at Liverpool Museum. Naylor Beckett was born in Liverpool and spent much of his life in Ceylon before moving to New Zealand in 1883.

A letter addressed to Naylor Beckett from George Wall, a fern enthusiast resident in Ceylon, describes a recently completed fern-hunting expedition. Dated “Colombo, July 23, 1871”, it commences:

“My dear Sir,

I returned here last night from a trip through Moosowakka Suffragum & Rahnapoora with Major Hutchison. I went on business but took my fern papers and worked on the way. Your kind letter and most valuable catalogue awaited my return and I lose no time in thanking you for them.

We had awful weather, but except on one day we carried out our programme and worked through the dreadful downpour, regardless of leeches end all the multiform discomforts of incipient rain. — I think we have made a very good bag, all things considered, and we have confirmed an opinion which we have both gradually been brought to that even the rare ferns are much more widely spread than generally supposed. Your list is in itself a strong confirmation of that opinion too ...”

The letter continues with a list of the chief new finds. It was written on a date midway through Hutchison’s period of fieldwork; see Table 1.

In the correspondence on file in Liverpool is a letter to Beckett from F.J. Hutchison dated “Colombo, 30 Dec. ’71”. It reads, in part:

“... Mr Wall wrote to you a full account of our doings at Matale, and I hope expressed, as I asked him to, my acknowledgments to you, with his own, for the excellent instructions you have given us, thanks to which the expedition was the most successful we had ever made ... We had, as you know, planned two other expeditions, one to your part of the country and another to the Singh Raja Forest, both of which Mr Wall’s engagements forced him to give up, much to our disappointment. The latter I have since partially accomplished, partially only, because I found the distances were not at all what I had been led to expect. In fact to quote Mr Thwaites, to whom I sent an account of my doings, I got “the cream of the Singh Raja Forest ferns.” Mr Wall has written to me thrice since he reached England. He has had some interviews with Baker at Kew [1], and sent me a copy of notes made there on some of the Ceylon ferns which I will enclose as I have no doubt you will be interested in them. You will see that Baker pronounces the Acrostichum, which we found near Morawaka, and of which Mr Wall sent you a specimen, to be a distinct species [2] and not merely a form of A. (Gymnopteris) variabile as we supposed ...

There will not I fancy be many gaps in your Ceylon collection but it is possible that I may be able to fill some of them for you, and I need scarcely say that it will give me the greatest pleasure to do so ...”

Notes: [1] John Gilbert Baker (1834-1920) was then an Assistant Curator of the Kew herbarium; later (1890-1899) he held the position of Keeper.


<table>
<thead>
<tr>
<th>Place</th>
<th>Date</th>
<th>Place</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hantam</td>
<td>1.1871</td>
<td>Newera Eliya</td>
<td>1-2.1871</td>
</tr>
<tr>
<td>Hapootella</td>
<td>5.1871</td>
<td>Oodoowelle</td>
<td>10.1870, 1.1871</td>
</tr>
<tr>
<td>Helbodde</td>
<td>8.1870</td>
<td>Pittawelle</td>
<td>8.1871</td>
</tr>
<tr>
<td>Hewissa</td>
<td>10.1871</td>
<td>Poorie</td>
<td>5.1872</td>
</tr>
<tr>
<td>Hoolakande Pass</td>
<td>8.1871</td>
<td>Puselawe</td>
<td>8.1870, 1.1871</td>
</tr>
<tr>
<td>Horton Plains</td>
<td>4.1872</td>
<td>Rambodde Pass</td>
<td>1.1871</td>
</tr>
<tr>
<td>Kambodde</td>
<td>8.1870, 1.2.1871</td>
<td>Rambodde</td>
<td>2.1871</td>
</tr>
<tr>
<td>Kandy</td>
<td>10.1870</td>
<td>Rottowa forest</td>
<td>7.1871</td>
</tr>
<tr>
<td>Kegalli</td>
<td>6.1872</td>
<td>Telgamma</td>
<td>10.1871</td>
</tr>
<tr>
<td>Kornegalle</td>
<td>2.1870</td>
<td>Vicarton</td>
<td>8.1871</td>
</tr>
<tr>
<td>Maturalta</td>
<td>4.1871</td>
<td>West Matale</td>
<td>8.1871</td>
</tr>
<tr>
<td>Morowa Korle</td>
<td>7.1871</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There is also at Liverpool a letter to Beckett from Wall dated "Colombo, 19 July 1872" which refers to "Major H.". The text of the letter is as follows:

My dear Sir,

I acknowledged your kind letter a day or two ago and I now send you a list of the ferns I have yet to find. It is cleared of several by my last trip and does not contain a large proportion of very rare ones. Of these I have been fortunate in finding a good many. Of Diacalpe Aspidioides for instance Major H. and I discovered the headquarters between Mathooratee [1] and Ordupussellmon on the Kooroonda Oga where we found it in profusion and of great size. One frond I gave Mr Thwaites [2] was 2 feet long without the stipes. — Still I have a deal to do to complete my collection of known ferns, especially as some of those I found at first I spoiled not knowing how to manage them. I have not more than 150 or 160 species mounted and fit to mount.

I have also suffered loss by insects, and it is a serious labour to poison all even with my rolling apparatus, which is infinitely more expeditious than the feather or brush. I hear there is a better method of poisoning by means of the fumes of Carbolic Acid. — Do you know this method?

I fear I shall not be able to visit Dick [3] or you again so soon as I intended: but I must go to East Matahi and to Singhe Rajah forest before I go home if possible.

The Nephrodieae trouble me so much and I do not take much notice of them, as I expect to tackle them separately when I have cleared off all the rest. Latterly I have collected considerable quantities of all the ferns I have found, so I hope to be able to requite your kindness by contributing to your collection. I send herein a frond of an Acrostichum which I suppose I am bound to call Ac. Variable [4] but my series of this plant was already most remarkable before I added this to the strange variety of forms this fern assumes. Do you know this form?

More anon

Yrs very Sincerely,

George Wall.

Notes: [1] Hutchison has a specimen of *Diacalpe aspidioides* (cat. no. 103) from "Maturatte, April 71". This species is now sometimes known as *Peranema aspidioides* (Blume) Mett. (e.g. Sledge, 1982).

[2] G.H.W. Thwaites (1812-1882) was, at the time, Director of the Botanic Gardens at Peradeniya, Ceylon. According to Desmond (1977), G. Wall was a friend of his.

[3] "Dick" is possibly a reference to Richard Henry Beddome (1839-1911), author of "Ferns of British India" (1865-70).


The Hutchinson herbarium contains 42 specimens contributed by George Wall in addition to those which were collected during joint excursions. It is significant, however, that Hutchison did *not* receive material from either Thwaites or Naylor Beckett.

The list of collectors represented in the Hutchinson herbarium includes only one other botanist resident in Ceylon: William Ferguson (1820-1887), a civil servant in Ceylon who published various works including "Ceylon Ferns" (1872) and "Ceylon Ferns and their Allies" (1880). There are letters from Ferguson to Naylor Beckett in the files at Liverpool, one of which reveals that Beckett assisted Ferguson in the editing of his "Ceylon Ferns" prior to publication.

The picture one builds up is of a group of enthusiasts co-operating in the mutual enrichment of their collections, some of whom — Hutchinson included — were able, through fieldwork, to contribute rarities at the request of other collectors and who in turn acquired valuable exsiccata from other parts of the world.
vol. 1, 1906: chapter entitled "Vitae Itineraque Collectorum Botanicorum"
See also Greenwood (1972).

Orange River Colony, South Africa.

Clarke, Charles Baron (1832-1906). Superintendent of Calcutta Botanic Gardens, 1869-71; worked at Kew after retirement. Co-author (with Henderson) of "Ferns of N. India" (1880). Dhusmala, India, 1874.

Corrie, Dr. Dates and occupation unknown. Fiji.

Provenance given as "New Caledonia". Although only a few specimens are attributed to "Craig" in Stansfield's catalogue, there is a significant number of specimens from New Caledonia which lack details of the collector. By checking the names of such ferns in Flore de la Nouvelle Calédonie, no. 3: Pteridophytes (Brownlie, 1969) it is clear that they include a number of endemic species collected by Vieillard. It is likely, though difficult to prove, that Craig supplied Hutchison with a collection whose labels had been lost or discarded.

Day, John (1824-1888). Amateur fern and orchid enthusiast and traveller. Australia, Ceylon, Fiji, Indonesia, Japan, New Zealand, West Indies (Trinidad, Jamaica). Most are from Japan.

Ferguson, William (1820-1887). Surveyor, Ceylon Civil Service. Author of "Ceylon Ferns". Ceylon, St. Helena.


Grant, James Augustus (1827-1892). Army Officer. Hong Kong.


Hutchison, H. McLeod (1840-1925). Army Officer. Probably a relative of F.J. Hutchison, but exact relationship unknown. According to Hart's Army List for 1867, he was Lieut. in the 14th (Buckinghamshire) Regiment of Foot, whose 2nd Battalion returned from Jamaica in 1864. Jamaica (see also Prior).

Moss, Miss (dates unknown). An amateur naturalist who, in 1885, introduced the Common Myna (Acridotheres tristis) and the Grass Frog (Rana grayi grayi) to St. Helena. [Information from Dr Q. Cronk in litt. 24.11.1982].

Wall, George (c. 1821-1894). Head of the firm of George Wall & Co., a businessman based in Colombo and keen amateur pteridologist. Ceylon.

ACKNOWLEDGEMENT
I am indebted to Stephen Harrison for his unpublished notes on the Hutchison herbarium, which saved me much time in the preparation of this account.

REFERENCES
BEDDOME, R.H. 1865-1870. The ferns of British India. Madras.
THE STATUS OF *OPHIOGLOSSUM AZORICUM* (OPHIOGLOSSACEAE : PTERIDOPHYTA) IN THE BRITISH ISLES

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**ABSTRACT**

The status of *Ophioglossum azoricum* in the British Isles is examined by comparing the gross morphology, epidermal features, spores and cytology of the three British species of *Ophioglossum*, *O. azoricum*, *O. lusitanicum* and *O. vulgatum*, together with their ecology and distribution. The possibility that *O. azoricum* is just an ecotype of *O. vulgatum* is considered. It is concluded that these two taxa cannot be satisfactorily separated morphologically and that *O. azoricum* appears to be merely at one end of the spectrum of variation shown by *O. vulgatum*. *O. azoricum* is maintained as a separate species for the present because certain populations are so distinct in habit, but it is now evident that cytological investigation combined with extensive field studies is necessary to elucidate the status of this taxon.

**INTRODUCTION**

The taxon now known as *Ophioglossum azoricum* C. Presl was first found and recognised in Britain as distinct by J. Boswell Syme in the Orkneys in the mid-19th century (Boswell Syme 1871). Due to its similarity to *O. vulgatum* L., it has been referred to as a variety or subspecies of that species in the European literature for well over 100 years. However, in 1964, Rothmaler accepted *O. azoricum* as a species. He described it as morphologically distinct from *O. vulgatum*, and intermediate in many respects between that species and *O. lusitanicum* L.

The nomenclature of the taxon has been rather confused (see synonymy below). This can be principally attributed to the existence in Africa and parts of western Asia of a further taxon, *O. polyphyllum* A. Braun, which was erroneously regarded by some botanists as a subspecies or variety of *O. vulgatum*, and to which some European specimens were referred. Pichi-Sermolli (1954) showed that *O. polyphyllum* was distinct from the European plants, which he referred to *O. vulgatum* var. *ambiguum* Coss. & Germ. A comparison of these two taxa and their distribution in Macaronesia is given by Lobin (1986).

There are three species of *Ophioglossum* in the British Isles, of which one, *O. lusitanicum*, may easily be distinguished morphologically from the other two. Its winter growing season also means its identity is unlikely to be mistaken. *O. azoricum* and *O. vulgatum*, however, are less easy to separate, as most of their characters overlap markedly in range. This comparative study of the three taxa was undertaken to find characters to distinguish the two summer-growing species, and also to see if *O. azoricum* is truly intermediate between the other two and sufficiently distinct to warrant specific recognition.

**Synonymy**


CYTOLOGY

Löve and Kapoor (1966, 1967) suggest that *O. azoricum* is of hybrid origin, an allopolyploid derivative of a chance hybrid between *O. vulgatum* and *O. lusitanicum*. The taxon may be intermediate morphologically, but the cytological basis for their hypothesis is founded on insubstantial evidence.

Few chromosome counts have been reported for European specimens of *Ophioglossum*. These are summarised in Table 1. As yet, counts for British plants have been published from only one sample each of *O. lusitanicum* and *O. vulgatum* (Manton 1950) and none for *O. azoricum*. European counts suggest the chromosome number of *O. vulgatum* is $n = 240-260$, and of *O. lusitanicum* is $n = 125-130$. However, Löve and Kapoor (1966, 1967) give the chromosome number of *O. lusitanicum* as $2n = 240$, but with no reference source. Furthermore, their count for *O. azoricum* ($2n = 720$) is based only on Icelandic material. They consider their earlier count (given under the name *O. vulgatum* ssp. *ambiguum* var. *islandicum* Löve & Löve, in Löve & Löve 1961) of $2n = 480$ to be an inexact estimate. This is presumably the basis of ‘$2n = c.480$’ cited for *O. azoricum* in *Flora Europaea*; Rothmaler’s decision to recognise the taxon here as a good species was not based on cytological evidence.

Further cytological studies of this genus in Britain and Europe as a whole (including the Azores) are obviously required, particularly to help establish the status of *O. azoricum*. It is interesting to note that Japanese material of *O. vulgatum* has also given a chromosome count of $n = 240$ (Kurita & Nishida 1965), but that Indian specimens of *O. lusitanicum* and *O. vulgatum* have revealed chromosome numbers of a range approximately double those of European and Japanese material (Ninan 1956, 1958, Verma 1956).

<table>
<thead>
<tr>
<th>Species</th>
<th>Origin</th>
<th>Author &amp; Date</th>
<th>$n$</th>
<th>$2n$</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>O. lusitanicum</em></td>
<td>Guernsey</td>
<td>Manton 1950</td>
<td>125-130</td>
<td>c. 128</td>
</tr>
<tr>
<td></td>
<td>England</td>
<td>Manton 1950</td>
<td>250-260</td>
<td>c. 256</td>
</tr>
<tr>
<td><em>O. vulgatum</em></td>
<td>Sweden</td>
<td>Ehrenberg 1945</td>
<td>240, 247-</td>
<td>c. 344*</td>
</tr>
<tr>
<td><em>O. vulgatum</em></td>
<td>Netherlands</td>
<td>Verma 1958</td>
<td>251 (c. 248)</td>
<td></td>
</tr>
<tr>
<td><em>O. vulgatum</em></td>
<td>Finland</td>
<td>Sorsa 1962</td>
<td>250</td>
<td>c. 480</td>
</tr>
<tr>
<td><em>O. vulgatum</em></td>
<td>Spain</td>
<td>Löve &amp; Kjellqvist 1972</td>
<td>480</td>
<td></td>
</tr>
<tr>
<td><em>O. vulgatum</em></td>
<td>Sweden</td>
<td>Löve &amp; Löve in 1976</td>
<td>480</td>
<td></td>
</tr>
<tr>
<td><em>O. azorianum</em></td>
<td>Iceland</td>
<td>Löve &amp; Köppel 1966, 1967</td>
<td>360</td>
<td>720</td>
</tr>
<tr>
<td><em>O. azorianum</em></td>
<td>Iceland</td>
<td>Löve &amp; Löve in 1976</td>
<td>720</td>
<td></td>
</tr>
</tbody>
</table>

* based on sectioned cells rather than a ‘squash’
** as *O. vulgatum* ssp. *ambiguum* var. *islandicum*

MORPHOLOGY

General morphology

As previously mentioned, *O. lusitanicum* is morphologically distinct from the other two British species, but *O. azorianum* and *O. vulgatum* overlap considerably in their range for most characters. They are usually separated by the number of fronds per plant,
frond size and shape, and the number of sporangia per fertile spike. For example, two of the criteria used to recognise *O. azoricum* for the *Atlas of Ferns of the British Isles* (ed. A.C. Jermy et al. 1978) were 14 or less pairs of sporangia and a sterile blade less than 3.5 cm long.

*O. vulgarum* is said to produce usually only one frond, occasionally two per plant, whilst *O. azoricum* and *O. lusitanicum* regularly bear 2-3 fronds. However, populations observed in the field or preserved as herbarium specimens indicate that *O. vulgarum* produces more than one frond more commonly than is generally supposed, and the other species have usually two fronds, sometimes one, and occasionally three.

*O. lusitanicum* is not a variable species. Sterile blades are narrowly lanceolate, 8-23(-38) mm long, 1.5-4(-6) mm wide. They are widest at about the centre of the frond, narrowing gradually to the base and apex, the latter being slightly rounded. The sterile blades of *O. vulgarum* tend to be broadly ovate-lanceolate to ovate, usually widest below the middle. They are extremely variable in size and shape even within a single population, 17-150 x 8-58 mm, with the apex ranging from acute to very rounded or apiculate. The base may be attenuate to cordate, often clasping the stem. Some specimens of *O. vulgarum*, on the other hand, are relatively small, with lanceolate sterile blades, and are very similar to those of *O. azoricum*. The latter have blades 9-22 (-40) x 4-10(-14) mm which are broadly lanceolate to ovate, usually with cuneate bases and acute to obtuse apices, the lamina being broadest at or just below the centre.

The angle at which the sterile blades grow is sometimes distinctive for different *Ophioglossum* species. Those of *O. lusitanicum* are often reflexed, and so held close to the ground (Fig. 1b), though occasionally they are more upright. Fronds of *O. vulgatum*, by contrast, tend to be quite erect (Fig. 1a). *O. azoricum* tends to resemble the former in its reflexed habit (Fig. 1c, d), a feature not mentioned in the type description, but shown by some individuals of the isotype (BM). This is, of course, a character which is often lost on herbarium specimens, however carefully they are pressed (Fig. 2), but it seems, generally speaking, to be one of the best field characters.

The other principal character commonly used is the number of pairs of sporangia on the fertile spike. *O. lusitanicum* has 3-8(-13), *O. vulgatum* 11-44, and *O. azoricum* 4-13(-17), the range for the latter overlapping that of the other two species. Size of fronds and sporangial number do not seem to be directly correlated; some specimens of *O. vulgatum* with tiny leaves (less than 2cm long) may have as many as 20 sporangial pairs, others far fewer, and likewise some large individuals have relatively few sporangia.

Other features of plants, such as the length of the fertile spike and the common stalk, and the relative proportions of fertile blades were studied for a large number of specimens, but did not prove to be useful in identification. They are very variable, differing with the maturity of the plant, depth of the rhizome below the soil surface, habitat and climate. The shape of the rhizome is also not constant. *O. lusitanicum* does tend to have an elongated, rather cylindrical rhizome, but in the other species small specimens have relatively small, globose rhizomes, whereas in larger individuals they are considerably bigger and much more elongated. Hand-cut sections of roots of varying sizes stained with safranin showed the stele of all three taxa to be monarch.

**Venation and epidermal characters**

Venation was one of the key characters on which Prantl (1884) based his classification of *Ophioglossum*. Clausen (1938), however, realised that venation was not a reliable character, due to its variability within a single population. In 1962, Mahabale based a key to Indian *Ophioglossum* species on characters of venation. Panigrahi and Dixit (1969) likewise considered venation important in identification, and Bhambie and Madan (1982) also reported venation patterns to be taxonomically significant at species level, in terms of areole number per unit area of frond. However, Wagner *et al.* (1981) and Wagner *et al.* (1984) showed that a single species could produce a range of fronds, from small ones with simple venation to large forms with more complex venation.

In this study, fronds taken from herbarium sheets were cleared in 10% bleach ('Domestos') and stained with an aqueous solution of methylene blue. They were thereafter stored in 50% alcohol. Venation patterns were drawn using a microscope drawing attachment, or by tracing photographs. *O. lusitanicum* was the most distinct species, having only a primary network of veins forming rather long, narrow areoles parallel with the mid-vein. Very few included free veinlets are present (Fig. 3a, b). The areoles of the primary vein reticulum of *O. azoricum* are less protracted, and the more central, larger areoles contain a finer secondary mesh. Included free veinlets are common but not numerous (Fig. 3c, d). The venation pattern of *O. vulgatum* is much more variable, probably owing to its range of frond size. In large fronds, the majority of primary areoles contain finer veins forming a secondary network, and also many free included veinlets (Fig. 3f). In smaller blades the secondary reticulum is less well-developed and has few free included veinlets (Fig. 3e), thus not being very significantly different to that of *O. azoricum*. Since it is usually small-fronded *O. vulgatum* specimens which tend to be confused with specimens of *O. azoricum*, it appears that
venation characters are of rather limited usefulness. If extensive studies of fronds of different sizes and developmental stages could be undertaken similar to those of Wagner et al. (1981), differences between the venation patterns of *O. azoricum* and small individuals of *O. vulgatum* might become evident. However, it is equally possible that *O. azoricum* would prove merely to be at one end of the spectrum of variation shown by *O. vulgatum*.

Epidermal characters, particularly cell-shape and stomatal orientation, have also been considered useful in distinguishing species of *Ophioglossum* (Prantl 1884, Mahabale 1962, Maroti 1965, Van Cotthem 1970, Pant & Khare 1969). For this investigation whole fronds, cleared and stained as above, were mounted and photographed using bright field microscopy. In one case the epidermis was peeled off and mounted in glycerine jelly. In each sample the area between the mid-vein and margin in the centre of the frond was photographed for comparative study and then drawn from the negative with the aid of a photographic enlarger.

Once again it is *O. lusitanicum* which is markedly different from the other species. The epidermal cells on the lower surface are narrowly rectangular and parallel with the long axis of the frond (Fig. 4b); on the upper surface the cells are squarer and more rounded (Fig. 4a). The lower epidermal cells of large fronds of *O. vulgatum* have very undulating margins, tending to be fairly long and narrow and parallel with the long axis of the frond (Fig. 4h); those of the upper surface have similarly undulating edges, but they are much more irregularly shaped (Fig. 4g). In small-fronded individuals, the epidermal cells of both surfaces are much smaller, with very much less sinuous margins (Fig. 4e, f). *O. azoricum* specimens studied greatly resemble small individuals of *O. vulgatum* in the shape of epidermal cells though the margins are rarely sinuous (Fig. 4c, d).

In all three species the stomata are sunken, and distributed more or less equally on both surfaces of the fronds. On the lower surfaces the stomata are all parallel with the main vein (Fig. 4b, d, f, h). In *O. lusitanicum*, the stomata on the upper surface are also mostly parallel with the long axis of the frond (Fig. 4a), but in the other two species they are randomly orientated (Fig. 4c, e, g), even in the centre of the frond.

Thus it seems that the epidermis does not provide good characters for separating *O. azoricum* and small specimens of *O. vulgatum*.

**Spores**

As early as 1857 spores were considered diagnostic for distinguishing European *Ophioglossum* species (Durieu de Maissonneuve 1857). Prantl (1884) placed considerable emphasis on spore size and ornamentation in his classification of the genus and these characters were also found to be useful in distinguishing Japanese species (Nakamura & Shibasaki 1959, Kurita 1981) and Indian species of *Ophioglossum* (Mahabale 1962, Pant & Khare 1971). However, in the most recent monograph of the genus, Clausen (1938) found spore characters to be of only limited value in distinguishing species, although this may in part reflect his broad species concept. Wieffering, in his preliminary revision of Indo-Pacific species of *Ophioglossum* (1964) implied that spores were characteristic only of sub-genera rather than species.

All spores used for this study were removed from herbarium specimens and were not chemically treated prior to observation. Spores were glued to stubs with ‘Araldite’, coated with gold palladium and examined with an Hitachi S800 SEM. Permanent preparations are kept at BM.
FIGURE 4. Epidermal features of *Ophioglossum*. Portion illustrated is from centre of sterile blade half-way between mid-vein and margin; vertical axis of frond is horizontal across page. a,b, *O. lusitanicum*, G. Wolsey, March 1869, Guernsey, Channel Islands; a, upper epidermis and b, lower epidermis. c,d, *O. azoricum*, A. Cleave, June 1982, Lundy, Devon; c, upper epidermis and d, lower epidermis. e,f, *O. vulgatum*, R.J. Pankhurst & A.O. Chater, 12 August 1983, Berneray, Outer Hebrides; e, upper epidermis and f, lower epidermis. g,h, *O. vulgatum*, F.J. Hanbury, 12 June 1875, Trotter's Cliff, Kent; g, upper epidermis and h, lower epidermis.
The equatorial diameter of spores, taken from at least five herbarium specimens of each species, was measured in air. The overall size range for 30 spores from each sample was as follows (range of sample means in bold):—O. vulgatum 28-30-38-43μm, O. lusitanicum 28-29-34-40μm, O. azoricum 35-38-42-45μm. Page (1982) also found that spores of O. lusitanicum tend to be smaller, and those of O. azoricum larger, than O. vulgatum spores, but Ferrarini et al. (1986) report spores of O. lusitanicum in Italy to be intermediate in size between those of O. vulgatum and O. azoricum. However, the ranges overlap considerably, and since a single sample may have a range of up to 10μm, it is important to use the mean size of a large sample. It should also be noted that the medium in which spores are measured has a bearing on size, and it is advisable to use controls of known identity.

Spore size is thus of limited usefulness, and the same seems to be true of the ornamentation of spores, as revealed by light microscopy (LM) and scanning electron microscopy (SEM). Spores of European O. vulgatum have been variously reported as being tuberculate (Durieu de Maissonneuve 1857, Rothmaler 1964), having small, but distinct blunt tubercles (Page 1982), lopho-reticulate (with projecting anastomosing ridges forming an open angular reticulum) (Harris 1955), having a coarse network, tubercular in outline (Verma 1958), verrucate, appearing reticulate (Pant & Misra 1976), reticulate with prominent lamellae (Knox 1951), reticulate with muri which vary remarkably in height and width (Ferrarini et al. 1986), and scabrose-foveolate or bacululate (Moe 1974). O. lusitanicum spores, on the other hand, have been commonly described as smooth (Durieu de Maissonneuve 1857, Rothmaler 1964, Page 1982), though Knox (1951) described them as irregularly pitted, Fernandes & Queirós (1980) as finely reticulate with small areoles, Ferrarini et al. (1986) as foveolate, and Wildpret de la Torre et al. (1974) as granular. Spores of O. azoricum have been referred to as tuberculate (Rothmaler 1964), coarsely reticulate, not tuberculate (Bailey 1880) and reticulate- verrucate (Fernandes & Queirós 1980).

There is obviously a lack of uniformity of terminology throughout the literature, although there is considerable variation in spore wall ornamentation between spores of different populations of a species, and even of one individual. Spores of O. lusitanicum were more uniform than those of the other two species. SEM studies revealed O. lusitanicum spores were irregularly pitted with many small, irregularly shaped pits, these being more numerous on the distal surface (Fig. 5e, f). These pits are visible in LM, and the outline of spores in equatorial view appear almost smooth, but slightly crenate.

O. vulgatum spores are much more variable than those of O. lusitanicum. The majority of spores observed under SEM were deeply pitted, especially on the distal surface where the many large, irregularly shaped pits were crowded together, the pit walls thus forming a very irregular reticulum (Fig. 5b). On the proximal surface the pits are usually smaller and further apart (Fig. 5a). Some spores studied, however, have more widely-spaced pits, still forming a reticulum, but with some walls much wider and flat-topped. This supports the view that the reticulum comprises pit walls rather than tubercles. Under LM the equatorial outline of all spores is irregularly tuberculate, but the reticulum on the distal surface is also visible.

The spores of O. azoricum are generally intermediate in ornamentation between the above species. Most spores studied by SEM were irregularly pitted on both surfaces, the irregularly shaped pits being generally further apart on the proximal surface, and slightly larger than the pits of O. lusitanicum spores (Fig. 5c, d). LM observations also reveal these pits, and the equatorial view is not as smooth as in O. lusitanicum spores, but usually more regular and not as tuberculate as in spores of O. vulgatum. However, some O. azoricum spores have larger pits which are crowded together, forming a reticulum as in O. vulgatum.
FIGURE 5. SEM photographs of *Ophioglossum* spores. All x1300. a, b, *O. vulgatum*, M. Bell, July 1977, Aston Clinton, Buckinghamshire; a, proximal view and b, distal view. c, d, *O. azoricum*, F. Townsend, June 1863, St. Agnes, Scilly Isles; c, proximal view and d, distal view. e, f, *O. lusitanicum*, M. Dawber, 21 January 1886, Guernsey, Channel Islands; e, proximal view and f, distal view. All spores untreated.
Thus, three distinct types of spore have been found in British Ophioglossum corresponding to the three taxa and these are shown in Fig. 5. However, there is considerable variation and thus overlap, particularly between O. azoricum and O. vulgatum, which means spore ornamentation is not a reliable character in distinguishing these two species. The spore wall surface between the pits is granular in most samples of the three species, though in some specimens the granules appear to coalesce. It is difficult to be sure that spores of equal maturity are examined in every case, and it is likely that some of the differences in the spore wall ornamentation may be attributed to different degrees of maturity, as some wall layers are not deposited until just prior to sporangial dehiscence, and layers which have been laid down may be entirely or partly lost before spores are examined (Lugardon 1978).

**DISTRIBUTION AND ECOLOGY**

**Distribution of Ophioglossum in Europe**

Durieu de Maisonneuve (1857) discusses at some length what was probably the first discovery in Europe of the taxon now called O. azoricum. It was found in two quite different French localities, Pocancy near Paris by Puel and Vigineix in 1846, and in the coastal dunes at Cap-Ferret near Arcachon in 1857 by Durieu de Maisonneuve. These discoveries caused great excitement among local botanists, who debated whether the plants were O. lusitanicum, a reduced form of O. vulgatum or indeed, a third species. The taxon was described and named a few years later by Cosson and Germain (1861) as O. vulgatum var. ambiguum.

O. azoricum has since been reported from a number of European countries, and the distribution given for this species in *Atlas Florae Europaeae* (Jalas & Suominen 1972) is western Europe, from Iceland in the north, Great Britain, Ireland and France, to the Azores, Portugal, Corsica and Sardinia in the south, and Czechoslovakia and Poland in central Europe. Other records give O. azoricum in Spain (e.g. Casasecas et al. 1982, López González 1983, Monge & Velayos 1984) and (as O. vulgatum f. ambiguum) in Italy (Fiori 1943). Lobin (1986), in his discussion of Ophioglossum in Macaronesia, reports O. azoricum from Madeira as well as the Azores, but regards reports for the Canary Islands and Cape Verde Islands as erroneous. Many of these sites are coastal or at least have an Atlantic climate; others are continental, which is interesting since specimens found inland in Britain with an Atlantic climate would normally be considered to be small O. vulgatum, and not candidates for O. azoricum. However, since the identity of this taxon is probably as confused in Europe as it is in Britain, these records may not reflect its true distribution.

O. lusitanicum is essentially a species of the Mediterranean region and western Europe, ranging from Portugal in the west to Turkey in the east. This is again a predominantly coastal plant with some inland stations. The third species, O. vulgatum, on the other hand, occurs throughout most of Europe, but is rarely found in the Mediterranean region.

**Distribution and ecology of Ophioglossum in Britain**

*Ophioglossum vulgatum* is relatively common throughout Britain, particularly in lowland central and south-eastern England. It is less frequent in the upland areas of Scotland, Wales and south-west England. Fronds generally appear in late April or May, mature in June or July and die down in August to September.

This species grows in a wide variety of habitats. Most commonly it may be found in old damp meadow pastures, but it also occurs on the drier chalk downlands of southern England, as well as in old chalk pits and marl pits. Damp, often peaty depressions in heathland provide a suitable habitat, as do sand-dune slacks. In E. Norfolk *O. vulgatum* grows in mown Phragmites mire on shallow peat over lake muds,
and the species has also been collected from the edge of a wet willow wood where it was growing in shallow water on flint shingle. Colonies are often found on sandy soils growing in association with bracken, and also in woods, copses and hedgebanks, sometimes in deep shade.

By contrast, *O. lusitanicum* is a very local species, found only in a few sites on St. Agnes in the Scilly Isles, and Guernsey in the Channel Islands. Plants may be evident above ground as early as September, maturing from November to March and dying down by the end of April. Timing depends on the seasons, which may vary considerably from year to year. This tiny fern is mainly to be found in short turf on the moist peaty or sandy soil of coastal rocky downs and cliff-tops. These sites usually face south or south-west and are relatively exposed.

Jeremy *et al.* (1978) record the distribution of *O. azoricum* as Channel Islands, Scilly Isles, Lundy (Devon), Studland (Dorset), Skomer Island (Pembrokeshire), Ravenglass (Cumberland), Inner Farne (Northumberland), St. Kilda (Outer Hebrides), Dunnett Head (Caithness), and a number of sites in Merioneth, Caernarvon, Anglesey, Shetland Islands, Orkney Islands and the west coast of Ireland (Donegal, Sligo, Mayo and Kerry). These records were based on data culled from herbarium specimens, floras and field records, using the criteria of sporangial number (14 or fewer pairs), sterile blade size (less than 3.5cm long) and habitat (occurring in short turf near the sea). There are a number of specimens from other sites in various British herbaria labelled *O. azoricum*. However, I am doubtful that many of the specimens from these well-known localities are anything other than small forms of *O. vulgatum*, and have seen more convincing specimens from inland sites in Hampshire. *O. azoricum* follows the same seasonal growth pattern as *O. vulgatum*, being evident from April to September and maturing in June or July. It is reported to grow in short, grazed turf on top of cliffs and sea crags (e.g. in Orkney), and also in sand dune slacks (e.g. at Ravenglass). These are generally damp, often exposed sites, similar to those preferred by *O. lusitanicum*.

I have seen the following specimens which are distinct in habitat from *O. vulgatum* and have small fronds and relatively few sporangia thereby falling within the present concept of *O. azoricum*:


**DISCUSSION**

Species delimitation in *Ophioglossum* is a worldwide problem. These simple plants have few characters relative to other ferns, and classifications have often been based on features which in other pteridophytes would be considered unnoteworthy. Of the
three species recognised in Britain, *O. lusitanicum* is clearly distinct in terms of growing season, size, frond shape, venation, epidermal cells and stomata, and spore ornamentation. The other two taxa, however, were found to overlap in all these respects to such an extent that many herbarium specimens could not be determined with any degree of certainty. The above features do not really help to separate *O. azoricum* from small specimens of *O. vulgatum*, though it is perhaps possible that more extensive studies might reveal significant differences between the taxa that were not evident in this study.

It is common for juvenile plants, especially ferns, to be fertile despite their small size and with a morphology often quite different from that of mature specimens. There is no reason why this should not apply to *Ophioglossum*, and it may be that some plants named *O. azoricum* are merely juvenile forms of *O. vulgatum*.

Wagner *et al.* (1981) point out that those familiar with *Ophioglossum* in the field are more likely to have reliable taxonomic opinions than herbarium workers. It is true that different populations undoubtedly appear very distinct in the field, but how much of this is due to ecotypic variation? Wagner *et al.* (1981) showed experimentally the range of variation in frond size and venation in a single species.

It seems quite possible that *O. vulgatum* would not grow as luxuriantly in exposed or heavily grazed coastal sites, as in a damp meadow, just as other pteridophyte and spermatophyte species growing in adverse conditions are stunted and different in habit to specimens in more favourable situations. An example of this may be the Hampshire specimens referred to above which grow in small damp depressions in areas regularly trod by humans and grazed by rabbits. These plants greatly resemble coastal specimens by *O. azoricum* in size and habit. Are the Hampshire specimens true *O. azoricum*? Alternatively, are many, if not all the populations hitherto called *O. azoricum* in reality just an ecotype of *O. vulgatum*? It is interesting to note a comment by P. Taylor (unpubl. data) that he has produced plants similar to those of *O. azoricum* on Skomer Island by starving ordinary *O. vulgatum*. Miss E. Bullard (pers. comm. via A.C. Jermy) likewise considers that one would expect frond size and sporangial number to be reduced in the impoverished soils of Orkney where *O. azoricum* is found. I hope to cultivate under uniform conditions plants which appear distinct from different habitats, and also to take plants from a single population and grow them under a variety of conditions, to see if differences are maintained in the first instance or generated in the second.

The angle at which the sterile blade is held was noted to be a useful field character. Specimens of *O. azoricum* from Ravenglass and Lundy had distinctly reflexed fronds compared to the upright habit of *O. vulgatum*. This feature is, however, not clearly shown by herbarium specimens. There is an interesting series of collections from Swambister, Orkney, made by J.T. Boswell Syme over a period of 20 years. The samples may be from more than one population, but there is a great range of variation in size. In general, the larger the specimen, the more numerous the sporangia. One sheet in particular (BM) has many specimens collected in 1855 with two fronds, sterile blades up to 50-60mm long, 20-25mm wide and up to 19 pairs of sporangia. Many of these do have distinctly reflexed fronds. Most of the other collections from 1855, 1873 and 1875 comprise smaller individuals with 7-16(-18) sporangial pairs and sterile blades 7-35 x 4-15mm. A high proportion of these have more than one frond per plant and sterile blades reflexed to some degree. Plants in the first-mentioned collection, although larger than *O. azoricum* is usually defined, do appear to have the characteristic habit of this taxon. Even this feature may be the result of the habitat; in the taller vegetation of *vulgatum* sites fronds are more likely to be erect and tall, whereas in the short turf of *azoricum* sites they are more likely to be
small and reflexed. Ecological data of any sort is often absent from herbarium specimen labels, so extensive field studies would be most useful, collecting data on frond size and habit, ecology including observations on associated species, height of vegetation etc. Photographs to accompany herbarium specimens would contribute valuable information.

In conclusion, it is evident that although there are some specimens which are distinct in size and habit from typical $O. vulgatum$ and which may be confidently termed 'O. azoricum', there are many individuals and populations intermediate between these two extremes. This prevents satisfactory separation of the two species on morphological grounds. They do not seem to be as distinct in measurable terms as the two North American varieties of $O. vulgatum$ (now recognised as species) studied by Wagner (1971). Although in many respects it seems that $O. azoricum$ should be synonymised with $O. vulgatum$, the fact that some populations are so manifestly distinct with their tiny reflexed leaves leads me to accept it as a separate species for the time being pending further research.

I did not find substantial evidence of $O. azoricum$ being intermediate between the other two British taxa, but rather found it to be merely at one end of the range of variation exhibited by $O. vulgatum$ under differing conditions. This factor, coupled with the distinctness in many ways of $O. lusitanicum$ from $O. azoricum$, offers little morphological support to the proposal of the latter's hybrid origin.

As well as extensive field studies, a cytological survey of different populations of $Ophioglossum$ (including those in the Azores) is necessary to help establish the status of $O. azoricum$ in Britain and, indeed, Europe. If there are three cytologically different taxa involved, chromosome counts combined with morphology may enable the two problem taxa to be more satisfactorily defined.

ACKNOWLEDGEMENTS

Thanks are due to the staff of the following herbaria for lending specimens: CGE, DBN, E, K, LIV, NMW, OXF, RNG. I am grateful to Miss J.M. Camus, Dr M. Gibby, Mr A.C. Jermy and Mr W. Lobin for helpful discussion. I would also like to thank Mr A. Cleave and Mr K.H. Hyatt for allowing me to use their photographs.

REFERENCES


SHORT NOTE

ADIANTUM x SPURIUM, A NEW NAME FOR A. x VILLOSOLUCIDUM

In a series of papers entitled “Cytotaxonomic studies of the ferns of Trinidad” (Jermy and T. Walker, 1985, in Bull. Brit. Mus. (Nat. Hist.), Botany ser. 13 (2): 133-276) the name Adiantum x villosolucidum Jermy and T. Walker, was used as an epithet for the hybrid between A. lucidum (Cav.) Swartz and A. villosum L. This hybrid was found on several occasions in Trinidad where the parents grew together, and is most likely to be found elsewhere throughout the sympatric range of the two species in the West Indies and South America.

It has been pointed out that according to Article H.10.3 in the International Code of Botanical Nomenclature (Voss et al., 1983, Regnum Vegetabile 111, Utrecht) designations consisting of the names of the parents combined with only the termination of one epithet changed is considered to be a formula and not a true epithet. The name villosolucidum is therefore invalid and to rectify the mistake we propose here the following substitute:


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OBITUARY

CHING REN CHANG 1898-1986

Ching Ren Chang was born on 16 January, 1898, in Wujing County of Kiangsu Province. His first academic course was on forestry and he graduated from Kingling University, Nanking in 1925. For the next three years he lectured at the Department of Biology, Southeast University, Nanking. Between 1927 and 1932, Ching was Head of the Botany Section of the Metropolitan Museum, Nanking, moving to Peking, as Head of the Herbarium of the Fan Memorial Institute of Biology, in 1932 until 1945.

During these early years Ching Ren Chang started to specialise on ferns and visited the Herbarium of the Hong Kong Botanical Garden in 1926 to study the fern collections there. He followed this up with a major European visit 1929-32 during which time he studied under Carl Christensen in Copenhagen, and visited the British Museum and Kew and herbaria in Austria, Czechoslovakia, France, Germany and the Netherlands. In all of these he photographed as many fern types as he could find and this collection, now in the National Herbarium, Beijing, is an important reference database.

Between 1945 and 1955 his energies were directed to agricultural improvement, but on the setting up of the Academia Sinica in 1955 he was made a Member, and Director of the Phytotaxonomy Department of the Botanical Institute in Beijing. He continued working on ferns to the end, latterly as an Adviser of the Botanical Institute, publishing over 140 papers and books. A full list will be published in the Bulletin of Pteridology in Taxon. He has trained and inspired many young Chinese botanists and leaves a strong contingent of pteridologists in both Academia and University Departments.

Ching Ren Chang married Zuo Jin Fu in 1933, who passed away in 1964. He leaves a son, Ching Li-Ming, with whose family he lived during his last years.

A.C. Jermy & K.H. Shing
BRITISH PTERIDOPHYTE RECORDS

Compiled by A.J. Worland

The records are presented thus: 100km square/10km square followed by the recorder’s name. Listed additions have been received up to the end of March 1987.

POST 1980

1.2 Lycopodium clavatum 17/52, 17/64 J. Clark. 34/19, 35/40, 35/41, 35/52 G. Halliday.
3.1 Huperzia selago 34/19, 34/28, 34/39, 35/60, 35/70, 35/71, 35/81 G. Halliday
4.1 Diphasiastrium alpinum 17/52 J. Clark
6.2 Isoetes echinospora 07/94, 17/04, 17/26 A.C. Jermy & J. Clark
7.1 Equisetum hyemale 17/45 J. Clark
7.4 Equisetum arvense 17/05 A. Stirling
7.7 Equisetum palustre 17/05 A. Stirling
8.1 Botrychium lunaria 17/22, 17/31 J. Clark. 34/28, 35/23, 35/70, 35/80, 35/81 G. Halliday
9.1 Ophioglossum vulgatum 17/41 J. Clark
11.1 Cryptogramma crispa 17/42 J. Clark
14.1 Hymenophyllum tunicinii 20/88 M.H. Rickard
14.2 Hymenophyllum wilsonii 35/34, 35/53 G. Halliday
16.1-3 Polypodium vulgare agg. 17/05 A. Stirling
16.1 Polypodium vulgare 17/25 U.K. Duncan
16.2 Polypodium interjectum 07/93, 07/94, 17/04, 17/05 A. Stirling
17/17 15, 17/25, 17/26 J. Clark
17.1 Pteridium aquilinum 07/93, 17/05 A. Stirling
20.1 Oreopteris limbosperma 07/94 U.K. Duncan
21.1 Asplenium scolopendrium 17/04, 17/25 A.C. Jermy & J. Clark
35/14, 35/15, 35/25, 35/36, 35/41, 35/43 G. Halliday
21.2 Asplenium adiantum-nigrum 07/93, 17/72, 17/74 J. Clark
21.7 Asplenium trichomanes 07/93 A. Stirling. 35/36 G. Halliday
21.7a Asplenium trichomanes subsp. trichomanes 17/72 J. Clark
21.8 Asplenium viride 07/93 A. Stirling. 17/94 A.C. Jermy & J. Clark
21.9 Asplenium ruta-muraria 17/43 J. Clark
24.1 Cystopteris fragilis 17/72, 17/73 J. Clark. 34/19, 34/28, 35/14, 35/27, 35/36, 35/44, 35/45 G. Halliday
22.1 Athyrium filix-femina 07/93 A. Stirling
26.2 Polystichum aculeatum 34/19, 34/28, 35/00, 35/35 G. Halliday
27.2 Dryopteris philip-mas 07/93 A. Stirling
27.3 Dryopteris ophioglossoides 17/04 A. Stirling. 17/26 U.K. Duncan
27.9 Dryopteris dilatata 07/94 A.C. Jermy & J. Clark
28.1 Blechnum spicant 17/04 A.C. Jermy & J. Clark
29.1 Pilularia globulifera 17/04 A.C. Jermy & J. Clark

PRE 1980 (AND POST 1980 IN BRACKETS)

(17/25) V. Gordon. 17/26 J. Clark
5.1 Selaginella selaginoides (07/94) U.K. Duncan. 17/04 A. Stirling
17/15, 17/26 A.C. Jermy & J. Clark. 17/25 J. Clark
7.3 Equisetum fluviatile 07/94, 17/04 A. Stirling. 17/15, 17/25 J. Clark
17/26 U.K. Duncan
7.4 Equisetum arvense 07/94, 17/04 A. Stirling. 17/15, 17/25, 17/26 J. Clark
7.5 Equisetum sylvaticum (17/25) V. Gordon
7.7 Equisetum palustre 07/94, 17/04 A. Stirling. 17/15, 17/25, 17/26 J. Clark
8.1 Botrychium lunaria 17/15 J. Clark
9.1 Ophioglossum vulgatum (17/15) U.K. Duncan. 17/25, 17/26 J. Clark
14.2 Hymenophyllum wilsonii (17/15) U.K. Duncan. 17/26 J. Clark
16.1-3 Polypodium vulgare agg. 07/93, 07/94, 17/04 A. Stirling. 17/15, 17/25, 17/26 J. Clark
17.1 Pteridium aquilinum 07/94, 17/04 A. Stirling. 17/15, 17/25, 17/26 J. Clark
21.1 Asplenium scolopendrium (07/94), (17/15), (17/26) U.K. Duncan
17/26, 17/33, 17/34, 17/43, 17/44 J. Clark
(17/26) U.K. Duncan
RECORDS

Would members and leaders of field meetings kindly send any new or updated records to the pteridophyte records recorder for checking and inclusion in the annual lists of updates and amendments.

21.7  Asplenium trichomanes 17/04 A.C. Jermy & J. Clark. 17/15 J. Clark
21.9  Asplenium ruta-muraria 17/15, 17/43 J. Clark
21.10 Asplenium septentrionale 20/88 M.H. Rickard
22.1  Athyrium filix-femina 07/94, 17/04 A. Stirling. 17/15, 17/25, 17/26 J. Clark
24.1  Cystopteris fragilis 35/26, 35/34 G. Halliday
27.2  Dryopteris filix-mas 07/94, 17/04 A. Stirling. 17/15, 17/25 J. Clark (17/26) U.K. Duncan
27.5  Dryopteris aemula 17/15, 17/25 A.C. Jermy & J. Clark
27.8  Dryopteris carthusiana 44/37 J. Bouckley
27.9  Dryopteris dilatata 07/94 A. Stirling. (17/15) V. Gordon. 17/25 J. Clark. (17/26) U.K. Duncan
28.1  Blechnum spicant 07/94 A. Stirling. 17/15, 17/25, 17/26 J. Clark