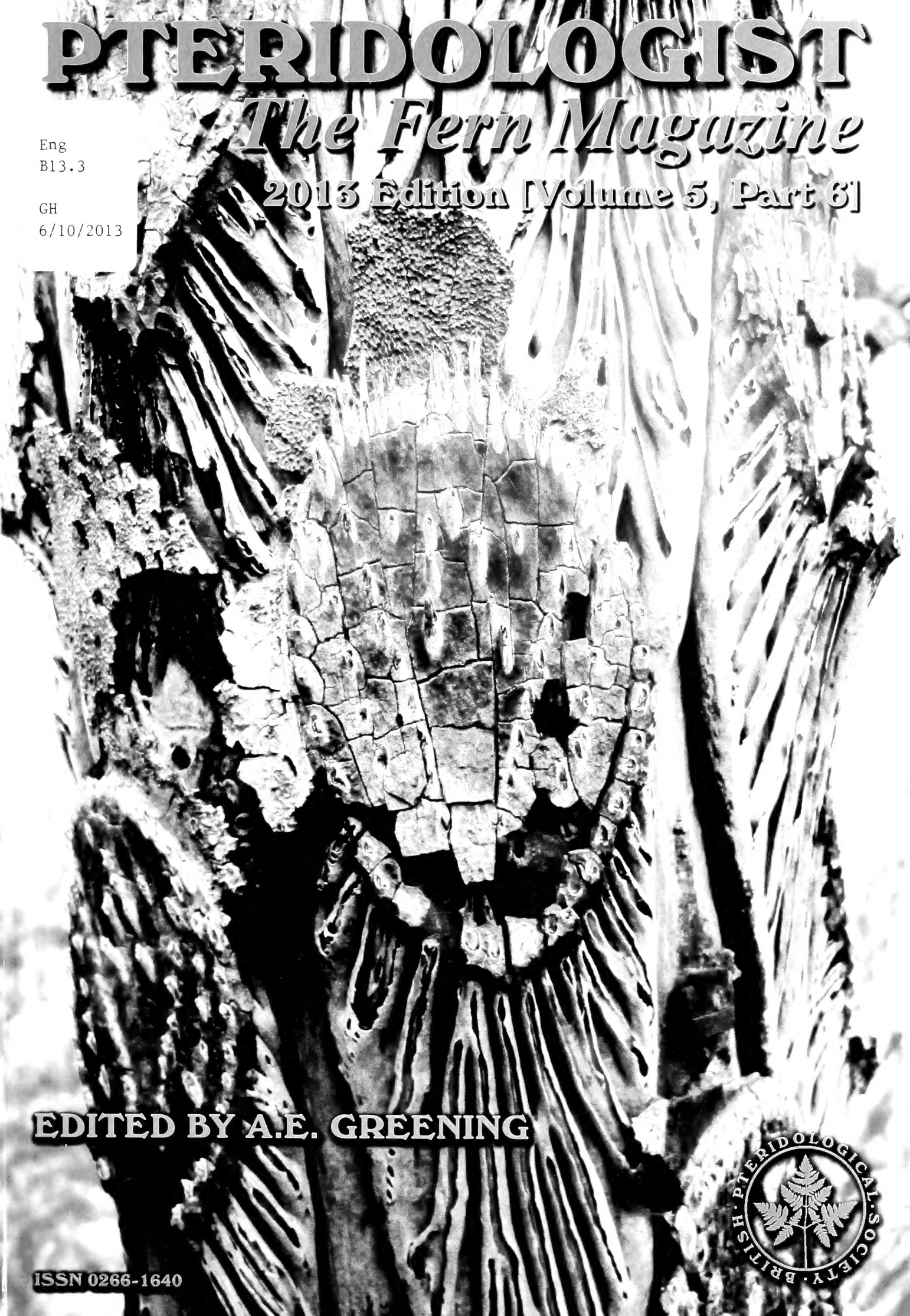
PTERIDOLOGIST

The Fern Magazine

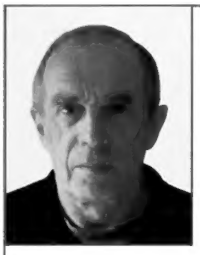
2013 Edition [Volume 5, Part 6]



EDITED BY A.E. GREENING

ISSN 0266-1640

Editorial



This is the last part to Volume 5 and the biggest *Pteridologist* ever. At 88 pages, plus cover, it has taken a considerable amount of time to lay out, edit and deal with all the 'small' changes that authors insist on making. Each page takes anything from one to two hours to complete. A serious accident at the end of January meant that I had the time to devote to this issue but I will be glad to throw away my crutches and enjoy the outdoors later this year. I will just have to remember to start numbering the next volume from page 1 onwards.Once again many thanks to the authors who have contributed an amazing selection of articles. This magazine depends on people who are prepared to put pen to paper and also provide stunning photographs. Each year new authors come forward with interesting articles and I hope that this will continue.

Last year the article on stem dichotomy in *Cyathea australis* prompted responses from two authors who have reported similar growth in different ferns (Pages 394 and 417).

If there is a theme this year then it has to be propagation. Rolf Thiemann shows us how to grow hybrids starting on page 404 with practical advice on dealing with prothalli. He then describes *Polystichum* hybrids in another article with an emphasis on garden worthiness. Julian Reed continues this theme with advice on frond base propagation and finally Tim Brock shows us the result of growing an *Asplenium scolopendrium* cultivar with some amazing results seen on page 449.

The main article this year is written by Paul Sharp on page 465. I urge you all to read this carefully. He shows that fern allies are not really allies at all. The horsetails are actually ferns of a specialised nature and other so called allies are not allied to ferns at all!

Jeremy Roberts describes a fern currently unique to Britain. If you want to know what *Hymenophyllum* × *scopulorum* looks like and how it was found please turn to page 424. His article has been reprinted, with modifications, from The Carlisle Naturalist. This is the first time I have allowed a reprint in this magazine simply because the author had set such a high standard in the origional article and it was unnecessary to ask him to rewrite for this magazine.

The article from Chris Frazer-Jenkins (alias C.R. Ferny-Jokings) on page 433 must be taken in the spirit it was written. One day I will try and persuade Chris to write a more serious article about ferns. I know he spent an interesting time in the Annapurna sanctuary last year which would make fascinating reading.

Last year I appealed for some help with proof reading. Alison Paul and Bryan Smith rose to the occasion but the biggest help was from an overseas member. Brian Ottway lives in Portugal and had thought about offering some sort of services to the BPS. He has been invaluable with his eagle eye and attention to detail. Thank you Brian for all your help.

I am sure the cover will have caught your attention. It certainly caught mine when I saw it at the AGM of the North-West group last year. I alternate from using a British cultivar to a foreign fern for the cover and it was time for something a bit different. This dessicated and weathered tree fern was about 3 metres tall and about 25cms diameter at the point where the photograph was taken. There were others less weathered nearby. It was probably a *Dicksonia squarrosa* judging by what was growing in the area. Can you tell what sort of internal structures are visible? I would love to hear your opinion.

If you have a photo of a British cultivar that you think is suitable for the next issue, please get in touch.

Alec Greening
e-mail: alec.greening@virgin.net

Notes for contributors

Ideally I would like contributions on disc or by e-mail, with high resolution images.If this is not possible I will not rule out typed or hand-written copy. In general please follow the style of material in this issue.

Preview

Printed by: MTP Media(2008) Ltd. Kendal. Cumbria

PTERIDOLOGIST 2013

Contents: Volume 5 Part 6, 2013

The Mingan Moonwort, *Botrychium minganense*. Found in Greenland in 2011.
Photo: Peter Struck

Cover picture: Front.
The dessicated trunk of a tree fern, taken on the Queen Charlotte Track at the north end of South Island, New Zealand.
Photo: John Grue.

Cover picture: Back.
Gymnocarpium robertianum.
Photo: Adrian Dyer.

Unless stated otherwise, photographs were supplied by the author of the articles in which they appear

Polypody Census

Julian Reed
19a Northdown Road, Kemsing, Sevenoaks.
Kent. TN15 6SD
e-mail: julianreed@waitrose.com

Last autumn I had the privilege of seeing Martin Rickard's collection of pressed *Polypodium* fronds from the census he did in the 1980s and this gave me the thought that it was time for another survey. We know of some new varieties found in the wild and raised in gardens. It would be good to document these and establish which of the older cultivars are still in cultivation. Maybe we can find some of the ones we think have been lost, like *P. australe* 'Omnilacerum Bennett' and *P.australe* 'Grandiceps Parker'. A survey would be a useful tool for future identification and help standardize the names of cultivars more widely grown.

So please send me or Martin pictures of your polypodies. As an example I have taken some pictures of one of my own:

1) to give the look of the whole plant.

2) to give size of frond and vertical orientation.

It would be useful to have an idea of where they were growing, eg. under trees, against a shady fence, in a greenhouse , heavy shade or full sun, soil type etc., what ever you feel appropriate.

If you prefer, your details would be kept private if an article is published, but we would prefer to acknowledge members cooperating with the survey. You are unlikely to be pestered by hoards of polypodium groupies.

If known please name all specimens, where known please supply history, ie. where you bought it, or who gave it to you, or from which cultivar it was raised. Even if you think the given name is wrong please let us know the name under which you received it – or even if you made it up yourself. At the very least please label your plants with a number so you will know which one we are talking about when we reply.

The intention is to let you now personally what you have and confirm cultivar names and make a electronic BPS data base as reference.

Please e-mail Martin on h.m.rickard@btinternet.com

I can be found at julianreed@waitrose.com

If you prefer to send pressed fronds please send to the above address and I can do the rest.

I would like to take the opportunity to thank Martin for his help and insight in setting this up.

Ferns can be bad for you?

The fern on the left was bought at a well known furniture warehouse. After you have wandered through the displays upstairs you descend to an assortment of sales areas and if you look carefully you will usually find a fern.

The label starts with:-

ORMBUNKE Phlebodium Blue Star	£2.99

Everything in this store is given a swedish name and in this case ormbunke means fern. The price was good! The label continues:-

> Bright, not in direct sunlight. Keep moist, but remove remaining water from saucer/pot. Water on saucer/or in pot. Fertilise once a month. Mist leaves if air is dry.

I stand the pot in water once a month! The last part of the label reads:-

> **Only for decoration, not suitable for consumption.**

So now we know! We can use the fern for decoration - does that mean it can used as a paintbrush for the walls! However, it would appear that we are not allowed to eat it, shame - it often looks so edible! AEG

Artificial Hybrids of *Polystichum*.

Rolf Thiemann
Im Tuessenberg 10, Altena, D-58762 Germany
e-mail: rolf.thiemann@arcor.de

When I started growing ferns, I came across two interesting fern hybrids. The first was in the show garden of the German fern-nurseryman Johann Lintner in Niederoffleiden near Marburg. There I saw a very large specimen of *P.* x *bicknellii* (*P. aculeatum* x *P. setiferum*). This was my first contact with a *Polystichum* hybrid and I was very impressed by its magnificence. My second sighting took place in a forest gorge in southern Austria. Here I found *P.* x *luerssenii*, (*P. aculeatum* x *P. braunii*) which was also a very impressive plant. I dreamt of having such wonderful plants in the garden and the idea of synthesizing hybrids began to develop in my mind. Some years later I found one plant of *P.* x *illyricum* (*P. aculeatum* x *P. lonchitis*) in the Bavarian Alps. I counted the plants of the parent species in the neighbourhood and found 25 plants of *P. lonchitis* and 40 plants of *P. aculeatum*. I calculated that the chance of producing a hybrid plant would be in the order of nearly 1 in 65. Surely this could not be an insurmountable obstacle for an amateur like me. I hoped to get one hybrid if I sowed the spores of the parents together and cultivated one hundred plants. That was my initiation into the fern hybridizing work that I began in 1998.

For my first experiment I wanted to make *Polystichum* x *bicknellii*. This hybrid had a special interest for me because it is a very fine plant. From a German point of view it is a little exotic because the one parent, *P. setiferum,* is very rare in Germany and therefore the hybrid with *P. aculeatum* is also extremely rare. *P. setiferum* only occurs in Germany in a few places, mostly west of the Rhine.

The cross was successful and I grew five hybrid plants, but I could have spared myself the work because during the creation of the plants a *P.* x *bicknellii* arose by itself in a wall in my garden. A little later I had this experience again. My attempt to hybridize *Athyrium niponicum* 'Pictum' with *A. filix-femina* 'Cristatum' was not successful, but later this hybrid arrived by itself in the garden in a mossy place near *A. niponicum*.

I continued my work for a couple of years and then in the year 2000 I modified my method and sowed the spores separately, pricking out the prothalli. This technique is described in an article on page 404. Since I started, I have created 30 different hybrids mainly in the genera *Polystichum* and *Asplenium*. Some of the *Polystichum* hybrids I have developed are described and featured below.

Polystichum aculeatum x P acrostichoides

Allthough probably triploid, all five plants synthesized show no hybrid vigour. They are a little larger than *P. acrostichoides* and a little smaller than *P. aculeatum*. All plants have a similar habit to *P. aculeatum* and mostly resemble this parent (Fig.2). This is understandable because the hybrids have two genomes from the tetraploid *P. aculeatum* and only one from the diploid *P. acrostichoides*. If you look carefully some differences are easily observed. The hybrids are a slightly bluish green while *P. aculeatum* is a more yellow-green. This is only conspicuous if you put two fronds directly together (Fig.3). The fronds of the hybrid are also

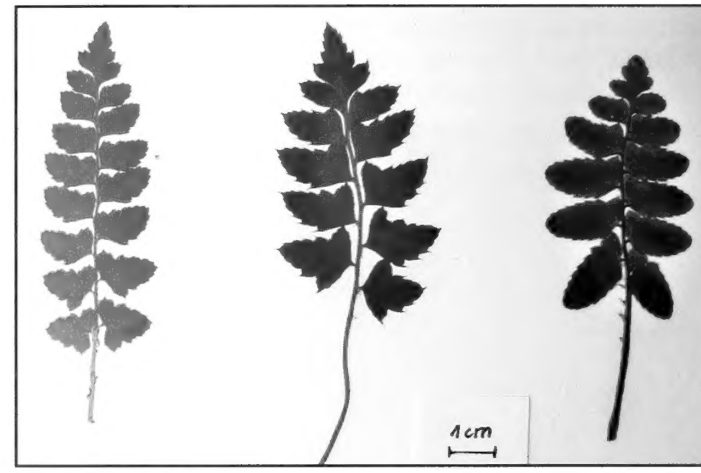


Fig.1. Fronds from very young plants of:-
Polystichum aculeatum (left), *P. aculeatum* x *acrostichoides* (middle) and *P. acrostichoides* (right) in 2001.

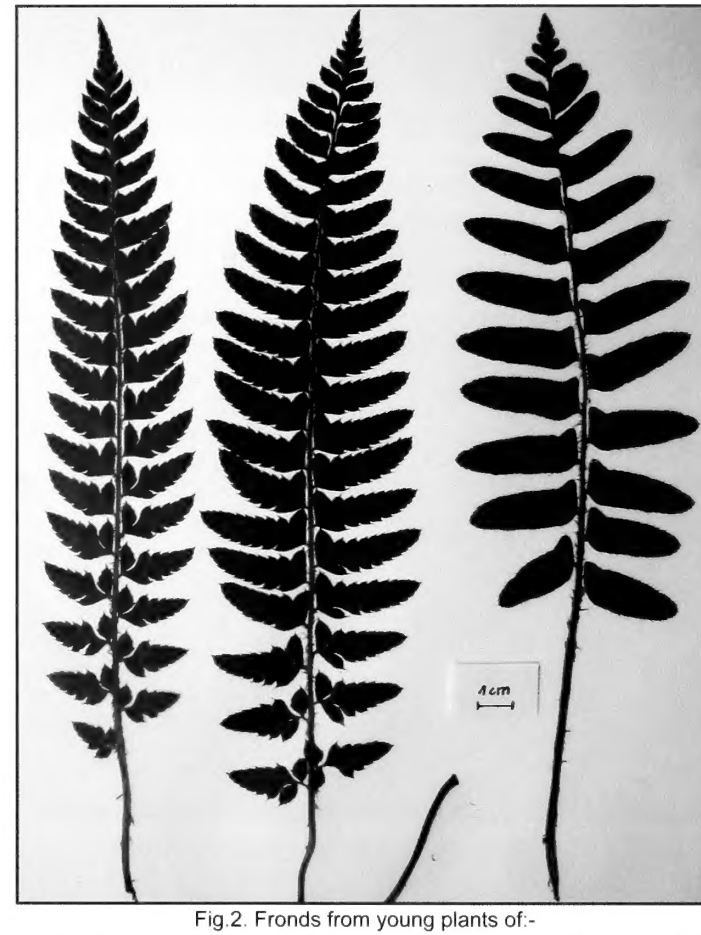


Fig.2. Fronds from young plants of:-
Polystichum aculeatum (left), *P. aculeatum* x *acrostichoides* (middle) and *P. acrostichoides* (right) one year later from Fig. 1.

Fig.3. Pinnae detail of:-
Polystichum aculeatum x *acrostichoides* (left),
Polystichum aculeatum (right)

more upright than those of *P. aculeatum*. Sometimes the fronds show a very slight dimorphism between the lower and the upper part (with sori). The pinnules are not stalked but are sitting more or less on the midrib of the pinnae. The scales are pale brown (Fig. 4), compared to the dark brown ones of *P. aculeatum* and the whitish scales of *P. acrostichoides*. The spores are abortive. Whereas the adult plants of the hybrid strongly resemble *P. aculeatum*, the young plants are easy to distinguish (Fig. 1).

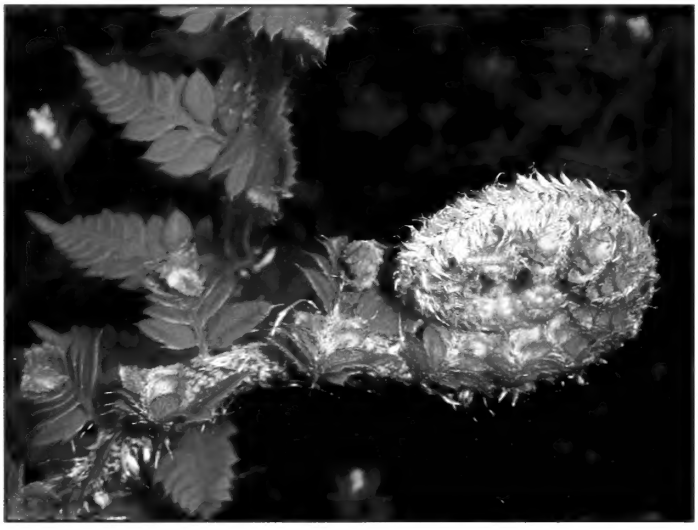


Fig.4. *P. aculeatum* x *acrostichoides*, whitish-pale scales on young crozier in spring.

Because of the similarity with *P. aculeatum*, from a gardener's view point, this hybrid adds little to the enrichment of the fern garden and is only of interest to the specialist fern collector and perhaps for science (Fig. 5).

Fig.5. The adult *Polystichum aculeatum* x *acrostichoides* in the garden

Polystichum x *arendsii*. (*P. munitum* x *aculeatum*)

This hybrid was first described by Christ in 1906 (Allgemeine Botanische Zeitschrift für Systematik, Floristik, Pflanzengeographie etc., 12. Jahrgang 1906, Karlsruhe). I would like to thank botanist Andreas Sarazin of Essen, who discovered the old article with the description of this hybrid. The hybrid was named after the German gardener and perennial cultivator Georg Arends (1863 – 1952) in Wuppertal. In contrast to the previous hybrid, *P.* x *arendsii* is a wonderful addition to the garden (Fig.7).

Adult plants of this hybrid are some of the largest I have ever seen in the genus *Polystichum*. A frond length of 120

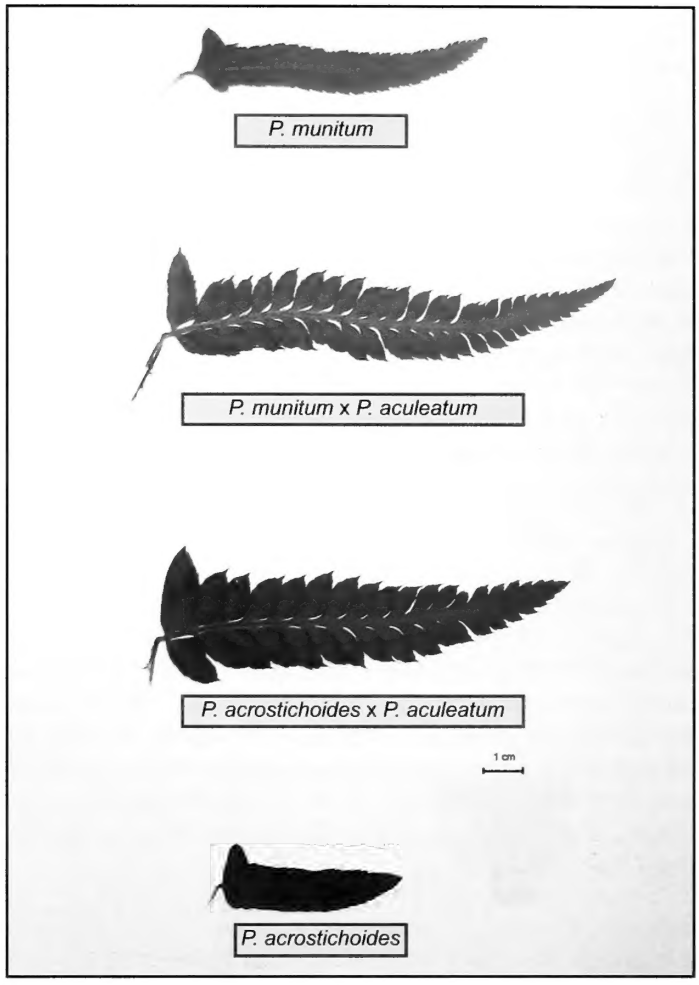


Fig.6. The hybrids of *P. aculeatum* with *P. munitum* and *P. acrostichoides* comparing the pinnae from the hybrids and the parent species

- 150 cm (4 to 5 feet) is normal if the plant is growing in the right conditions. Here everything comes together – both parents are large and the hybrid is triploid. The hybrid shows exceptional hybrid vigour and produces a magnificent statuesque plant, in contrast to the parents.

Characteristics are the dark green colour and the very long and narrow pinnae. The fronds are also very narrow in relation to their length and the plant's overall size means that it needs a lot of room. Because of the length of the pinnae, there are a large number of pinnules which sit in the same way as in the hybrid reported above. They look more or less joined to the midrib of the pinnae (Fig. 6).

Fig.7. *Polystichum* x *arendsii*

Typically the pinnae are s-shaped, which they inherit from the *P. munitum* parent (Fig. 8).

In the garden this hybrid causes no problems, being easy to cultivate like normal forest ferns.

Fig. 8. Pinnae detail of *Polystichum* x *arendsii*

Polystichum acrostichoides x *P. munitum*

This hybrid is much smaller than *P. munitum* and is only a little larger than *P. acrostichoides*. The morphology is between that of the parents (Fig. 9 - Fig. 13). The fronds are not as upright as those of *P. acrostichoides* and if they have sori they are slightly dimorphic. The sori-bearing pinnae are narrower than those without sori. Also they are a little more toothed. However, the dimorphism is never as strong as in *P. acrostichoides*. Generally all pinnae are broader than those of *P. munitum*. Whereas the fronds of young *P. munitum* are very regular and uniform, those of the young hybrids are sometimes a little irregular. The hybrid has one good property inherited from *P. acrostichoides*; it builds up new crowns relatively quickly and can therefore be propagated by dividing after a few years. The plant is also easy to cultivate, tolerating dry ground just like its parent *P. acrostichoides*.

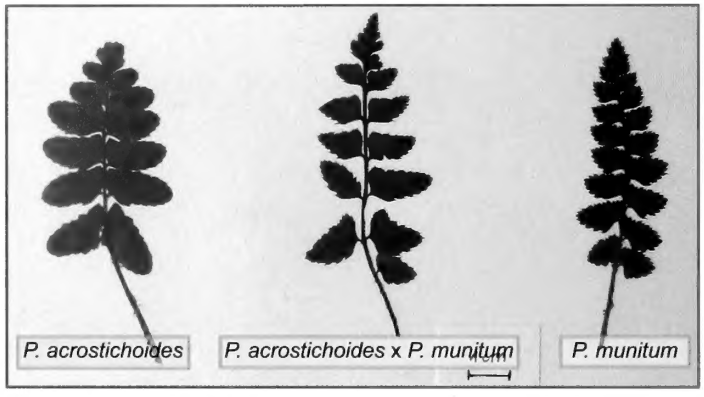


Fig.9. Fronds from very young plants.

Fig.10. Fronds from young plants one year later from Fig.9.

Fig.11. Development of the hybrid *Polystichum acrostichoides* x *P. munitum*

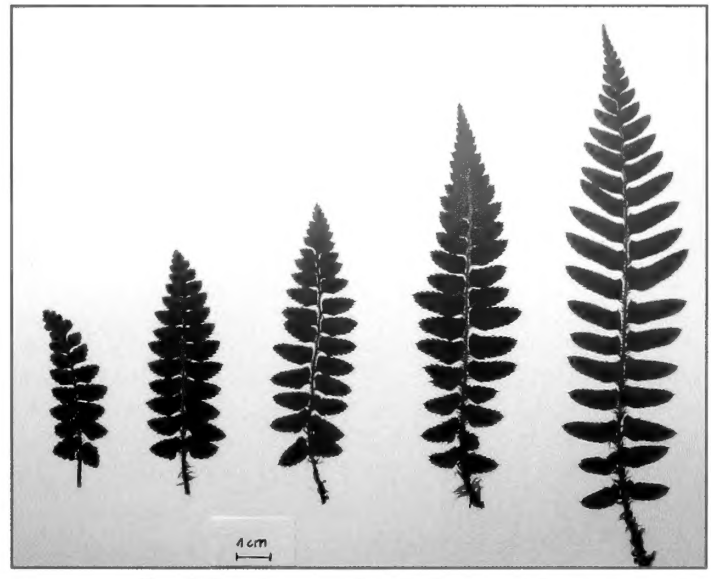


Fig.12. Development of *Polystichum munitum*

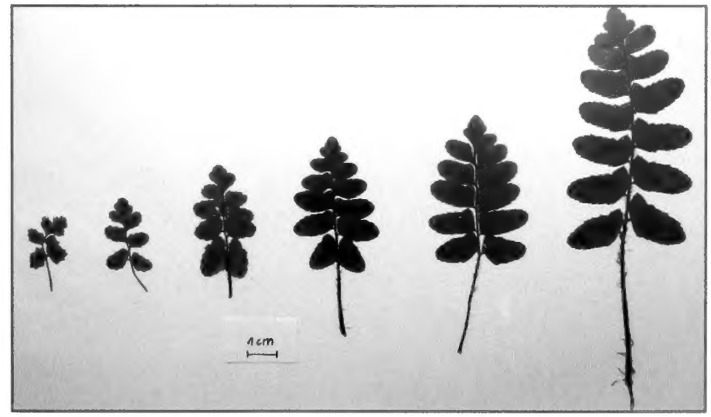


Fig.13. Development of *Polystichum acrostichoides*.

Polystichum x *lesliei* Rumsey & Acock (*P. munitum* x *P. setiferum*)

P. x *lesliei* was first described in Britain, where it has been found twice. Synthesizing this hybrid in 1999 was one of my first successes.

It is a very nice plant (Fig.14). The fronds are pale green and not glossy. The pinnae and pinnules have nearly the same shape as *P.* x *arendsii*. The outstanding feature of this plant was the very slow development. This summer, 2012, the plant has at last reached the size of the parents, 13 years after the spores were sown. However it is not fussy in cultivation and is now developing some new crowns.

Fig.14. Polystichum x *lesliei*

Polystichum x potteri Barrington (*P. acrostichoides* x *P. braunii*)

This is also the result of my early work. In nature, the hybrid is a native of Eastern North America where both parent species occur. It was described from there by David Barrington in 1986. I used the European type of *P. braunii* as one parent of the hybrid. The native hybrids in North America have *P. braunii* var. *purshii* as parent but there are few morphological differences between the varieties.

With its light vivid apple-green colour the fronds make it a gem in the border with dark green ground cover plants. This hybrid is strong growing. Some hairs on the upper side of the fronds betray the parentage of *P. braunii* and the light colour and the soft texture also come from this ancestor. As in *P. aculeatum* x *P. acrostichoides* the young plants are easier to distinguish than the adult plants (Fig.16 - Fig. 18). ❒

Acknowledgements:-
I wish to thank Pat Acock for preparing the text prior to publication.

Fig. 15. *Polystichum* x *potteri*, young croziers in spring.

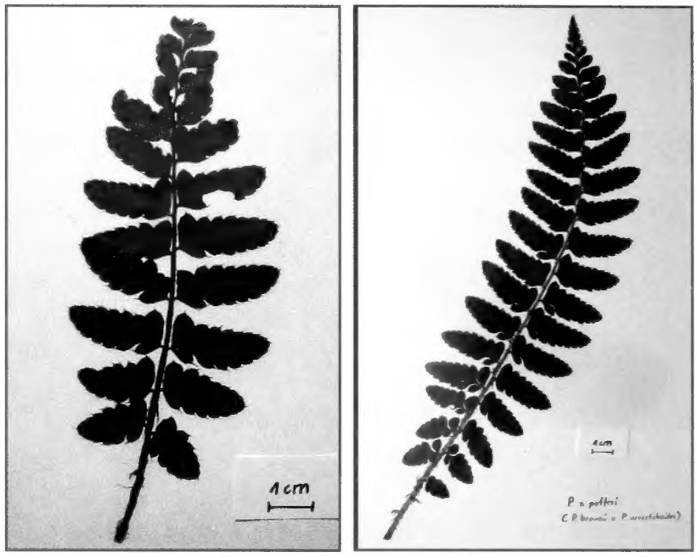


Fig.16.
(Left) Frond from a very young plant of *Polystichum* x *potteri*.
(Right) Frond from a young plant of *Polystichum* x *potteri* one year later.

Fig.17.Pinnae detail of *Polystichum* x *potteri*

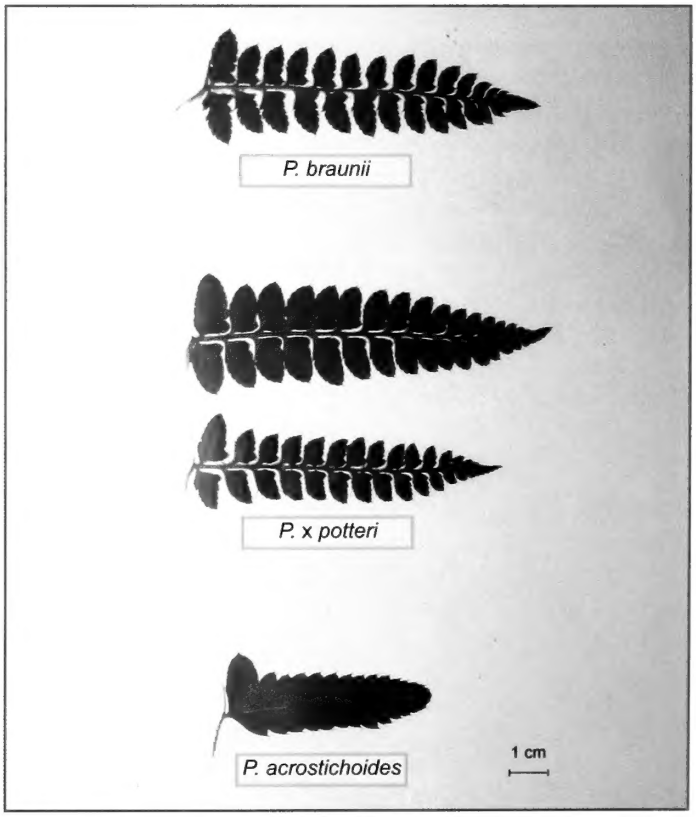
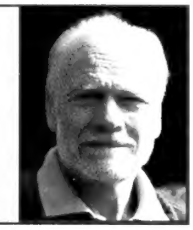


Fig.18. Comparision of the pinnae from adults plants of *Polystichum* x *potteri* and it's parents.

Dichotomy in a Dwarf Tree Fern

Alistair Urquhart
82 Banbury Road, Kidlington, Oxon, OX5 2BX
e-mail: alistairurquhart@ntlworld.com



After reading with interest the article on stem dichotomy in *Cyathea australis* (Pteridologist 2012 Edition, Bostock and Knight) I was reminded that I had, in my collection, observed a similar effect in miniature in my only example of *Blechnum gibbum* (Figs1 & 2). I have grown the fern from an immature plant by pot culture in ericaceous soil for some 20 years to a trunk height of 70cm. The container is overwintered in a conservatory (Min temp 8° C) and in the summer months joins the rest of my tender *Blechnum* collection in a fern house. About 10 years ago at a height of 45cm the trunk branched into 2 rhizomes which grew on with equal vigour to the present day.

I have only ever seen one other mature *Blechnum gibbum*, a single trunked specimen at RHS Pershore, and therefore do not know if dichotomy is unusual in this species. It certainly does not occur in any of the other examples of *Blechnum* species in my collection.

The report by Bostock and Knight in last year's edition leads me to look for some traumatic event in the history of my fern to explain the instigation of branching. In general terms it is clear that pot culture in an Oxfordshire glass house does not compare with life on a balmy south pacific island but the only specific event of note that occurred at about the time of branching was a complete defoliation during one winter. As to the reasons for the defoliation I can only speculate, I have to rule out a low temperature event as the conservatory also houses ferns of much more tender species that were not defoliated at the same time. However low relative humidity is a possible cause, *Blechnum gibbum* is a notoriously thirsty fern even in winter and if I had been less than vigilant with watering and damping of the trunk in a long period of artificial heating, then the dry environment may have been to blame.

It will be interesting to see what the future holds. According to some accounts the fern has already reached the maximum trunk height for this species, other sources suggest a maximum height of 90cm. I am no botanist and have no knowledge as to what limits height in this species but the total trunk length including the branch now exceeds 90cm, but of course the height of both crowns above the root remains at 70cm. Could it be that branching allows the fern to continue to make growth without the crown extending too far from the roots in dry conditions?

Having outgrown the conservatory, the fern will, this year, suffer the trauma of a winter in a frost free fern house (Fig. 3), it may not survive but I can report that it has proved happy to date at a minimum temperature of 8° C. I await developments. ❐

Fig.1.The *Blechnum gibbum* trunk emerging from a 44cm diameter pot.

Fig. 2. Detail at the point of branching

Fig. 3. The fern is now housed in the larger of these greenhouses, at a minimum temperature of 2° C.

The Dead of Winter?
Keeping Tree Ferns alive in the U.K.
Part 2. Mike Fletcher continues his trials

1 Silcott St, Brightlingsea, Colchester, Essex CO7 0DP
e-mail: mikefletcher@waitrose.com

In the middle of February we moved from Harrogate in North Yorkshire to Brightlingsea, on the south coast of Essex. In preparation, fearing a harsh winter, we transferred most of our garden plants to large Ikea blue bags in November – young trees loaded first, shrubs next and small plants at the top. The tree ferns were left alone until shortly before the move, so that they could continue to benefit from the electrical frost protection described last year.

Fig.1. *Dicksonia antarctica*, December 2010, Tree fern No. 2.

To the discomfiture of our movers, Pickfords, virtually our entire garden, complete with statues and sundry garden furniture, shared the removal van with our other effects in an undignified transit from "oop there" to "down hair", which took two days in snowy conditions. They were then unceremoniously dumped while we unpacked (O.K., I admit it, my wife Dawn unpacked.) 147 boxes and we both busied ourselves until the ground thawed out. Happily there were few fern losses, although a much-prized *Asplenium Scolopendrium* 'Golden Queen' was one of them. Curiously, that fern appeared unfazed by the move but subsequently steadily faded away.

However, the tree fern trials continue, with some surprise findings.

After a bitterly cold and wet spring, I now write this in a delightful May heat wave. I had unwrapped No. 1 last month (see Fig.3). This was the crippled fern that I had surrounded with a roofing felt "plant pot" containing seed and potting compost, intended to encourage and feed aerial root growth from the still-alive top section.(Fig.2) At that time the jury was still out on whether the apparently alive bottom section could somehow link up with it despite the apparently dead middle section. The "plant pot" seemed to help; the aerial roots in the upper section are clearly visible in the photo but, sadly, this year there were no signs of life whatsoever lower down, with no sap oozing out like there was throughout last year. When the fronds did develop, they were small and pale just as they were last year, desperately in need of food that those aerial roots simply couldn't reach. Reluctantly, I've sawn off and discarded the bottom part, then replanted the top part as a fern with a 2-foot trunk.

There's no reason why "Shorty" shouldn't do well, once established. He's on the left in Fig. 4, taken in July.

I'll jump to No.3 (on the right in Fig.4), for reasons that will become apparent. Imported in 2011, this five-footer was disconnected from its heater and dug up on the day before the move. It was good to see that it had changed from a log to a rooted plant, but it was about to experience a mid-life crisis! Because the ground was still snow covered, I wrapped the roots with what I had - just a couple of bin liners - and entrusted it to an unheated removal van the very next day. After a 2-day journey it was then dumped horizontally until the Brightlingsea ground thawed out. You can imagine my relief when, during this hot May weather, a flush of chubby crosiers scampered to develop into exquisite, lush fronds. All my tree ferns now have the benefit of some shade from a neighbour's walnut tree until about 2 p.m., and they seem to enjoy that very much. I've already got my irrigation system going in hopeful anticipation of a glorious summer, but many of my plants are resentful of the impoverished soil in this garden, so I'm embarking on a soil improvement programme.

Do you remember No.2, the magnificent one that featured in the title shot last year and is repeated in this year's? (Fig.1) You may recall that its heating system failed in a cruel winter, and it had shown no signs of life for an entire year, so I had sacrificed it to beheading and dissection in the best interests of all tree ferns yet to come. Remarkably, that dissection actually turned out to be a vivisection, for deeply within could be seen embryonic, cruelly starved crosiers too weak to reach the daylight. Riddled with guilt, I had held the ill-fitting halves together with cable ties and planted them in seed and potting compost. Well, this March I planted it outside - that 12-inch Frankenstein's monster still held crudely together, with the 2 sections gaping apart just as they were when first tied together. It had a gloomy, greyish brown complexion and, planted out near the other two, it was an ugly sight indeed, with no signs of life.

Fig.2. Tree fern No. 1 with it's roofing felt 'plant pot'.

Fig.3. Tree fern No. 1 showing aerial roots in the upper section.

I had meant to write this update last week. But I'm a practiced procrastinator and I hadn't got around to it until today, Friday 25th May. Last Sunday I glanced at Frankenstein and almost fancied I could perhaps see a chestnut brown bump, just visible atop the nearest segment. I didn't really trust my eyes, but by Tuesday a rather small green crosier was courageously sniffing the air above the far segment, soon joined by a second. Both have moved

Fig.4. Left: 'Shorty' recovering well.
Right: tree fern No. 3.

upwards in the May heat wave, and today there is another chestnut brown "caterpillar" emerging from the far segment. Frankenstein lives! The "bolts" holding the monster together are clearly visible, but he lives! HE LIVES!! I know he has roots that reach the ground (please forgive me for not sharing that bit with you earlier – they had grown during the winter), and the brown caterpillars now have tiny green "legs", so they'll have started to photosynthesise already. (See footnote.) There is, of course, the possibility of rot or other malevolent intrusions in through those gaping slits, but with every hour, every day, Frank is growing stronger and may yet triumph. Of course, I don't really know if Frank is actually one fern with a cleft palate, so to speak, two ferns forming bizarre Siamese twins, or two quite separate beings lashed together! I'll perhaps know at the end of the season, for I'll probably undo the ties and see if the meristem are meristems or whether the meristems is a meristem (if you get my drift). At present the fronds are forming a ring as though it's a single organism, but I may need to call them Frank and - er – Francesca, perhaps?

The poem "If", by Rudyard Kipling, entreats us to treat triumph and disaster, those 2 impostors, just the same. Wise advice, but let's enjoy the odd triumph while we can, thereby gaining the strength to overcome the next disaster. I see them as both sides of the same coin - as day is to night and summer is to winter. Right now I'm enjoying this summer. It's now August, and all the tree ferns are looking luxuriant, though none, of course, has produced new fronds in this first season after replanting. (Addendum September 2012 – Frank has now produced a 4th frond!)

Our tree fern collection has acquired 2 new members. In two different, "ordinary" nurseries, many miles apart from each other, Dawn and I separately spotted untrunked examples of *Dicksonia squarrosa* for sale. Unlabelled, and hiding amidst undistinguished terrestrial ferns, these "extra-terrestrials" have now "gone home"! Both are actually new sproutings from the base of trunks that had died at some time. They're vigorous growths, not at all reminiscent of the weak pups often produced by squarrosas. One has 2 pups, the other has just one. I suppose I must soon decide whether to remove the remains of their dead parents, and whether to separate the Siamese twins. With all this vivisection and division, I shall soon own the largest collection of the smallest tree ferns in England!! As I'm 78, I won't see them become giants, that's for sure.

Brightlingsea poses quite different challenges to those of Yorkshire, of course. We are about 300 yards from the sea, which will temper winter temperatures unless the wind is from the land to the North. The prevailing winds are southwesterly and are frequently salt-laden, which doesn't seem to bother the ferns at all. Brightlingsea is reputed to be the sunniest place in Britain, but with my irrigation system and some shade from that walnut tree, they are very happy. As always, complacency is the enemy; irrigation systems and frost protection need to be present and monitored. They may not be needed this year or the next. Or even the one or two after that. But there probably will come a time. When will I become too lazy, too indifferent, too incompetent or just too old to care for them properly?

Time will tell. ❐

Fig.5. 'Frank', the remains of tree fern No. 2, still held together with cable ties, yet flourishing.

Footnote: Alastair Wardlaw told me in a recent e-mail that some years ago in the plant physiology lab at Glasgow University, he did preliminary experiments with Malcolm Wilkins, the Regius Professor of Botany. These showed that tree-fern fronds (*Dicksonia antarctica, D. fibrosa* and *Cyathea smithii)* could photosynthesize (in the light) and respire in the dark, at temperatures only 2 or 3 degrees C above freezing. Therefore, if the fronds of UK garden tree-ferns can be kept un-withered throughout the year, the plants should be actively alive even during the winter months. On the other hand, if fronds are frost-withered, say, in mid-December, then the plants are effectively lifeless until new fronds appear the following summer. Long-term, he doesn't think it does the tree ferns any good to have their metabolism shut down for 6-7 months of the year (as it is in Scotland), year after year. He points out that in their native lands the tree ferns are green throughout the year. Therefore in UK he favors providing sufficient winter protection – by habitat or wrapping - to keep the fronds winter-green – at least in most winters.

William Farrow Askew 1857-1949

Barry A. Thomas
The Institute of Biological, Environmental and Rural Sciences
Aberystwyth University. Aberystwyth SA23 3DA
e-mail: bat@aber.ac.uk

William Askew began selling hardy ferns in the late 19th century from his English Lake District fern nursery at Grasmere, in the middle of the county that is now known as Cumbria (Previously known as Cumberland) He later moved to Derwent House outside Grange in Borrowdale, near Keswick, many miles to the north, but still in the English Lake District, where he and his wife ran a hotel while he continued to grow and sell ferns.

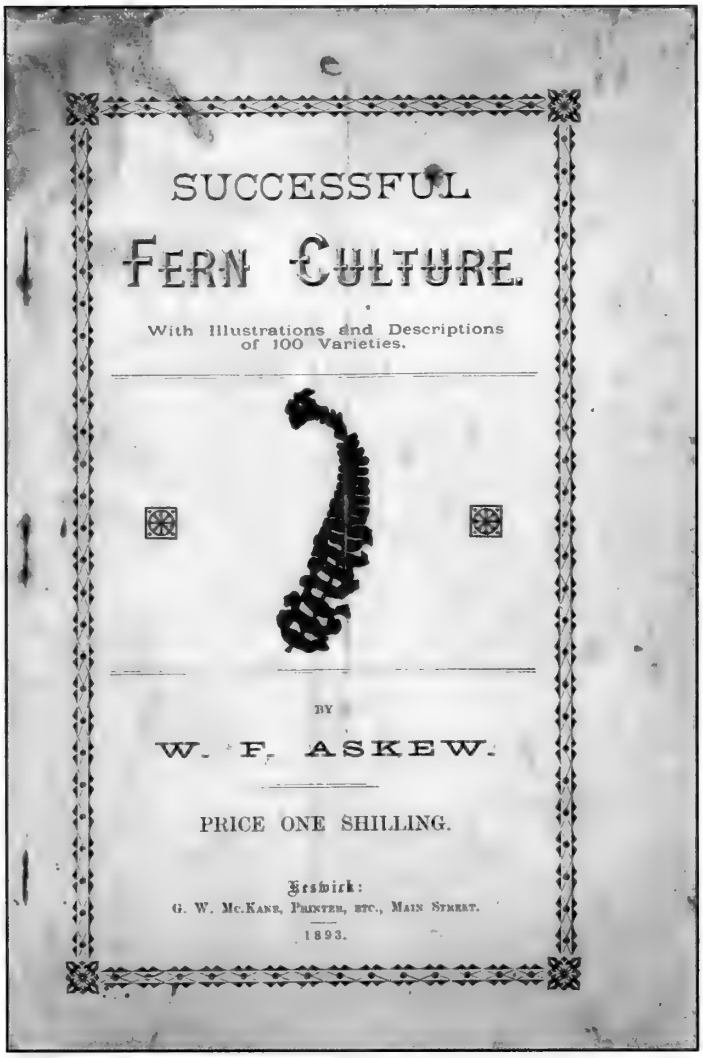

SUCCESSFUL
FERN CULTURE.
With Illustrations and Descriptions of 100 Varieties.
BY
W. F. ASKEW.
PRICE ONE SHILLING.
Keswick:
G. W. McKane, Printer, etc., Main Street.
1893.

Fig. 1. The cover of "Succesful Fern Culture" published in 1893

He wrote a number of booklets on ferns with the earliest (that I have seen) being his "Successful Fern Culture" that was published in 1893 (Fig.1). (It was priced at 1 shilling which is worth about £3.00 today, taking inflation into account.) It included 5 pages of "Hints on how to cultivate hardy ferns", 8 pages of "Short Descriptive Notes on Varieties" and a page each on "How to make a rockery" and on "Fern Walls," all interspersed with 15 plates of named fern varieties including his new "Crested Lady Fern" (Fig. 2). Four pages of advertisements were appended at the end. Much later he used the written text, with only a few updates, for an undated eleven page booklet "Successful Fern Cultivation" which was for sale at three shillings and sixpence (Worth today £8.00, taking inflation into account.) and a version without illustrations at one shilling and sixpence. In 1945 he was selling his "A list of Native Ferns – Cultivated for Sale" for fourpence; a catalogue that included his crested *Filix apauforme* (Askew) at one shilling, (£1.30) *Filix glomeratum* (Askew) and *Filix-mas grandiceps* (Askew) at two shillings and sixpence each (£3.20) and his dwarf *Polypodium vulgare* semilacerum multifidum (Askew) at one shilling and sixpence.(£2.00) This catalogue also shows that by now Askew was also selling "Hardy Exotic" ferns and a few "Greenhouse and Window Plants."


ASKEW'S NEW CRESTED LADY FERN.

Fig. 2. Askew's new crested Lady Fern that featured as the front page in his 1893 "Successful Fern Culture"

Askew did purchase ferns from other nurseries to build up his collection, notably from H. Stansfield of Sale. He collected and grew several new varieties that were listed in his booklets: *Athyrium* Capitatum Grandiceps (Askew) described as a great crested form in a large terminal crest, fine for exhibition; *Athyrium* Capitatum (Askew) formed from Depauperatum; *Athrium* Congestum (Leyland) found in Borrowdale. A small and

choice form of Congestum [Leyland] was named after his wife's family name.

He exhibited many times at the Southport Flower show where in 1932 he won first prize for "Three Polypodies", third prize for "12 Hardy Ferns" and third prize for "One new Fern" which was probably his *Athyrium* Capitatum (Askew) or Congestum (Leyland). In 1947 he didn't do quite as well, gaining only a second prize for "British Hardy Fern – any kind" and third prizes for "Three distinct Varieties of Hardy Polypodium" and "Three distinct varieties of Polystichum."

Fig. 3. William Askew (standing centre) holding his wining pot of "Three Polypodies" at the Southport Flower Show in 1932.

SOUTHPORT FLOWER SHOW.

Mr W. F. Askew, Grange Fern Nurseries, has obtained first prize for three Polypodies, third prize for 12 Hardy Ferns, and third prize for one new Fern. AUGUST. 1932.

Fig. 4. Notice from the 'Southport Visitor', 1932

Askew was member of the British Pteridological Society from about 1910 until his death in 1949. I went with about 60 members of the Society to visit Derwent House on Sunday 21st September in our Centenary Year (1991) where we saw a number of the ferns from his nursery still growing in the grounds of the Hotel (BPS Bulletin vol. 4 (2), p. 75). These ferns included a large bush-like *Dryopteris affinis* 'Grandiceps Askew', *Athyrium filix-femina* 'Multifidum' and 'Corymbiferum', and a small form with pendulous pinna-lobes and *Dryopteris oreades* 'Cristata Barnes' We were given tea by Mrs Deidre Lopez, Askew's granddaughter, who was still living in Derwent House at the time. She has now moved elsewhere. The only previous written account of William Askew was a very short note by Nigel Hall in his account of "Victorian Fern Nurserymen" in our Bulletin, 1982, vol. 2 (4), p. 190, but no mention of Askew's 1893 booklet was given by Nigel Hall and Martin Rickard in "*Fern Books In English Published before 1900*" published by the BPS in 2006.

The photographs and cuttings were donated by Mrs Deidre Lopez and will be deposited in the BPS archives.

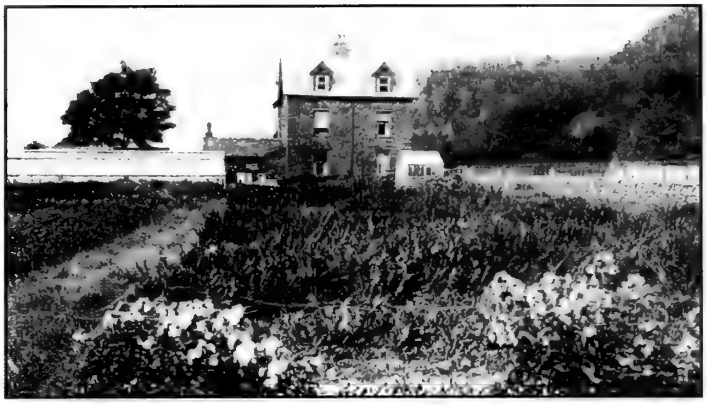


Fig. 5. Derwent House in the late 1920s with a sward of ferns.

Fig. 6. William Askew in the garden of Derwent House .

References:-

Askew. W. F. (1893). *Succesful Fern Culture*. G. W. Mc.Kane (Printer), Main Street. Keswick.

Askew. W. F. (1945) *A List of Native Ferns - Cultivated for Sale.*

Edwards. P. J. (1991) 'Lake District National Field Meeting 18-25 September.' *The Bulletin* (Vol. 4. Part 2) BPS

Hall. N. (1982). 'Victorian Fern Nurserymen' *The Bulletin* (Vol. 2 Part 4) BPS

Hall. N. and Rickard. M. (2006). *Fern Books in English Published before 1900*. BPS Special Publication No. 9.

Memo from

W. F. ASKEW

FERN NURSERY

GRANGE, KESWICK,

CUMBERLAND.

Fig. 7. Memo heading from his Fern Nursery.

BOTRYCHIUM SPECIES IN GREENLAND

Prof. Dr. Peter Struck
University of Hamburg;
Bornstrasse 25, D-20146 Hamburg, Germany
e-mail: prof.dr.peter.struck@t-online.de

INTRODUCTION

My interest in Pteridophytes started when I was 15 years old, and even then I was particularly interested in Ophioglossaceae. After hunting these elusive ferns for over 20 years in Central Europe I have managed to find 7 species: *Botrychium lunaria, B. matricariifolium, B. virginianum, B. multifidum, B. simplex* ssp. *simplex, Ophioglossum vulgatum* (in Germany, Denmark, Switzerland and Austria) and *O. lusitanicum* (in France).

In 1996 I paid my first visit to Iceland. The results of my studies were documented in the *Pteridologist* 2011 edition (Volume 5 Part 4) and a short summary is as follows:-

I found *O. azoricum*, *B. lunaria, B. boreale, B. lanceolatum* (including two types) and *B. simplex* var.. *simplex* in several locations. However there was one *Botrychium* that I couldn't identify so I sent a specimen of this plant to Donald Farrar, Iowa State University, together with another nice moonwort that I thought was *B. lunaria*. Imagine my surprise when the second plant was identified as *B. minganense*, which is common in the USA but was unknown in Europe at that time. The first plant turned out to be *B. tenebrosum*, which was also unknown in Europe.

Since these exciting discoveries I have made annual visits to South Greenland and Iceland spending 2 weeks on each island. These visits are always in June which seems to be the best time to find Botrychiums.

Most glaciers in Greenland are currently in recession, so each year new areas are exposed where the *Botrychium* species can become established. Precipitation is also in decline and the reduced levels of rain and snow mean that low lying areas are becoming drier, which drives the *Botrychium* higher up the mountain slopes. Here, these intriguing ferns grow underneath *Salix* or *Betula* shrubs or in the case of grassland or open sand locations they are accompanied with *Thymus polytrichus* ssp.*arcticus* (wild thyme), mosses and lichens.

On my first visit to Greenland I noticed that this vegetation was very similar to Iceland, which looked promising for these plants. Sure enough, on the very first day I found large specimens of *B. lunaria, B. lanceolatum* and *B. boreale*, around the airport of Narsarsuaq in the southern tip of Greenland (Fig.1.). After visiting this area for 3 years I began to think that all the *B. lunaria* located was *B. lunaria* var. *lunaria.* Specimens sent to Donald Farrar however confirmed that most of the plants were *B. lunaria* var.*melzeri*, with their distinctive pinnae that do not overlap.

21 kilometres (13 miles) south of Narsarsuaq is the village of Igaliku (population just under 60) which is best known for the ruins of Garðar, once the religious heart of 12th-century Norse Greenland. It is also the home of a spectacular sheep farming settlement at the head of the Igaliku Fjord and even more important, the area is mosquito free! This is a blessing when coming from Narsarsuaq, which seems to be mosquito heaven. I first visited this area in 2008. Arriving by helicopter gives one a chance to fully appreciate the Greenland Fjord area (Fig.2). On exploration I immediately found many specimens of *B.tenebrosu*m in grassland and heathland. This fern had not been previously found in the Narsarsuaq area and the discovery was a promising start. The next year I visited Lake 35 to the north of Igaliku and was surprised to find, growing closely together, *B. matricariifolium* and *B. minganense*, again both previously unknown in Greenland.

Two days later I was exploring Eriks Fjord to the north of Narsarsuaq and was delighted to find *B.multifidum*, not a new species for Greenland, but new to me. All

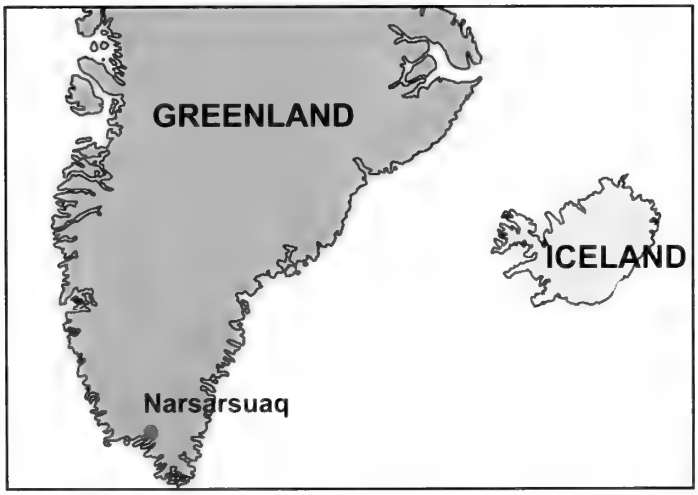


Fig.1. Map showing the location of Narsarsuaq in the southern tip of Greenland

Fig.2. *Botrychium* country near Narsarsuaq

these finds have been confirmed by Don Farrar and he also confirmed that nearly all *B. lunaria* in Igaliku are the var. *melzeri*.

A few kilometres to the east of Narsarsuaq is the famous 'Flower Valley' at an altitude of just over 600m. This valley is suffering from a lack of precipitation and as the soil dries out the flowers disappear. For many years I have known this plateau as a place of great beauty where sea eagles and ravens roam freely over the many small lakes that nestle between granite outcrops.

In 2012 I explored this area and hunted through the grasses and mosses. I was rewarded by finding large groups of *B. boreale*, many colonies of *B. lunaria* var. *melzeri* and a few *B. lanceolatum*. I also found *B.lunaria* var.*lunaria* and, most exciting of all, the tall, slender species *B. nordicum*, which is new to Greenland. (D. Farrar has not genetically verified this collection) I had previously discovered this fern some years ago in Iceland. It grows with its triangular toothed and asymmetric-standing pinnae in groups between high grass-plants. For me this was the highlight of my Greenland explorations and a moment that I will treasure forever.

Donald R. Farrar, Professor in the Department of Botany at Iowa State University, has been a great help. By using isozyme analysis he has been able to confirm the new Iceland species *B. nordicum* and the new variety *B.lunaria* var. *melzeri*. These taxa await formal publication, but are discussed more fully in the dissertation by Mary Stensvold.

BOTRYCHIUM SPECIES IN GREENLAND

1. *Botrychium boreale* Milde (Fig.3), 2n = 180

The Northern Moonwort is a tetraploid, probably derived many thousands of years ago from a hybrid between *B.lunaria* and *B. lanceolatum*. Its broad, pinnately dissected pinnae are intermediate in shape between these two species. In recent years rain and snow has been rare in Greenland, so *B. boreale* migrates higher up the mountains. The higher the location, the taller the plant, up to 35 cm. *B. boreale* likes to stay in groups of 5 to 10 plants, often coming from one rhizome and found growing with tall grasses. You will find it round the villages Nanortalik, Narsaq, Narsarsuaq, Igaliku and Qaqortog. Their pinnae are yellowish-green, mostly overlapping, with the yellow and orange-coloured sporangia opening two weeks later than *B. lunaria*.

2. *Botrychium lanceolatum* (S. G. Gmel) Ångstr. ssp. l*anceolatum* (Fig. 4), 2n = 90.

The Triangle Moonwort grows in dry locations, mostly near the coast, mostly with *Botrychium lunaria*. It likes to stay under *Salix* and *Betula* shrubs, in sandy dunes and often in groups of 3, 5 or 10 plants. The leaf stalk is white near the ground, then green and then red at the top. In Iceland we know a different type of *Botychium lanceolatum* with yellowish-green leaf stalks and no red colour as well as (rarely) the-red stemmed type. In northern continental Europe *B. lanceolatum* ssp. *angustifolium* also occurs (but it is much more common in eastern North America). The sporangia of Greenland plants are first dark-green and then turn orange. They open 2 weeks after the sporangia of *Botrychium lunaria*. Around the airport and the harbour of Narsarsuaq many plants of this species can be found.

Fig.3. The Northern Moonwort, *Botrychium boreale*

Fig.4. The Triangle Moonwort, *Botrychium lanceolatum* ssp. l*anceolatum*

Fig.5 The Common Moonwort, *Botrychium lunaria* var *lunaria*

Fig.6. Melzer's Moonwort, *Botrychium lunaria* var. *melzeri*.

3. *Botrychium lunaria* (L.) Swartz. var. *lunaria* (Fig. 5), 2n = 90

The Common Moonwort, is to be found everywhere in South Greenland, mostly in heathland and grassland. In shady situations it reach a height of 25 cm; in sunny and dry places with grazing sheep sometimes only 2 cm. The pinnae are dark green and glossy, overlapping and not dentate. This *Botrychium* is the second after *B. matricariifolium* to open its yellowish sporangia.

4. *Botrychium lunaria* (L.) Swartz. var. *melzeri.* Stensvold *ined.* (Fig. 6), 2n = 90.

Melzer`s Moonwort, named after the famous Austrian botanist Helmut Melzer, who died in 2011, can be found in Iceland and Greenland. It is a greyish-green *Botrychium* with very small non-teethed or extremely large, but dentated basal pinnae, not overlapping with the adjacentpinnae. It often has two secondary sporophores, beginning near the basal pinnae, and one, two or more sporangia on the pinnae. The plant is smaller than *Botrychium lunaria* var. *lunaria* and the pinnae are not glossy. The first pinnae are usually smaller than the second pair of pinnae. Around Igaliku, this variety is more widespread than the variety *lunaria*. It likes to grow with *Botrychium boreale* and *Botrychium simplex* ssp. *tenebrosum*, often between and under *Salix* and *Betula* shrubs or in high grass.

Fig.7. The Daisy-Leaf Moonwort, *Botrychium matricariifolium*.

Fig.8. The Mingan Moonwort, *Botrychium minganense*.

Fig.9. The Leather Grapefern, *Botrychium multifidum*

5. *Botrychium matricariifolium* (A. Braun ex Döll) W.D.J. Koch (Fig. 7), 2 n = 180,

The Daisy-Leaf Moonwort is not known from Iceland but from Continental Europe and North-America. I was the first to find a big group of it in 2009 by Lake 35 north of Igaliku. It stands there in open grassland together with *Botrychium lunaria* var. *melzeri* and *Botrychium simplex* ssp. *tenebrosum*. The place is very sunny, so that the plants are small. I could not find a second location of this species in Greenland. It has hairs on the stem and brown-orange-coloured sporangia, opening one week before *Botrychium lunaria*.

6. *Botrychium minganense* Victorin (Fig. 8), 2n = 180.

The Mingan Moonwort was previously only known from North-America. However, since 2002 I have found many locations in Iceland of this fern and in 2011 I first found it in South Greenland by Igaliku, near Lake 35. The pinnae form 9 -11 horizontal pairs, slightly spreading and the sporophore are twice as long as the trophophore. The sterile part is greyish-green and the rhizome reaches extremely deeply into the dry sandy ground. This plant does not like any competition. It is one of the most picturesque moonworts, with its symmetrical, upright, triangular pinnae. Large old plants have 2 or 3 sporophores and yellowish sporangia on the basal pinnae. In Iceland it grows only in black lava-sand, but by Igaliku, in Greenland, it grows in a heathland location together with *Botrychium simplex* ssp. *tenebrosum*.

7. *Botrychium multifidum* (S.G. Gmel.) Rupr. (Fig. 9), 2n = 90.

The Leather Grapefern occurs near the farm of Qinugua, in the northern part of Eriksfjord, in swampy grassland and in open fields, usually together with *Botrychium lanceolatum*. This species is known from Europe, Asia and North-America, but not from Iceland. The leaves are green over the winter, so that you see on a plant in July one dark-green trophophore with hairs on the stem from this year and one yellowish-green without hairs from the last year. Sometimes from just one rhizome 2 or 3 sporophores occur, often with red stems. The sporangia are yellow-coloured and ripen 4 or 5 weeks later than *Botrychium lunaria*. It is not easy to find this moonwort between mosses, grass and young plants of *Salix*. Usually you will find only one plant of this nice species. In Greenland, *B. multifidum* cannot reach the size of the plants in North-America and Asia.

8. *Botrychium nordicum* M. S. and D. F. (Fig. 10), 2n = 90.

This *Botrychium* is a new species, determined by Mary Stensvold and Donald R. Farrar from the Iowa State University. I was the first, to find this species, in 2008 in the Kaldalon-Fjord, North-Western Iceland. This fern is also known from Norway and, since 2012, from South-Greenland where I found it east of Narsarsuaq on the mountain named "163" (Fig. 2). This *Botrychium* is diploid, has a very tall dark-green slender stem, very deep roots, and it likes to live between tall grasses, together with *Botrychium boreale* and *Botrychium lunaria*

Fig.10. *Botrychium nordicum.*

Fig.11. The Least Moonwort, *Botrychium tenebrosum*

var. *melzeri*. The first pinnae are triangular and toothed, not symmetrically located on the stem; the upper pinnae are dentated. Often you will see a second and a third sporophore instead of basic pinnae, and sometimes 2, 3, 5 or 8 plants occur out of only one rhizome. The spores ripen 2 or 3 weeks later than those of *Botrychium lunaria*. D. Farrar has not genetically verified this collection.

9. *Botrychium tenebrosum* (A.A. Eaton.) (Fig. 11), 2n = 90.

This member of the Least Moonwort group of species is one of the smallest *Botrychium* species. It has been incorrectly considered to be a variety of *B. simplex*, based on shade grown plants. In Iceland where you may see both growing close together in open habitats in more than 100 locations, the two species appear quite different. *B. simplex* is rare in Continental Europe. *B. tenebrosum* is not known from Continental Europe, but it is very widespread in Iceland and around Igaliku in South-Greenland, though not around Narsarsuaq. Both species are to be found in North-America. *B. tenebrosum* is a yellowish-green extremely slender fern, which appears to be persistently juvenile. The simple, sterile, part of the leaf is located on the top of the fertile part, not near the ground like that of the *B. simplex*. Often there are sporangia on the sterile part and a second or third sporophore coming out of the trophophore. This fern ranges between 2 mm to 22 cm in height, and grows under shrubs or in grassland from 0 m to 100 m above sea-level, sometimes singly, but mostly in groups. The spores ripen at the same time as the spores from *Botrychium lunaria*.

Donald Farrer writes

> "In our North American treatments we are recognizing this taxon as *B. tenebrosum* A. A. Eaton. It is sufficiently distinct genetically and morphologically to warrant listing as a distinct species. Dr. Struck's collections in Iceland were instrumental in allowing us to properly understand its relationship to *B. simplex*."

ACKNOWLEDGEMENTS:

I am indebted to Donald R.Farrar and Mary Stensvold from the Department of Botany at Iowa State University, and USA Forest Service, Alaska Region, who analyzed the *Botrychium* species I found in Iceland and Greenland, by means of enzyme electrophoretic studies.

Thanks also to Ingo Würtl and my son David Julian Struck for assistance in the photos.

REFERENCES:

Stensvold, M. C. (2008). A taxonomic and phylogeographic study of the *Botrychium lunaria* complex. Ph. D. dissertation. Iowa State University.

Struck. P. (2011). '*Ophioglossaceae* in Iceland' *Pteridologist* (Volume 5, Part 4) BPS

Fern Hybridization

Rolf Thiemann
Im Tuessenberg 10, Altena, D-58762 Germany
e:mail: rolf.thiemann@arcor.de

Hybridization of ferns has two goals: scientific research and producing novel plants for the garden. In recent times the latter reason has mostly taken place in other groups of garden plants such as roses or lilies rather than ferns.

Probably the first person who realized the possibility of crossing ferns and synthesizing fern hybrids purposefully was Edward Joseph Lowe. In the middle of 19th century, shortly after the archegonia and antheridia had been discovered on the gametophyte, he started his crossing work. His method was to sow spores from the parents close together (the "Lowe Method"). Mainly he crossed varieties of a species together to get new cultivars.

Scientific fern hybridization was undertaken from time to time in order to understand relationships between the ferns. The centre of this activity was the University of Leeds. Irene Manton, J.D. Lovis, Ann Sleep and others did hybridization work to understand relationships mainly in *Polystichum*, *Asplenium* and *Dryopteris*. Many other scientists made fern hybrids too. Some of the most important are W. Döpp (Marburg), G. Vida (Budapest) and T. Reichstein (Basel).

About my work.

I have cultivated ferns in my garden for about 30 years. In 1998 I started crossing ferns to produce hybrids which were not available in the trade. My first goal was *Polystichum* x *bicknellii*. From 1999 up to the present I have continued this work. The results so far are 30 different hybrids between species, 21 in the genus *Polystichum*, 7 in the genus *Asplenium* and 2 in *Dryopteris*. In the genus *Asplenium* I have also made 2 intraspecific hybrids, *A. trichomanes* ssp. *trichomanes* x ssp. *inexpectans*, and *A. scolopendrium* ssp. *scolopendrium* x ssp. *japonicum*.

In the following account I report my work and hope this will encourage others to do the same.

Growing the Prothalli.

Growing the gametophytes for crossing purposes is in principle no different to growing for common propagation. I take it as read that the main feature of propagating ferns by spores is known, but some special attention to the following details should be noted. Firstly I shall describe the methods of sowing and breeding that I use. But if you have your own method and have success with it please continue to use it!

Harvesting the Spores.

Spore collecting for hybridizing needs special attention to cleanliness from extraneous spores. Therefore, try to harvest spores from the parent plants when the spores are ripe but the sori are still closed. Then wash the cut frond or frond part under running water, dry it with a clean kitchen paper towel and put in a paper-bag or envelope. Special attention is needed to the corners of the envelopes as they are often not well sealed, and it is recommended that they are sealed with gummed tape. Also fold the top of envelope down one or two times before closing it by gluing. After this, store the spore packet in a cool dark place. The spores will be capable of germinating for some years and in a number of species, especially in the genus *Asplenium*, they can survive for some decades. Exceptions to this rule are the spores of *Osmunda*, *Matteuccia*, *Onoclea* and the filmy ferns. Spores from these are short lived, surviving only a few weeks. Also the spores from filmy ferns must not dry out. The only way to keep spores from the aforementioned ferns for a longer time is to put them into a freezer. I don´t clean the spores from the "chaff". If you do that your house will be contaminated with spores of all the species you have cleaned. If possible, do not cultivate other adult ferns in the room you are using for this work, especially not apogamous ferns e.g. *Pteris* species and *Adiantum raddianum*.

Sowing.

Sowings can be made throughout the year but it is best to avoid the months from September to January. At this time germination is often delayed and the development of the prothalli is slow. The longer the prothalli have to develop the greater is the risk of damage by fungi. I use plastic boxes with a clear cover as a growing container. As a substrate I take peat which is modified for garden culture, being nearly pH. – neutral, water absorbent and low in nutrients. In Germany it is traded under the name"TKS 1". I sterilize the quantity I need in a microwave. I water the substrate directly after filling the boxes and before sowing the spores. Watering after sowing washes lots of spores deeper into the soil, preventing germination. For each sowing, I use a special room and I use the room only once a day. During sowing all the windows and doors of the room must be closed so that the air is nearly still. It is also important that the envelope with the spores is kept close to the growing box (see Fig. 1), otherwise the spores might miss the box and you will wait in vain for the prothalli.

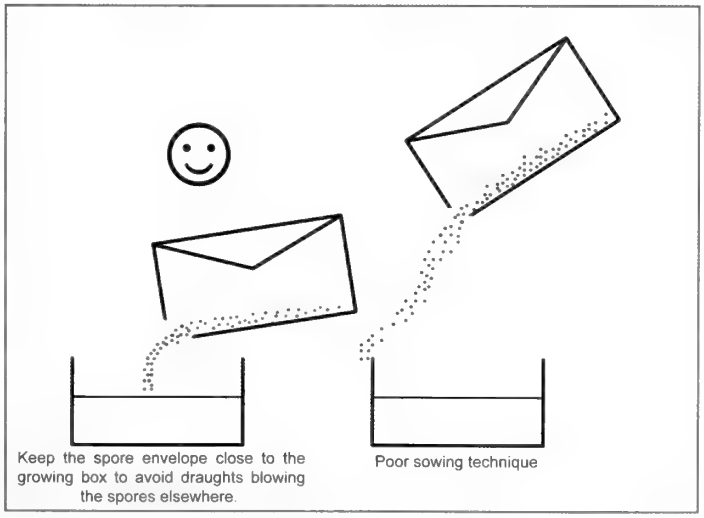


Fig.1. The importance of sowing the spore close to the growing box.

Since I don´t clean the spores, I use the sowing technique shown in Fig 2. Most of the "chaff" stays in the envelope if you do it carefully.

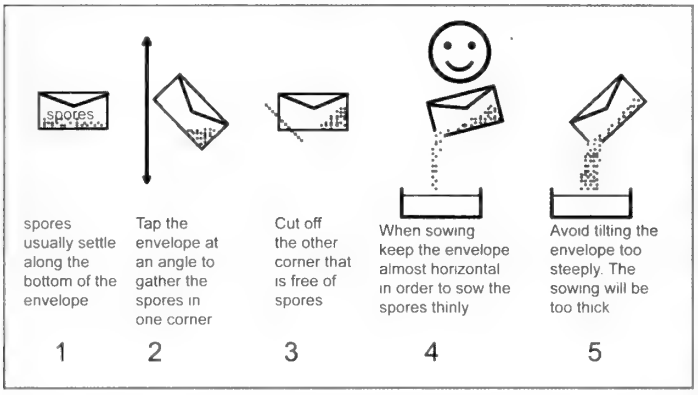


Fig.2. The sowing technique used when the spores have not been cleaned.

Growing the prothalli.

After sowing, the boxes should be put in a shaded, but not dark, corner of the room. The ideal temperature is about 22^0 – 24^0 C. The spores germinate in a few days but this is seen only with the help of a microscope. After 2 to 4 weeks a green gleam on the surface of the soil shows that the germination was successful. Sometimes you will see that the prothalli persist in a state of filamentous growth. The reasons can be keeping them too dark, too wet or sowing too densely. Whatever the reason, please prick out the prothalli to alleviate the mistake. Changing only the conditions without pricking out is of little use because the prothalli will continue to grow as filaments for a long time. Problems can occur in just one or two weeks, so lift the covers and examine the growth. It can be dangerous at this stage, for the prothalli can have some species of mould, other fungi, algae and mosses growing amongst them. If I see a fungus attack, remembering that not all are dangerous, I touch the attacked area with a squirrel-hair paint-brush dipped in a fungicide. Against mould, I use a fungicide with the active substance fenhexamid and against other fungi, one with the active substance fosetyl ((Aluminium tris-O-ethylphosphonate). Both fungicides are very effective and tolerated by the prothalli and sporophytes (see Fig.3). I always keep a stock of the solution of both fungicides in jars and by using a paint brush only small quantities of the fungicide are employed. For algae and mosses, keeping the boxes very dark until the algae and mosses die is effective. The prothalli can survive a surprisingly long time with very little light. The more fertilizer the compost contains, the more problems are experienced with algae. To avoid invasion with larvae of fungus gnats the boxes must always be covered.

Fig.3. Mould attack on the prothalli of *Woodsia fragilis* stopped by fungicide. Dead prothalli in the centre.

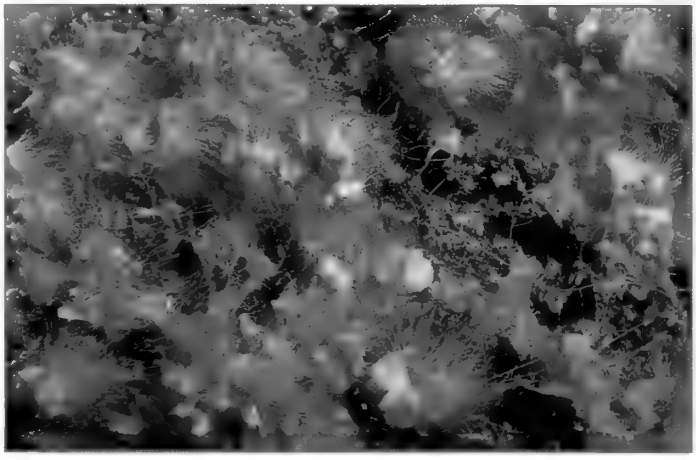


Fig.4. In dry conditions the prothalli produce more rhizoids than usual. (*Dryopteris goldiana*)

If the prothalli are nearly adult, keep them moderately dry. They are surprisingly tolerant of dry conditions and can produce large numbers of rhizoids (see Fig.4). If watering is necessary, do it from below to avoid fructification. Prothalli can live many years. If they don´t produce sporophytes they continue to grow, propagating themselves vegetatively with the older parts dying after some time (see Figs. 5 and 6). Thus it is possible to keep the prothalli for future work without the continued need to propagate more.

Fig.5. Old, dying prothalli producing new prothalli in order to survive. (*Osmunda regalis*)

How to create the hybrids.

General advice.

There are some things we must consider before we start sowing. Firstly, we decide what species we would like to cross. After this, we must decide which species should be the "mother" and which the "father". In many cases it makes little difference, but if one of the parent species is apogamous this can only be used as the father. Apogamous gametophytes produce new sporophytes without sexual crossing. They do not produce archegonia or eggs, but

Fig.6. 8 year old prothalli of *Polystichum acutidens,* freshly pricked out in a new box.

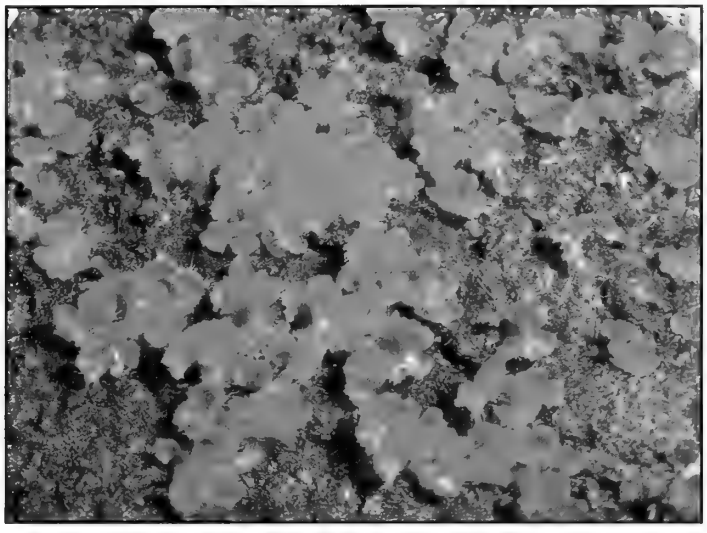


Fig.7. Well spaced prothalli of *Polystichum haleakalense*, ideal for using in hybridization.

have normal antheridia. Therefore, it is impossible to cross two apogamous species. In some other cases the choice is still not straightforward. For example, it is known that *Asplenium* x *alternifolium* (*A. septentrionale* x *A. trichomanes* ssp. *trichomanes*) can only be produced if *A. septentrionale* is the mother and *A. trichomanes* ssp. *trichomanes* is the father. The reciprocal cross is lethal. A little reading may prevent disappointment later! It is not essential but is good practice to sow the mother parent first and the father parent 2 months later. Why? The gametophytes first develop the antheridia and later the archegonia. If the gametophytes of both species are the same age the spermatozoids will be ripe at the same time, they then swim out and will not be able to find a ripe egg. Later the eggs are ripe but there are no spermatozoids for fertilizing. The result is that for a long time no sporophytes will appear. The mother species must be sown very thinly so that later it is possible to prick out enough single prothalli (see Fig.7). The father species can be sown more densely. To obtain a thin sowing, it is easier to use a larger growing box than is necessary for normal sowings, e.g. 15 x 20 cm (6 x 8´´) or more.

In order to recognize a hybrid early, it is helpful to document the development of the young plants of the parent species, if you have the opportunity, before starting (see Fig. 9).

When prothalli are pricked out, they should be set at a distance of 2 cm (0.8´´) from another one of the same species to be sure that there is no fertilization by the same species. From my observations, the spermatozoids have a radius of action of not more than 1.5 cm (0.6´´). Prothalli which will be used as mother should be pricked out as early as possible if they are heart-shaped. After 5 to 6 months most gametophytes have ripe eggs. In *Osmunda* it can take a year or more.

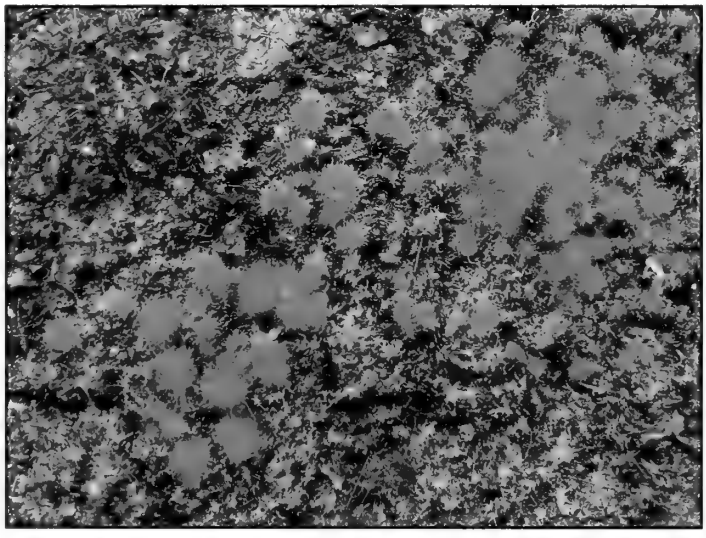


Fig.8. A dense sowing. The bowl shaped clusters are where whole sporangia were sown prior to them releasing spores.Even the single prothalli will be difficult to prick out later.

Fig.9. Documentation of sporophyte growth, this example is *Polystichum drepanum*.

The methods:

Method 1.

The most simple method is to sow the spores together. This is the method which Lowe used. Growing the prothalli and the sporophytes is the same as for the normal propagation of ferns. The drawback of this method is that a very large number of plants are produced before the possible hybrids are identified. For amateurs with little space, that may be a problem. This method may be of more interest to professional gardeners who grow large quantities of

ferns for sale. By choosing parent species which have a very different appearance, e.g. a pinnate species and a bipinnate species with the same ploidy it is easier to recognize the hybrids and to separate them early. Another drawback of this method is that you cannot easily see if the spores of one of the species have germinated.

Method 2.

In this method, the spores of the parents are sown separately and later the prothalli are pricked out in a row alternating species A and species B (see Fig 10). I used this for some years after moving away from method 1. I mention this method only for reasons of completeness. It is better to use method 3.

Method 3.

This is now my prefered method with the different gametophytes pricked out in pairs. Here, the sowing is again separate and the prothalli are pricked out. In contrast to method 2, the prothalli here are put in pairs together with other pairs in a row (see Figs.10 and 13). The advantage of this method is that for many of the new sporophytes it is possible to say which is the mother and which the father. Many of the prothalli can later still be identified as either the mother or father species and hence be used for a new trial.

Method 4.

This "chess-board method" was used by T. Reichstein in Basel. It has the great advantage that each prothallus is surrounded by 4 prothalli from the other species (see Fig. 10). The disadvantage is that, after some months, the prothalli have grown so much and become so intermingled that it is later not possible to prick out the rest of the prothalli for a new trial because it is no longer possible to identify to which species they belong. A second disadvantage is that in most cases it is not possible to say which is the father and which the mother of a new sporophyte. These disadvantages are also found in method 2.

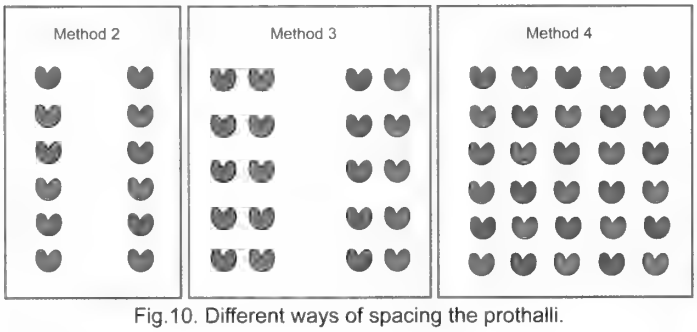


Fig.10. Different ways of spacing the prothalli.

Method 5.

In this method we prick out the prothalli of the mother species in a chess-board pattern at a distance of 2 cm. After this we sow the spores of the father species over them. In this instance it is possible to see an interesting phenomenon: the older prothalli produce substances which suppress growth and/ or induce the small young prothalli in the neighborhood to produce more antheridia so that they do not have the resources to grow larger and form archegonia (see Fig 11). In this way the older prothalli maximize their chance of getting fertilized and minimize the chance of being suppressed by a new sporophyte in the neighborhood. Really quite cunning!

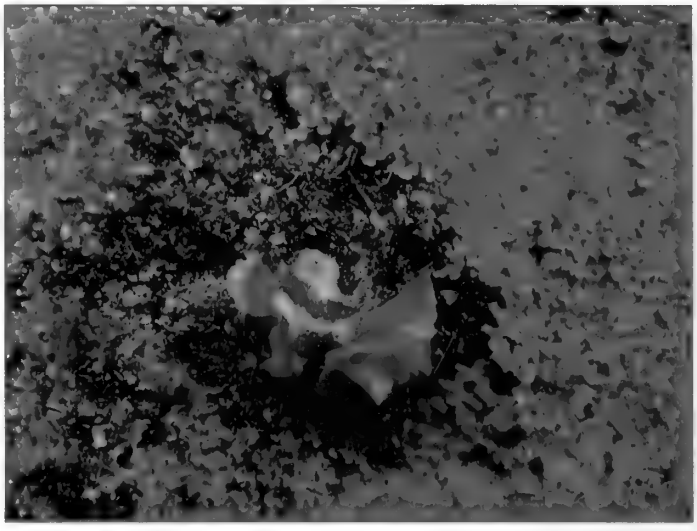


Fig.11. The adult gametophyte of *Dryopteris dilatata* suppressing the growth of *Dryopteris remota* prothalli.

Method 6.

We prick out the mother prothalli as in the previous method. After this we put a small cluster of the 2 months younger father prothalli in water. After some hours we examine the water under a microscope to see whether there are spermatozoids in the water. If so, we dab the water with a brush onto the mother prothalli. If not, we repeat the process every week until swimming spermatozoids are produced.

Growing the young sporophytes.

The young plants are pricked out in clear plastic boxes. To eliminate the risk of invasion by fungus gnats, the boxes must always be closed. However this increases the risk of attacks by fungi because the air in the boxes is very stuffy and wet. To get better air conditions, I burn a hole in the cover with a candle 3 - 5 cm (1 – 2´´) in diameter. If the hole is larger there is a danger of forgetting to water, if smaller it does not help with the risk of fungus attack. Previously I used a knife instead of the candle but then the plastic material often breaks. I close the hole with a little sheet of kitchen paper (see Fig.12). The paper stops the fungus gnats but transports moisture outside. So the shelter for the plants is perfect. Since there is no hole in the bottom, the watering must be done very carefully.

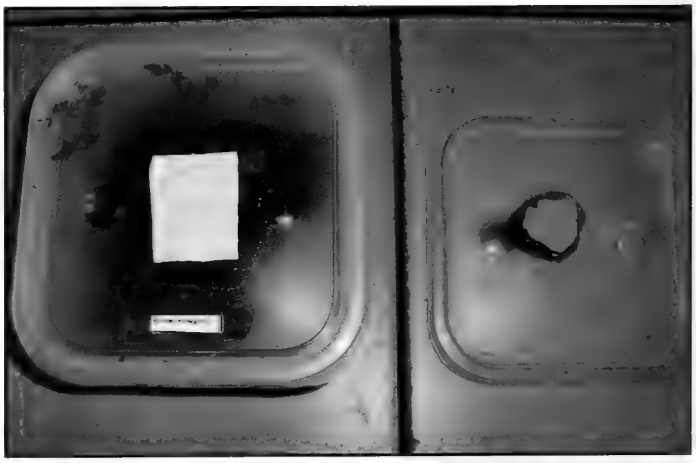


Fig. 12. Breeding box with young sporophytes, showing the burned hole on the right and on the left the hole covered with kitchen paper.

Suitable Genera for Hybridizing.

In most fern genera hybrids are known. Therefore, in principle, there are no restrictions to producing hybrids. However, as I mentioned earlier, there are some limits for reasons of apogamy. Also, in genera in which hybrids often occur, some combinations are impossible or extremely difficult to realize. Some fern genera are just right for our gardens and these are the ones that will yield hybrids of most interest in our gardens and amongst our colleagues.

Asplenium.

The *Asplenium* genus is widespread over the world. Many species occur in Europe. In the garden, only a few species are common in cultivation: *A. trichomanes*, with its cultivars 'Incisum Moule', 'Ramo-Cristatum' and 'Stuart Williams'; *A. scolopendrium* with many cultivars and *A. ceterach*. In nature, a lot of hybrids between the species have been found in the last 150 years, but most of them are very rare and artificial crossing is also very difficult. In 3 trials to create *A.* x *gastoni-gautieri* (*A. fontanum* x *A.viride*), I bred more than 300 plants – without success. On the other hand, I crossed *A. onopteris* with *A. sibiricus* and got 9 hybrids in 200 plants. I think chance is a large factor at work.

Backcrosses in this genus are nearly as successful as primary crosses in the genus *Polystichum* (1 – 5 %).

Athyrium.

This large genus has delivered many species for the garden and many hybrids are found in nature. Crossing, although as difficult as in *Asplenium,* has produced some interesting hybrids. Some have arisen naturally by themselves in American gardens such as *Athyrium 'Ghost' and Athyrium 'Branford Beauty' (which are probably crosses of A. niponicum 'Pictum' with varieties of A. filix-femina).* Many other interesting combinations are still to be tried in this genus mainly between cultivars of *A. filix-femina* and Asian species.

Dryopteris.

This is also a large genus which has enriched our gardens with many species. Within this genus, hybridization is difficult but there are a lot of allopolyploid species (species which arose by chromosome-doubling of a hybrid). Such species can relatively easily backcross with their parent species more so than in the other genera mentioned previously. In *Dryopteris*, there are many apogamous species. Hybrids between these and normal sexual species can inherit this apogamy so that they are fertile and can be propagated by spores.

Polystichum.

This genus encourages us to continue the hybridization work if the trials in the other genera have been unsuccessful. Here we have a fantastic playground for the hybridiser. I know of no other fern genus in which crossing is so easy but this is also relative. To be sure of success, a hundred plants should be grown. That means if you use method 3 you should prick out 70 or 100 pairs of prothalli. The results in my work are, in most cases, between 1 and 5 hybrid plants, in backcrosses perhaps a few more. But there are also combinations which are impossible or nearly impossible.

Goals.

The goals for crossing garden ferns include more luxuriant growth, winter hardiness and the addition of garden worthy plants with better cultural characteristics. There is plenty of material available to meet these goals. Luxuriant growth often occurs in hybrids (hybrid vigour), but especially in triploid hybrids (one parent is diploid and one tetraploid). Winter hardiness will be most easily promoted if you cross a diploid fern with low hardiness with a tetraploid of a fully hardy species. I don´t know for certain but possibly the property of frost hardiness is not only found in the chromosomes but perhaps also in the protoplasm. If creating a cross with the goal of hardiness and both parents have the same ploidy, then the hardier parent should be chosen as mother. To enrich the assortment of interesting cultivars, some crosses are obvious e.g. *Athyrium filix-femina* cultivars with *A. niponicum* 'Pictum' or *Polystichum proliferum* with cultivars of *P. setiferum*. The small Polystichums which occur in nature at high elevations are often fussy in garden culture. Here we can try to cross them with other small species which are not so difficult, e.g. *P. lanceolatum*. It also helps that generally hybrids are not as fussy as their parents.

There are also some scientific goals: in allopolyploid ferns often one or both parents are unknown. Crossing these species with the presumed parent species can help to identify the progenitors.

So much to do – so little done! ❐

Acknowledgements:-

I wish to thank Pat Acock for preparing the text prior to publication.

References:-

J. D. Lovis (1968). 'Fern hybridists and fern hybridising. Part II Fern hybridising at the University of Leeds', *Fern Gazette* 10(1) BPS

G. Eberle(1970). *Farne im Herzen Europas*, 2. Auflage, Senckenbergische Naturforschende Gesellschaft Frankfurt

G. Hegi (1984). *Illustrierte Flora von Mitteleuropa*, Band I Teil 1, 3. Auflage

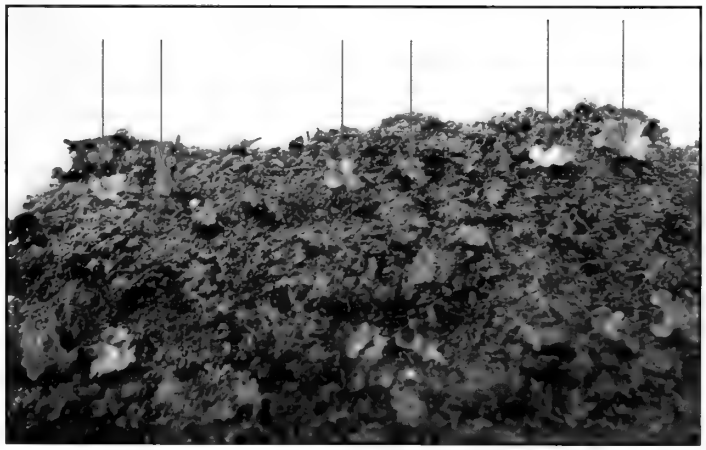


Fig. 13. Method 3. This is now my prefered method with the different gametophytes pricked out in pairs.

Habitats for *Dicksonia antarctica* at Logan Botanic Garden.

Alastair Wardlaw.
92 Drymen Road, Bearsden, Glasgow G61 2SY
e-mail: a.wardlaw@tiscali.co.uk

Logan Botanic Garden is a regional garden of the Royal Botanic Garden Edinburgh, the two being separated by 143 miles (230 km). It is located 11 miles (18 km) south of Stranraer on the Galloway Peninsula, and about ¾ mile (1.2 km) inland from the Irish Channel. Logan enjoys a mild climate due to the North Atlantic Drift. Other distinctive features are the considerable protection from South-Westerly gales provided by a tall perimeter wall and a deep shelter-belt of mature woodland.

Logan must have one of the largest collections in Britain, in the order of hundreds, of *Dicksonia antarctica* tree-ferns. These provide useful opportunities for observing two types of variation in this species: the variation between individual plants in the same habitat, and that between plants in different habitats. In a September 2012 visit to Logan I took pictures to illustrate these points.

Fig.1 shows around 20 *D. antarctica* of an age where they were just beginning to develop trunks. They were set out in individual plots on an area of lawn within the walled garden. These relatively small tree ferns had been provided with insulating wrapping during the previous winter and had survived. Although there was some individual variation, most of the specimens had settled in well. This grove-to-be had replaced similar plantings of the South African tree fern *Cyathea dregei* which, despite wrapping, had not withstood the exceptionally long freeze of a recent winter.

One of the several clusters of mature *D. antarctica*, also within the walled garden, is illustrated in Fig.2, which includes the perimeter wall itself. There are three tall-trunked and well-fronded specimens, together with one with a bent trunk that was obviously struggling. Questions that might be asked are: why the differences, and is the bent-trunked specimen likely to recover?

An apparently more congenial site for the tree fern was the Tasmanian Glade of Fig. 3, as seen from its viewing platform. Despite being outside the walled garden, this area benefited from a central stream which delivered both

Fig. 1. Multiple plantings of small D. antarctica in an open location within the walled garden at Logan.

Fig. 2. Cluster of four mature *D. antarctica* within a few metres of the new plantings of Fig. 1 and also within the walled garden. Arrows indicate the top of the perimeter wall.

Fig. 3. The 'Tasmanian glade' at Logan from the viewing platform, with *D. antarctica* amid eucalypts.

moisture and drainage. Being in a valley, albeit modest, this habitat more closely resembles what the tree ferns might experience in their native Australia, with wind-protection from both the valley location and the close-growing eucalypts. These latter, however, were not yet tall enough to give overhead protection from the radiative frosts that are liable to occur on cold, clear nights. Notice that the two specimens shown are proportionately longer-fronded, in relation to trunk height, than the larger-trunked tree ferns in the more open location of Fig. 2.

The most congenial location for *D. antarctica* at Logan seemed to be in an understorey area outside the walled garden and near to the Tasmanian Glade. It had overhead shelter provided by a variety of mature evergreens and also wind protection delivered by the shelter-belt. Note how the specimen in Fig. 4 has numerous long fronds, in good condition, and emerging from the entire width of the top of the trunk. It contrasts very favourably with the bent-trunked specimen in Fig. 2.

Fig. 4. *D. antarctica* growing at Logan in an understorey area, on a slope, outside the walled garden.

Discussion

With its exotic shape and size, the Soft Tree Fern *Dicksonia antarctica* is generally recognized as an excellent 'architectural' plant. Seeing such specimens at Logan should stimulate the appetite for visiting these tree ferns in their native habitats in South-East Australia and on the Island of Tasmania. In these locations it is very much a fern of the moist forest understorey, in places where a flash is needed to take pictures.

It is perhaps, therefore, worth re-emphasising that the sites where tree ferns grow in the wild may be much more restricted than the sites where a previously pot-grown specimen, or an imported trunk, will thrive in a garden with suitable shelter. Starting with wind-blown spores, the early stage tree fern in the wild needs an unoccupied micro site and continuous moisture for long enough, certainly months, maybe a year or two, for the prothallus to develop and be fertilized. Thereafter, a few years will be needed to deliver even a modest-sized tree fern.

In contrast with these requirements in the wild, an artificially-raised tree-fern, or harvested trunk, may grow well in direct sunlight, even in Australia, provided it is given wind-protection and high humidity.

In addition to the large and deliberately-planted *D. antarctica* at Logan, there were numerous juveniles appearing spontaneously in moist places where spores had landed and germinated. Favourite locations were disintegrating peat blocks around the margins of shrub beds and crevices between stone slabs in shady places. These sites presumably provided the continuous moisture required for the early stages of tree fern life.

The moisture delivered by the maritime climate at Logan also sustained the large specimens of *D. antarctica* growing in the open. However, even these specimens (Figs. 1 and 2) seem to suffer from some moisture deficit by not having as proportionately large fronds as the plants in the Tasmanian glade (Fig.3) or in the woodland understorey (Fig. 4).

Logan thus encapsulates the general horticultural advice that, for *D. antarctica* to flourish long-term in a British garden, it needs constant high humidity, plus protection from wind and winter frosts.

Completely different from these habitat variations is the question of genetic variation within the species *D. antarctica* itself. This would be of particular interest to British gardeners who want to grow the most frost-hardy varients. It would be good to know whether, in fact, there is actual genetic variation in frost-hardiness of *D. antarctica*, particularly if it was coupled with a capacity for vigorous growth during British summers, which are so much cooler than those in Australia.

The specific question, therefore, is whether tree ferns sourced from the highest altitudes, and therefore the coldest regions, in the States of Tasmania and Victoria, might be faster-growing in a British summer and hardier in a British winter, than tree ferns from milder regions of SE Australia? The specimens at Logan came, down the years, from diverse Australian sources but none, identifiably, from the highest altitudes.

Logan, nevertheless, may already possess one, or a few, unusually frost-hardy *D. antarctica*. These could have emerged as 'survivors of the fittest' from the 'selection pressures' of the periodic severe winters, when a disturbing proportion of the neighbouring specimens were killed. Tree ferns raised from the spores of such 'winter-fittest' specimens would be interesting to compare for winter-hardiness with plants grown from spores of 'winter-unselected' mature tree ferns, such as those available as potted trunks in garden centres. ❐

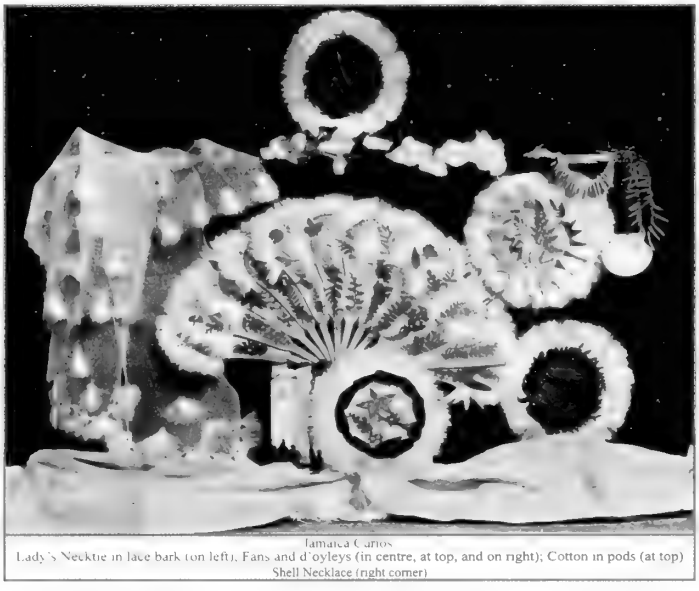
Acknowledgement

I thank Richard Baines, Curator of Logan Botanic Garden, for information and helpful comments. These included the information that 'after recent severe winters, some mature specimens were totally killed whereas self-sown undisturbed sporelings growing in the same location, came through totally unaffected.'

Jamaican fern decorated doyleys and their origins.

Michael Hayward
6 Far Moss Road, Blundellsands, Liverpool L23 8TQ
e-mail mhaywardL23@blueyonder.co.uk

Fern decorated lace-bark doyleys are one of many craft items that were sold in Jamaica, chiefly to tourists, over a long period from the 1860s until the 1930s (Fig. 1). 'Doyleys' and 'D´Oyleys' are spellings peculiar to the Jamaican dialect, perhaps influenced by the name of the first British Governor of the Island, General Edward D´Oyley. D'Oyley is today a relatively common surname in Jamaica. These attractive artefacts, which are purely decorative items, are relatively easily acquired. When I started to research who might have made and sold them, I was struck by their sophisticated designs, much more in keeping with the 'Elegant Arts' that Victorian ladies were expected to pursue than with the products of local native crafts. Yet they were clearly produced in considerable numbers and were constructed of only inexpensive or locally gathered materials. The cut-outs used to decorate some of the doyleys (Fig. 2) invite comparison with the elaborate decoupage practised by Victorian ladies. Much information was obtained by searching the Jamaican newspaper archives. Martin Rickard and Barrie Stevenson showed me from their personal collections.



Jamaica Curios
Lady's Necktie in lace bark (on left); Fans and d'oyleys (in centre, at top, and on right); Cotton in pods (at top)
Shell Necklace (right corner)

Fig. 1. A collection of tourist items bought in Jamaica. Leader, 1907

The production of lace bark from the *Lagetta lagetto* tree was once common in the islands of the Greater Antilles, particularly Jamaica, Cuba and Haiti, and it was used chiefly for decorative items of clothing and for rope work. The small tree from which it was produced grew in the upland limestone districts of Jamaica. Unlike the better known bark cloths of the Pacific Islands (Tapa) which are constructed as multi-layered fabrics, mostly from the Paper Mulberry *(Broussonetia papyrifera)*, the inner bark of *Lagetta lagetto* (syn. *L. linearia*) was drawn out into a single layered material. Stretching during preparation opened up the rhomboidal interstices in the membrane to produce the gauze or lace like fabric. Lace bark was prepared and sold commercially in Jamaica until the 1930s with a later revival of production until the 1980s. It is recorded that a cravat of Jamaican lace bark was presented to King Charles II

Fig. 2. Star shaped doyley from an elaborate exhibition or wedding set - see also Fig. 6.

by Sir Thomas Lynch, (Sloane, 1725). Recent papers by Pearman & Prendergast (2000) and by Brennan & Nesbitt (2010) discuss the production of lace bark.

The earliest reference that I have found to the doyleys is in a letter from Dr Charles Campbell of Kingston, Jamaica, to the director of Kew (1868). With the letter he enclosed a sample of his wife´s work *'made from the Lace Bark of the Island, together with ferns and then bordered with the dried sheath of the Mountain Cabbage Palm'*. He describes his wife as being in the habit of making similar items for schools and charities. Lace bark doyleys and a lace bark fan sent from Jamaica to the Paris Universal Exhibition of 1878 by Rev. George Brooks (secretary to the Bishop of Kingston) were described in the catalogue as follows... *'Fan made of the bark of the Lagetta liniearia tree grown in Jamaica; the border is cut out of the spathe (sheath of the fruit) of the Mountain Cabbage Palm; Tassel, made of the fibre of the Pine Apple; Frame of yellow Sanders Wood and the Ferns are collected from different parts of Jamaica.*

Doyleys made of the bark of the Lagetta liniearia tree growing in Jamaica; the borders are cut out of the spathe, or sheath of the fruit of the Mountain Cabbage Palm; the Ferns are collected from different parts of Jamaica. The above Fans and Doyleys are sold for the benefit of the Orphanage for Girls at Half-way Tree, Jamaica'

Neither the Campbell letter (1868) nor Rev. Brooks' description (1878) of the doyleys mentions a fringe, although the fan had a fringe. The doyley fringe was probably a later development of the style. At the end of the Paris exhibition all the items left on the Jamaican stand were to be offered to Kew for their economic botany collection.

Mrs Campbell and Rev Brooks´ wife were both on the fund raising committee for the Alms Houses and Orphanage

Fig. 3. Selection of the Women´s self-help Society wares. Leader, 1907

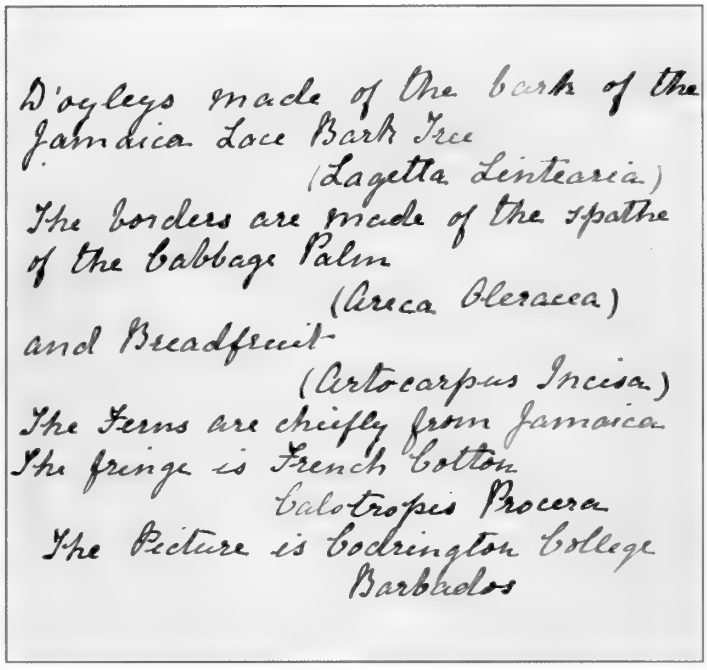


Fig 4. Typical text sheet – the wording varies between sets.

of St Patrick Church in Kingston. There was much poverty in Jamaica at this time and in 1879 the Governor´s wife, Lady Musgrave, set up the 'Women´s self-help Society', the stated aims including *'finding remunerative work both for poor women of the humbler class and for persons who, though belonging socially and educationally to a higher class, have need to provide by their own efforts some supplement to their otherwise inadequate resources'*. The Society, which was not confined to Kingston, set up a depository in Kingston where items made by the women were sold, on commission (Fig. 3). Mrs Campbell was a vice-president of the Society and after her death her memorial notice (Daily Gleaner, 1886) stated that she devoted much of her time to the instruction of women of the self-help society in the production of saleable items. We do not know whether the basic idea for the production of the doyleys can be attributed to Mrs Campbell but she was undoubtedly a catalyst in setting up their production as a mini industry, initially by the women´s self-help society. They were later sold in a number of curio shops in Kingston and on the local market. The depository was a recommended stop for tourists.

In a description of a visit to a Kingston market (Forrest & Henderson, 1906), amongst the many items offered for sale are *'cocoa-nuts carved into men's heads, the red hair left to make a frizzy beard. These, the lady says, are very fine. There are little gourds set on wooden skewers, and so formed into babies' rattles. These the arch maiden sells to young men and maidens. Last of all, she produces dainty d'oyleys and table-centres and fine ornaments made from the lace bark-tree, and fashioned with ferns and pressed blossoms. These things cost a great deal of money, but as a rule they are very decorative. When you leave her stall, the lady pursues you for many yards with a mammoth lamp-shade, which, she assures you, will be greatly appreciated by your home folks.'*

Tourists coming to Jamaica, principally from Britain and from North America, would have been the main purchasers of these artefacts but they also appear on lists of wedding gifts published in local newspapers, both in Jamaica and in Australasia (Sir Anthony Musgrave was appointed Governor of Queensland in 1883) so were clearly regarded, at least by Lady Musgrave, as prestigious items. The self-help society and a number of individually named ladies (and occasionally gentlemen) sent doyleys and other craft items for exhibition and sale to international exhibitions including New Orlean (1885), London (1888), Jamaica (1891), St. Johns (1902). The women´s self-help society celebrated its Jubilee in 1929 and the press report still mentions the production of doyleys.

As well as setting the design standards for the doyleys, Mrs Campbell and her cohort started the practice of including a written account of the materials used in their production (Fig 4). I have seen five such lists and a printed list with a lace bark fan. All follow the same format of short paragraphs, but with slightly different wording, giving both local and Latin names of the plants used (but not of the ferns!) The folders for the doyleys are of relatively simple construction made of card or paper with ribbon ties (Fig. 5 & 6).

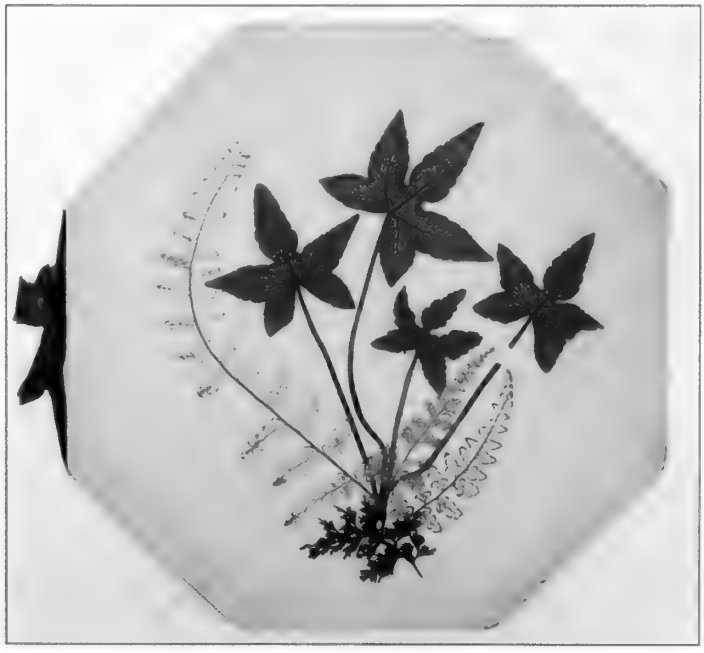


Fig. 5. Early card cover with *Hemionitis palmata* and *pityrogramma*. (Photograph: Martin Rickard)

Fig. 6. Elaborate later cover with inlaid white silk panels and decorative ribbons.

Fig. 7. Some doyleys were sold mounted behind glass.

Some of the card covers were trimmed with pinking shears and hole punches and are probably of later origin. The front covers all have fern decoration (often lost). Two seen have a central window with a lace bark insert. Another has a photograph of Codrington College, Barbados, on the front cover. This college, still in existence, was the Anglican Theological College for the whole of the British West Indies, so this example was no doubt being sold for church funds. One cover is particularly elaborate with cut out round windows lined with white silk, decorated with ferns, pressed flowers and an bunch of decorative ribbons (Fig. 6). This half set of 6 doyleys could well have been intended as a wedding present or for sending to an exhibition.

A report in the Daily Gleaner of items sent to an exhibition in St. Johns, New Brunswick, in 1902 describes fern decorated doyleys with very many forms. Fringed doyleys, doyleys edged with seeds, with embroidered edge, with fibre and lace edge, with etched edge and doyleys mounted behind glass. Two of my own examples have been mounted on card and framed (Fig. 7). The frames are modern but the mounts appear to be older, so they might even have been sold ready framed. The doyleys were usually sold in sets of 12 or half sets of 6 but many of the surviving sets have been split up.

The doyleys with a fringe, the type most commonly now seen, are constructed from a circle of lace bark, 10-11cm in diameter. A ring of thin card is glued to the back to stiffen the doyley and anchor the edge of the lace bark. The seeds of *Calotropis procera*, known locally as 'French Cotton' are glued around the edge of the face to provide the fringe. In some of the sets seen a fancy circlet cut

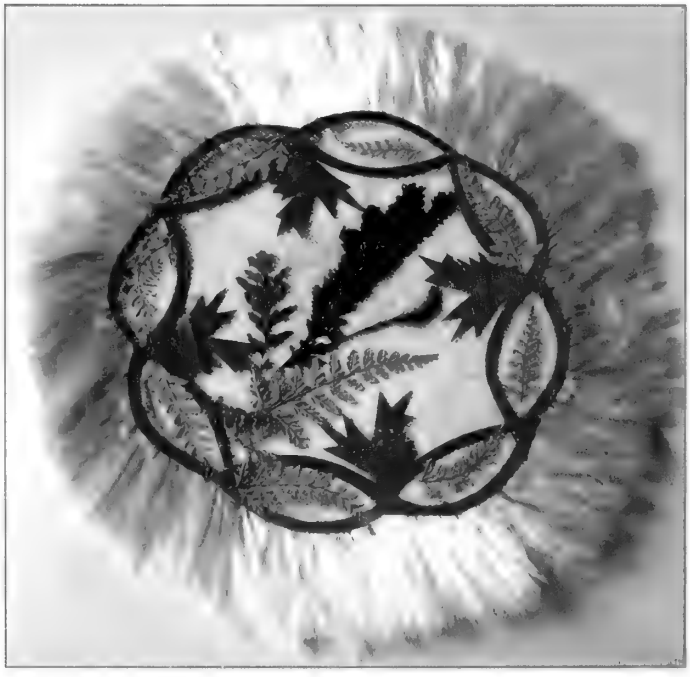


Fig. 8. Doyley bordered with spathe of the Bread Fruit tree, *Attocarpus incisa*. (Photograph Barrie Stevenson)

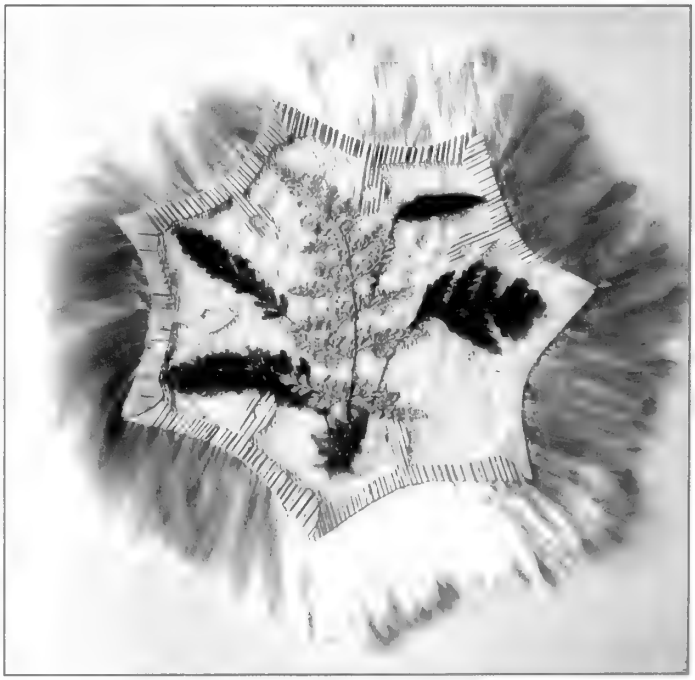


Fig. 9. Doyley bordered with spathe of the Mountain Cabbage Palm *Areca* (*Roystonia*) *oleracea*. (Photograph Barrie Stevenson)

Fig. 10. Doyley bordered with ring of *pityrogramma calomelanos*.

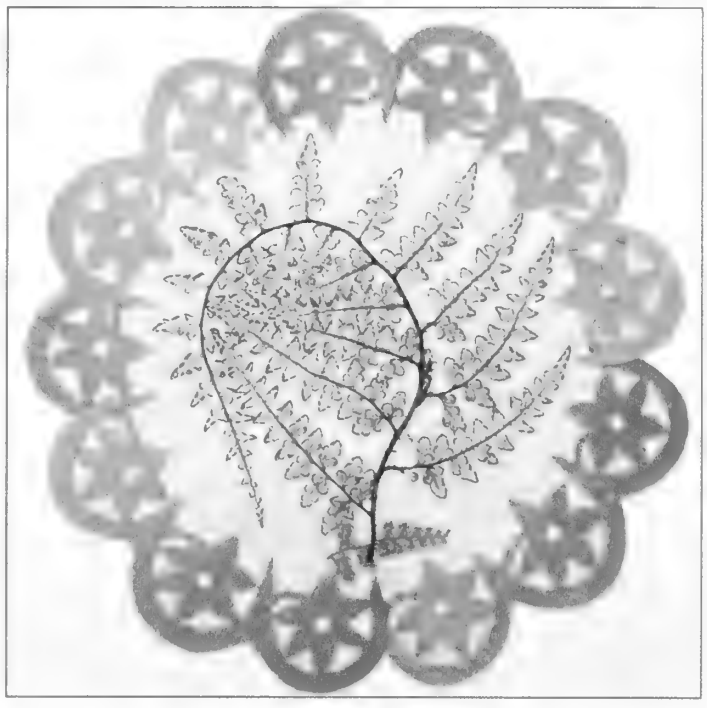


Fig. 11. Early doyley without fringe. Cabbage palm border.
(Photo Martin Rickard)

from either the red-brown spathe of *Attocarpus incisa*, the Bread Fruit (Fig. 8), or the much paler spathe of *Areca oleracea,* the Jamaican Mountain Cabbage Palm (Fig. 9), is glued over the edge of the lace bark. The cut patterns are extremely variable, commonly of sinuous form but occasionally representing butterflies or other objects. In other sets of fringed doyleys the circlet on the face is made of small fern pinnules, usually of the gold form of *Pityrogramma calomelanos* (Fig 10). On all of the doyleys the central space is filled with a 'bouquet' of fern fronds and occasionally a selection of small pieces of selaginella, moss, pressed flowers, grasses and small berries. The ferns are remarkably well preserved in all of their details. The overall size of the fringed doyleys is 17-18 cm. One set of doyleys seen has star shape rather than the usual round form (Figs. 2 & 6) and a particularly elaborate decoupage of *Attocarpus incisa.*

Martin Rickard´s collection is made up from 2 (or more) sets of doyleys (there are 2 covers) none of which have a fringe.(Fig.13.) The disc of lace bark is slightly larger in these sets and the circlet of the spathe of Bread Fruit or Cabbage palm is wide and elaborate. Some doyleys in this collection are of much superior design and construction to others, four of the doyleys having the lace-bark tinted a pastel blue, green or pink (Fig. 2). The ferns on the octagonal cover (Fig. 5) are particularly well preserved. One Edwardian illustration shows doyleys with the lace bark more deeply dyed than those in this set (Fig. 1).

Barrie Stevenson´s collection is a complete set of 12 doyleys with the hexagonal paper cover and dividers of folded sheets held in place by a white ribbon. The ferns on the cover are quite distressed but internally the fringed doyleys (Figs. 8 & 9) are in excellent condition. The descriptive text is written directly on to the first page of the dividers rather than being on a free sheet.

The ferns used to decorate the centre of the doyley are always mounted with the sori showing where the examples are fertile (Fig. 12), which helps in their identification. Jamaica has a very extensive fern flora, around 600 species (Proctor 1985) including six species of Pityrogramma and almost fifty filmy ferns. Although some of the contemporary records say that the ferns were collected from all parts of Jamaica, all of those so far identified are described by Proctor as being locally common in the St. Andrew Parish and the Blue Mountains behind Kingston. The women´s self-help group had a branch at Montego Bay (Leader) and perhaps others and it is possible that all might have collected ferns. Amongst the species identified with a fair degree of certainty are *Pityrogramma calomelanos* in gold and silver varieties, *P. ebenea* and probably *P. sulphurea*, the most commonly used ferns. *Hemionitis palmata* and *Asplenium pumilum* are readily identified. On some sets of doyleys filmy ferns are common; *Hymenophyllum polyanthos, H. hirsuta* and *Trichomanes hymenophylloides* and many other unidentified filmies. Small fertile fronds of *Anaemia sp.*, *Elaphoglossum sp.* and many other ferns are found together with an occasional spike of *Selaginella sp.*

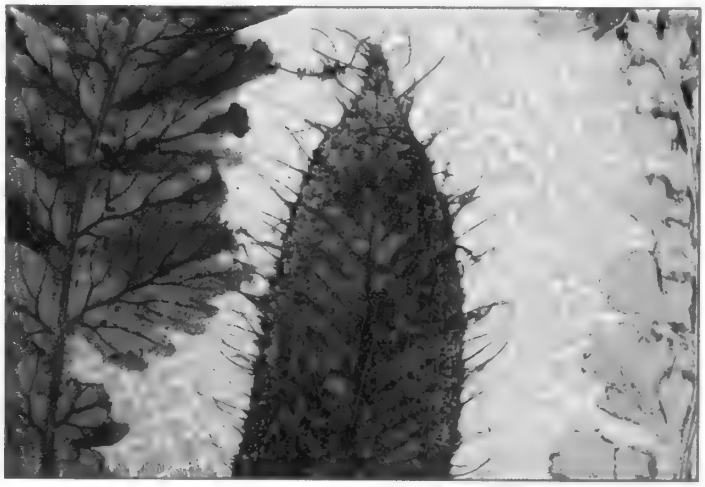


Fig. 12. Close up of the lace-bark. Doyley with *Trichomanes*, *Elaphoglossum* and *Pityrogramma*.

Jamaican fern decorated doyleys and their origins.

The women´s self-help society celebrated its jubilee in 1929 and the doyleys are still recorded as being produced at this time, along with many other craft items. Folding fans are perhaps the most elusive of the fern decorated items, costing 12/- in 1905. I do not have a price for the doyleys, which were said to be 'very expensive', but today they can often be found priced quite reasonably on internet auction sites.

Fig. 13 . Martin Rickard's collection made up of two, or more, sets. (There are two covers.)

My thanks are due particularly to Barrie Stevenson whose showing his set of 12 doyleys at the 2012 AGM (Figs 8 & 9) inspired me to start my own collection, and to Martin Rickard who showed me his own collection of fern doyleys (Fig. 13) and encouraged me to research their origin. A full set of high resolution images of my own, Barrie´s and Martin´s doyley collections can be viewed at www.fernalbums.co.uk by following galleries/ Jamaica and I am very grateful to all who have allowed me to post their images to this site. ❒

References :-

Brennan, E. & M. Nesbitt. (2010). *Is Jamaican Lace-Bark (Lagetta lagetto) a Sustainable Material?* London: Text for the study of textile art, design and history: Vol 38: pp2010-2011

Campbell, C. (1868). *Letter from Charles Campbell,* Director's correspondence *KDLC 13393.* London: RBG Kew archives

Henderson, J. (1906). *Jamaica painted by A S Forrest and described by John Henderson.* London: A. C. Black

Leader, A. (1907). *Through Jamaica with a Kodak.* Bristol: John Wright & Co.

Pearman, G. & Prendergast H. V. D. (2000). *Plant Portraits. Items from the lacebark tree [*Lagetta lagetto *(W. Wright) Nash; Thymelaeaceae] from the Caribbean.* Economic Botany 54(1) pp 4-6

Proctor, G. R. (1985). *The Ferns of Jamaica.* London: British Museum

Sloane, H. (1725). *A voyage to the Islands of Madera, Barbados, Nieves, S. Christopher and Jamaica.* Vol II: p22. Printed for the author

Whortley, Edward Jocelyn. (1906). *Souvenirs of Jamaica.* Kingston: Educational Supply Co.(not seen).)

The fern that never gave up!

Roger Amos

16 Murray Road, Rugby, Warwickshire CV21 3JN

e-mail: rog@rogeramos.co.uk

website: www.rogeramos.co.uk

Two years ago I attempted to rehome an *Asplenium trichomanes* subs. *trichomanes* from a disused railway bridge on to my rockery. I knew it was unlikely to establish itself and, sure enough, it didn't. So I transferred the ailing fern to a covered flowerpot in my greenhouse. After a while it did produce a few minuscule new fronds, while the old ones rotted. Recently I noticed the strange sight in the photograph. There is now a row of well formed prothalli along the axis of one rotten frond. Presumably spores that had never got away from the sori found themselves in contact with a suitable growth medium and germinated.

Meanwhile, to provide *A. trichomanes* for my rockery I decided to grow specimens from spores (collected from an example on a nearby wall). Watching the young sporophytes develop has been fascinating: considering that they all come from the same parent they show a remarkable diversity of form and vigour – there are some photographs on my website. ❒

Fig. 1. Well formed prothalli growing along the line of the axis of the old frond.

FERNS at the PHILADELPHIA FLOWER SHOW

Jack Schieber
1621 Chinquapin Road, Holland. Pennsylvania. U.S.A.
e-mail: jaroma4@verizon.net

The theme of the Philadelphia Flower Show this year is "BRILLIANT" and it's all about Britain. The Show is always the first week in March and one can learn a little about it at http://theflowershow.com/. The Delaware Valley Fern and Wildflower Society (DVFWS) has had an exhibit at the Show for many years and we always manage to include ferns. This year our exhibit is the street side of a British pub with ferns growing about, together with other pub related items we've experienced in Britain and/or learned about from our British friends.

Fig.1. The pub entitled 'The Fox and Fern' is the setting for The Delaware Valley Fern and Wildflower Society in 2013

Setting up the show is quite a process. Members of DVFWS dig ferns from their gardens in the fall and pot them. In late December we take them to the greenhouses of the Horticultural Center in Philadelphia where the staff kindly assist us in their care and forced growth. It's a bit of a crap-shoot because the temperature and light are not controlled specifically for our ferns and some plants do well and others do not.

Fig.2. Detail of the setting for the flower show.

You would think that over the years we would have learned how to do it. What we have learned is that if we are going to use fifteen plants, dig thirty for forcing.

Fig. 3. The main fern bed of the display with *Matteuccia struthiopteris* and the fertile fronds of *Osmunda regalis* var. *spectabilis* at the back.

This year we have about fifteen species in the Show. Although we try to have 'British' ferns we are limited by what we have in our gardens. There is very little variety in the nursery trade and the material is usually too immature. Two British cultivars in the Show are *Dryopteris filix mas* "Parsley" and *Athyrium filix-femina* "Victoriae". Every different species must be labelled and must be approved by the folks who run the show. We generally know at least as much as they do but names change. For Glade Fern they had *Athyrium pycnocarpum* which was used for a hundred years. We had the more recent *Diplazium pycnocarpum*. When we checked it out it turned out that the genus is now *Homalosorus* based on more recent studies including DNA. I had never even heard of it.

One troubling aspect of the process is the hardship on the ferns. We dig them out when they often haven't gone dormant and then start to push them to growth when they really haven't had time for their winter rest. Then, after the show we store them in pots in some dark corner or in the garage until frost is past and they can be replanted in the garden. It takes at least a couple years for them to recover. I realize that ferns are only inanimate plants that probably don't have feelings and maybe I'm a little odd but I feel for them. ❐

Multi-trunking in *Cyathea*.

Paul Spracklin
42 Greenwood Avenue. Benfleet. Essex. SS71LD
paul@oasisdesigns.co.

I was interested to read the account in last years *Pteridologist* by Peter Bostock and Laurence Knight of stem dichotomy in *Cyathea australis*. It reminded me that I have seen something similar elsewhere in a different species, indeed within a different group, of *Cyathea*.

I visit the island of Madeira just about as often as time and money allow. There are many compelling reasons for planty folk like us to go there, not the least of which is to feast the eye on vast numbers of *Cyathea cooperi* tree ferns that are widely cultivated throughout the island. In the wilder, wetter parts they are doing a pretty good job of naturalising, too. Just like me, they seem to relish the gentle Madeiran climate.

Fig. 1. *Cyathea cooperi* showing stem dichotemy. Santana, Madeira

Taking just one example, a short stroll around the lush grounds of Monte Palace Subtropical Gardens soon reveals *Cyathea cooperi* to be a plant completely in its element. Around every corner is the next 'perfect specimen' and there are hundred upon hundred to choose from in that garden alone. Repeat this in all the other major gardens, plus the individual specimens peppered throughout small private plots, and the numbers soon become mind boggling...

The town of Santana on the northern coast is firmly on the tourist route, being one of the last places where you will see those traditional colourful little A frame houses. When alighting from the coach during my first time there, around 10 years ago, my head was turned more by a branched specimen of *Cyathea cooperi* directly outside the town hall (now removed). A little further down the road there is a specimen with an almost corkscrewed trunk. Another was apparently bending away from a power line.

Further investigation revealed a significant proportion of these local *Cyathea cooperi* showing multi-trunking – possibly as many as one out of every eight plants. These were evidently plants that had developed several trunks in the course of growing, rather than multiple plants set out together when small. I would estimate that possibly up to a quarter of all the plants in town were showing some abnormality or other.

A coach trip didn't allow much time for botanising, so I went back with a hire car and a very patient wife to take a

Fig. 2. *Cyathea cooperi* showing stem dichotemy. Santana, Madeira.

closer look on a more recent visit and took several photos, some of which are attached. The greatest number of trunks that I counted on an individual plant was eight! Quite remarkable, especially when not a single plant of the, literally, thousands of other specimens on the island I have seen show any sign of this whatsoever.

One can only speculate as to the cause. Might it be geological in origin? A seam of something strange running through the bedrock in that one place that has had a damaging effect on the DNA of this population? Or just simply the run of the DNA dice. A one-off mutation that the relatively contained population is now destined to throw out ad infinitum? I am sure I don't have any answers but it is quite a curiosity and certainly worth a visit if you find yourself on Madeira with an afternoon to spare. ❐

Reference:-

Bostock P. & Knight L. (2012) '*Stem dichotomy in Cyathea australis.*' *Pteridologist Vol.5 Part 5.*

Fig. 3. Side branching.

Fig. 4. Avoiding the power lines.

Fig. 5 A corkscrew effect

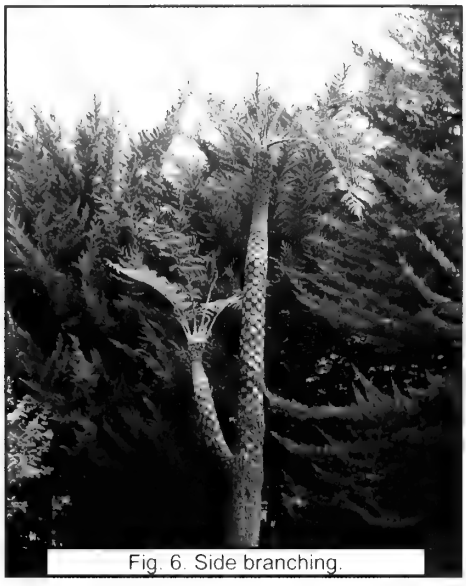


Fig. 6. Side branching.

Various abnormalities exhibitied in *Cyathea cooperi* around the Santana area.

Ferns are good for you! (They absorb airborn pollutants)

Last year. in October, I was touring Normandy in Northern France. The weather was dismal and there are only so many World War II sites you can visit before they start to blur into each other.

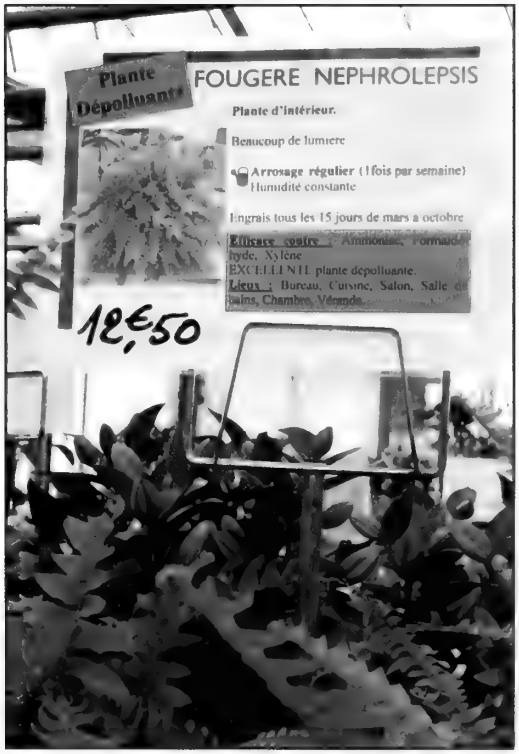
Out of curiosity I called in a local plant nursery. A huge stand, facing the tills, sold the only fern in the nursery. It was a *Nephrolepsis* species selling for €12.50 (about £10.00). At that price I nearly walked past the display until I read the claims that this is a 'depollutant plant'. Apparantly it can absorb Formaldehyde, Ammonia and Xylene. Several photographs later I left the nursery determined to find out more about this property.

It would appear that work started at NASA has discovered that plants and their root-associated micro-organisms can biodegrade and treat indoor air and water pollution.One of the plants studied was the Boston fern (*Nephrolepis exaltata* 'Bostoniensis')

The world renowed pioneer in this field is Dr. Wolverton who worked as a civilian scientist for NASA developing means to protect against and destroy toxic chemicals and pathogenic microbes. The Boston fern ranked 9th as an air purifying plant. (Top plant was the Areca Palm, *Dypsis lutescens*). This science is known as phytoremediation (Plant restoring balance.) and for more information try the following web sites:-

http://www.wolvertonenvironmental.com/
http://webecoist.momtastic.com/2009/04/08/air-purifying-plants/
http://www.englishgardens.com/10-best-clean-air-house-plants

AEG



The Story of a National Collection of British Ferns.

Alastair Wardlaw.
92 Drymen Road, Bearsden, Glasgow G61 2SY
e-mail: a.wardlaw@tiscali.co.uk

National Collections

I didn't deliberately set out to have a *National Collection of British Ferns*. In 1997 I found accidentally that I already had one – more or less. The chance event leading to its official recognition was a garden visit from the late Cameron Carmichael, the local representative of NCCPG (National Council for the Conservation of Plants and Gardens) in this part of Scotland. After seeing my ferns, he encouraged me to submit an application to NCCPG Headquarters (then in Wisley) for the collection to be recognized as a national collection of British ferns. Which I did, and it was.

I then held the NCCPG-accredited *National Collection of Ferns (British)* for 12 years from 1999. Typically (Fig. 1) it was listed in the annual Directory, along with the 600+ other *National Collections*, of garden plants (including several collections of ferns) in the UK, as:

Ferns (British)
Prof A. C. Wardlaw, 92 Drymen Road, Bearsden,
Glasgow, East Dunbartonshire, G61 2SY
Tel: 0141 942 2461
Email: a.wardlaw@tiscali.co.uk
No. of plant types: 145
Mature garden with British and foreign ferns in shady parts;
palms and exotics in sunny areas.
Open: By appt.
Entry: Voluntary donation to NCCPG.
Directions: Side lane off E side Drymen Rd;
100yds N of Bearsden Station. Park at Station.
T

Fig. 1. Ferns (British) in the Plant Heritage (NCCPG) Annual Directory for 2009.

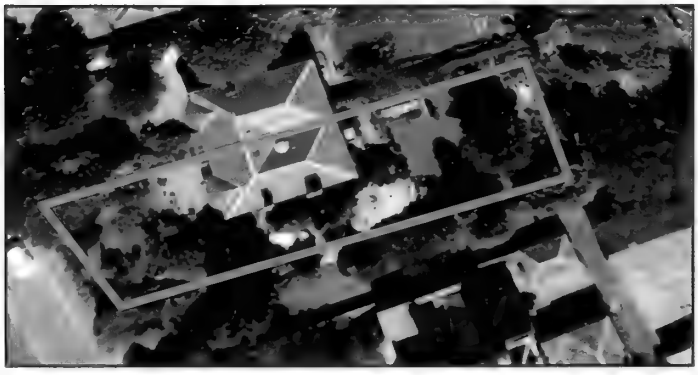


Fig.2. Google Earth view of our house and garden at Grid Reference NS 544719, 45 metres above sea level. The total area is 0.1 hectare, of which the fern-growing sites occupy about 20%.

In 2011 after a period of ill-health, the increasing paperwork of being a Collection holder, led me to have the collection de-registered. Now I just look after the ferns themselves. Visitors continue to be welcome to see the approx. 300 different ferns in the garden (Fig. 2).

The NCCPG goes back to 1978 when a group of horticulturalists decided to do something about conserving garden plants - as had already been started with conserving the wild plants in the British countryside. They founded the National Council for the Conservation of Plants and Gardens (NCCPG), later given the snappier title of Plant Heritage (PH). The NCCPG/PH, like the BPS, is a registered charity and enjoys the same Patron, HRH The Prince of Wales.

The main requirements for a National Collection (at the time I applied) were:

- The collection must contain at least 75% of the taxa listed under that plant group or varietal category, in the RHS Plantfinder (now on the web).
- The sources of the plants must be on record, which should be available for inspection. All specimens must have been obtained by an acceptable method, i.e. there should be no 'kleptophytes'!
- The plants and their surroundings must be well-tended – so a lot of gardening-TLC is involved in maintaining a National Collection;
- Each planting must be clearly labelled, e.g. as Fig. 3.

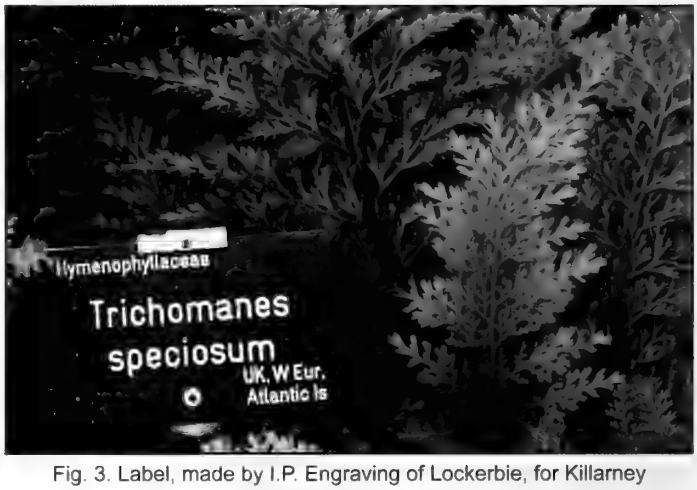


Fig. 3. Label, made by I.P. Engraving of Lockerbie, for Killarney Fern (*Trichomanes speciosum*).

- The garden must be open to the public, either regularly, or by arrangement;
- There should be evidence that the collection is not static, but is developing and evolving;
- The Collection holder must send an annual report to the NCCPG/PH, and must keep updated the entry for the annual Plant Directory, as opposite-above;
- The Collection must be open to inspection every few years by an NCCPG/PH representative, to ensure that the registration conditions are still being met.

For the garden owner, a National Collection delivers no financial reward, nor help with expenses. 'To be perfectly honest' (as one says in such circumstances!), holding a National Collection is done to spread interest in, knowledge of, and enthusiasm for, a particular group of plants; also to

enjoy the status and kudos that come from being recognized as an expert therein. The only monetary element is that garden-opening events are expected to raise funds for the NCCPG. The garden owner in return gets indemnity insurance against possible visitor mishaps.

Perhaps more problematic is the long-term conservation of the actual plants themselves in National Collections. Private owners typically have to give up eventually because of human frailties; while public gardens are liable to lose staff with the specialist knowledge needed to maintain and develop a particular National Collection. Either way, the living plants themselves may not be conserved long-term. It is not an easy problem to solve, without a trust fund or the like, to keep a living-plant collection going indefinitely. I strongly encourage other members of our Society, and also the BPS as an organization, to become more involved with National Collections of living ferns.

Martin Rickard, in the first volume of Pteridologist (1988), reviewed national collections of ferns as they existed then. He noted that the first was at Kew, around 1880, long before the NCCPG was founded.

British ferns

As described previously (Wardlaw, 2004), my lifelong interest in British ferns started as a schoolboy in the 1940s. In wartime Cheshire I was taken on bicycling fern forays into the countryside, by my father, the late Claude W. Wardlaw, who was Professor of Cryptogamic Botany at the University of Manchester. I enjoyed searching particularly for the hard-to-find species, such as adder's tongue and moonwort. Much later, from 1970 onwards, as co-owner of the property shown in Fig. 2, I have now had 42 years of collecting living ferns, watching them growing and alas, all too frequently, dying!

Fig.4. *Ophioglossum azoricum* acquired as a turf, with the landowner's permission, from the Island of Tresco in 2000, and still alive with 18 shoots, in 2012.

What was until recently the PH-accredited National Collection of Ferns (British) now has around 160 taxa, made up of 55 British fern species and subspecies, 7 hybrids, about 91 cultivars and 7 naturalised aliens. Intermingled with these British ferns are about 140 hardy foreign ferns – in which PH/NCCPG had no interest – giving a total collection of about 300 different ferns in the garden. A detailed list, as hard-copy or sent electronically as a PDF file, is available on request.

Of the British fern species, the only 'classic' species I never had is *Ophioglossum lusitanicum*. The main 'classic' species presently missing is *Woodsia alpina*, which I unfortunately lost to slugs soon after it had been donated. My wife forbids *Equisetum* spp. in the garden despite their status nowadays as bona fide ferns.

Not all the British native ferns are impressive garden plants, but they may be satisfying for a pteridologist to grow. *Ophioglossum azoricum* has survived for 12 years (Fig. 4) without special attention. *Ophioglossum vulgatum* has similarly done well. Moonwort I have found very slug prone and difficult to keep beyond a couple of seasons. For the past 33 years I have kept an Accessions List of all the ferns planted out in the garden - British and foreign - and their source. This was essential when applying for National Collection-registration in 1997. At the end of 2012 I was up to Accession No. 1172, which included many hardy (and definitely un-hardy!) foreign ferns. Now only about 300 taxa still survive, indicating the mismatch between what some ferns need long-term, and my ability to provide it.

Fig. 5. *Polypodium* x *font-queri* after about 10 years of colonizing a garden tree stump.

Early acquisitions of common fern species were from the local countryside, before such 'liberation' became illegal. Later, the collection was greatly expanded when I discovered the RHS Plantfinder, with its listings of specialist fern nurseries in the UK. In 1991 I joined the BPS and made much use of the Spore Exchange and of the opportunities to acquire unusual taxa at BPS meetings. My basic aim has been to grow as wide a range of ferns as possible – British and foreign - within the garden space available.

My wife and I have a 'her-and-his' garden'. She has the sunny side for roses and other herbaceous plants; I occupy mainly the shaded side with ferns. Most of the ferns are growing in the shade of rhododendrons and conifers, on rocky banks and in-between shrubs (Fig. 6) but some sites are open to the sky (Figs. 4, 5 & 7).

A special micro-habitat (Fig. 6) had to be provided for *Asplenium marinum*, a species which will not survive in the open garden. Similar microclimate-enclosures, with organised seepage water, are used for *Anogramma*

leptophylla and the 3 British species of filmy fern, of which *Trichomanes speciosum* is shown in Fig. 3.

Although Glasgow gardens normally get enough rain, there are periods when additional watering is needed. This is provided by a sprinkler system, turned on manually (Fig. 6). Further experiences with growing British ferns are given elsewhere (Wardlaw, 2002, 2004).

Fig. 6. Fern-growing area, in the shade of rhododendrons and conifers, with the special habitat for *Asplenium marinum* (Pink arrow). Yellow dotted area of gravel has a buried, downward-sloping, polythene sheet with upturned edges that delivers water, by drainage and seepage, into the base of the *A. marinum* enclosure. This aims to create an oceanic climate and to give frost protection, imitative of a seashore cave. White arrow: sprinkler, with a 2-metre radius

Fig. 7 Poolside habitat with *Blechnum penna-marina*, *Matteuccia struthiopteris*, *Onoclea sensibilis*, *Osmunda regalis*, *Polypodium interjectum*, *Thelypteris palustris* (and anti-heron wires to protect the fish).

Perspectives.

Of the approximately 53 'classic' species of native British ferns (e.g. Page 1997), 21 have the conservation status of 'rare', 'vulnerable' or 'threatened'. Of these, 5 are legally protected under The Wildlife & Countryside Act of 1981. Garden collections, such as here, may therefore have 'insurance' value if the wild species becomes extinct – as has happened, for example, with *Dryopteris cristata* in Scotland.

This approach should consider carefully the adjective 'British' as applied to a fern. All the 'classic' species of native British fern also occur in nearby European countries, and often much farther afield. A notable exception is *Athyrium flexile* (now classified as a subspecies of *A. distentifolium*). It is a truly 'British' fern, in the sense of being a native taxon that occurs nowhere else. For the majority of fern species, however, it would be more accurate to describe them as 'in the British flora' rather than implying that they are exclusively 'British'.

This may seem pedantic, but consider again the example of *Dryopteris cristata* which is now very local and threatened in Britain, being confined essentially to the Norfolk Broads. It occurs widely in Europe and right across North America. Would conservationists justifiably be dismayed if it became extinct as a wild plant in Britain, provided it survived in British gardens and as a wild species in other countries?

Providing horticultural-TLC to so many ferns down the years has made me spiritually aware that each plant has an individual life-story of which I know almost nothing. My Accessions List is only a superficial record of a particular fern's immediate source. Fern books provide general information about anatomy, distribution and identification, but with no trail backwards in time or location to when and how each species or variety first came into being as a distinct biological entity. The geologically-oldest species in the collection here is probably the North American *Osmunda claytoniana*, which Moran (2004) states is little changed since the late-Triassic, 200 million years ago.

With the ferns accepted as 'British', there is the additional mystery of how and when they first arrived in what are now the British Isles. From their first establishment as 'spore-landed immigrants', when and how did they further spread into the wild places of Britain to give their present distributions? Did the spores that gave rise to our fern flora blow in from Europe only after the end of the last Ice Age around 10,000 years ago? Or do parts of the British fern flora go back much farther in time, to earlier interglacials? Was transmission before or after the severance of our landbridge with France, by the English Channel, around 6000 years ago? The ferns themselves maintain a coy silence, as ferns do!

Although not apparent to the naked eye, the air of the garden must, from time to time, be heavily laden with fern spores, since almost all the plants have fertile fronds. Yet the spreading of most ferns within the garden by spores seems to be a very uncommon event, apart from prolific sporespreaders such as Lady Fern, Hart's Tongue, and a few foreigners. Of the 300 different taxa in the collection, no more than about 10 have spread by spores, during several decades of opportunity. Some however, like Ostrich Fern, spread vegetatively, and extensively. There is, therefore, in my view a mystery of how a post-glacial Britain ever became richly fern-colonized by wind-blown spores, particularly by the species which have shown no such tendency in the short distances within my garden. ❐

References:-

Moran, R.C. (2004). *A Natural History of Ferns* p.77. Timber Press, Portland.

Page, C.N. (1997). *The Ferns of Britain and Ireland*, 2nd Ed, p540. Cambridge University Press, Cambridge.

Rickard, M. (1988). 'National collections of ferns.' *Pteridologist* 1 Part 1: pp212-213.BPS

Wardlaw, A.C. (2002). 'Horticultural approaches to the conservation of the ferns of the British Isles.' *Fern Gazette*. 16: pp356-361.BPS

Wardlaw, A.C. (2004). 'A garden of British ferns.' *Bulletin* 6: pp177-179. BPS

Frond base propagation.

Julian Reed
19a Northdown Road, Kemsing, Sevenoaks.
Kent. TN15 6SD
e-mail: julianreed@waitrose.com

This article was prompted by the disappointment of many present at the BPS cultivar group meeting held on 1st September last year when we ran out of time to demonstrate frond base propagation using *Asplenium scolopendrium*.

So, why propagate from frond bases? Various answers spring to mind, the most obvious being:-

1) To propagate sterile varieties. (Assuming they are garden worthy enough to propagate!)
2) To save the life of plants that have had their crown destroyed or damaged.
3) To propagate from a plant that has no ripe spores without uprooting the plant.
4) It is quicker and easier than growing from spores and the plants are identical to the parent.

Fig. 1. A prepared frond base about 1 inch (2.5 cm) long. The old roots have been removed and the frond base sterilised.

Some history.

Charles Druery gave a description of frond base propagation in his book 'British Ferns and their Varieties' (1910). In summation he states that in order to restore the health of an old fern it is best to dig it up, wash thoroughly and cut away the old frond bases and dead roots of the caudex (the stem-like bit below the crown).This leaves the crown and the green piece below the crown This needs to be re-potted in as small a pot as possible. You will be left with the small sausage-like frond bases. Trim away any roots from these as well as any dead material and wash them well. He goes on to say that a couple of inches (5cm) of well washed silver sand is put in a glass jar, the frond bases are scattered over this and covered with a glass slip. Then stand in a well lit position in a room or conservatory. If in the growing season or if warmth be afforded white pimples will appear within a few weeks and in time each pimple will become a plant. He also reported that he found 36 plants on a 1inch piece of frond base (In my experience I have never seen so many on a frond base.)

Fig. 2. The frond base placed on sterilised silver sand that had been pre-washed. Note the plastic bag ready to seal the pot.

Reginald Kaye also wrote about this type of propagation in his book 'Hardy Ferns' (1968) and I followed his system when I did this for the first time, a long time ago. His method is very similar to Druery. He says that you need to be very clean with all that you do and to cover any container with glass or polythene. His estimate is an easily achievable 1-12 plantlets per frond base. He then says to transfer them to sandy compost when big enough to handle and keep covered with glass or polythene until well established. He also points out that the new plants will be identical to the original.

Figs. 1 to 3 show three stages in the process. I must admit that I thought I had lost this particular frond base as it went white with fungus. Fortunately, I did not get around to getting rid of it and was delighted to see the young fronds appear. However, treatment with a weak solution of potassium permanganate (rosy pink in colour) would have helped.

Fig. 3. Small ferns ready to be split off and transferred.

Frond base propagation.

Method:-

You will need:-
Kitchen paper towel
Washed sand (horticultural grade sand or horticultural silver sand)
Clean thickish plastic pots (thin ones distort or melt) or seed trays if working with a lot of frond bases
Fresh sealable sandwich bags for pots or clean sheets of glass for seed trays
Sharp knife
Cold pre-boiled water
Sterilised tweezers or plastic gloves
I also use a dilute sodium hypochlorite solution based on a retail product used for sterilising baby bottles. I dilute according to the manufacturer's recommendations.
In fact, lots of growers do not sterilise frond bases, they just wash them thoroughly.

Pots and sand

1) Sterilise pots or seed trays with boiling water
2) Place a piece paper towel in base of pot or seed tray to stop the sand washing out
3) Half fill container with pre-washed sand
4) Place kitchen paper towel over levelled sand
5) Pour boiling water so it over flows container
6) Repeat 5) at least 2-3 times. Leave paper in place.
7) Allow to cool in sealed sandwich bag or cover with glass

Collecting frond bases

Lift the plant, shake any loose soil off the roots and then wash the remaining soil from the roots. I use a hosepipe, but you could use a bucket of water. Most ferns will produce a lot of frond bases and therefore a lot of plants. You need to ensure that you have plenty of sterilised pots of sand ready to cope with all this propagation. Remember to re-pot the fern after you have removed all the frond bases.

However, if you do not want to lift the plant, run your finger down the side of the plant and feel for a frond base. Then push it down and out. It should click off and then you can remove it. This may not get the whole frond base but as long as you have most of it and it is green in the centre it will be fine. Look for older frond bases at least 2-3 years old as these seem to work better than ones from this year's fronds as they are usually too soft.

Preparing frond bases

1) With sharp knife trim off any bits of root and any torn off pieces of caudex (rootstock) and the dead pieces of brown dead stipe (frond stem)
2) Wash thoroughly **or** soak in Sodium Hypochlorite solution for 15mins
3) Rinse in cold pre-boiled water

Dealing with prepared frond bases.

Take the paper off the top of the pot as this has kept it clean while cooling, then press the frond base horizontally into the sand (others prefer to insert them in the sand with the root end pointing up). Re-close the bag squeezing most of the air out. Place in a propagator or warm window ledge in a well lit position out of direct sun light. I use a window ledge with a radiator under it as I seem to do most of my propagation in autumn but in summer a warm window ledge or greenhouse will be fine.

As mentioned above, within several weeks to a month they will start to produce tiny white pimples easily confused with sand grains. Only open the bag if you need to treat for moulds.

Soon they will produce small fronds but wait until they obviously have roots. Then they can be removed like a seedling and taken off the frond base by sliding the point of a needle to pop them off. Leave any that are too small or not rooted and place frond base back in the same orientation. You can get several batches of plants before the frond base has run out of steam.

The young plants then need to be potted into compost with some extra sand in it and either put into a plastic bag or under a plastic propagator cover. Keep closed and humid till growing well then introduce a small amount of air. After 3 days slowly give more air and over a period add more so they get used to your growing environment without flagging. They can then be grown on till they are ready to go into their own individual pots. This is best done between March and early September so they are well rooted out to survive the winter. Overwinter in a cold frame or greenhouse or keep growing on in a heated greenhouse or spare room if your beloved allows!

Looking through the back copies of the *Pteridologist* I found that Martin Rickard wrote an article in 1986 called 'Vegetative reproduction in Ferns.' where he talks about artificially induced bulbils on leaf bases of *Asplenium scolopendrium.* He mentions how a mystique round this easy process has developed and that it works well on *Oreopteris limbosperma* and *Athyrium felix femina* He talks of *Polystichum setiferum* being more difficult. I did try *Polystichum* a few years ago but had no success, will have to try *Athyrium*.
Do have a go, it is easier than growing from spores.
Good luck!

References:-

Druery. C. T. (1910). *British Ferns and their Varieties* George Routledge and Sons, Ltd
Kaye R. (1968). *Hardy Ferns.* Faber and Faber Ltd.
Rickard M.H. (1986). 'Vegetative Reproduction in Ferns.' *Pteridologist* Vol 1. Part 3. BPS.

Fig. 4. 6 month old *Asplenium scolopendrium* 'Kaye's Superb' grown using this method.

The Filmy-ferns of the Bewcastle Fells

Jeremy Roberts
Eden Croft, 2 Wetheral Pasture,
Carlisle CA4 8HU
e-mail: fjr@edencroft2.demon.co.uk

Introduction

The two UK species of *Hymenophyllum* are small and insubstantial ferns, with their pinnae a mere one cell thick. Because they often grow with bryophytes they can be difficult to distinguish for the unitiated. They are notably shade and humidity demanding, and grow most typically in very sheltered and humid habitats in the aboriginal oakwoods in the west of Britain.

In Cumbria, the more familiar Wilson's Filmy-fern (*H. wilsonii*) (Fig. 2) is sufficiently tolerant to occur beyond the woodlands in shaded sites in ravines and on cliffs well up into the Lakeland hills, for instance to at least 670 metres altitude on Helvellyn (pers. obs.).

The second species, the very much more local Tunbridge Filmy-fern (*H. tunbrigense)* (Fig. 5*)*, is largely restricted to the milder and damper southwest woodlands and ravines in Cumbria, being locally frequent in Eskdale, and does not penetrate into the Lakeland hills away from the areas of old woodland (Halliday, 1997).

The filmy-ferns may well have been widespread throughout northern England during the so-called Climatic Optimum, about 9,000–5,000 years ago, at a time when woodland covered the landscape and extended well up into, or even over, the hills. Since then, the widespread removal of woodland has restricted the filmy-ferns to the remaining patches of ancient woodlands, and to a few pockets where they have persisted in exceptional and chance circumstances. Hence, there is the distinct sense that existing sites are 'relict' in nature.

This historical conjecture may explain why these species are so rare and scattered in the Pennines, and in their extension northwards, the Border ranges, where woodland destruction has been so pervasive and prolonged. However, it is clear that suitable micro-habitats for filmy-ferns can also persist, apparently over long periods, in regions currently well beyond existing natural woodland, such as deep within crevices amongst the boulders and crags of the 'tors' of exposed ridges.

Filmy-ferns in the Bewcastle Fells

The Bewcastle Fells lie in the far northeast corner of Cumbria along the Northumberland border. Far from any road-head, they are made more remote by an intervening and almost continuous belt of dense coniferous plantations, not all in public ownership. The western escarpment of the fells has a series of gritstone 'tors', or outcrops, stretching for over 6 kilometres, with the locally well-known Christianbury Crags (Fig. 1) at the northern end of the series (NY577824). These are by far the most extensive and also at the highest altitude (480 m O.D.). Although not at any great height, the scarp experiences a quite severe climate with many days of cloud cover. It faces the full force of Atlantic gales, whilst also being open to dry and cold north-easterly winds. Due to their remoteness, these fells have not been as thoroughly explored botanically as many more accessible Cumbrian hills.

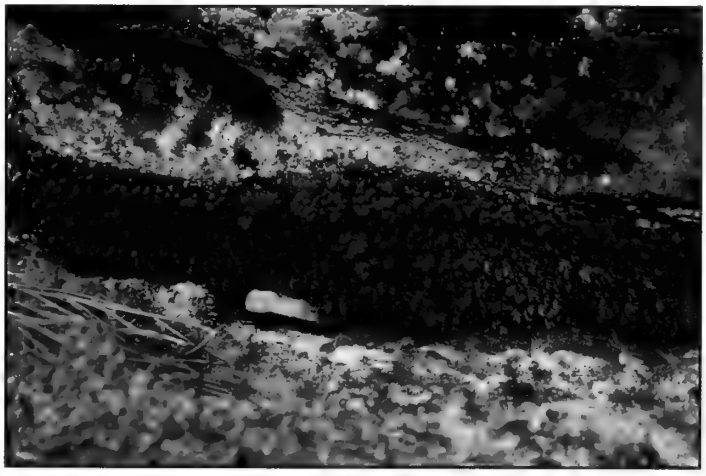


Fig. 2. *H. wilsonii*

Filmy-ferns were first recorded on the range as recently as 1957, when *H. wilsonii* was recorded by Derek Ratcliffe on Tod Crag (NY585799). A few other records in the same area were made subsequently, but elsewhere

Fig.1. Christianbury Crags, the highest outcrop on the Bewcastle Fells at a height of 480m. Note the large boulders at the base of the outcrop that form cavities suitable for filmy-ferns.

Fig. 3. Looking for those elusive ferns often means unusual poses in Bewcastle Fells. This is the site for *H. tunbrigense* shown in Fig 5.

in the northern Pennines and Border ranges this species has perhaps only three other sites. In 2005, Mike Porter was shown a known patch of filmy-fern in a deep crevice on Long Crag at the south of the range (NY584782). He soon realised that the colony was in fact not the expected *H. wilsonii* but *H. tunbrigense*.

Fig. 4. A typical site for filmy-ferns. Long Crag and one of the sites for *H. tunbrigense*

This species was known in three very scattered sites in the wider Borders area – in Cumbria, only in the Lyne valley to the west where Derek Ratcliffe knew a patch, now apparently gone, on a single boulder (Halliday, *ibid.*) and in Northumberland, to the east of the high ground, at a couple of sites at lower levels (Swan, 1993). However, it was found more recently by the author in July 2011 at a new site in western Northumberland – Spy Crags, above Lampert, in the upper Irthing valley (NY688756, etc.). Here it grows luxuriantly in at least twelve patches – probably the strongest site for either *Hymenophyllum* in that county. In 2012, it was located by Phill Brown in yet more new sites, on Paddaburn and Johnny's Crags, to the north (NY6577; NY6578).

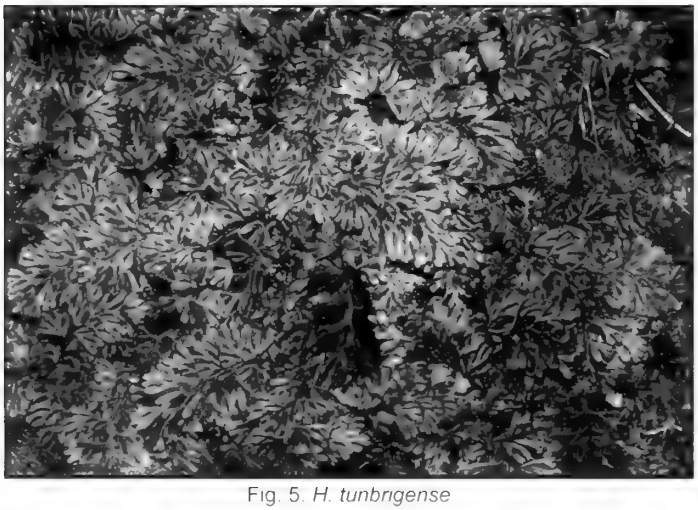


Fig. 5. *H. tunbrigense*

Eager to see the *H. tunbrigense* in its 'new' site at Long Crag, I visited the area on 30th April 2009. On the ascent, it was a great surprise to find several patches of both species on crags, even before reaching Long Crag itself! Typical habitat is shown in Fig. 4. Having clambered down into one particularly large cavity (Fig. 6) formed by the slumping of boulders from the scarp-edge, I found it festooned with filmy-fern on all the walls and even on the floor. Initially assumed to be an especially luxuriant form of *H. tunbrigense*, on closer inspection some characters seemed to be intermediate between the two species, perhaps suggestive of hybrid origin (Fig. 7). This likelihood was however remote: I knew perfectly well that such a find would be new to science! The few fronds brought back were inadequate to prove such a presumption, and the puzzle was left for a later time when I could have a better look at the plant and also attempt to uncover just how much filmy-fern and of what species there might be along the ridge.

Fig. 6. The first site where *Hymenophyllum* × *scopulorum* was found in 2009.

In the event, it was the spring of 2010 when I returned, exploring all the outcrops from north of Christianbury Crags to south of Long Crag, a stretch of 6km of rough heather moorland. In fact, the exercise proved to be no more than a sampling exercise, rather than any thorough 'exploration'. It soon became obvious that any deep and dark space between, below, or behind loose boulders and slabs, or down vertical crevices and cracks of the jointing planes, could hold filmy-ferns – and such places were quite literally innumerable! Often the hollows were obscured behind or beneath deep heather in the haphazard jumbles of huge boulders below the scarps, making the exploration somewhat hazardous. Four over-full days in April and May were devoted to visiting all the sets of crags along the escarpment. The largest set of crags, at Christianbury (Fig. 1), over 300 metres long, took two-and-a-half hours to cover even rather cursorily, the eventual reward being just two patches of *H. wilsonii*,

Fig. 7. The hybrid filmy fern, *Hymenophyllum* × *scopulorum*.

at the very furthest point from where I had started! Some patches of ferns were so far down narrow cracks that they were out of reach, and could not be sampled to identify the species. Where fissures could not be inspected by eye, being at right angles within the blocks, a few could still be inspected by inserting a camera and taking flash photographs, revealing a filmy-fern patch on one occasion! Eventually, scattered along the ridge over several miles, twenty colonies of filmy-ferns were revealed, the majority being *H. tunbrigense* (eleven), with fewer of *H. wilsonii* (seven). Many more are likely to have been overlooked. The cavity with the puzzling plant from the previous year was carefully examined, and all patches there seemed referable to the same intermediate type.

A hybrid filmy-fern

It was a remarkable experience late in the evening on the last day I allocated to this work, and on the very last substantial crag to be explored, to come across a series of deep gashes in the scarp, large enough to be clambered down into (Fig. 8). They looked perfect for filmy-ferns and sure enough as I peered down into the depths of the largest crevice, I saw on both walls spreading patches so dense as to make a deep blanket of long fronds. Here was the putative hybrid again, separated from the 2009 site by a mile of heather moorland and blanket bog!

Fig.8. The second site where *Hymenophyllum* × *scopulorum* was found late in the evening.

In many fern hybrids, the sporangia demonstrate their sterility by aborting and shrivelling at an early stage. Checking the characters carefully back home, it was noticed that in the mature sporing plants from both sites, the sporangia were often fully developed (Fig. 9). However, in all cases, the spores within were white, and under the microscope were clearly colourless and empty of cell contents. The sporangia are covered by membranes (indusia): those of the two species and the hybrid – clearly intermediate in character – are shown in Fig. 12. Sample specimens from each of the twenty sites were examined by Dr Fred Rumsey at the Natural History Museum, who has studied filmy-ferns widely for many years. Dr Rumsey was able to confirm my identifications of the eighteen colonies of the two species, and also the hybrid nature of the puzzling plants at the two sites described above. Work carried out by Mark Carine at the museum has corroborated the hybrid origin, and examination of the chloroplast DNA indicates that material from both sites have *H. tunbrigense* as the maternal parent (Carine, unpublished). This is the

Fig. 9. Frond and indusia of *Hymenophyllum* × *scopulorum*

first confirmed discovery of the F1 hybrid between the two native European *Hymenophyllum* species. A polyploid complex is known in Madeira (where both species occur), evidently derived from this hybrid (Rumsey et al., in prep.). This complex includes a third species, *H. maderense* Gibby & Lovis (Manton et al., 1986). Chromosome studies have demonstrated that this plant is derived from the F1 hybrid by doubling of the chromosome complement – allopolyploidy, the process which allows such a hybrid to regain its fertility and so behave as a new species. The F1 hybrid is however not known on the island at present.

The F1 hybrid has been formally described as *Hymenophyllum* × *scopulorum* F. J. Rumsey & F. J. Roberts (Rumsey & Roberts, 2012). The epithet derives from Latin *scopulus*, and implies a rock, crag or promontory, suggested by the habitats of the two known sites.

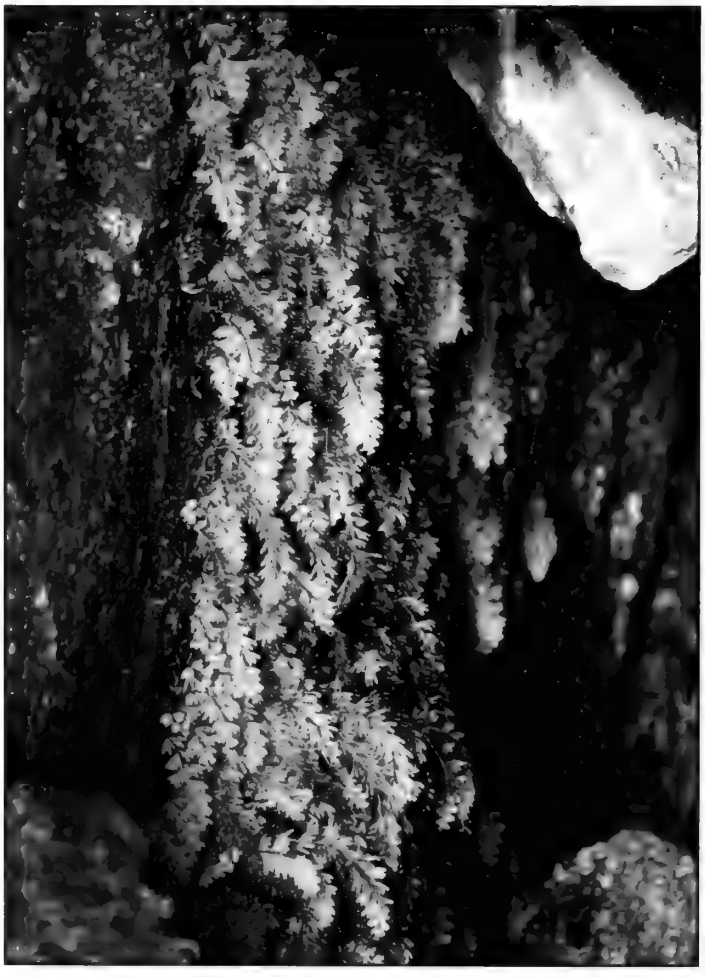


Fig.10. *Hymenophyllum* × *scopulorum*

The outcrops supporting the two colonies of the hybrid are separated by a mile of open heather moorland. It is an intriguing puzzle as to how these two colonies of a sterile fern, with very slow lateral growth and no other methods of propagation, became established. Do they derive from two separate hybridisation events? Did the plant arise once, and somehow become dispersed so that it now occurs in two well-separated sites? Can the plant produce some fertile spores – or has it done so in the past? None of these possible explanations seems anything other than remote... but some sequence of events has brought about the existing situation! Given that hybridisation between these two species seems to be a profoundly rare event, its occurrence twice in one limited area seems unlikely. However, Dr Rumsey argues (*ibid.*, p. 96) that:-

> "hybrid hot-spots are known for pteridophytes, i.e. sites where either a range of uncommon hybrid taxa form and/or the repeated production of a single otherwise very rare hybrid occurs. What remain to be elucidated are which aspects of the environment or the particular behaviour of the plants, may be acting to facilitate hybrid formation".

Readers of the *Pteridologist* might now be tempted to go and explore Bewcastle Fells to see the hybrid for themselves. However please be warned! One site is on private ground for which I have never yet managed to locate the owners (shooters) and the other is either a longish trek through this private land without permission, or an absolutely awful trek across very rough and overgrown moorland going 'round the long way'! Seeing both sites is very much recommended, but it takes at least 7 hours from car back to car, and the end-of-road car park is itself a long drive from anywhere. It really is quite an expedition!

Killarney Fern gametophyte

The remaining member of the British Hymenophyllaceae is the near-fabulous Killarney Fern (*Trichomanes* (*Vandenboschia*) *speciosum* Willd.). Always a rare and very local plant, this was almost rendered extinct by gross over-collection during 'the Victorian fern-craze'. It exists, or rather the sporophyte exists, in a very few sites in Cumbria, and in other humid and mostly western regions of the UK. The surviving Cumbrian plants are small and vulnerable, and do not compare with some spectacular colonies in Wales, Scotland and Ireland, where sheets of hundreds or even thousands of fronds exist.

It was a great surprise when, in late 1989, a visiting American botanist, Dr. D.R. Farrar, pointed out the gametophyte (sexually-reproducing) generation of this fern at two sites in the Lake District, which had never before been identified in Europe (Rumsey, Jermy & Sheffield, 1998). (Similar gametophytes exist widely in north America in several similar species, in areas where the sporophyte is rare or unknown.) The gametophytes look very much like mats or felts of filamentous algae – and no doubt had previously been overlooked on that account. Crucially, these mats have an independent and effectively perennial existence, and presumably exist for long periods in the absence of the sporophyte. Indeed, some gametophyte sites may have arisen millennia ago at some distance from any sporophyte by chance settlement of spores. We now know that this gametophyte form is quite remarkably widespread in Britain and the more oceanic parts of western Europe, and is in similar habitats to the *Hymenophyllum* ferns, but considerably more widespread. However, it generally occurs much deeper into humid crevices. Indeed, sometimes it can hardly be seen without the aid of a torch. In Cumbria, it is known in such places in sandstone caves and hollows along the River Eden, and in many similar sites in the Lake District. It is clear that it requires the high humidity and freedom from competition of its deep and dark habitats, but it is astonishing that it can photosynthesise successfully in the very low light levels pertaining. Its filamentous growth-form allows slow lateral growth, but the strands readily fragment and presumably can colonise new sites after transport perhaps by slugs or other invertebrates or by flood events – many existing sites are close to running water. It also produces multicelled gemmae which break off and act similarly as propagules. It was for a number of years thought that this gametophyte generation was not capable of producing the sporophyte generation, at least in present climatic conditions (and attempts at artificial stimulation had also failed). However, we now know what the juvenile sporophyte plant looks like – a very slender tongue-like structure, similar to some liverworts – and this has now been identified in many places where the gametophyte is known (Anon., 2006). In Cumbria, sites were found by the late Ken Trewren in the Eden and Lyne valleys. However, the mortality rate of these young plants is probably high, so that recruitment into the population of mature sporing plants is almost negligible. This fact, coupled with the inevitable natural loss of plants over the long term through habitat changes or erosion, and the human plundering already described, have rendered the sporophyte rare and precious.

The abundance of suitable humid nooks and crannies in the Bewcastle outcrops made it very likely that the gametophyte phase of Killarney Fern would be present there, and this was kept in mind during searches. However, it remained unseen until October 2011 when it was found in good form by Bruce Brown and Alison Evans (Fig. 11). Ironically, the locality was within the original Tunbridge Filmy-fern cleft on Long Crag, growing in cracks opposite, where it had been overlooked, while the present author and other visitors paid their respects to the filmy-fern on the other wall! It is very likely to be more widespread in the area. However, as Bruce Brown suggested (pers. comm.), it may be that the climate of the Bewcastle Fells, although evidently suitable for the gametophyte, is too extreme for the development of sporophytes.

Fig. 11. *Trichomanes* (*Vandenboschia*) *speciosum* gametophyte.
Photo Bruce Brown

Identification of *Hymenophyllum* filmy-ferns

When growing well, the two *Hymenophyllum* filmy-fern species can be separated with some confidence on growth form. *H. wilsonii* often makes rather untidy patches, the fronds mostly standing away from the rock surface. The fine segments of the fronds tend to droop at the tips, in a somewhat 'clawed' fashion. *H. tunbrigense* fronds are generally rather shorter, paler and bluer in shade; the segments tend to lie more in one plane, and hence make often flatter sheets closer to the substrate, with the fronds somewhat overlapping.

Confirmation should always be made by examination of the indusia, the small two-lipped 'pockets' which enclose the sporangia like a purse. The lips of *H. wilsonii* are longer than they are wide and smoothly rounded at the margin. *H. tunbrigense* has a broader 'purse', and the margin is strongly and sharply serrated. These are small features and need a hand-lens to be seen clearly (Fig. 12). There are other features which require a microscope. The chloroplasts of *H. tunbrigense* are relatively large and well-defined, with about 30-40 in each cell, whilst in *H. wilsonii* they are much smaller, less well-defined, and number about twice as many per cell (Fig. 13). In all these features, the hybrid *Hymenophyllum* × *scopulorum* falls between the parents. It does however show some hybrid vigour, making large patches in its two known sites, the fronds splaying out from the rock surface to make deep 'blankets' in parts. The indusium is wide, often almost circular, and the margins of the lips are undulating in outline or with a few blunt teeth. As stated above, the consistent abortion of the spores is the strongest confirmatory feature of the hybrid. ❐

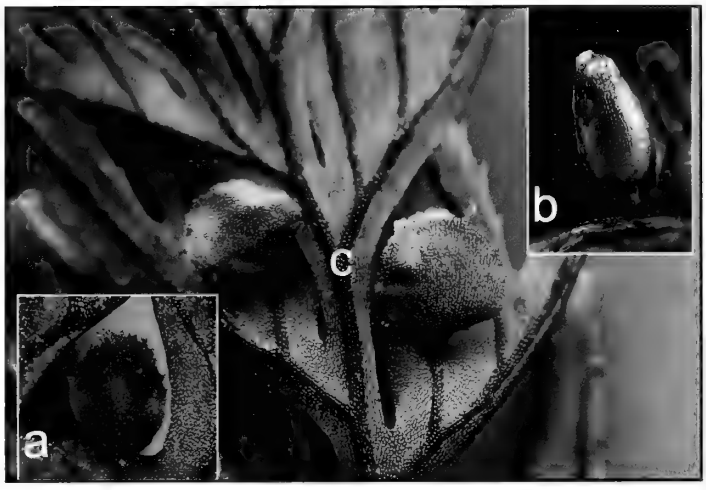
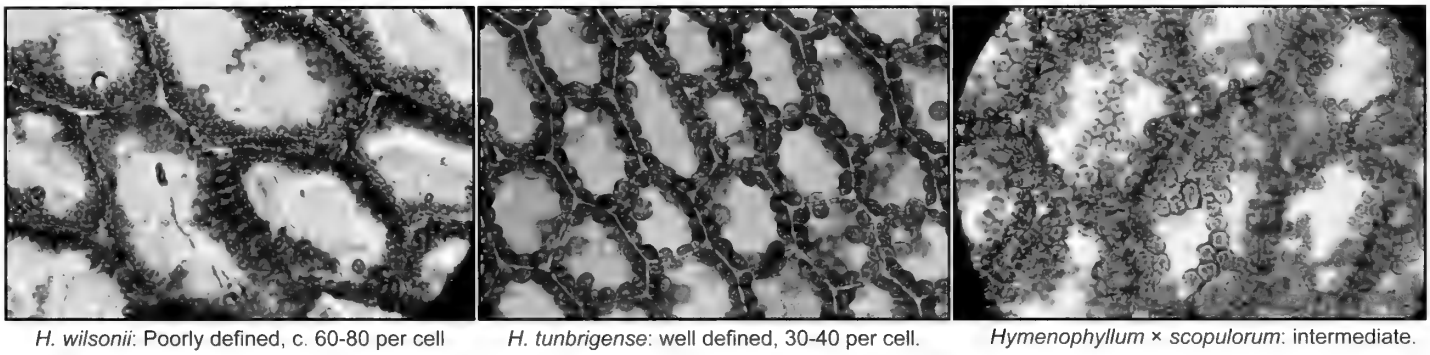


Fig. 12. Using the indusium as a means of identification.
a. Serrations on *H. tunbrigense*. b. Smooth and rounded *H. wilsonii*.
c. Hymenophyllum × *scopulorum*, often round with a few blunt teeth.



H. wilsonii: Poorly defined, c. 60-80 per cell *H. tunbrigense*: well defined, 30-40 per cell. *Hymenophyllum* × *scopulorum*: intermediate.

Fig. 13. Using the chloroplasts as a means of identification

References:

Anon.(2006). 'Have you seen this plant' *Pteridologist* **4** (5): 141-3

Halliday, G. (1997). *A Flora of Cumbria.* The Centre for North-West Regional Studies, University of Lancaster. Lancaster.

Manton, I., Lovis, J.D., Vida, G. & Gibby, M. (1986). 'Cytology of the fern flora of Madeira.' *Bulletin of the British Museum* (Natural History), **15**: 123-161.

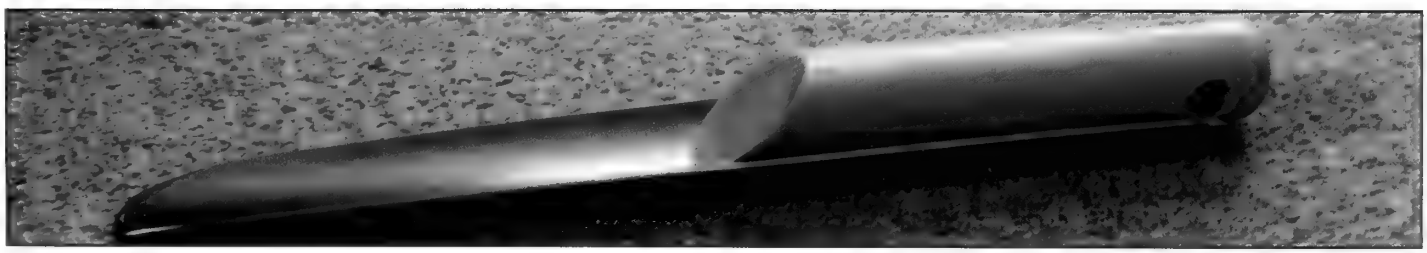
Rumsey, F.J., Jermy, A.C. & Sheffield, E. (1998). 'The independent gametophyte stage of the Killarney Fern *Trichomanes speciosum* Willd. (Hymenophyllaceae) and its distribution in Britain and Ireland.' *Watsonia*, **22**: 1-19.

Rumsey, F.J. & Roberts, F.J. (2012). 'A new *Hymenophyllum* hybrid from the British Isles: *Hymenophyllum* × *scopulorum* F. J. Rumsey & F. J. Roberts (*H. tunbrigense* (L.) Sm. × *H. wilsonii* Hook.).' *New Journal of Botany*, **1** (2): 93-7.

Swan, G.A. (1993). *Flora of Northumberland*. The Natural History Society of Northumbria. Newcastle upon Tyne.

This article is reprinted (with modifications) from *The Carlisle Naturalist*, vol. 20, no. 1, with permission.

What's in a name or when is a fern trowel not a fern trowel?



I featured this implement two years ago when it was being marketed as a fern trowel and commented on the fact that perhaps Pteridomania was making a comeback. However the company that sells this garden tool have decided to rename this product, perhaps it wasn't selling well. From now on it is called a rockery trowel! AEG

The Moss House at the University of Manchester Botanical Experimental Grounds.

Yvonne Golding
The Firs Botanical Gardens, University of Manchester, Whitworth Lane, Manchester M14 6HE
e-mail: Secretary@eBPS.org.uk

In 1851 Sir Joseph Whitworth, the Manchester engineer and inventor, had a fine country villa designed by architect Edward Walters, built in what was then rural Fallowfield but which now is a busy student quarter of Manchester.

Fig. 1. The main house of The Firs Estate now Chancellors.

Today the house and gatehouse is a Grade II listed building. The Firs estate consisted of the house and the extensive grounds some of which were walled and cultivated as a large garden. There are many references to Whitworth's interest in armaments in the area, namely Gunnery Lane, which borders the grounds and The Range, which is now a series of lean-to glasshouses built onto the original walls but which was originally the site of the rifle range where Whitworth tested his rifles! Whitworth died in 1887 and generously bequeathed the estate to Manchester University. Part of the land was used to develop athletic grounds and the house and garden were leased to Charles Prestwich Scott, the editor of The Manchester Guardian. C.P. was often to be seen on his Dursley Pedersen bicycle, a one-off that he had especially made. He cycled from The Firs to his office in Manchester until he was 80 years old. When he died in 1932, subsequent Vice-Chancellors of the University lived in the house until the late 1980's. Today the house is a hotel and conference centre and has been renamed Chancellors. Around 1.5 acres of the estate, the former walled vegetable garden, became the Botanical Experimental Grounds for the University; of this 0.5 acres are under glass or occupied by other buildings. Here the University grows plants for research purposes and maintains an important teaching collection of plants. Today we tend to refer to it as 'The Firs' as the full name is rather long-winded.

In one corner of the grounds is a north-facing, lean-to brick greenhouse. Known as the Moss House, brick walls surround 3 sides and the clear roof is covered with shading, making the house frost-free and dark: ideal, certainly, for growing mosses, but not just them! We have no idea who originally built it or exactly when. The first reference to the Moss House is in an early genetics paper (1923) published by William H Lang FRS who was Professor of Cryptogamic Botany at Manchester, in which he quotes:

'In 1916, at my suggestion, Miss M. Edmond's made sowings from a large plant of the Common Hart's Tongue Fern (*Scolopendrium vulgare*) which had been growing in the Moss House of the Manchester University Experimental Grounds for a number of years'. He goes on to say 'the plant is believed to be one of a number collected from Skibbereen, Co. Cork, when the Moss House was being stocked'.

Fig. 2. The interior of the Moss House showing various specimens of *Leptopteris*

Fig. 3. A magnificant specimen of *Trichomanes* (*Vandenboschia*) *speciosum*. There are several of these in the Moss House.

Today *Asplenium scolopendrium* freely spores itself around on the rockwork and I believe these may be progeny from this original Irish fern.

Fig. 4. A large speciman of *Leptopteris hymenophylloides*

Walking into the house is like entering a fairy wonderland; it is shady, cool and moist which is perfect for ferns. There are Victorian benches around the perimeter and these, along with the walls, are covered by rock work which is smothered in mosses, liverworts and ferns. The star plants are two very large specimens of the New Zealand filmy fern *Leptopteris* both of which have formed trunks. If planted when the house was originally stocked there is a good chance that these plants may be approaching

Fig. 5. The damaged roof of the Moss House after a heavy fall of snow in January 2012.

100 years old. One specimen becomes fertile in some years and has spored itself around the house; some of these plants are also now quite large. We think this is *L. hymenophylloides* though there is some dispute! The other specimen doesn't spore so is most likely a hybrid between *L. hymenophylloides* and *L. superba*. Maybe at one time there were also plants of *Leptopteris superba* in the Moss House. So far I have been unable to discover who originally planted these. As well as these magnificent specimens there are several plants of *Trichomanes* (*Vandenboschia*) *speciosum*, some of which are original material donated from Fred Rumsey's research work and some introduced by myself from Canary Island material. I've also introduced *Hymenophyllum tunbrigense* (collected with permission from the Forestry Commission) and have tried *H. wilsonii* (collected from the same location) but clearly the conditions are not right for this species as it always fails. In addition I have inherited some filmy ferns from the collection of

Fig. 6. Yvonne Golding protecting the ferns with fleece.

Gerry Downey which includes another *Trichomanes* but we are not quite sure of the species. Other fern species in the moss house are *Blechnum spicant*, *Cystopteris fragilis*,*Cystopteris diaphana* (probably random sporelings from Canary Islands material), *Dryopteris aemula* and *Athyrium filix-femina* which I periodically pull out to make room for more interesting ferns.

I've been keeping an eye on the Moss House for around 15 years. In winter 2005 one of the roof panels blew off in a gale so with the help of gardener Tom we managed to repair this by replacing with a spare panel. But in Jan 2012 the roof totally caved in after high winds and a heavy fall of snow. This was just about the worst time to have the house exposed so the whole area was quickly covered in several layers of fleece putting the larger plants into additional fleece bags. The plants remained in this state until April, when the university agreed to fix the Moss House. Unfortunately this turned out to be very complex as a thin layer of asbestos was discovered along the top of the old brick wall. To cut a long story short this was removed (a very elaborate procedure) and the wall demolished and rebuilt, a new timber frame was put in place and a good

Fig. 7. The neglected bed alongside the Moss House

quality roof installed. We put up more shading and then unwrapped the plants. They sulked for a while but very soon perked up; we didn't lose a single fern though much of the moss and liverwort looked in a poor state for a while. Estates and Services did a fantastic job but I imagine it was very expensive.

Back in 2008 we created a fern bed in front of the Moss House into which we planted ferns bequeathed to us by BPS member Barbara Porter. This fern bed is now well-established with a good display of around 30 species of hardy ferns. Before the Moss House wall was demolished we dug up as many of Barbara's ferns as possible as we knew the border would be trampled. The *Osmunda* collection, at one end of the border, was too well established to remove so we covered it with a tarpaulin and hoped for the best. In fact the timing was perfect as we just managed to get the covers off as the *Osmunda* began to put up new croziers.

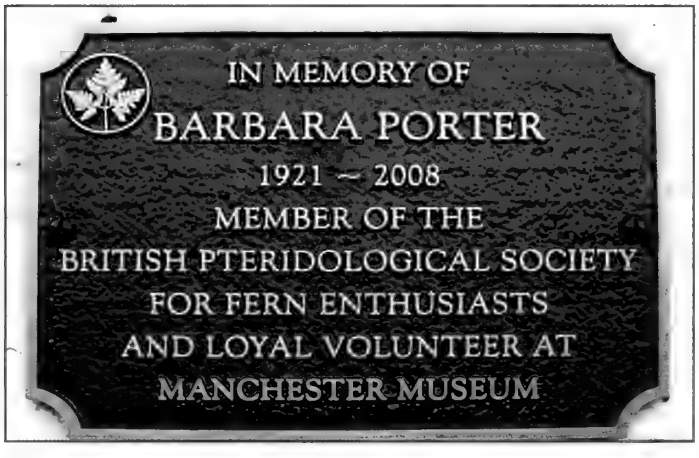


Fig. 8. The plaque in honour of BPS member Barbara Porter.

During the rebuilding the make-shift watering system had been destroyed so we looked into buying an automatic watering system. In view of the large financial input from the university to rebuild the house we didn't feel we could ask for this so BPS member Roland Ennos applied to the Greenfield Fund for a small grant to buy a watering system. This bid was successful and in December 2012 one of our Firs volunteers, Stuart, fixed up the system for us and it works perfectly.

The Moss House looks good for another 100 years and with the new watering system in place requires minimum maintenance, though I'm starting to think we really should rename it The Filmy Fern House! ❐

Thanks are due to BPS members Alison Evans; Dave Bishop; Joan Watson; Roland Ennos and Firs volunteers Stuart, Ian and Win who all helped during this difficult time when the Moss House lost its roof, and of course to Manchester University Estates and Services, notably Richard Sandland, whose team did such a fantastic job in restoring the Moss House.

BPS members are welcome to visit the Filmy Fern House by arrangement with:-
Roland Ennos, e-mail: r.ennos@manchester.ac.uk

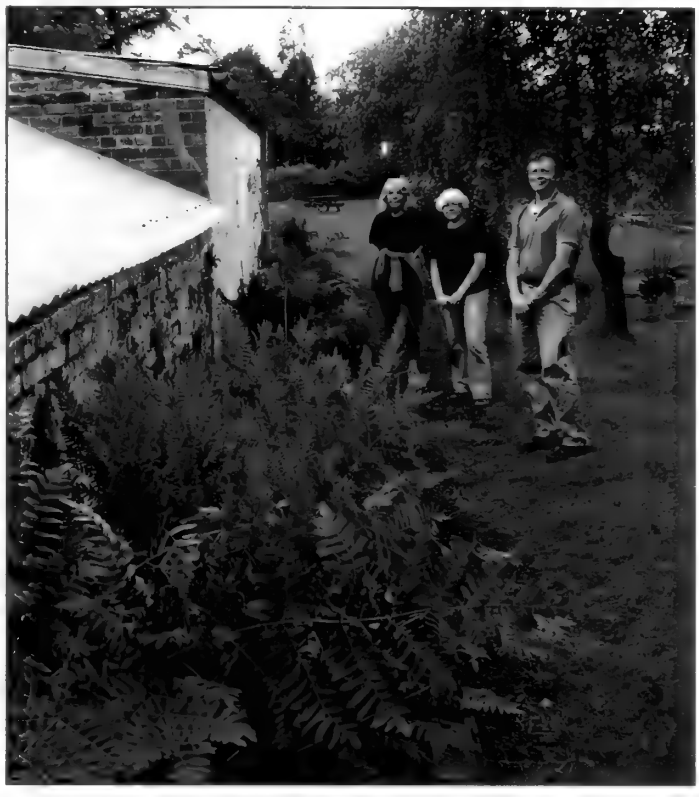


Fig. 9. Working on Barbara Porter's bed in front of the Moss House. Left to right: Win, one of our volunteers, Yvonne Golding and Roland Ennos

Fig. 10. The restored bed at the end of the work, looking as good as ever after all the hard work put into it.

References:

Charlton, W.A. & Cutter, E.G. (1986). 135 years of Botany at Manchester. The University of Manchester.

Lang, W.H. FRS. (1923). *On the genetic analysis of a heterozygotic plant of Scolopendrium vulgare*. Journal of Genetics. Vol XIII, August.

VANDALISTIC BOTANISTS*

Reproduced from ***The British Fern Gazette***, Vol. 2, No. 16, pp.104-105, January 1913.

Downloaded as a PDF file and slightly edited, from the website of the Biodiversity Heritage Library at:

www.biodiversitylibrary.org/bibliography/58803

Although the horticultural world is indebted to the travelling botanist for countless additions to our cultivated plants which they have discovered abroad and introduced into this country, there is, unfortunately, another side to the matter, or rather another class of botanists who appear to consider the enrichment of the herbarium, the hortus siccus, as the only legitimate goal of their acquisitions, and think that they have done their duty and achieved a triumph once the rare and perhaps unique plant has been uprooted, properly dried, and recorded.

In my now long experience several instances of this kind have come to my notice, and the record of a particularly glaring case lies before me as I write. Since the principle only is attacked neither name of finder nor locality is given, but only the facts.

In the United States, where that beautiful fern Adiantiun pedatum is fairly common, a fern which is normally perfectly deciduous, the fronds dying down completely in the autumn, a plant was found at the end of November, 1912, in a perfectly green condition, though the ground was frozen hard at the time at a temperature of 25°F. Under these circumstances it was perfectly obvious that this particular plant was so constitutionally different from the normal that in all probability under cultivation it would prove to be evergreen instead of deciduous, and thus constitute a most valuable acquisition.

What, however, was done with it? We learn that "all of the fronds were green when collected, but two became somewhat brown in the process of drying," and the record concludes with the remark, " How and why this particular plant was enabled to withstand temperatures which destroyed all of its kind and how much longer it might have survived are points over which one can only speculate."

Is it not extraordinary that it did not occur to the finder that its survival or non-survival lay entirely at his discretion? All he had to do was to lift it carefully, take it home as a living plant, and test it by growing it on, by doing which he might not only secure a valuable prize but in time could have enriched the herbaria of himself and his friends to his heart's content. It is, however, quite clear from the tenor of his remarks that the precious root was sacrificed, and all that remains of it are the dried fronds and the bare record.

That deciduous ferns are capable by a sort of constitutional "mutation" or "sporting" of assuming an evergreen habit is shown by the case in this country of Cystopteris sempervirens, a form of C. fragilis. This was found in the winter in the Highlands of Scotland in a perfectly green condition, precisely like that of the A. pedatum in question, viz. as a solitary plant of which the normal form, though common, had entirely disappeared owing to its perfectly deciduous nature.

The finder, however, was not a botanist, but a fern lover. He at once appreciated the prize, lifted the plant, took it home and cultivated it, thus ascertaining that the constitutional variation was a permanent condition. Eventually he sent me some fronds, perfectly green in the dead of winter, and as they were fertile I sowed them and obtained an abundant crop, all of which proved so far from being deciduous that *'sempercrescens" rather than "semper-virens" is appropriate, since it grows continually, and at the moment of writing (April) there is a pot of it with last year's fronds perfect and a number of new ones rising, while C. fragilis proper is only just moving.

The term "vandalism" is obviously appropriate, strong as it is, when new discoveries are nipped in the bud as it were by precisely those people who ought to know better, and since such records have come before me by pure chance it is to be feared that they only represent a small percentage of the actual cases where the herbarium has proved to be the grave of precious finds.

Some time back, also in the United States, a new fern was recorded. Here the discoverer merely took all the first crop of fronds for his herbarium, kindly leaving the root intact, but in the same season he told a friend and the latter visited the spot and took the second crop, an operation from which it is almost certain the plant would never recover.

Another case occurred in Scotland, where I was told of the habitat, not this time of a new fern, but of a rare species. When guided to the spot not a trace of the fern could be found, but I learned that a professor had visited the place just previously with a body of students, and the presumption is that again the herbarium had been enriched at the expense of the local flora. ❐

Chas. T. Druery.

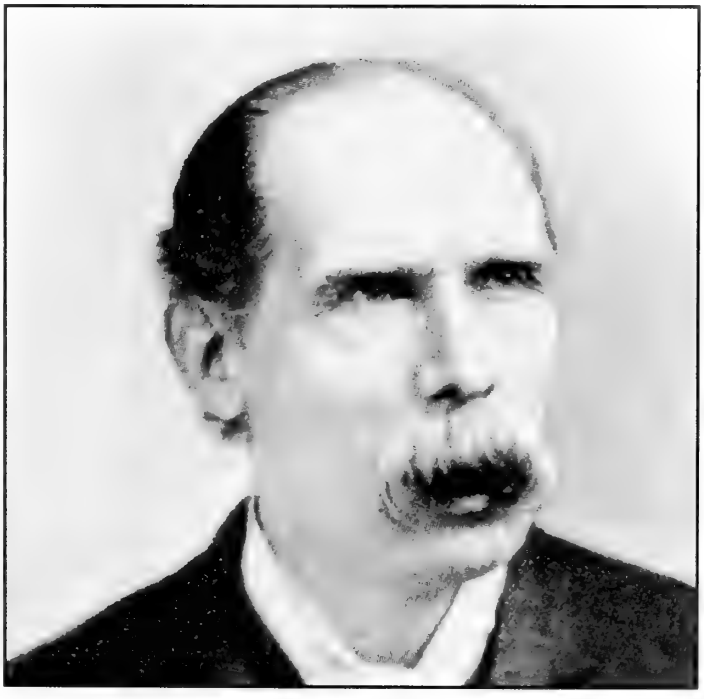
*By permission of the Gardeners' Chronicle

Note from the Editor:-

The *British Fern Gazette* was the forerunner of the Society's present *Fern Gazette*. It was started in 1909 and issued in a total of 10 volumes, until 1973, when it was replaced by its successor.

Facsimile copies of all 10 volumes can be accessed at the website of the Biodiversity Heritage Library given above. They can be read on screen or downloaded as PDF files. The volumes are well indexed.

The two World Wars seriously interfered with production of The British Fern Gazette. For example, Vol. 4-5 with 288 pages covered the decade 1919-1929. There was a single Vol. 7 for 1935-1950. A.E.G.



Charles Thomas Druery. (1843-1917). President of the BPS 1898 - 1901.

Photo: BPS archive

Use of wild Orchid-root as growth medium in commercial Tree-fern cultivation in S.W. Rajasthan.

C.R. Ferny-Jokings.
Institute of Cyatheology, University of Pokaran,
Thar Block 53-c, Jaisalmer, Rajasthan 64Y0007, India.
e-mail: chrisumptuous@hotsnail.co.us

Introduction

Tree-ferns are among the most ancient land-plants, and evidence of their predominance in the primaeval fireplace goes back to the Carboniferous Period. Their stately trunks and fronds were once the wonder of Sikkim, Lakshadweep and other areas of India, as witnessed by the Hooker in his journal of early 19th Century travels and political bungles in the jungle. But unfortunately, many are now under severe threat due to their former use in floriculture and as tooth-brushes for elephant breeding centres, or due to the young fronds being used symbolically in the more unmentionable traditional ceremonial practices and tribal ayurvedic medicinal hocus-pocus of the Goonds of Rajasthan. Thus several species are on the verge of extinction throughout most of the country, while all are protected by law. However the irresistible social desirability of having tree-ferns adorning living spaces, bathrooms, office areas and new upper-echelon private housing colonies in suburbia can now be satisfied by commercial tree-fern cultivation, which has been found to be most practically and efficaciously carried out utilising the root- and pseudobulb-masses of otherwise quite unwanted wild orchids. Commercial tree-fern cultivation utilising orchid root-mass is recommended as a suitable way to empower local communities by reducing unemployment among youths and their unfortunate addiction to debilitating virtual flower-power games. A successful pioneer project is described here and such operations are hoped soon to be expanded nationally as a means to benefit the population and make proper use of India's natural wild resources.

Fig. 1. C.R. Ferny-Jokings is also the President of the 'Tree-Fern Protection Squad', here suitably garbed and ready for action. (Note the kukhri knive ready for cutting down any orchid root mass)

Tree-fern cultivation project

Trials of orchid-root medium were initiated in the year 2K in the suitable climatic conditions of S.W. Rajasthan, a local hot-spot of biadversity. Following repeated tests, we obtained significantly better results and growth-rates of ferns by utilizing orchids collected in the wild, rather than using cultivated material. Areas such as Manipur, northern Arunachal Pradesh and also certain strict reserves in the South-Western Ghats are abundant sources of unexploited orchid-root litter. But as a substitute we were also able to outsource local orchid sanctuaries and other waste areas for a ready supply of material. From experience we found that local young people are best employed for gathering orchid-root substrate as they are more capable of getting round or square Forest Officers, penetrating remote areas of unspoilt forest and climbing the large, mature trees that are home to the greatest tonnage of otherwise useless orchid-root.

Fig. 2. A useful orchid root system only obtainable by climbing large mature trees.

Unfortunately several species of orchids were somehow either red-listed or otherwise protected by CITES, but these regulations should be ignored and can easily be circumvented by cultivating local political connections and influence in the wider interest of tree-fern cultivation, for the greater benefit of the nation. Some of the most suitable and rarest orchids were fortunately almost extinguished from their natural habitats in the wild due to enthusiastically unsustainable use during the Victorian tree-fern craze of prehistoric imperial centuries, led more recently by the Iron Lady. But saucy orchidologists of the Bottomtickle Service of India have sometimes found new populations which can be located from their books and publications and exploited beneficially. Many other suitable species still grow abundantly in certain biodiversity hot-spots, such as in restricted areas of N.E. India and in the Western and Southern Ghats of S. India, where they have not yet been put to use as tree-fern cultivation is only now beginning to become popular, from Rajasthan in a green leather conveyor belt right through to Connaught Place.

On collecting the orchid raw material, leaves and flowers should be cut off, especially the latter as they are very unsightly and detrimental to the environment, clogging drains and causing monsoon floods, while degrading environmental aesthetics in a similar way to multicoloured plastic litter. The unwanted waste of flower litter should be raked up and burnt at once.

In our trial run: 30 kg of *Bulbophyllum rothschildianum*,

consisting of approximately 1000 plants, were collected over three days by native collectors in the Sheroy Fern-Reserve, Ukhrul, Manipur, until no more could be found anywhere apart from in the Chief Minister's swanky living room. Plants had evidently been growing surreptitiously in the reserve over many decades, or even centuries, judging by their size and extensive colony formation. Flowers and other useless litter were cut off and discarded, and care was taken to remove the young growing tips to prevent the slightest chance of unwanted regrowth. After transporting to Jaisalmer, the residual root-mass was then broken up by beating it energetically on the ground with spades and frantic rhythmic trampling upon by turbanised Rajput paeons wearing large and heavy gold-plated lead ear-bangles left over from recent Hymenophyllaceous filmy shooting on the sets of I'madad and Icewarrior Beecham.

The mass was then separated into small samples and packed symbolically upside down in 100 large local-traditionally designed pots kindly provided by the Ministry of Rajasthani Local Crafts, Nathan Road, Kowloon, Hong Kong. Pioneer sporeling ferns were then introduced. These had been carefully grown on agar from a maximum of 5 spores collected by microtweezer, without harming even a single pinnule, from target-species in threatened wild tree-fern populations (in accordance with the new government

Fig.3. The Orchid root mass prepared by systematic trampling and beaten by spades.

regulatory guidelines on the confection of biodiversity). The sporelings were increased in number by laboriously unnecessary and expensive tissue-culture methodology in our extensively redundant new tissue culture facility deep under the ice on the north side of Nanda Devi Himal. New growth of fern was observed in the pots after a week. After 6 months the very very healthy young tree-ferns of c. 20 cm. in height were ready for distribution to garden centres and florists in selected metropolitan cities, where the unfortunate public is generally deprived of the spiritually refreshing presence of vivid, greenly waving tree-fern fronds, and has had to make do only with vulgarly coloured Orchid flowers as a poor substitute.

After several such trial runs, the following protected orchid species were found most suitable for macerating into root-medium, to promote rapid growth of tree-ferns:

Paphiopedilum hirsutissimum (Threatening to be endemic to an English Wine go-down in the Khasi Hills).

Bulbophyllum rothschildianum (Critically Endangering and endemic to a jumming-field near Ukhrul - now upgraded to the IUCN's HC (Handle with Care) category, since half the village elders ran away in a state of OID (orchidaceously induced terror)).

Vanda coerulea (Near Dangerous and indigenous to everybody else's greenhouse, except mine).

Dendrobium indistinguishabile (now Extinct in the Wild after we got to hear about it).

Medium-scale commercial operation has subsequently been initiated locally in Kalimpong, Shillong, Bangalore and up the Khyber Pass, during the spring growing season of 2011, utilising orchid substrate collected under black licence from local strict reserves. The operation became profitable due to gullible punters by autumn 2011 and is now planned to be expanded throughout the nation to wherever orchid growers gather. A secret list of Reserves capable of providing the greatest biomass of orchid-root was most helpfully provided to us under the table by Professor Vej of the Seriously Orchid Society of India, whom we kicked back unexpectedly, while looking over our shoulders to avoid the anti-corruption attention of the Any Old Hazard movement.

Fig.4. Large scale cultivation of orchids used in trials in preparation for the eventual loss of wild plants.

Conclusions

As a result of large-scale cultivation, involving the use of c. 40 tonnes of mixed orchid-root medium during the last year, we have been able to oversee the beneficial greening of the desert in a suitable target area of nearly 0.5 hectare located most appropriately within our University Campus at Pokaran. Providing the source of substrate material does not become depleted next year, we hope to plant a further 1 hectare around the Senior Government Servants We Wish To Cultivate' residential area and so on, on a yearly basis, while orchid stocks last. During our trials, we also thought that planting tree-ferns might be a useful way to remove heavy-metals, including isotopes of Led Zeppellins, from soil and flea-ash, as several quite unrelated ferns are well known as arsenic-accumulators, among other acid-house pollutants, and we hoped we might get an increased research-grant if we mentioned that.

While some concern has been expressed that the source of orchid-root may not easily be renewable at this rate, we recommend finding new pristine forest areas in, for example, remote northern Arunachal Pradesh, which have not yet been exploited and may even contain undocumented species that could prove to be yet more suitable to pound to pieces in order to increase tree-fern growth in people's back gardens, which are all one from Kashmir to Kanyakumari. We also suggest that if the worst came to the worst, some artificial culture of the most suitable species for producing maximum quantities of orchid-medium could be undertaken when natural supplies inevitably dwindle in just a couple of years.

Acknowledgments:-

The author is grateful to Mr. Something Pradhan (don't ask which one, I am as confused as U R), local secretary of the Seriously Orchid Society of India, Kalimpong Branch, for helpfully providing lists of suitable species and where to grip them. The third-man (still unidentifiable) is also most grateful to Professor Vej, Chunkigarh, for much help and encouragement in the common cause of commercial exploitation of India's natural orchid resources. The senior author would like to thank the junior author and another author would also like to endorse his gratitude to a further author, while the nearer author would like to thank his supervisor, being himself, and the, er, senior author.

The study outlined above was undertaken under a grant no. 123-explo-57 VARs-2011, of umpteen quivering kidnapped Crore-patties kindly provided by the Indian National Academy of Commercial and Applied Pseudosciences, New Delhi.

Fig.5. Tree ferns growing in orchid root medium in a secret research station in S.W. Rajasthan.
The size of these ferns is a direct result of the care taken in preparing the growth medium by intensive maceration using spades
These tree ferns are now ready to be distributed to garden centres and florists in selected metropolitan cities where they will provide a pleasant alternative to brightly coloured orchids.

References:-

BRUMMIDD R. (2001). Am I a woody fern? - and how can any of you clado-nerds chop it up and disprove it?, Hatson 78(3) 764-769

CLOUDHURRY H. J. (2009). Indian Orchids and how to cook them, a superb photographic compendium of all species with original mouthwatering recipes, pp. 622. Bottomtickle Service of India, Howzatt?!

DIXIT R. D. (1986). Lonesome tree-ferns, an urgent need of conversation, Indian Fun J. 3(1-1001): 42-45

FERNY-JOKINGS C. R. (2020). (in press). Taxonomic chaos and disruption while sinking one thousand new species of Tree-Fern from Kalinga Island, New Guinea, pp. 25. Bishop Sing and Mahindra My Pal Sing (can he?), Dare-a-Doom, India.

GAMMIE G. (1893). Note on Sikkim Tree-Ferns. By G. Gammie Jun., of Mongpo, British Sikkim [Sorry? Exactly!] (Communicated by C.B. Clarke, F.L.S.), J. Linn. Soc., Bot., 29: 204

HOLLTUM R. E. (1966). Desirably grown Tree ferns of the genus Cyathea Sm. in Asia (excluding Malaysia under an ASBO), Kew Bullfight. 19(3): 463-487

HOLLTUM R. E. & TRYON R. M. (1977). A [polite] exchange of views on the Cyatheaceae, Flora Malesiana Bull. Sheet 7(30): 2835-2839

HOLLTUM R E (1978). The real gloves-off exchange of views on the Cyatheaceae with that silly little transatlantic fellow, Argumenta Titanica 1(1): 1-1001 *¿XX!& *$!*¡**oof! Help, chaps!!!!

HOOKER J. D. (1849). Notes, chiefly Botanical, but with some naughty remarks on the local talent on the side, made during an excursion from Darjiling to Tongló, a lofty mountain on the confines of Sikkim and Nepal, J. Asiatic Suc. Bengal 18(203)

HOOKER J. D. (1857). Journal of Himalayan Exploits among Ladies of Sikkim I have known, but couldn't tell you about in front of Lady Hooker: 57, t. 43. W'm. Pamper & Daughters (wash their feet in soda-waters), Soho, London.

RANIL R H G, PUSHPAKUMARA D K N G, JANSSEN T, FRASER-JENKINS C R & WIJESUNDARA D S A (2011) Constipation priorities for extinct Tree ferns (Cyatheaceae) in Sri Lanka, Taiwantsya 56(3): 201-209

SMITH AR AR AR, SHOOTPEST A B C, MISSEDIT O & DANG U (2012). Clading your sister's parsimony under Cyatheaceae (Pterriblefighta) supported only by her boot-straps, J. Molecul. Syst. Genette 95(4): 1037-1030

VERMIFUGE S C (2011). New and unheard of methods of self-inbreeding systems and genetic intractability in Indian cyatheoid pteridophytes, part 1, self-spiflicating recombinant types, J. Genet. Mutate Whatsup Watson?, Crick Neck Memorial. Vol.1(0): ½-1 = μm^2.

The writing of this paper was stimulated by the recommended use of tree-fern slabs as a growing medium at a recent national Orchid conference in N. India, and was greatly assisted by Mr. Cibotium Toddy and friends, of Matalbari village, Outer Assam (first author only, as the second was carried off with his 24 buxom Parganas by the Calcutta temperance society and hasn't been heard of since closing time last Saturday night).

Distribution of *P.australe* 'Cambricum'

Martin Rickard
Pear Tree Cottage, Sutton, Tenbury Wells, Worcs. WR15 8RN,
e-mail:h.m.rickard@btinternet.com

(For simplicity throughout this article the old species name *Polypodium australe* has been used, not the new, confusing but politically correct name, *Polypodium cambricum*.)

Polypodium australe `Cambricum' was first discovered by Richard Kaynes of Bristol in 1668. It is the plumose form of *P.australe*. The locality was Cwm George near Cardiff. Similar but slightly different forms have been found elsewhere a very few times since and it still survives at its first known site. Collectively these cultivars are known as *P.australe* (Cambricum group).The original form is in cultivation as *P.australe* 'Richard Kaynes'.(Fig. 1.)

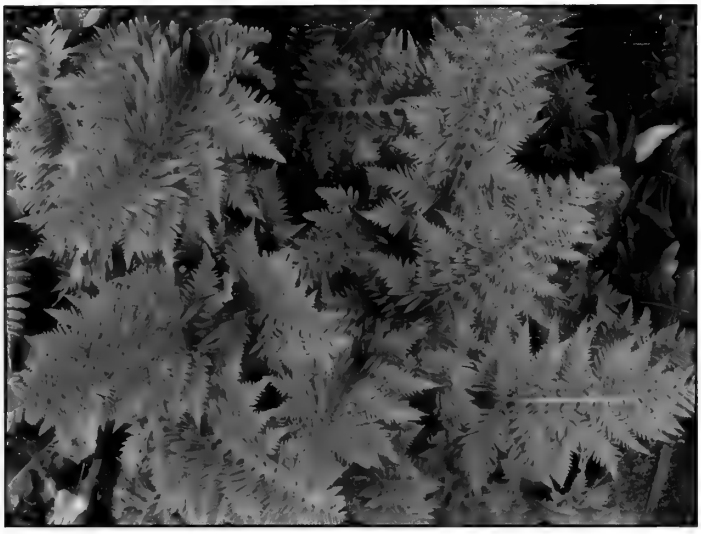


Fig. 1. *Polypodium australe* 'Richard Kaynes'.

Last year, for the first time in recent years, a new colony was found by Mark Jannick, this time in Ireland. This article attempts to catalogue all the recorded natural wild occurrences of *P.australe* which fit into the plumose 'Cambricum' group of cultivars.

Records in black seem likely to be wild occurrences of true *Polypodium australe* (Cambricum group). To qualify as probably natural, the record must be from an area where *Polypodium australe* is native. There must also be a herbarium specimen or reliable illustration, and no mention of a garden. In the past 'Semilacerum' and 'Omnilacerum' have commonly been confused with true 'Cambricum'. Any records suspect on that account have been excluded.

Records where the plant has probably been introduced are given in red.

Literature records which seem very unlikely are given in green.

By vice-county:

ENGLAND

Cornwall:

Recorded as an introduction on a grave in Landewednack churchyard during the 1980s by Rose Murphy in *Flora of Cornwall*. While it has not persisted the plant from here is still in cultivation.(Fig. 2)

Cheshire:

E J Lowe found "in a wood near Macclesfield, Cheshire",c.1853. Specimen in Moore Herbarium at Kew. Mentioned in Folio *Nature Printed Ferns*.1855. An anomaly here! Published in 1855 but seemingly claimed as first found in 1869 by Lowe (Lowe, *British Ferns*, 1890)! This record is rather unlikely as no *P.australe* is known locally, however, the herbarium specimen and the woodland locality just about sway it as a genuine record!

Fig. 2. *Polypodium australe* 'Cambricum' from Landewednack churchyard

Devon:

Recorded from South Devon by Mr. Easterbrook (Lowe in 1890), also fine specimen in Moore Herbarium at Kew labelled "South Devon, William Easterbrook, 1867." Possibly cultivated but there are many suitable habitats in south Devon.

Keble-Martin 1939 in *Flora of Devon* gives a record for Cambricum Willd. from Sidmouth on the authority of Cullen. Cullen wrote the Flora of Sidmouth in 1849 but I can find no mention of 'Cambricum', however, Newman in *History of British ferns* (1854) thanks Dr Greville for a gigantic specimen from Sidmouth, Presumably this form.

Gloucestershire:

Flaxley Wood, St Brody in Riddelsdell, Hedley and Price in *Flora of Gloucestershire* 1948.; I have searched this area without success. St Brody`s specimen in Gloucester herbarium is certainly correct. There are ancient buildings at Flaxley, it is possible the fern persists on a private wall. Equally it might have been of garden origin but description of the habitat as Flaxley Wood suggests otherwise. Flaxley is a limestone area. Flaxley Wood is quite large.

Downend, Bristol, recorded in 1841 by Samuel Freeman, *Phytologist* 1841. Even in 1841 Downend would have been a satellite of Bristol, therefore this record probably relates to a plant of garden origin.

Within 2 or 3 miles of Cheltenham, Prentice. in Riddelsdell, Hedley and Price in *Flora of Gloucestershire* 1948; Very vague, could mean anything!

Almondsbury, Thomas Moore in *British Ferns*. Buttress of old wall at Almonsbury, E.Morse, 1856. Specimen in Moore Herbarium at Kew.

Herefordshire:

Leinthall Starkes, wall in village. Planted circa 1985 by MHR. Still there.

Isle of Wight:

Steep Hill, Mr Hambrough, n.d.. Confirmed as 'Cambricum' by Bromfield, author of *Flora Vectensis*, 1856. Possibly wild but Steep Hill is the site of a botanical garden.

Distribution of *P.australe* 'Cambricum'

Lancashire:
Witherslack, T.Barrow, 1874. Distinct form known as 'Cambricum Barrowi'.(Fig.3) Specimen labelled 'Cambricum No.2' collected here by J.Bolton 1877 in Moore Herbarium at Kew; looks like 'Barrowi'. Searches of Whitbarrow/Witherslack from 1975 to 2012 have only uncovered tiny scraps of *P.australe*, and no 'Cambricum'. Interesting these two records are three year`s apart, suggesting Barrow did not collect it all.

Fig. 3. *Polypodium australe* 'Cambricum Barrowii' at Ivycroft Nursery

Silverdale, Hadwin, 1875. Distinct form known as 'Cambricum Hadwinii'. Specimen grown by Stansfield in 1869, Moore Herbarium Kew.
Yelland (presumably Yealand), R.Preston, 1871. Distinct form known as 'Cambricum Prestoni'.(illus.)

Warton Crag, J Bolton, 1877. Named 'Cambricum No.1'. Specimen in Moore Herbarium at Kew.

Conishead Priory, Furness,1848. Herbarium of J Forbes Young. Perhaps cultivated.

Norfolk:
Cromer. 'Cromer variety' found near Cromer by Henwood. Date unknown but c.1920. At the time Henwood was THE expert on Polypodium cultivars. There is no doubt about identification but since *P.australe* has never been found in Norfolk this plant must surely have been a garden outcast. Also known as 'Cambricum Henwood'. Illustrated in *Ferns for garden and greenhouse* by MacSelf (1948).

Nottinghamshire:
Papplewick, Riley,1839. Specimen in Herbarium of Soc. Bot. Lond., A bit akin to 'Prestonii' but predates that find. Papplewick was where Riley lived so this is almost certainly NOT where it grew wild.

Somerset:
Near Dundry Church. Seen in situ by Swete (Flora of Bristol, 1856). Search circa 1990 unsuccessful.
Bossington woods, Porlock, Miss Gifford in *Flora of Somerset*, Murray ,1896. Search circa 2000 unsuccessful. *P.australe* is in the area but it seems more likely this was a 'Semilacerum'.

Pennard, 'Cambricum Whilharris'. In E J Lowe`s possession before 1893. Found at Pennard near Glastonbury. *BFG* Vol 7, p.33. 1935. William Harris was the Head Gardener at Bristol Zoo and custodian of a very large fern collection, it seems likely Whilharris, or Wilharris was his nick-name. Some time spent searching this region in the 1980s did not uncover any *P.australe*, let alone 'Cambricum Whilharris'. The origins of this fine cultivar remain obscure.

Westmorland:
Troutbeck near Ambleside. Not an area for *P.australe*.

Worcestershire:
Kidderminster. Moore 1859 in *Nature Printed British ferns*. Seems very unlikely.

IRELAND
Antrim:
Newman in *History of British ferns* (1854) reports that a Mr Thompson found "a similar plant...in a glen at Red Hall, near Carrickfergus." Never confirmed, probably 'Semilacerum'.

Kerry:
Killarney, On the Castle ruins at Castlelough, Lower Lake Killarney 1903, Scully. Unfortunately Scully goes on to add - "...and elsewhere in the county." Causing suspicion that he did not distinguish between 'Cambricum' and 'Semilacerum' (= 'Hibernica'). This is about 1 mile from the new site found this year by Mark Jannick, neither he nor I have yet examined this castle.

Herbarium specimen in the Ulster Museum - *Polypodium vulgare* c. Cambricum Willd. Cultivated Drummore Garden, roots on scree (?) many years ago from Killarney, Kerry. Collected by Robt. Waddell. July 1896. Drummore Garden is in Scotland.

24.9.2012. Mark Jannick discovered five tiny pieces of 'Cambricum' growing on a wall in Killarney. Jim Dennison and I visited the site on 7.12. 2012 and also found five patches. Four very small but the fifth slightly larger. Almost certainly true 'Cambricum' but with such small plants there is a small chance of error.

Sligo:
In *The Botanist in Ireland*, Praeger cites records by Cuthbert Harrison in the *Irish Naturalists Journal* Feb. 1905, p.39: "The enclosed frond of Welsh Polypody was taken from a plant found on the shore of Loch Gill near Doonee Rock. I have also found it, and the Irish Polypody (= Semilacerum) on Goat Island, Loch Gill." No herbarium specimen appears to exist unless there is one at Glasnevin, but Praeger saw the frond so it must surely be correct. Also Harrison seems to know the difference between 'Cambricum' and 'Semilacerum'. I wonder if the "plant found on the shore" was washed up there from elsewhere, or if it had fallen from the cliff of Doonee Rock (which is limestone), or was growing on shore side rocks. Rather fascinating!

Wicklow:
Newman in *History of British ferns* tells that Mr Moore of Glasnevin in Dublin sent him a root from Wicklow. This was the only other reliable Irish record known to Praeger in 1905. Specimen collected at Bray Head in Moore Herbarium at Kew or the next record is presumably this plant.

The Dargle,1843, no collector. Specimen in NHM is labelled "wild from the Dargle". Records from the Dargle have usually been grouped as 'Semilacerum', but this is a true 'Cambricum'.

Distribution of *P.australe* 'Cambricum'

SCOTLAND

Dumfriesshire;
Rock at Moffat, collected by J Anderson August 1860. Specimen in Moore Herbarium, Kew is correct.

Lothians:
Near Edinburgh at Braid Hill. *P.australe* is in the area but Braid Hill is a large estate where it might have been cultivated.

WALES:

Anglesey:
Mill Dingle, Beaumaris, Mr. Sidebotham, n.d. Possible but no specimen seen.

Newborough, in a garden, circa 1995. Communicated by Rob Cooke. Confirmed as being of garden origin by Nigel Brown of Treborth Gardens, Bangor. In cultivation.(Fig. 4)

Fig. 4. *Polypodium australe* 'Cambricum', Newborough, Anglesey

Cardigan:
Llanafan, below a wall by road. Site visited and fern not found. It might have been a garden outcast. Herb. NMW – specimen not very convincing.

Caernarvonshire:
"Various parts of North Wales" according to Moore in *Popular History of British Ferns*,1851. Suspiciously common and obviously unreliable.

Conway Castle, Mr. Sidebotham n.d.. Also 1876 by Creswick Williams, specimen in NMW Cardiff. At least two colonies of 'Cambricum' grow planted on walls in a village near Conway. Found initially by W.Elfyn Hughes and the second much later by MHR. Hearsay evidence says they originated from Conway town walls. Now in cultivation as 'Cambricum Conwy'.(Fig. 5) Surprisingly, Griffiths, in *Flora of Caernarvonshire* (c.1895) does not repeat this record although he records var. serratum (*P.australe*) from the castle – the only site he gives.

Above Aberllyn, near Bettws-y-Coed, R H Roberts, 1952. Site destroyed by forestry, vide R.H.Roberts, specimen in NMW Cardiff not very convincing, Dick Roberts himself was not sure. He told me the site was destroyed in forestry operations.

Glynllifon, Walls of estate , Bernard Hankey. See *British Fern Gazette*, 1924,p.94. Possible, *P.australe* occurs locally. Bernard Hankey was a fern grower and Glynllifon was regarded as housing one of the best fern collections in the British Isles, he may have planted it on the walls but the reference says "found".

Fig. 5. *P.australe* 'Conwy', on a wall in a village near Conway, North Wales.

Denbighshire.
No locality, no date, Thomas Pritchard. Entirely possible. There are areas in the county where *P.australe* is common.An area worth searching.

Glamorgan:
Cwm George, Dinas Powys by Richard Kayse of Bristol, 1668. Lost in 1876 but refound by Riddelsdell in 1908, refound again in 1977 by Malcolm Wood (*Flora of Glamorgan* by Wade, Kay and Ellis, 1994).Small sample collected for analysis circa 1985.

Aber Valley, Frederick Ward herbarium, now in NHM.

Monmouthshire:
Raglan, Mrs Bagnall Oakley,1868. A dwarf form of 'Cambricum' known as 'Cambricum Oakleyae'. Presumably on the castle walls, searched circa 1990 with no success. *P.australe* present.

Overseas:
Remarkably, given the abundance of *P.australe* in much of Europe and around the Mediterranean Sea I have only found two vague records. Montpelier, South of France, Moore 1859 in Nature Printed British ferns. Also La Baumette, a suburb of Angers, Maine et Loire, manuscript by D.Perrault in a copy of *Fougeres de France* by Rey-Pailhade. I have always looked out for it in France, Spain, Italy and Majorca with no success. Neither have any of my enquiries to local pteridologists been successful.

Unlocalized:

Belmont, 1876, recorded as 'Imbricatum', but a true 'Cambricum'. Univ. of York Herbarium.

"Found in an old wall 5 or 6 years ago", Elworthy 1865. Named as 'Propinquum'. Distinct, possibly a 'Cambricum'. Specimen in Moore Herbarium at Kew.

This list is surely not complete. If I have missed any sources or anyone knows of additional colonies I would be very interested hear from them.

INTRODUCING *Cystopteris moupuensis.*

A R Busby
Croziers, 16 Kirby Corner Road, Canley, Coventry.
West Midlands. CV4 8GD
e.mail: matt4u@btopenworld.com

At the Society's 2010 Annual General Meeting at Dunchurch, Warwickshire, I found several ferns in small pots on the plant sales area. It was at the end of the meeting and I purchased half a dozen of them at a knock down price. One of the pots contained a tiny plant labelled *Cystopteris moupuensis*. I was pleased to add it to my small *Cystopteris* collection particularly as this is a species completely unknown to me. It sat in my small greenhouse largely ignored by me and sad to relate, because of my inattention to watering, it lost all its fronds. I was convinced that I had lost it completely but I gave it a good soak and placed it on the floor, in the shade of the greenhouse staging.

I forgot all about until going through the potted ferns in the greenhouse some weeks later; I suddenly discovered this pretty little fern on the floor (Fig.1). I was delighted to see that it was the *Cystopteris* that I gave little hope to seeing again. As it was in a very small plastic pot, it obviously needed repotting but what kind of substrate does it require? I searched through all my modern fern books but could not find any reference to it. Fortunately Sue Olsen's book, *Encyclopedia of Garden Ferns*, came to my rescue. Her book explains that this dainty little fern comes from China. Its fronds are bi pinnate to tri pinnate and triangular and it appreciates some shade. So my putting it in the shade of the greenhouse shading was exactly the right thing to do.

Whenever I must repot a fern that I have no knowledge of its soil requirements, I use a mix of J I Seed Compost with sharp grit and some well-rotted leaf-mould. I find that it results in a compost with a neutral pH that seems to suit most ferns. We are advised that it is suitable for zones 5 to 8 so it might need some winter protection north of the English midlands. At the time of writing, (March 2012) it has come through the winter in my frost-proof greenhouse which did go down to -3 at for a few days in January. I am so pleased it have this delightful fern in my collection. ❐

Fig. 1. *Cystopteris moupuensis* thriving after it had lost all it's fronds.

References:-

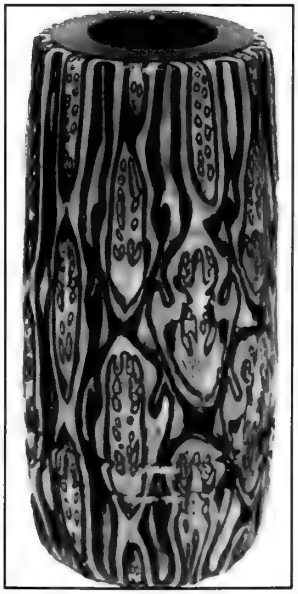
Olsen, Sue, (2007). *Encyclopedia of Garden Ferns*. Timber Press, Portland Oregon, 2007. ISBN 978-0-88192-819-8.

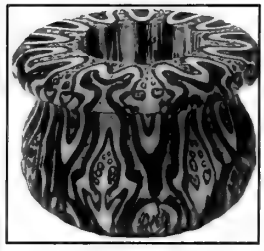
Tree fern ornaments.

Tree ferns, it would seem, can give pleasure even when thery are dead. The stand in the picture to the left is full of carved tree fern trunks, some examples are on the right.. I found them in the shop belonging to the Kauri Museum in New Zealand North Island.

The museum gives a fascinating insight into the early pioneer days of New Zealand and the chain saw museum has to be seen to be believed!

The tree fern used was the Black Mamaku or *Cyathea medullaris* whose croziers were a traditional food of Māori, while the plant's extract was known as a powerful healer, used for rejuvenating, cooling and hydrating the skin. AEG





A multitude of hybrid Polystichums in a Hampshire lane.

Ronnie Viane

Researchgroup Pteridology,
Dept. of Biology, Ghent University,
K.L. Ledeganckstr. 35,
B-9000 Ghent,
Belgium,
e:mail: Ronnie.Viane@UGent.be

Andrew Leonard

37 Lower Bere Wood,
Waterlooville,
Hampshire.
PO7 7NQ
e-mail: mail@andrew-leonard.co.uk

Andrew Leonard (A.L.) led a regional BPS meeting in September 2009 where he took a group to the see the sunken lane that runs from Buriton to Coulters Dean, in Hampshire (Figures 1 and 2). This lane had both *Polystichum setiferum* and some *P. aculeatum* but the majority of the polystichums appeared intermediate between these two species.

Fig.1. The entrance to the sunken lane.

In July 2012 A.L. sent 2 fronds to Fred Rumsey who pronounced them as *P.* x *bicknellii* because of a very high degree of abortive spores on both fronds.
In September 2012 A.L. sent fronds from 6 different plants to Professor Ronnie Viane (R.V.) to analyse using "flow cytometry" (see "en.wikipedia.org/wiki/Flow_cytometry"). The plants chosen were marked for future reference (see Figure 3).

The results turned out that all these plants were 3x (that is *P.* x *bicknellii*).

Fig.2. The level part of the sunken lane.

The plants sent to R.V. were not specially picked. A.L. estimates that of the 100 or so polystichums that grow in this lane, the vast majority are *P.* x *bicknellii* (see Figure 4).There are some that are clearly *P. setiferum* and there maybe some *P. aculeatum*.

R.V. is of the opinion that this is not a unique situation and he is currently investigating several localities in France where this also occurs. As yet there is just speculation but no scientific explanation.

The lane is best described as a cart track and is sunken between 2 fields that are used for agricultural purposes. The track runs level for about 500 yards and then ascends steeply. The polystichums mostly grow in the level part of the lane in the steep banks. The lane is damp during most of the whole year and half way along the level section, a spring occurs and the resultant small stream runs down the side of the track.

Dryoteris affinis, *D. dilatata*, *D. filix-mas*, *Asplenium scolopendrium* and *Polypodium* can also be found in this lane. ❐

Fig.3. Marking the chosen plants that were analysed using flow cytometry.

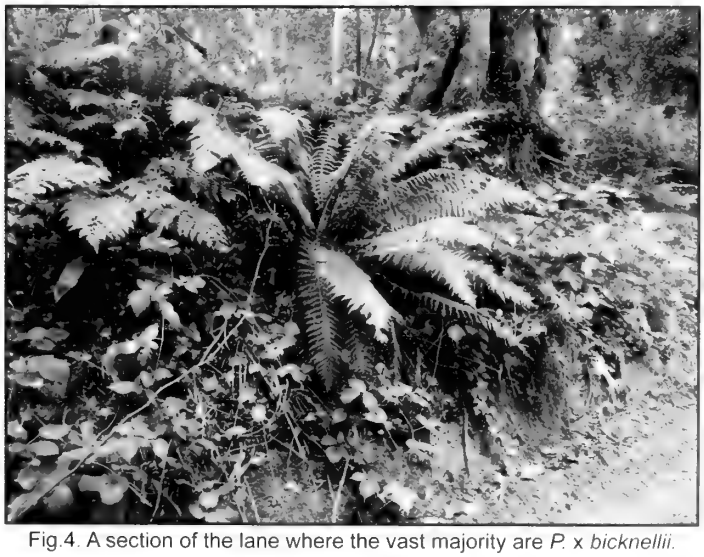


Fig.4. A section of the lane where the vast majority are *P.* x *bicknellii*.

A new site for *Polypodium australe* 'Cambricum'

Martin Rickard
Pear Tree Cottage, Sutton,
Tenbury Wells, Worcs. WR15 8RN,
e-mail:h.m.rickard@btinternet.com

(For simplicity throughout this article the old species name *Polypodium australe* has been used, not the new, confusing but politically correct name, *Polypodium cambricum*.)

Over the years I have been fortunate to visit Killarney in County Kerry, Eire several times. It is a wonderful area scenically and paradise for the fern enthusiast. Frequent in the back of mind while in the area is Richard Rush`s find of *Asplenium x confluens* (*A.scolopendrium x A.trichomanes*) near Killarney back in 1982. This was fully written up in the *Fern Gazette*, 12,**5**,301-302,1983. He found this extremely rare hybrid on an old wall. The precise locality was not given but he does say he found it 'approximately fifteen miles from Killarney'. There are some wonderful old walls in and around the town which might reward search and I mentioned one in particular I had never examined to Mark Jannick – that plant hunter extraordinaire – he is the botanist who refound the 'extinct' ghost orchid *Epipogium aphyllum* in Herefordshire four years ago.

Mark`s parents live in Eire so most years Mark has a chance to tour around looking for plant treasures, mainly ferns. Participants in the most recent Irish trip organised by Jim Dennison have Mark to thank for 3 of the 4 Killarney fern sites we saw.

Meeting Mark late last summer he told me he had visited the wall I mentioned but did not find any A.x confluens. He did, however, find a strange polypodium, somewhat along the lines of 'Omnilacerum' or even 'Cambricum'. He showed me pressed fronds he had collected. They were very small, perhaps 5 or 8 cms long. No sign of sporing, could these be fronds of wild occurring 'Cambricum' or just young fronds of a form of 'Semilacerum'? I felt 90% confident they were 'Cambricum'. For a polypodium junkie like me this was very exciting. Fortunately I had already planned a December trip to Ireland to visit Jim and Val Dennison so it was pretty easy for us to get down to see the site for ourselves.

The wall in question is of varying age, about 2 metres high. It is made of limestone with lime mortar. It is covered with *P.australe*, on and off, for about a kilometre on both sides of the road. Usually small plants on the face of the wall with large plants confined to the top. There must be tens of thousands of plants in total but much of the wall near the 'Cambricum' is almost devoid of vegetation. (Fig. 1). When we visited the site we found the 'Cambricum' straight away. Mark had as usual given very precise instructions, it was on a rather ancient section of wall, in full sun facing south, south east. Amazingly he had found five tiny plants, four within a metre or two of each other but a fifth 20 metres away. We, too, soon found his five plants. What is going on here? 'Cambricum' is sterile. How can there be 5 plants? It cannot spread by spores. There seem to be three possible explanations for this:

a)Maybe the wall had earlier been covered by a 20 metre long colony. This seems very unlikely in a heavily botanised area like Killarney, along a wall by a busy pavement, since surely a large colony would have been noticed and reported. The wall has been repaired in patches along this length so it is possible some material was removed during restoration.

b) Maybe these five plants have arisen *de novo*. If this is the case does that means there is a fertile plant of *P.australe* in the area with the tendency to produce a surprisingly high percentage of plumose plants.

c) Maybe the plants are planted. I think this is impossible. The plants are all on the face of the wall, not the top, and the wall is rock hard. If anyone has successfully established these plants in this wall I would love to know how they did it!

I am forced to think that option two is the most likely explanation. This thought is further strengthened by the slight differences between some of the plants. As I said above all plants are very small so any discussion of their morphology is possibly premature and certainly risky, if they ever grow to a good size they might look quite different. Nevertheless on the largest plant the pinnae divisions are not sharp tipped, while on the others some are. My feeling is we may have two different 'Cambricums' occurring at the same site.

Fig. 1. Jim Dennison examining the wall that has several colonies of *P. australe* 'Cambricum'

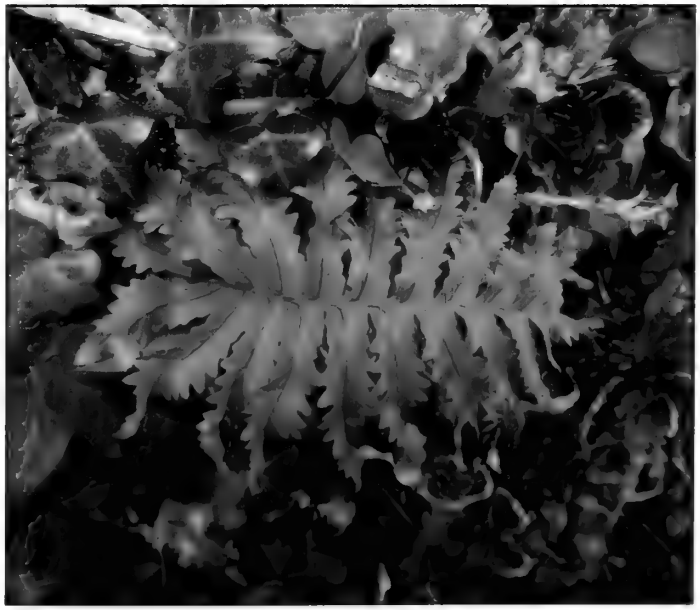


Fig. 2. A typical frond in colony 1.

Fig. 3. Colony 1.

Fig. 4. Colony 2.

It is quite possible we will never know if these separate plants are going to develop into morphologically different strains. None of the colonies of standard *P.australe* growing in similar situations on the wall have grown into large fronded plants, all are stunted. Many may be quite old. Colonies along the top of the wall seem to grow well. So these plants of 'Cambricum' all growing on the face of the wall appear to be doomed to remain dwarf then die out eventually.

Colony one: The largest colony is about 1.2 metres above the pavement and covers an area of about 30cms x 30cms, there are 5 or 6 fronds up to 10cm long by 6 cm broad. It is struggling in a mass of ivy roots and moss. I am not sure if the ivy is detrimental to the polypodium by strangling it, or if the ivy roots may be beneficial by accumulating moss and soil providing a lifeline to the fern. Although this is the largest colony none of the fronds are showing serrated pinnae segments and the fronds are ovate or broadly lanceolate, not obviously deltate.(Fig.2 and 3)

Colony two: About 45 cm directly below Colony one. This colony is near enough to Colony one to have possibly been physically connected at some point, although there is no obvious connection between the two colonies now. Morphologically the two colonies seem different. Fronds from Colony 2 are deltate and some pinnae segments are serrate. The largest of the 5 fronds is approx. 5 cm long by 5 cm broad. (Fig.4)

Colony 3: About 1.8 metres to the left of colony one, also about 1.2 metres above the pavement. The colony is 12 cm long by 7 cm wide densely packed into the mortar between two stones. There are approx. 10 fronds, the largest 7cm long by 7 cm broad. The fronds are deltate but the pinnae segments are not obviously serrate. (Fig.5)

Colony 4: Unfortunately I do not have measurements for the proximity of this colony to colonies 1 to 3. It was not far away, perhaps 2 metres further to the left of colony 3. There are 8 fronds with the largest 7cm x 7cm. The whole colony is about 10cm in diameter. Fronds are deltate with some serrations on the pinnae segments.(Fig.6)

Colony 5: This is the colony about 20 metres from the other four. It is very small consisting of only 3 fronds, the largest 3 cm x 3cm. The fronds are ovate, not markedly deltate, and the pinnae segments are not serrate.

The colonies seem to fall into 2 groups. Curiously colonies 1 and 5 make one group, with 2, 3 and 4 the other. Had the isolated colony 5 been morphologically different to the other 4, the idea of two different types of *P.australe* 'Cambricum' growing on this wall would have been more compelling.

Footnote: This is the only colony of wild, unplanted, *P.australe*'Cambricum' I have ever seen. It was not at all what I expected! The above pictures surely show just how small and unspectacular this fern can be struggling on an ancient wall. In future I will look more carefully among colonies of *P.australe* – maybe I have overlooked it in the past!

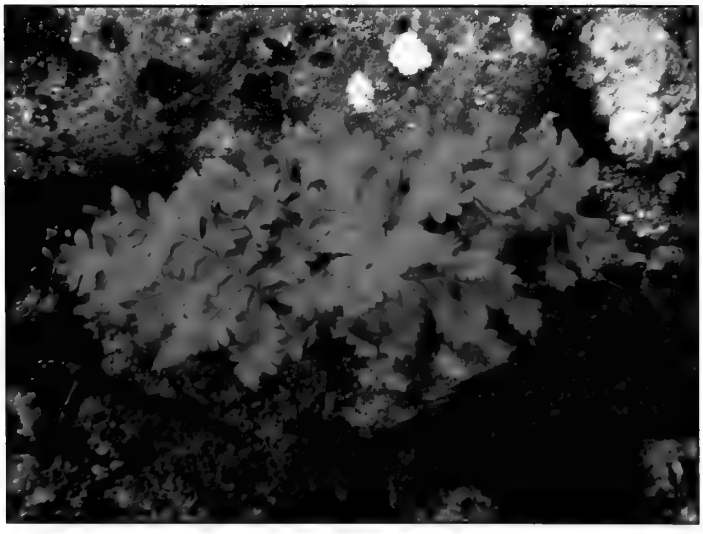


Fig. 5. Colony 3.

Fig. 6. Colony 4.

Hybrid Aspleniums in Mallorca

Alison Evans
Springfield House. Salterforth Road,
Earby. Lancs. BB18 6NE
e-mail: acl.evans@btinternet.com

The area around the Soller valley, in the northwest of Mallorca, is a well-known site of botanical interest and seems to be a hot-spot for hybridisation of aspleniums. Andrew Leonard visited this area in 2010 and was shown several of the hybrids by Dr. Juan Bibiloni, who has a wonderful plantsman's garden in Soller and a very informative website (http://jardin-mundani.es). Inspired by Andrew's pictures and Juan's website, a small group of us visited the area in November 2012. We were fortunate to be introduced to several of the hybrids by Juan himself in a tour of his garden (Fig. 1) and the surrounding countryside.

Armed with this new knowledge we then explored further. The two main sites we visited were the road from Soller to Tres Creus and the olive groves near Biniaraix (Fig. 2). We were able to identify typical plants of the species, but I, for one, was soon confused by the range of variation in some of the species and the plants we thought might be hybrids. Frequent reference to the printout of Juan's webpage, and discussions late into the evenings over the next couple of days, helped me to begin to sort out the taxa we were seeing. My aim in this article is to describe the hybrids that we believe we saw in the Soller Valley.

Andrew Leonard has constructed a very helpful diagram of the taxa involved and their relationships (Fig. 3). This shows two species in particular that seem to hybridise most freely, *Asplenium majoricum* and *A. trichomanes* subsp. *quadrivalens*, each of them being a parent of at least four hybrids.

Fig. 1. Touring the garden of Juan Bibiloni.
L to R. Juan Bibiloni, Andrew Leonard, Tim Pyner, Martin Rickard and Bruce Brown.

Fig. 2. The Soller valley in the northwest of Mallorca.
The November weather can be quite variable.

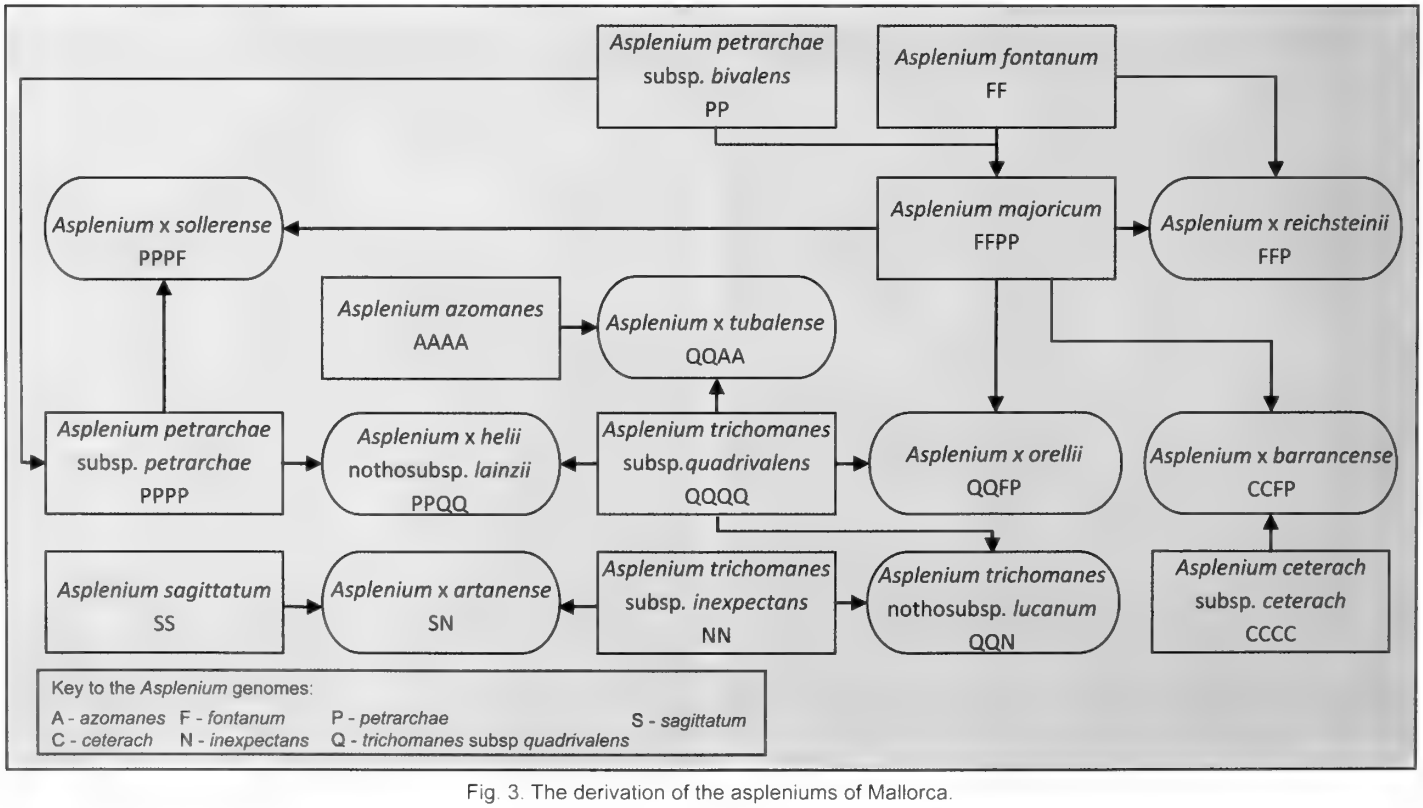


Fig. 3. The derivation of the aspleniums of Mallorca.

A. majoricum was new to me (Fig. 4). We found many colonies of it, at first thinking that some of the plants were hybrids, because it is quite a variable species. The name *A. majoricum* was first published by Litardiere in 1911, and a full description of the plant was given by Jermy and Lovis in the *British Fern Gazette* (1964). They used material that had been collected near Soller, the *locus classicus.* The stipe and rachis are wiry, shiny black underneath to about halfway along the frond, and green on top. The frond shape is described as 'elliptical to oblanceolate', with the lower pinnae being deeply lobed but 'never more than pinnatifid', that is they are not bi-pinnate as in *A. obovatum*. The pinnae are not so finely dissected as in *A. fontanum.*

Fig. 4. *Asplenium majoricum,*
Photo: A Leonard

A. majoricum was thought to be endemic to Mallorca, but was then found near Valencia (Perez Carro and Fernandez Areces, 1992), and more recently in Catalonia (Curto et al, 2012). Studies of meiotic pairing in artificial hybrids showed that *A. majoricum* is derived from the diploid hybrid of *A. fontanum* and *A. petrarchae* subsp. *bivalens* by doubling the chromosomes to become an allotetrapoloid, as cited in Hunt et al (2011). These authors have used genetic and allozyme techniques to study the populations of *A. majoricum* from Mallorca and from Valencia, and conclude that the species is likely to have colonised Mallorca from the mainland. The parents of *A. majoricum* are rare in Mallorca. Hunt et al were not aware of any records after 1917 of *A. fontanum* from Mallorca, and only found one site for *A. petrarchae* subsp. *bivalens.* They found that a colony of *A. majoricum* growing close to the latter did not appear to be descended from it. It seems that *A. fontanum* has survived in the Soller area, but the plants that Andrew was shown in 2010 have been grazed by feral goats, and although the crowns are now protected against grazing by metal cages, only one plant had any recognisable fronds in 2012. We didn't find any plants of the diploid *A. petrarchae* subsp. *bivalens*, although we found the autotetraploid, *A. petrarchae* subsp. *petrarchae.*

The backcross between *A. majoricum* and *A. fontanum* is the very attractive *A. x reichsteinii* (Fig.5). This plant was described by Bennert, Rasbach, and Rasbach in 1987, from material that they collected near Soller in 1986. In April of that year, Professor Tadeus Reichstein had found two plants growing in the area, then in October,

Fig. 5. *A.* x *reichsteinii,* the backcross between *A. majoricum* and *A. fontanum,* is a very attractive fern.
Photo. A. Leonard

four more plants were found. Morphologically this hybrid is intermediate between its parents, with rather less-dissected pinnules than *A. fontanum,* and the shiny black under-surface of the rachis extending for variable distances along the frond. It was found to be triploid with 36 pairs and 36 univalents at meiosis. The spores are abortive. This triploid hybrid should be sterile, but it appears to be much more common around Soller than *A. fontanum.* Bennert and the Rasbachs report that they were unable to find a single plant of *A. fontanum,* but by 1987 they were aware of 8 plants of *A. x reichsteinii.* In addition to the plant that Juan showed us, we found two other plants fitting the description. Juan speculates that *A. x reichsteinii* may by-pass meiosis to produce occasional triploid spores, and then by-pass gamete fusion so that a new triploid sporophyte grows directly from the prothallus. An alternative explanation might be that there are unrecorded plants of *A. fontanum* in the Soller area. When attempting to produce triploid hybrids of *A. majoricum*, Sleep (1967) had a higher success rate crossing with *A. fontanum* than with the other diploid taxa she used.

A. majoricum also hybridises with *A. petrarchae*

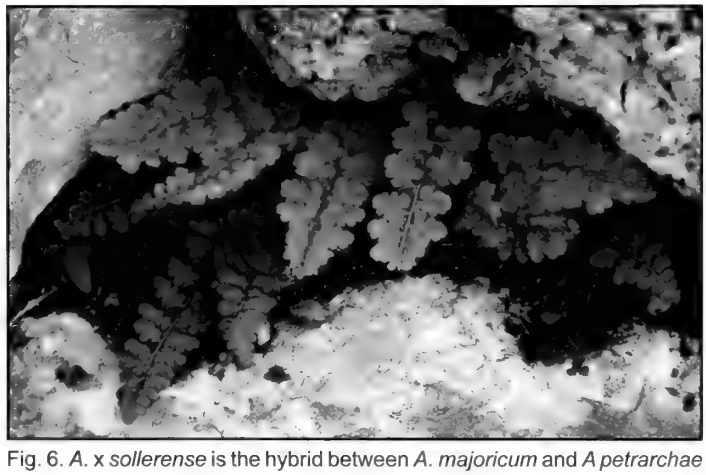


Fig. 6. *A.* x *sollerense* is the hybrid between *A. majoricum* and *A petrarchae* subsp. *petrarchae*
Photo: A. Leonard

subsp. *petrarchae* to form *A. x sollerense* (Fig. 6.). This looks like a very large *A. majoricum*, with bright green, pendulous fronds, but it has the hairy character of its *petrarchae* parent, with single-celled glandular trichomes. The frond is wider in the distal half, unlike *A.* majoricum. The pinnules are rather broader and perhaps less incised than those of *A. x reichsteinii.* This allotetrapoloid has three sets of chromosomes from *A. x petrarchae*, and one set from *A. x fontanum.* According to Juan, *A. x sollerense*

can produce spores that look good, which may be why the taxon is quite common in the Soller valley.

To further confuse matters, *A. x orellii*, the hybrid between *A. majoricum* and *A. trichomanes* subsp. *quadrivalens,* can also look rather like *A. majoricum.* It is distinguished by the rachis being dark brown on the upper and lower surfaces, only becoming green at the end of the frond. (Fig. 7). This hybrid is not hairy.

Fig. 7. *A* x *orellii*, the hybrid between *A. majoricum* and *A. trichomanes* subsp. *quadrivalens.* Inset the underside of the frond.

Photos: A. Leonard

One hybrid that we had no doubt about was *A. x barrancense,* the hybrid of *A. majoricum* and *A. ceterach* (Fig. 8). This handsome little fern has a thick green rachis that is not wiry as in *A. majoricum,* but has a sparse covering of scales on the underside. It has lobed pinnules that are rather more distant than in *A. ceterach.* Tim Pyner found this tiny plant in a niche in the wall above the road to Tres Creus on the morning of our last day, just before we had to leave for the airport.

Another new taxon for me was *A. azomanes,* also known as *A. trichomanes* ssp. *coriaceifolium.* This is another allotetrapoloid species, being derived from the hybrid of *A. azoricum* and a subspecies of *A. trichomanes.* The hybrid of *A. trichomanes* subsp. *quadrivalens* with *A. azomanes* is *A. x tubalense.* This is also quite

Fig. 8. *A.* x *barrancense*, the hybrid of *A. majoricum* and *A. ceterach.* Inset: The underside of the frond.

Photos A. Leonard

straightforward to recognise (Fig. 9). It has long fronds, which grow out from the wall, unlike *A. azomanes*, which tends to hug the wall. Each pinnule has a small acroscopic lobe with one or perhaps two sori on it.

Fig. 9. *A.* x *tubalense* is the hybrid of *A. trichomanes* subsp. *quadrivalens* with *A. azomanes.* Inset: The underside of the frond.

Photo. M. Rickard Inset. A. Evans

A third hybrid of *A. trichomanes* subsp. *quadrivalens* that we think we identified, *A. x helii* nssp. *lainzii* is more difficult to distinguish (Fig. 10). This is the hybrid with *A. petrarchae* subsp. *petrarchae*, and differs from the glabrous *A. x orellii* in having glandular multicellular hairs on the stipe and lower part of the rachis. This nothosubspecies was described in 1996 by Perez Carro and Fernandez Areces.

Fig. 10. A possible *A.* x *helii* nssp, *lainzii.* The hybrid between *A. trichomanes* subsp. *quadrivalens* and *A. petrarchae* subsp. *petrarchae*

Photo: A. Leonard.

We initially thought that we would be able to see all the Mallorcan ferns in two to three days. We were wrong! We realised when we looked at our pictures afterwards that some of the 'odd' *A. trichomanes* we had seen might have been subsp. *inexpectans*. This raises the possibility that we also overlooked *A. trichomanes* nssp. *lucanum*, the hybrid of the subspecies *quadrivalens* and *inexpectans.* We also became aware of the literature on the hybrids between the *A. trichomanes* complex and the two subspecies of *A. petrarchae*, i.e. the other nothosubspecies of *A. x helii*. A further hybrid to look out for is the diploid *A. x artanense* (Rossello 1990), thought to be the hybrid of *A. sagittatum* and *A. trichomanes* subsp. *inexpectans.*

Juan Bibiloni's website (http://jardin-mundani.es) has a great deal of information on these plants. Once on the site, choose the English option and then 'The hybrid ferns of the Soller valley'. There are more photos of Mallorcan ferns on Andrew Leonard's website (www.andrew-leonard.co.uk). I also recommend that you visit the 'gallery' on the website of Jose Luis Perez Calo (www.joseluisperezcalo.com) for some very clear and beautiful pictures of many ferns, including these aspleniums.

In November the ferns were only just recovering from a dry summer. Some of us are returning to Mallorca in April 2013 in the hope of seeing the ferns in better condition, when we will revise what we have already learnt, and hope to find further hybrid taxa. Then, with any luck, our update will appear in the *Pteridologist* 2014.

References:

Bennert, H.W., Rasbach, H. & Rasbach, K. (1987) *Asplenium x reichsteinii* (= *Asplenium fontanum x A. majoricum*: Aspleniaceae: Pteridophyta), a new endemic fern hybrid from Mallorca, Balearic Islands. *Fern Gazette* 13 (3): 133-141.

Curto, R., Royo, F., Lopez-Alvarado, J. & Saez, L. (2012) Three new *Asplenium* L. taxa (Aspleniaceae, Pteridophyta) for the flora of North-Eastern Iberian Peninsula. *Orsis* 26: 45-50.

Hunt, H.V., Ansell, S.W., Russell, S.J., Schneider, H., & Vogel, J.C. (2011) Dynamics of polyploidy formation and establishment in the allotetrapoloid rock fern *Asplenium majoricum*. *Annals of Botany* 108: 143-157.

Jermy, A.C. & Lovis, J.D. (1964) *Asplenium majoricum* Litardiere. *British Fern Gazette* 9 (5): 163-167.

Perez Carro, F.J. & Fernandez Areces, M.P. (1992) *Asplenium x protomajoricum* hybr. nov. (*A. fontanum* subsp. *fontanum* x *A. petrarchae* subsp. *bivalens)* y precisions corologicas sobre *A. majoricum* en el Levante espanol. *Anales Jardin Botanico de Madrid* 49: 187-194.

Perez Carro, F.J. & Fernandez Areces, M.P. (1996) Hybrids of the genus *Asplenium* L. (Aspleniaceae) in the Iberian Peninsula. *Anales Jardin Botanico de Madrid* 54: 106-125.

Rossello, J.A., Cubas, P., Gradaille, J.L., & Sastre, B. (1990) *Asplenium x artanense* (Aspleniaceae: Pteridophyta) A new diploid hybrid from Mallorca, Spain. *Fern Gazette* 13 (6) 349-355.

Sleep, A. (1967) A contribution to the cytotaxonomy of *Asplenium majoricum*. *British Fern Gazette* 9 (8): 321-329.

Acknowledgements:

Many thanks to Andrew Leonard for organising the trip, and for his photographs and diagram, also for making contact with Juan Bibiloni, to whom we are also most grateful for showing us several locations. Thanks also to Bruce Brown, Tim Pyner, and Martin Rickard for their observations, taxonomic skills, checking spores, and providing papers, and to Jose Luis Perez Calo for his helpful suggestions on the text and diagram.

A new hardy fern for the garden.

Adrian Dyer

499 Lanark Road West. Balerno, Edinburgh. EH14 7AL

e-mail: adrian@dyer.freeserve.co.uk

Several years ago I was given an unidentified fern. It is hardy, quite attractive in an understated sort of way, but not a British native species. After several attempts at identification, I have found a name for it and labelled it accordingly as *Ivenoidea wotitis* (Fig.1). This species is usually placed in the family Mysteriaceae, which includes the only surviving representatives of a group with an imperfect fossil record, the Hypotheticales. Strangely, professional pteridologists seem to be unaware of the existence of this fern (Christopher Fraser-Jenkins has even identified my plant as *Dryopteris uniformis*!) but amateur enthusiasts frequently report that they have ferns to which this name can be applied. However, these reports also reveal considerable morphological diversity among these ferns, which indicates that *Ivenoidea wotitis* is in need of taxonomic revision. In due course it may be split into several species, and perhaps even more than one genus. Accounts of other members of the Mysteriaceae should be sent to the editor.

Fig. 1. *Ivenoidea wotitis*, a member of the Mysteriaceae family that is often misidentified.

Pedigree* of a word

John Grue
Briarfield, Moss Lane, Broadbottom,
Hyde. Cheshire. SK14 6BD
e-mail:john.grue@virgin.net

(*Pedigree: early 15c., "genealogical table or chart," from Anglo-French pe de gru, a variant of Old French pied de gru "foot of a crane,")

One of the charms (and obstacles) of botany is the specialist vocabulary which each group of plants has accumulated. The obstacle particularly arises when you discover that the words you learned for flowering plants have little use for Bryophytes and even less for Algae. Most botanical language was specifically coined to make description and analysis of structure and function possible. If we think, for example, of reproduction in ferns, communication would be almost impossible without *gametophyte, sporophyte, sporangium, antherozoid, sorus, prothallus, archegonium, antheridium, spore, alternation of generations.* In most cases these words and phrases were coined deliberately by early botanists (Goethe was particularly prolific when he wasn't writing great literature) to describe structures which were new in description. Mostly they made use of their knowledge of Latin and Greek, but sometimes of the vernacular. In a few cases, most famously Hooke's use of the word "cell", a metaphorical use (the chambers in cork seemed to him to be like the cells in a monastery) became the source of a whole developed vocabulary. Interestingly the prefix cyto- did not appear until the 1870s

Considering the difficulty of learning and remembering, it is hard to explain why we have redundant vocabulary which exists in books despite being seldom, if ever, used. One of the expressions I enjoyed learning and rolling around my tongue was *circinate vernation.* This mellifluous expression from the Latin for spiral and for springtime is one I have never heard spoken since (except by me!). (It can sometimes be found in paleobotany) It means that ferns have an unrolling of a spiral as their method of growth of a new frond. I also met the word *crozier.* This word was a puzzle, as it is clearly cognate (part of the same family of words) with words such as crux, cross and crucial. Everyone likes the word crozier. People use it as a house name, as a computer password and even as the name of a sculpture on the Irwell in Lancashire. No doubt there are even one or two cats or dogs with this charming name!

Why don't we call the unfurling spiral of the frond a *circina*? Why do we call it a *crozier* when it has no

Fig. 1. A crozier of *Polystichum setiferum*, gently unrolling its spiral in the springtime. An example of circinate vernation?
Photo: A. Greening

Fig. 2. A pastoral staff.
© Trustees of the British Museum

resemblance to a cross? The word is even used in Mycology to name a curved structure, not a cross, in the sexual stage of some Ascomycota, presumably borrowed from its use in Pteridology.

The story begins in the mediaeval church. Bishops in procession would carry a pastoral staff (Fig. 2) (we would say a shepherd's crook), as a symbol of their pastoral (Latin *Pastor*: a shepherd) role. Ahead of them would walk a servant with a cross held high. This person was the *crociarius*, later, in early French, the *crocier* or the *croisier*. So the crozier was originally a person carrying a cross. In time, the word somehow became applied to the person carrying the bishop's pastoral staff. Its first use to describe the staff itself dates only from 1610,according to some sources, though others have it earlier or later. Something comparable appears to have happened in France, where the crozier (both botanical and episcopal) is "la crosse", and the cross carried before the bishop is "le croix". The origin of the name "Lacrosse" becomes clear!

By the 19th century the transfer of meaning from person to shepherd's crook was complete. Now it became possible for botanists to use the word crosier The first reference recorded by the Oxford English Dictionary is a simile to describe the unfurling shoot....

[1831 J. Davies *Man. Mat. Med. 425 Leaves alternate, rolled up* like *a crosier before their expansion.] .....*

Fig. 3. An ornate crozier head.
© V and A Museum.

Then later it appears in Charles Lyell's Elements of Geology as a name (probably it was still a metaphor).....
1874 C. Lyell *Elem. Geol.* xv. 230 *The Croziers of some of the young Ferns are very perfect.*

It would be fascinating to see examples of the transition between the use of crozier in Botanical English as a simile to its eventual use as a noun used without thought to its origins. I suspect the OED would also be interested!

I imagine many of you with an interest in the history of pteridology have more knowledge and examples of early uses. I would love to see them.

The story continues. The original shepherds crook was quite simple, even when used for ecclesiastical purposes. Later it became ornamented with religious symbols such as crosses, carvings of lambs, Alpha and Omega etc (Fig.3).

And now something really odd happened. The crook, which had (mistakenly) given the name of crozier to our unfurling fern, now began to borrow fern-like fronds from the world of Botany. Many Victorian croziers are decidedly vegetated! Was this deliberate? Was it merely the extension of the almost universal tendency to use plant forms in decoration?

I like to think that there was an unconscious and accidental transfer of associations from our pteridological crozier back to the crozier of the bishop. I can't really call this a hypothesis as it clearly un-testable: but it is something to think about next time you see bishops in procession. ❐

The Free Dictionary (on-line)
crosier
unfolding (uncurling) new leaf on bracken and most ferns; inspiration for the tip of ecclesiastical staffs.

On-line Etymology Dictionary
crozier (n.)
late 13c., from Old French crocier, from Medieval Latin crociarius "bearer of a cross," from crocia "cross;" also from Old French croisier "one who bears or has to do with a cross" (see cross (n.)). The two words merged in Middle English. Technically, "the bearer of a bishop's pastoral staff;" erroneously applied to the staff itself since 1733.

Oxford English Dictionary
a. **The curled top of a young fern.**

[1831 J. Davies *Man. Mat. Med.* 425 Leaves alternate, rolled up like a crosier before their expansion.]

1874 C. Lyell *Elem. Geol.* xv. 230 The Croziers of some of the young Ferns are very perfect.

a. **The pastoral staff or crook of a bishop or abbot. (= medieval Latin *crocea*, *crocia*.)**

1500 *Inv. Ch. Goods St. Dunstan's Canterb.* in *Archæol. Cant.* (1886) XVI. 315 A vestment for Saint Nicholas tyme with crosyar and myter.

1539 *Inv. St. Osyth's Priory* in *Trans. Essex Archæol. Soc.* 5.55 Item a Crosyer of sylver gylte.

1596 W. Lambarde *Perambulation of Kent* (rev. ed.) 247 A great dispute..not for the Crosse (for that is the Archbishops warre) but for the Crosier of the Bishop of Rochester.

1610 J. Guillim *Display of Heraldrie* iv. iii. 194 The..Shepheard, of whose Crooke this Croysier hath a resemblance.

1782 J. Priestley *Hist. Corrupt. Christianity* II. x. 251 The crosier, or pastoral staff, was the lituus of the Roman augurs.

1827 W. M. Praed *Poems* (1865) I. 243 A pious priest might the Abbot seem, He had swayed his crozier well.

1846 J. Stephen *Ess. Eccl. Biogr.* (1850) I. 53 To place the Sceptre on a level with the Crosier.

1862 J. Eadie *Eccl. Cycl.* (at cited word), The crosier bequeathed by William of Wykeham to New College, Oxford.

'Breeches-Pocketum'

Tim Brock
Delfryn, Pentre Rhew, Llanddewi Brefi, Tregaron, Ceredigion.
West Wales. SY25 6SB
e-mail: tim.brock108@gmail.com

I have been struggling to write this article for some time as I was waiting to see how some new ferns turned out that I had been raising from spores as they were taking some time to mature. There has been a mixed response from the people that have seen them so I was going to give this the title of "Beauty is in the Eyes of the Beholder" but later decided that it should be called 'Breeches-Pocketum' after Charles Druery.

This journey started with a remark in Druery's book *British Ferns and Their Varieties* with a description and anecdote about *Asplenium scolopendrium* 'perafero-sagittatum' (page 226).

> As a converse variation of this, there are numerous forms in which the taper tip is replaced by an abrubt termination of the frond, the midrib suddenly stopping short, and ending in a projecting thorn in the centre of a frilled pocket, or projecting from the chord of a semicircular end, with the spores arranged like the figures of a clock. The pocket may be in front or at the back, and in one instance, raised by ourselves, there are pockets in the rounded lobes at the junction of the stalk (S. v. peraffero sagittatum), which a jocular friend named "breeches-pocketum"

Unfortunately there does not appear to be any drawings or photographs of *Asplenium scolopendrium* 'breeches-pocketum' or 'perafero-sagittatum' in any of the books of Druery, Moore or Lowe but I guessed it would be a sagittate form so I set out to create it by crossing 'Sagittato-cristatum' with 'Peraferens'. (Figs. 1 and 2)

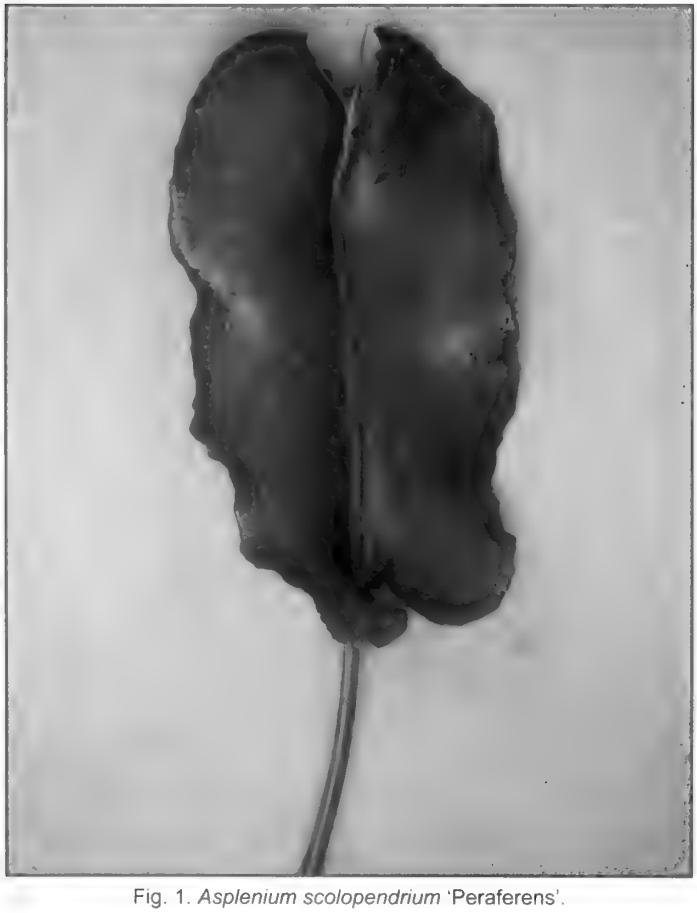


Fig. 1. *Asplenium scolopendrium* 'Peraferens'.
One of the parents of the cultivar.

Fig. 2. *Asplenium scolopendrium* 'Sagittato-cristatum'.
The other parent of the cultivar.

This was done in the usual way of mixing quantities of spores from fronds of each cultivar into sterile John Innes seed compost and then waiting to see what the combinations would be. With me this can take several years as it can be a slow process as I do not have access to any artificial heat to speed things up.

The results have been very promising as can be seen by the images taken with a scanner but the plants are only a few years old and may develop more as they mature.

As 'Sagittato-cristatum' was used as a parent rather than just 'Sagittatum' a feature has been that some plants have several pockets at the top of the frond. There are several variations between the plants and some have larger pockets at the back of the fronds so I have been holding onto them all and observing them closely to see how they will eventually turn out.

One plant has fronds that are shorter and consistently lie horizontally as though hovering like butterflies and each one is complete with its own antennae.

As a project I think it has been a success as I think the plants fit the description in Druery's book. I would recommend mixing spores to anyone wishing to recreate cultivars from the past and E.J.Lowe was a great advocate of this in his book *Fern Growing* (Fifty years' experience in crossing and cultivation) with photographic examples of ferns that he created. I would like to see *Asplenium scolopendrium* 'Crispum Muricatum' recreated again by crossing the spores of a fertile 'Crispum' with 'Muricatum'

or maybe someone out there still has some plants of this old cultivar? I hope this article inspires others to have a go.

References:

Druery. C. T. (1910). *British Ferns and their Varieties* George Routledge and Sons, Ltd

Lowe E. J. (1898) *Fern Growing*. John C. Nimmo, London.

Moore. T. (1859). *The Nature-Printed British Ferns* (Two Vols) Bradbury and Evans

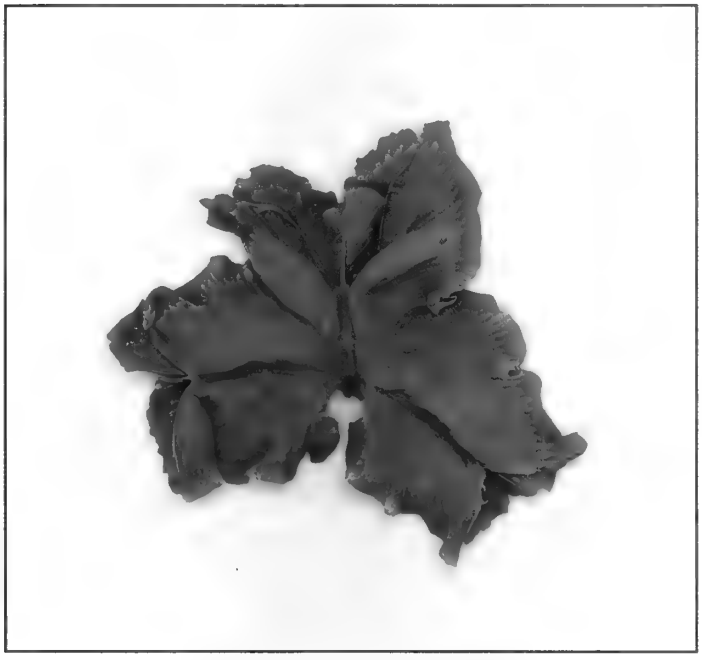


Fig. 3. *A. scolopendrium* Perafero-sagittatum Group.
Three equally sized pockets at the end of the frond

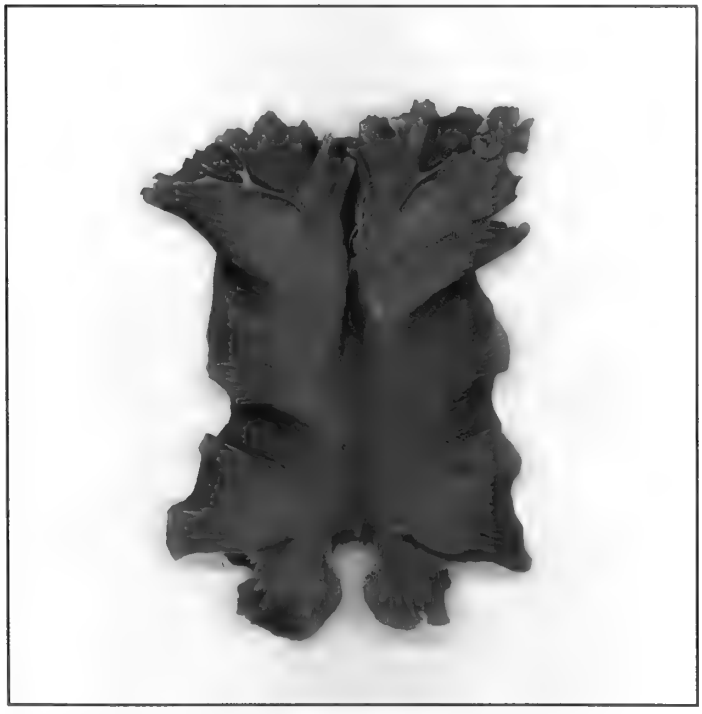


Fig. 4. *A. scolopendrium* Perafero-sagittatum Group.
Two pockets at the end and two smaller ones at the base of the frond.

Fig. 5. *A. scolopendrium* Perafero-sagittatum Group.
Two pockets at the end and two more pockets at the base of the frond.

Fig. 6. *A. scolopendrium* Perafero-sagittatum Group.
Several pockets at the end and two smaller ones at the base of the frond.

FERN HUNTING IN MALAYSIA

Valdy Pierozynski
25 Mayflower Way, Farnham Common,
Bucks SL2 3TU
e-mail: valdypiero@yahoo.co.uk

Recently I had the opportunity to travel to Malaysia on business. Being the fern fanatic that I am, I added a few days holiday to the trip specifically to look at ferns, especially the epiphytes which are so abundant in this part of the world. I had been to Malaysia about 20 years before so I knew the fern flora was pretty amazing. I was lucky enough to stay in a down-town hotel in the capital Kuala Lumpur (KL) and this enabled me to walk around and admire the amazing rain trees which grow all over this very verdant city. KL is one of the few cities I know where temperature and humidity are just right throughout the year for every tree of significant size and age to be covered in epiphytic ferns (Singapore is another such city but Bangkok, for example, is not). The trees most often producing these "aerial gardens" are the locally named "rain trees (*Albizia saman*), originally from South America. These trees have a very scaly bark which traps dust and moisture and allows germinating spores to survive the early stages of their development. The folding of their leaves at around 5pm (they are also known as "5 o'clock trees"!), as well as before a storm, allows dew and rain to reach the inner areas of the crown, the surface of the branches and the main trunk, where the ferns are growing.

One of the most common epiphytes on rain trees is *Drynaria quercifolia* which is easily recognised by its two types of fronds. First there are upright, stiff, sterile nest fronds which hug the bark of the host tree and soon turn from green to brown and die, but function as collectors of debris for the fern to root into. Secondly, there are the spore-bearing fronds which usually hang down from the tree branches and may be a metre long. I am always amazed to see trees festooned in this fern right next to huge office blocks and shopping malls in the centre of town (Fig. 1). Other common associated epiphytic ferns are the true *Microsorum scolopendria* (the *M. scolopendria* grown as an ornamental in Florida and California, and sometimes available in the UK in garden centres as a house plant is, actually *M. grossum), Microsorum punctatum, Davallia denticulata, Drymoglossum piloselloides, Pyrrosia laceolata* and *Pyrrossia longifolia* and *Vittaria elongata*. Some of these ferns not only grow on rain trees but also on young narrow- trunked trees (Fig. 2) and palms such as those in the Kuala Lumpur City Centre (KLCC) Park next to the Petronas Towers (Fig. 3).

After a day or so in KL, I decided to venture out further afield and visit one of the hill stations, Frasers Hill or *Bukit fraser* in

Fig.1. Rain-tree in downtown KL with *Drynaria quercifolia, Davallia denticulata* and *Pyrrosia lanceolata*.

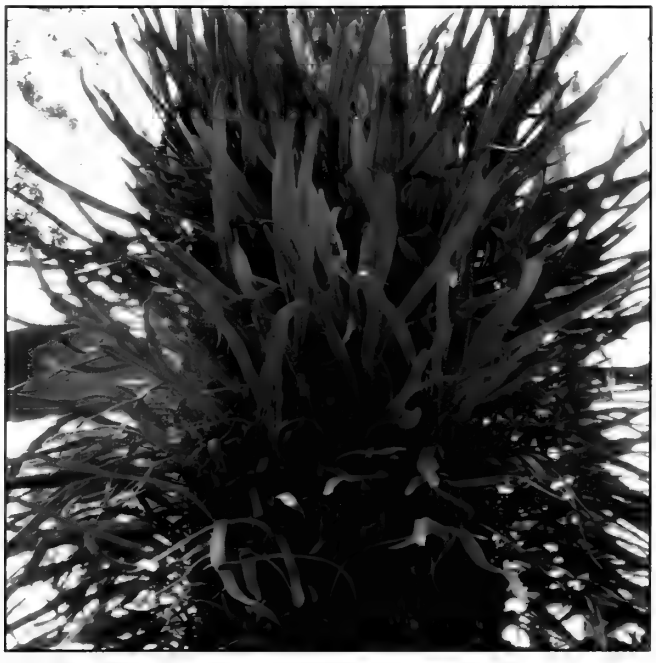


Fig. 2. *Pyrrosia longifolia* on young tree in KLCC Park

Fig. 3. Epiphytic ferns (*Pyrrosia longifolia, Davallia denticulata, Vittaria ensiformis*) and orchids on palm in KLCC Park

Fig. 4. *Drynaria quercifolia* smothering rain tree branches (fronds up to 1.5m long).

Malay, at about 1500m altitude. Although the hill station is about 2 hours drive from KL, it took me about 5 hours (!) because there are just too many places to stop and admire/photograph so many amazing plants. It was just as well that I left KL early because the hill station is reached by a very windy one-way-only road, with ascents during odd hours and descents during even hours.

On the way there, one could see many trees with the ubiquitous *Drynaria quercifolia* completely covering some trees (Fig. 4) and also abundant Bird's Nest ferns, *Asplenium nidus*, living up to their names (Fig. 5). These ferns are very efficient leaf litter collectors with the fronds forming a nest-like basket. As new fronds grow from the centre of the nest, leaf litter is held firmly between the frond bases. Roots grow through the decaying organic mass to further hold it in place and the entire mass forms a sort of sponge, soaking up rain water. Old fronds hang down below the nest showing varying degrees of disintegration Occasionally, when the nest becomes very large and heavy, it may become dislodged from the tree. The spongy mass can also support other ferns and epiphytes, and can be a home for snakes and scorpions.

Fig. 5. *Asplenium nidus*, the Birds Nest fern

Fig. 6. *Phymatodes nigrescens* with raised sori "buttons" on surface of the frond

Fig. 7. *Davallia denticulata* growing on an old oil-palm

Fig. 8. *Vittaria ensiformis* with juvenile red fronds on an old oil-palm

Another occasional epiphyte on some trees was the handsome *Phymatodes nigrescens* with its 2 foot long blue-green fronds (Fig. 6). The sori are deeply sunk into the lamina of the frond in a row on each side of the main veins of the lobes and form raised "buttons" on the upper surface, a very distinctive feature.

The road led past may old oil-palm plantations with many epiphytic ferns growing in the persistent leaf bases or "boots" of the old palms; these included *Davallia denticulata* (Fig. 7), *Gonophlebium subauriculatum, Pyrrosia* species and *Vittaria ensiformis* with juvenile bright red fronds (Fig. 8). Another larger *Vittaria* species, *V. elongata*, with wider but green juvenile fronds, was also present.

As the road began to climb, ferns such as *Blechnum orientale* (Fig. 9) became more abundant by the roadside and in clearings in the forest. This fern is locally known as *paku lipan* or the Centipede Fern for obvious reasons! These Blechnums were very distinctive against the general green background on account of their red juvenile fronds (a common characteristic of Blechnums world-wide and especially when growing in a sunny aspect). At about 1000m *Drynaria rigidula* became abundant (Fig. 10). This species does not like lowland heat (unlike *D. quercifolia*) but still has dimorphic fronds; its sterile fronds are smaller and more delicate looking than those of its lowland cousin. Where the montane forest met the road and the light was stronger, overhanging tree branches were often covered in both *D. rigidula* and *D. sparsisora*, the latter similar looking to *D. quercifolia* but smaller overall and with upright, as opposed to pendent, fertile fronds (Fig. 11). In the more shady parts of the forest *Angiopteris evecta* was common with huge fronds several metres long (Fig.12). Tree ferns were now also more abundant, with the most handsome probably being *Cyathea contaminans* (Fig.13).

At last I began the 500m ascent to Frasers Hill itself. All along the ascent the forest banks are covered in *Dipteris conjugata* (Fig. 14). This fern spreads by means of stout, hairy long-creeping rhizomes to form pure stands. Along the way were many terrestial ferns including *Dicranopteris linearis*, another scrambling fern, and the tropics answer to bracken.

Fraser's Hill is named after Louis James Fraser, a Scotsman, who prospected for gold in Australia but eventually struck it rich with tin, up here in the 1890s. Employing Chinese miners to do the hard work for him and earning his keep by operating mule trains down the mountain, Fraser also set up opium and gambling dens to increase his profits, which may have had something to do with his subsequent

Fig. 9 The Centipede Fern, *Blechnum orientale*

Fig 10. Lush growth of *Drynaria rigidula*

Fig. 11. *Drynaria sparsisora* (on the left), *Drynaria rigidula* (on the right)

Fig. 13. *Cyathea contaminans* near Frasers Hill

Fig. 12 *Angiopteris evecta* in deep shade

Fig. 14. *Dipteris conjugata* at Frasers Hill

mysterious disappearance! The tin ran out in 1913, but the lush valley within was rediscovered as a colonial hill resort which, thanks to its elevation, is considerably cooler than the lowlands, and typically about 18 - 25 deg C. year round. In 1922 a road had been cut through the mountains to the valley, which soon sprouted bungalows and even one of Malaya's first golf courses. Fraser's Hill retains a wonderfully weird mixed-up character, where locals eat curries off banana leaves in tudor-style English cottages next to a golf course while the call to prayer sounds from the mosque. However, there is pristine montane rain forest here, with abundant walking trails, making fern spotting a joy (but being careful to avoid leeches, especially after rain).

One of the commonest and largest epiphytic ferns, found mainly on trees (but at Frazer's Hill also on stone walls) is *Aglaomorpha heraclea* (Fig.15). This is a fern related to *Drynaria* but it lacks dimorphic fronds. Instead the base of each stiff frond widens out so that a basket is formed to trap leaf litter and debris (in the same way the sterile nest fronds do in *Drynaria*). *Aglaomorpha heraclea* may have fronds more than 2 metres long and can get so large that it may crash to the ground and continue growing there. It also has a very stout rhizome covered in rust-coloured scales which encircles the trunk of a host tree so that the fronds appear to be arranged as in a crown. Most *Aglaomorpha* species do this; *A. coronans*, a species found further north, is named after this habit. *Aglaomorphas* have sori which are produced in two fairly regular rows between the main cross veins of the lamina; this is an important characteristic to distinguish this fern from a related and similar looking large epiphyte, *Merinthosorus drynarioides*.

Several smaller epiphytic ferns found on the trees and earth banks at this location were quite common. These included *Crypsinus trilobus*, with its very distinctive thick and shiny three to five lobed sterile fronds (Fig. 16) and much more narrowly lobed fertile fronds. Another species was *Belvisia revoluta* (Fig. 17), the so-called "rat's tail fern", on account of the long tail-like fertile portion of the frond. In Malaysia there is another larger species, *Belvisia mucronata*, but I did not see this fern.

Tree ferns are also ubiquitous at this elevation. Frasers Hill is frequently draped in cloud and *Cyathea contaminans* looks particularly handsome when silhouetted against the gloom (Fig. 18). With the frequent cloud, humidity is very high and epiphytes

Fig. 15. *Aglaomorpha heraclea* encircling a tree trunk

Fig. 16. *Crypsinus trilobus* at Frasers Hill

Fig. 18. *Cyathea contaminans* against the mist at Frasers Hill

Fig. 17. *Belvisia revoluta*, the Rat's Tail Fern

were growing on stone walls and even on suspended cables. At this location was a particularly foliose species of *Angiopteris* (Fig. 19). It was once thought that the genus *Angiopteris* consisted of only one species (*A. evecta*), but current thinking is that it may contain 10 or even as many as 100 species! Much additional taxonomic research clearly needs to be done! Certainly this fern did not look like the *Angiopteris* seen previously (Fig. 12).

Other ferns seen were *Photinopteris speciosa* (now *Aglaomorpha speciosa*, but which does not look like the typical *Aglaomorpha* on account of its one-pinnate fronds), *Microsorum sarawakense*, *Microsorum musifolium* (now sometimes available in UK garden centres under the name "Crocodile Fern" on account of the pattern of the veins which looks like crocodile skin)and *Pyrrosia floccigera*.

After several hours wandering the jungle trails I decided it was time to get something to eat and then head back to KL (this time it did take about 2 hours!). Next day I decided to visit the Genting Highlands which are closer to KL than Frasers Hill but at a higher altitude (1800m or about 6000 feet above sea level). I had been to Genting Highlands 20 years before and at that time there was already a casino (the only legal land-based casino in Malaysia) and big hotels there. The reason I had gone there was that the summit of Genting was clothed in cloud and elfin forest with many different epiphytes and also many Nepenthes species or pitcher plants. At that time, building development had already started to encroach on the delicate ecosystem on the summit and now, 20 years later, there is little of it left. Now the place is a huge holiday resort and theme park called *Resorts World Genting*, with five huge hotels (one of which was the largest hotel in the world between 2008 and 2010 with 6118 rooms!) and which is a bit like Disneyworld... but in virtually perpetual mist! I guess visitors must welcome the coolness and escape from the searing sun of the lowlands, and many Malays come here for family holidays, but to me from Europe, where we generally take holidays in warmer and sunnier climes, it seemed a little strange to have your holiday in the mists!

Previously there had been a very windy, slow and narrow road to the summit but now there was a dual carriageway for much of the way followed by a fast road to the resort with lots of speeding traffic. I guess that's progress! There is also a 2 mile long cable-car ride to the resort.

There are some small roads which leave the resort and climb to the very summit where there is a telecommunications station (fenced off and guarded!). Along these roads it is possible to stop and wander around the cloud forest (and elfin forest on the ridges) and admire the moss covered boughs and branches of trees and the many types of pitcher plants growing on the ground. The whole atmosphere is quite eerie on account of the general silence and continual swirling mist from the clouds and broken only occasionally by some strange sounds presumably made by unknown insects. The moss covered trees have a wealth of small epiphytes, mainly ferns and delicate orchids. Filmy ferns were present, mainly *Hymenophyllum* species and several *Crypsinus* species like *C. platyphyllus, C. subfasciatus* and *C. enervis* (Fig. 20). The latter was easily distinguished by the black colour of the lamina on each side of the midrib. Other epiphytic ferns included *Phymatosorus laciniata* and *Ctenopteris* species. Terrestial ferns tended to be small and delicate and included *Gleichenia microphylla* (Fig. 21) and *Sphenomeris chinensis* In shade the latter has finely dissected green fronds, but in exposed places,

Fig. 19. Foliose species *of Angiopteris*

Fig. 20.*Crypsinus enervis* on moss-covered branch in cloud forest at Genting Highlands

Fig. 21. *Gleichenia microphylla* on bank at Genting Highlands

like Genting, with increased solar radiation, fronds are a delicate pale-pink (Fig. 22).

On the way back down to KL, I stopped off at a spot where there were many Cyatheas growing in groups and on a rocky bank found a huge plant of *Merinthosorus drynarioides* (Fig. 23) with 2m long fronds. This fern is superficially similar to *Aglaomorpha heraclea* with its very stout scaly rhizome and sterile fronds, but the fertile fronds have very reduced spore-bearing pinnae which are very distinctive. These spore-bearing pinnae fall off quickly after the spores have been shed, leaving the bare midribs sticking out, as on this plant.

Fig. 23. *Merinthosorus drynarioides* with 2m long fronds

Fig. 22. *Sphenomeris chinensis* on bank at Genting Highlands

From my brief visit I hope I have given the reader a flavour of some of the wonderful ferns to be seen in this part of the world. If you get a chance to go to Malaysia then I would thoroughly recommend it. In my experience it is a very friendly country and there is so much to see. There are fantastic beaches and mountains, and still many vast areas of protected primary rain forest. The flora is quintessentially tropical and the ferns are to die for! Even if you just visit KL, there are so many ferns to see in just an hour's walk around the city. ❐

JUST GOOD FRONDS.

These croziers* look, for all the world, as though they are enjoying an intimate moment. Spring must be in the air!

However, spring has been very late this year and any sign that new years growth is on its way is extremely welcome.

The fern was bought as *Cyathea tomentosissima* from that wonderful company Fernatix. The owners, Kerry and Steven, have won many gold medals for their exhibits and their enthusiasm for ferns is obvious when you meet them.

A research paper, published last year by Barbara Hoshizaki and Daniel Yansura in the American Fern Journal, has shown that this fern is a cultivar of *Cyathea cooperii,* using DNA sequence analysis. This distinctive tree fern appeared in a wholesale nursery in the 1980's. and quickly spread amongst collectors and growers. An attempt to identify the species came up with the closest match as *C. tomentosissima,* a tree fern that grows in New Guinea. Does anybody know what it is called now?

Whatever the name, I am sure the distinctive form will always remain popular. It's common names include 'Dwarf Woolly Tree Fern', 'Soft New Guinea Tree Fern' and 'Highland Lace'. It has abundant scales on the stipe, rachis and even on the pinnule midribs which makes it old name Tomentose (hairy) and -issima (very) seem very appropriate. AEG

* For an explanation of where the word 'crozier' originates please see pages 447-448.

Book review

Rock Landscapes; The Pulham Legacy; Rock Gardens, Grottoes, ferneries, Follies, Fountains, and Garden Ornaments.

By Claude Hitching, featured photography by Jenny Lilly. 30.2 X 24.0 cm. Garden Art Press. 2012. ISBN 978-1-87067-376-1. £35.

For nearly thirty years I have been fascinated by the magnificent garden structures and ornaments made by James Pulham and Sons. For me it started when a friend gave me a photocopy of *Picturesque ferneries and rock-garden scenery* by James Pulham (c.1877). It is a photocopy of the Royal Horticultural Society`s copy. As far as I can see no other copy is known. The great feature of this nineteenth century publication is the list of gardens where Pulham had worked up to 1877, and where he had used the artificial rock, he called Pulhamite. Using the list I had great fun touring around sometimes discovering Pulham masterpieces, sadly often overgrown and neglected.

Claude Hitching`s new account goes a long way to updating Pulham`s own list, but then far exceeds it by giving a highly detailed account of virtually all aspects of Pulham`s business. Appropriately, Claude Hitching was driven by the memory of his own grandfather who had worked as a 'Rock builder' for James Pulham and Sons between the late 1880s until the early 1930s.

Four generations of Pulhams (all christened James) ran the business. It started circa 1835 when Benington Lordship was created in Hertfordshire and petered out in 1939 as World War II started. The last of the four James Pulhams died in 1957, but not before he had served as Secretary to the British Pteridological Society from 1948 to 1950. See the *British Fern Gazette*, 1958, pp. 203-204.

The book traces the development of the Pulham business. Initially mostly building works where gothic style was needed but fairly quickly moving on to grottoes, urns, ferneries and any other sort of stone garden ornament the client required. He worked at many of the great gardens of the Victorian era, but work was not confined to gardens – in 1867-68 Pulham decorated the ground floor windows of the Victoria and Albert Museum in Exhibition Road, London – opposite the Natural History Museum where we hold so many British Pteridological Society meetings to this day.

The feature of Pulham`s work which really makes him stand out from other manufacturers of Terra Cotta garden ornaments was his skill at creating artificial rock. When creating a grotto or a cliff it looked like a grotto or a cliff –

Fig. 2. Madresfield Court, recently re-planted with ferns by Fibrex.

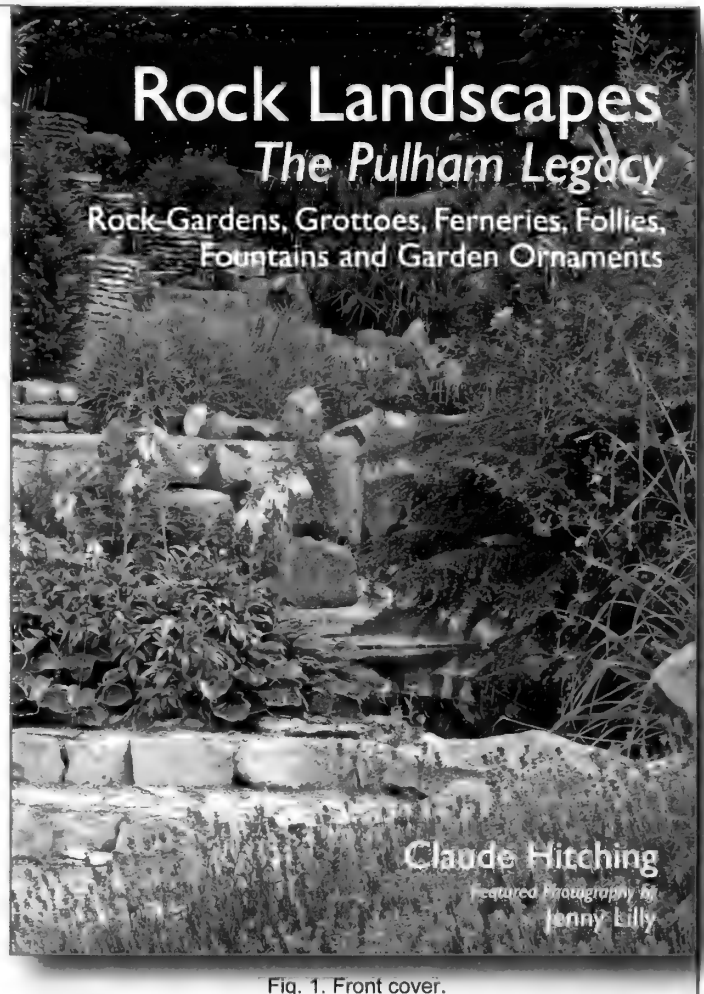


Fig. 1. Front cover.
(Danesfield House, Medmenham. Buckinghamshire.)

not like an artificial construction. He even put fault lines through many structures and you could follow the strata within a single outcrop or continuing on to an adjacent outcrop. Claude Hitching gives many examples of this skill. Just how the rock was manufactured is still obscure. Hitching quotes Pulham literature sometimes insisting no cement was used in creating the stone and sometimes talking about Pulhamite 'cement'.

Given the size of the subject and the amount of information researched by Hitching it is not surprising that this book is a weighty tome. Nevertheless it could have been many times bigger if Hitching had not chosen to simply highlight a selection of the Pulhams`s works. Highlighted properties include:

Highnam Court, Gloucester. 1847-1862. One of their first gardens, still in excellent condition. It included a lengthy stream with naturalistic rockwork, grottoes and rock outcrops – all ideal for fern growing. Pulham also designed and ornamented a splendid terrace.

Battersea Park,1865-1870. No fernery but the waterfall still exists. It was claimed by some the high rockwork was built to screen Clapham Junction railway station!

Madresfield Court, 1876-79. One of the most remarkable Pulham sites. Artificial rockwork is built up to a good height with tunnels, pools, overhangs etc. Quite remarkable. This has recently been very successfully re-planted with ferns by Fibrex Nurseries. (See Fig. 2)

Book review: The Pulham Legacy

Waddesdon Manor, 1881-92. In two areas. Around the house many rock outcrops and an aviary, but at the foot of the hill there is a magnificent water garden with a remarkable cliff – ideal for ferns.

Dewstow House, Monmouthshire, 1895-1912. Today this is probably the best known Pulham garden. It features several large grottoes, underground tunnels, lakes and ornaments. The grottoes and much else has recently been replanted by Fibrex Nurseries but *Cyrtomiun caryotideum,* presumably one of the original plantings, persists from 100 years ago.

Buckingham Palace,1903-04. A rocky lake with an island reached by two bridges built by Pulham. Elsewhere there is a high earth embankment at the Victoria station side of the garden, presumably to provide some privacy. This is very successfully naturalised by frequent Pulhamite outcrops. No fernery here but in the shade of the rocks fern flourish.

Bracken Hill, Bristol, 1917-1930. The one time home of members of the Wills tobacco family. Fantastic rockworks here feature tunnels, pools and a purpose built outside fernery. Much natural limestone rock was used here in association with 'Pulhamite'. For many years this was the home of the Bristol Botanic Gardens, but sadly they have moved on.

In total almost 400 sites, mainly gardens, where Pulham worked are listed but clearly only only relatively few are dealt with in detail here. Hitching reckons there will be still more, as yet undiscovered. One mentioned, but not covered in detail is the fernery in Leominster, Herefordshire which I illustrated in the *Pteridologist* 2, 3 opp. p. 132 (1992). Of great pteridological significance because it was built for the brother of Edward Newman – one of the pioneers of the Victorian Fern Craze.

In my various visits to Pulham gardens over the years I had heard of Claude Hitchings and his project to give a full account of the Pulham family and their creations. Now it has been published I must say the wait has been worthwhile. This is a magnificent book sure to appeal to a wide group of gardeners and historians – and especially pteridologists!

Martin Rickard

A Bali Fishing Fern.

Agung Sedayu

Jurusan Biologi. Universitas Negeri Jakarta,Jl. Pemuda 10 Rawamangun Jakarta 13220. Indonesia

e-mail: goeng93@yahoo.com

In Bali, every aspect of life has always been connected to traditions. Some of these traditions are just fascinating. On admiring the magnificence of Lake Beratan, Bedugul, just a few hundred meters from the renowned botanical garden, a walk away from the more touristic part of the lake brought me into acquaintance with several local boys fishing. They described that they were going lazy fishing that evening, concentrating on herbivorous targets. Fishing for herbivorous fish freed them from digging worms. Instead, they prepared two kinds of baits. One was fried tofu, put aside from their afternoon snacks, and the other being a handful of young fronds of edible fern (*Diplazium esculentum*, Fig. 1), collected just few meters away from their fishing spot. The two baits were aimed at different kinds of targets. The tofu for "ikan weder" and the latter for "ikan tawes". "They won't bite vice-versa" the boy described.

Fig. 1. *Diplazium esculentum the edible fern known as "pakis" in Bali.*

The environs of Lake Beratan is inhabited by many species of fern, including tree-fern ("paku", *Cyathea contaminans*), however, only "pakis" (edible fern) was collected as bait. This fern is common around frequently inundated and drier areas of the shores of Lake Beratan.

Tofu was of course beyond my interest, but edible fern was something else. A small pinch of young pinnae, about 2 cm long, was rolled and mounted on a small sized hook (Fig. 2) with no sinker. "Tawes" (in formal Indonesian, the name is applicable to *Barbonymus gonionotus*, however, at Lake Beratan the name pointed to *Osteochilus hasseltii*, or "nilem" in formal Indonesian, Fig. 3) is herbivorous and is often concentrated by the more weeded lake bank. This fish seemed so crazy about edible fern that those boys didn't have to wait for ages to get a strike. Every dunk would soon be followed by a pull. I cannot agree more with the boys that it was indeed lazy fishing.

"Can you use cassava leaves or taro leaf stalks, as normally fed to pond tawes?" I asked out of curiosity. "Nope! Fern, just fern. It's fish tradition".

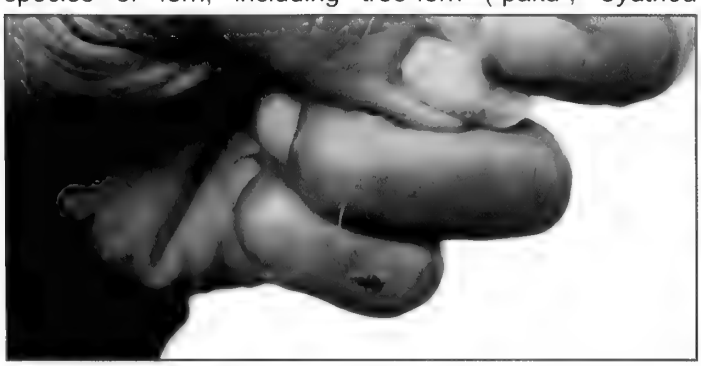


Fig. 2. Baiting the hook with pinnae of *Diplazium esculentum.*

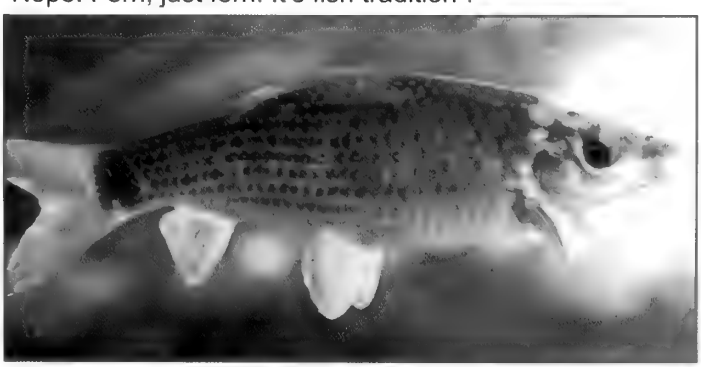


Fig. 3. *Osteochilus hasseltii* or Hard Lipped Barb.

Professor Eric Richard Holttum 1895-1990

Pat Acock
13 Star Lane, St Mary Cray, Kent. BR5 3LJ
e-mail: pat.acock@btinternet.com

On discussion with the Editor of The Pteridologist, Alec Greening, I suggested a series of one page articles on preeminent Pteridologists of the 20th Century sending him a list of those I propose with people I think would write them.

I first came to know of the "Professor", as Professor Holttum was known in the society, during our annual visits to Kew Gardens. Here Professor Holttum would come into the world famous Fern Houses at Kew that contained major collections of ferns lovingly cared for from expeditions back into the 19th Century by Bert Bruty and later John Woodhams. Here the Professor hampered by deafness would take written questions and expound on them from his vast treasure trove of experience and knowledge holding forth on a wealth of fern knowledge but especially on the Old World Tropics and more especially on Old World, *Thelypteris*, *Cyathea*, *Gleichenia*, *Tectaria* and *Schizea*.

The Professor was born in Linton in Cambridgeshire in 1895. At Cambridge University he came under the Professor of Botany, A C Seward who in Holttum's own words was primarily interested in fossil plants. He graduated with first class honours in Botany and also won the botany prize. Seward took him on as his assistant and in 1921 Tom Harris and Eric Holttum went with Prof. Seward to Greenland to study the Jurassic flora where Tom Harris developed a lifelong interest in fossil plants and Eric Holttum decided to move on to warmer climes by taking a post as Assistant Director of the Singapore Botanic Gardens. Here he was asked by the Director, Isaac Burkill, to study the Malayan ferns starting with putting the herbarium in order. Here he quickly realised that the system worked out by Diels and supported by F O Bower was seriously flawed. This led him to Carl Christensen, a Danish pteridologist, who had started listing the ferns in *Index Filicum* and the Professor considered the characters that Christensen was using were far more significant than the older systems. A lifetime exchange of ideas ensued.

During the Japanese occupation the Professor interred himself with the soldiers but because of his reputation he was sought out by the Japanese authorities and instructed to continue with his work, which by now had diversified and included the hybridisation of orchids and how to propagate them commercially.

He retired to Britain in 1955 and bought a house near Kew so he could continue his work on ferns.

I can remember the Professor and Clive Jermy at the 1972 symposium at the Linnaen Society Rooms rushing around to meet up with as many of the young researchers as possible to find out as much as they could about their methods and progress. I remember being approached by both and having to admit I was a mere mortal.

The Professor became a Quaker in 1920 and he regularly wrote in their journals and a synopsis of his beliefs is captured in a reprint from their journal called *A Personal Christology*. His thoughts are very interesting and although many might not form the basis of main stream Christian thinking they would certainly stimulate some interesting debate amongst our fundamental brethren.

Fig. 1. Professor R E Holttum on the occasion of his 95th birthday.

I read with sadness the professor's last letter to Clive Jermy made more poignant by remembering a young American researcher saying the professor might sort out all of *Thelypteris* within the next five years oblivious of the fact that the Professor was already 95. In the letter the Professor wrote to Clive to say he had just submitted his work on *Tectaria* to the Flora Malaysiana committee and felt that he might not be able to carry on with his work. He died a short time later.

The last time I saw the Professor, I was asked to see him onto a bus outside Rachel McMillan College, New Cross. The Professor had come right across London by bus from his home in Kew to attend a S. East Regional meeting that Paul Ripley had arranged with Barry Thomas. The Professor was delighted to see the antheridia swimming in the *Equisetum* prothalli gels that Nat Quansah had prepared for us and was an inspiration to all with his insight and lucid broad knowledge of the ferns despite being in his nineties. ❐

For further reading I would recommend:-

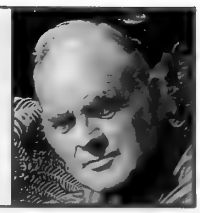
The Professor's introduction to the 1972 Symposium Papers *The Phylogeny and Classification of the Pteridophytes* (Jermy et al. 1973)

A Personal Christology (1975) Friends' Quarterly 19: 87-97

Holttum Memorial Volume (Ed. R J Johns 1997)

What is the natural life-span of a fern?

Adrian Dyer
499 Lanark Road West, Balerno, Edinburgh. EH14 7AL
e-mail: afdyer499@googlemail.com



The question

How long can a fern live, in the absence of premature death due to external agents? This question was prompted when I was celebrating the 50th birthday of a fern in my garden (see text box and Fig.1) The question is simple but there are complications in arriving at an answer.

The complications

The first complication is that, unlike flowering plants and conifers, ferns have two independent generations in the life cycle, each of which has a characteristic life span. Thus although many readers will assume the question in the title refers to an individual sporophyte, it could also be directed at the gametophyte. The growth of fern gametophytes in most species has inherent limits and in those species with more or less heart-shaped prothalli, they rarely live for more than a year if they produce a sporeling, only two or three years at most if unfertilised. There are however notable exceptions even within the small British flora. The gametophyte of *Anogramma leptophylla* is said to be perennial, though I am unaware of any recent detailed research on the life cycle of this species. The one-cell-thick ribbon-like gametophytes of the two *Hymenophyllum* spp. are perennial, growing indefinitely and branching to form dense mats (Rumsey and Sheffield, 1990), though how long they can live is not known. The gametophytes of *Trichomanes speciosum* occur in suitable habitats throughout much of Britain, usually in sites where the sporophyte is absent. Individual spore-derived gametophytes form clumps of branching filaments which are perennial, but they also reproduce

A case history: a 50yr old plant of *Dryopteris affinis* agg.

It is probably indelicate to reveal the age of a Lady Fern, but Male Ferns are less sensitive to such disclosures. The Scaly Male Fern plant shown in the photographs (Figs 1,2,3) reached its 50th birthday in the autumn of 2012 (if we take 'birth' of a fern to mean spore germination rather than embryo emergence). I raised it, initially on mineral agar in the laboratory, from a spore sown in September, 1962, shortly after harvesting it from a wild plant. It belongs to *Dryopteris affinis*, now usually treated as an aggregate subdivided into at least 3 species in Britain, and has the diagnostic dark patch at the base of the pinnae. Cytological examination has revealed that it is triploid (3x = 123) and apomictic (diplosporous, forming spores with the same, unreduced, chromosome number as the parent sporophyte, and apogamous, with a sporophyte developing directly from a bud on the prothallus without fertilisation of an egg). In most sporangia, the chromosome number is doubled in the last cell division before meiosis, allowing regular chromosome pairing and separation at meiosis; the result is 32 (instead of the usual 64) 'good' spores each with the same chromosome complement as the gametophyte and the parent sporophyte. In the other sporangia, almost all spores are abortive. At least 80% of the spores are capable of germination in laboratory cultures; the progeny form a clone of genetically identical individuals. On the basis of frond morphology (Fig. 3), it has been identified by Chris Fraser-Jenkins as *D. borreri*, to use the latest nomenclature, and close to Anthony Pigott's morphotype 'insolens'. The parent plant occurred in streamside woodland, now mostly given over to houses and gardens, bordering the Bavelaw Burn on the outskirts of Balerno village, close to Edinburgh (approximate map reference: NT168 658; latitude 55° 52' 40" N, longitude 3° 19' 54 W) at an altitude of about 200m.

Fig. 2. A crown of the plant shown in Fig.1

Fig. 1. 50yr old plant of *D.affinis* agg.
See comment on *"affinis/borreri"*.

When large enough, the sporeling was moved from agar to compost in a pot and the young fern was grown in successively larger pots until 1965 when it was planted out in soil in the newly established experimental beds of the Department of Botany, University of Edinburgh. Here the plant was in an open site in stony mineral soil unlike the habitat of the parent but it appeared healthy and enlarged steadily. It has never been split but it was moved in about 1990 to my garden, little more than 1km distant from the site of its parent plant. It is possible that this disturbance checked its growth for a while but for more than 20 years it has been in conditions of moist woodland soil partly shaded by trees, a habitat similar to that occupied by the parent plant. Over that period it has continued to steadily increase in size. Although it did not establish naturally in an undisturbed wild habitat, the size achieved in 50 years must give some indication of the growth potential of this clone.

Rhizome branching has been slow and at the end of its 50th year, this fern has only 9 distinct crowns (including one dead one). Eight of the rhizome branches are more or less upright, forming a solid clump with crowns up to 50cm above soil level. Each live crown produced up to 20 fronds this year and the plant formed 138 fronds in total. The majority of fronds were fertile and the total spore output for the year was estimated to be 5-10 billion (5-10 x 10^9).

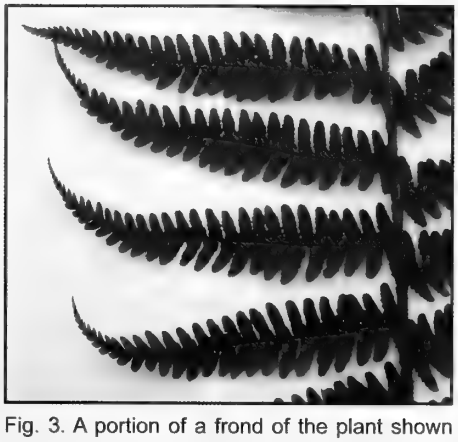


Fig. 3. A portion of a frond of the plant shown in Fig.1

There is no sign that this plant is approaching the end of its life span or has reached its limit in size. In a stable habitat, it would seem likely that this individual sporophyte could live for centuries rather than merely decades, continuing to get larger as well as producing new identical plants by apomictic spores. Furthermore, the clone to which it belongs, the history of which extends back through apomictic generations to the time when this triploid hybrid was first formed by normal sexual reproduction (probably involving a diploid and a tetraploid), could well be hundreds or thousands of years old.

vegetatively and colonise by means of detachable gemmae and the resulting clumps can extend the life of a clone even when the initial clump dies. It has been suggested that the sporophytes fail to form because the climate has changed since the sites were first colonised. It seems that the gametophytes are better able to withstand the change in conditions and survive as clones which must therefore be hundreds, possibly thousands, of years old.

Fig. 4.. A c.25yr old plant of *Polystichum aculeatum* with a single crown.

Turning to the sporophyte, the second complication is that although it is tempting to define an individual plant as that which develops from a single spore, in many species this definition is not easy to apply. Clearly, a tree fern specimen, with one crown at the top of an unbranched upright rhizome and root system, is, and remains for a long time, a single individual. In the British flora, *Polystichum aculeatum* is similar in that plants can have just a single crown for several decades (Fig. 4). At the other extreme are species such as bracken or the oak ferns (Fig. 5) that grow by horizontal branching rhizomes producing annual fronds at intervals along their length. Individuals of these species become difficult to identify when they intermingle with other individuals. Further complications arise when a fern plant formed from a spore produces separate individuals by one or other of the several processes of natural vegetative reproduction or artificial propagation, to form a clone of independent individuals all genetically identical to the parent. In relation to longevity, it might be important to distinguish between an individual and a clone because some types of clonal formation of new individuals might involve a process of rejuvenation in the new crowns that extends the life span. Thus, while a multi-crowned plant that is the entire product of a single spore is clearly an individual, and remains the same individual even when transplanted or re-potted, when such a plant is dug up and divided into two, can both the resulting plants be considered as the original individual or are they a clone? When a rhizome branch with its crown is removed as an offset and established as a separate plant, is the remainder still the original individual, is the offset also the original individual, or do they both become a clone? If and when the older parts of a bracken rhizome system decay naturally so that younger parts of the original plant are no longer physically connected and may be a considerable distance apart, does it change from one individual to a clone when the first rhizome break occurs? In species like *Dryopteris filix-mas*, the rhizome grows slowly and branches only occasionally but, in time, separate crowns grow apart and the old parts decay naturally so that different parts of the original plant are close together but unconnected. Are these parts of the same individual or are they separate plants, members of a clone? Then there are those species that have specialised structures for clonal reproduction, such as bulbils on the fronds (for example, as in some cultivars of *Polystichum setiferum* (Fig. 6) and *Woodwardia unigemmata*) or buds on roots (as in *Ophioglossum vulgatum* (Page, 1997)) and underground

Fig. 6. Bulbils on the frond of a cultivar of *Polystichum setiferum*.

Fig. 5. One -or more?- individuals of *Gymnocarpium dryopteris*.

rhizomes (*Matteucia struthiopteris*) that produce separate individuals when the connections with the parent plant break down naturally or when the propagules are removed during horticultural propagation. All the members of the resulting clone are formed from the same original spore and sporeling. Are they part of the same individual or are they separate individuals of a clone? Confusion is further confounded by the apomictic ferns that reproduce clonally, not by vegetative structures but by means of spores, as in *D. affinis* agg. (Fig.1). Modifications in the processes of both spore production (diplospory) and embryo formation (apogamy) result in sporelings that are genetically identical to the parent. After spore dispersal, these sporelings can establish at a considerable distance from the parent. The new individuals are not developed from the same spore but they are genetically identical. Are they part of the same original individual or are they a clone? At some point along this continuum, from an undivided plant with a single crown

Fig. 7. *Woodsia ilvensis* in a natural Scottish population.
photo H. McHaffie.

to a widespread population of apomictically produced and genetically identical sporelings, it is necessary to make a distinction between an individual and a clone. One definition causes fewer anomalies than the others. An individual plant is a complete and independent specimen; if there are two or more genetically identical but independent individuals, however derived from a common origin, they constitute a clone. Thus, a complete and independent specimen is defined as an individual plant whether it originates from a spore or by vegetative reproduction, and even if it is moved or re-potted. The age of an individual is measured from the time that it becomes independent. If parts of the plant are separated, released or removed to produce new individuals, the original plant is still an individual but also becomes one of a clone. The age of a clone is measured from the time that it arose from a sexually produced spore. According to this definition, the separated rhizomes and crowns of *D. filix-mas* described above would no longer be considered part of the original individual but members of a clone. Less clear-cut is the instance of a large multi-crowned plant being split in half with a spade; perhaps both resulting plants should be considered 'original' as well as members of a clone of two.

The third complication in determining fern longevity arises when a fern that reproduces or can be propagated vegetatively is also sexually fertile and produces normal spores. It is necessary when establishing age to be sure that a plant surviving for a known period in cultivation is the same individual as the one originally documented, and a not spore-derived descendant.

The fourth complication is the serious lack of information. It is very difficult to determine the age of a fern sporophyte. There is no equivalent of the annual growth rings in trees, and the size of a fern sporophyte can be affected by growing conditions and offers at best only a broad indication of age. As a consequence, there is very limited information on fern life spans in the literature.

The facts

There are statements in the literature like "[Wall Rue] *seems a fast-growing and perhaps short-lived spleenwort.*" and "*Royal Fern is a slow growing, but probably very long-lived, ...species .....*" (Page, 1997). The implication is that the typical life span is an inherent characteristic of a species rather than the consequence of external factors but the factual bases for these suggestions are not given. The available information on fern longevity is limited to indirect estimates over long periods or direct observation over shorter periods. Our ideas about fern life-span are mostly based on, perhaps distorted by, a random collection of records of a few ferns with a documented history. These recorded plants are rarely wild and are frequently unusual, perhaps atypical, ferns in cultivation.

As an example of the indirect approach, bracken individuals (or clones if the original plant has become subdivided by the decay of old parts of the rhizome) in the wild have been estimated to be several hundred years old. Age is calculated after using molecular markers to map the area occupied by a particular genotype and then measuring the dimensions of that area. Single genotypes have been found to extend for up to 390m in the UK (Sheffield et al., 1989) and 1015m in the USA (Parks & Werth, 1993). Assuming the point of origin of the clone is in the centre of the area occupied (although the rhizomes may have grown predominantly in one direction from where the spore germinated), and an annual growth of the horizontal rhizome of 1m (perhaps an over-estimate in some habitats), then dividing the radius of the area by the annual rhizome growth increment will give a conservative value for the age of the clones of about 200 years (UK) and 500 years (USA).

Fig. 8. A c.25yr old cultivated plant of *Osmunda regalis*.

Direct observation rarely starts with a fern as a sporeling, so the fern has already existed for what might be a very long period before observations begin. For plants in the wild, direct observations rarely extend beyond a decade or two, but Heather McHaffie (pers.comm. 2012) has photographic evidence of a well-established plant of *Woodsia ilvensis* (Fig.7) in Scotland that is almost unchanged after more than 40 years, and is certainly much older than that.

For plants in cultivation, recorded observations occasionally cover more than 50 or even 100 years for conspicuous individuals where old garden records exist. Thus, among cultivated species of the British fern flora, there are anecdotal accounts of individual plants thought to be more, possibly much more, than 100 years old for *Osmunda regalis* (Fig.8), a species of striking appearance long popular with gardeners (Page, 1997).

Even more distinctive are some of the cultivars beloved of Victorian collectors and some of these have recorded histories. A large specimen of the distinctive *Athyrium filix-femina* 'Victoriae' (Fig. 9) has been growing in the garden of Brodick Castle since some time between 1909 and 1925; it was derived, almost certainly by division or 'off-sets', from a plant in Buchanan Castle garden. The original plant was discovered growing wild near Drymen, close to Loch Lomond, in 1861. It was dug up, divided and part of it taken to Buchanan Castle garden where it was grown for at least 50 years. This unique variety has therefore has been in cultivation as a clone for more than 150 years and was alive for several years before that because it was already a large plant when discovered. The Brodick Castle individual is 87-103 years old.

Fig. 9. *Athyrium filix-femina* 'Victoriae'.

The striking and popular *Dryopteris affinis* (Cristata Group) cv. 'The King' (Fig. 10) has a long history. It was discovered growing wild in the grounds of Caercleugh, Charlestown, near St. Austell, Cornwall, in about 1850 (it had reached Kew by 1850) and brought into cultivation. It can be propagated by removing crowns, by inducing bulbils at the base of old fronds, or by spores (Druery (1913). Like all *D. affinis* s.s. individuals, it is a diploid apomictic and almost all the many spores produce new plants genetically identical to the parent. Plants indistinguishable from the original plant are still available in horticulture, so the clone, however propagated, is over 160 years old, even if no individual specimens of this age exist. Druery (1913) reports one individual that was 30 years old.

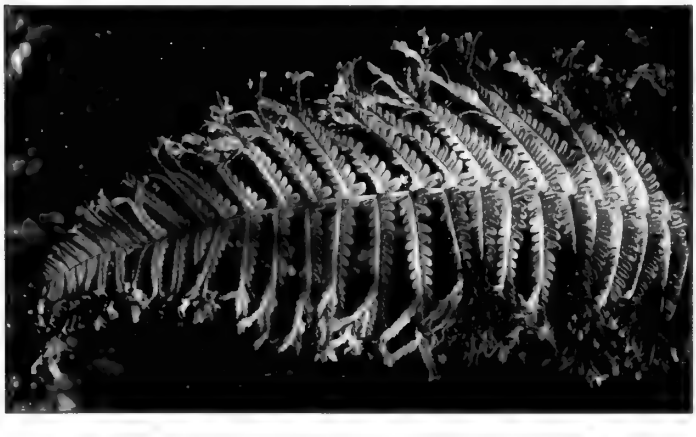


Fig. 10. *Dryopteris affinis* (Cristata Group) cv. 'The King'

In May, 1923, F.J.Allen reported an individual of unknown age of "*Scolopendrium vulgare* peraferum-cornutum" that had been found growing wild in the Mendip Hills in 1872, and was transplanted to a garden in the same neighbourhood where it was still growing well, maintaining its deformed morphology, more than 50 years later (Allen, 1923). Allen commented that "its capacity for life seems indefinite".

There is one example of a clonally-propagated plant that has a very long recorded history, both in the wild and in cultivation. *Polypodium cambricum* (once known as *P. australe*) cultivar 'Richard Kayse' (Fig. 11) is a still-available sterile clone of unique appearance that has been propagated by division since it was discovered in 1668 growing wild on an inaccessible limestone cliff in South Wales, where it was still growing more than 340 years later (Rickard, 2002).

Fig. 11 *Polypopdium cambricum* (*australe*) 'Richard Kayse'

Among exotics grown in Britain, examples include individuals of the Soft Tree Fern (*Dicksonia antarctica*) originating from the Blue Mountains of New South Wales, which were planted at Penjerrick Garden, Cornwall, in 1825. The Fox family, who owned the property, instructed their ships' captains to bring tree ferns back as ballast. Allowing for the fact that the plants had been growing for some, perhaps many, years before they were removed from the wild, these individuals must be more than 200 yrs old. They are still growing and the tallest is now about 45 ft tall and perhaps the tallest *Dicksonia* anywhere (C. N. Page, pers. comm., 2012). Another example is an individual of *Osmunda*-relative *Todea barbara* in Ascog fernery (Fig.12) on the Isle of Bute, Scotland, which was found among the derelict ruins before restoration and is thought to be a survivor of the original planting in 1870 and thus more than 140 years old (Merryweather and Wardlaw, 1998); its massive 1.5m high rhizome has even prompted suggestions that it is a thousand years old.

A few records relating to fern longevity can be found 'on line'. For example, in the US Botanic garden in Washington, D.C., *Angiopteris evecta* has been propagated clonally from a plant brought back in 1842 by W D Breckenridge, the botanist on Lt. Charles Wilkes expedition. The clone

is thus 170 years old. Other records of plants grown in pots for more than 33 and up to 90 years relate to "Hare's Foot Fern" (probably *Davallia canariensis*), "Boston Fern" (probably *Nephrolepis exaltata*), and "Staghorn Fern" (probably *Platycerium bifurcatum*). In the Pteridologist for 2012 there is reference to a 40-year-old plant of *Asplenium nidus* from Barbados shown at the Barbados Flower Show (page 369), and to a paper describing *Cyathea australis* tree ferns that are 300-400 years old (page 336).

Fig. 12. *Todea barbara* in Ascog fernery thought to be at least 140 years old. (photo: Graham Alcorn)

However, the less charismatic and less often cultivated British native species, even the more common ones, are rarely recorded in this way whether in the wild or in cultivation and overall there is a serious gap in our knowledge of the life of British native ferns. For this reason, any information about an individual fern of known age is of some interest, especially when it is from 'birth', and the age is more than a few decades (see text box). It would also be interesting to know how large they can get, though this is more difficult to determine in those species that have a horizontally spreading rhizome system.

The answer

The short answer to the question in the title is that we don't know. However, the limited information available indicates that we should probably think of some ferns as similar to seed-bearing trees in their longevity despite their smaller stature, and others as potentially almost immortal, like herbaceous perennial flowering plants.

Premature death may occur due to herbivory, disease, competition, storm damage, substrate depletion or erosion, changes in land use and management, and, over the decades or centuries of a potential fern life span, perhaps also climate change. Manmade habitats, from walls to reservoirs, where ferns establish naturally, and gardens, where most of the ferns present have been planted in arbitrarily chosen conditions, are particularly susceptible to change over that time scale.

In the absence of these external agents, an accumulation of mutations is probably the only factor that limits the life span of a clone-forming fern which spreads by horizontal rhizomes producing new roots, close to the frond bases, which can exploit untapped areas of the substrate. It remains to be proven whether other ferns have a finite life span, becoming over-mature and dying even when conditions remain suitable. If a finite life-span does occur, it is perhaps likely to occur in ferns with a short, more or less upright rhizome or caudex with limited branching to form a massive clump, like *D. affinis* agg. (Fig.1). In these, increasing amounts of old rhizome material built up between the roots and the fronds might create a barrier to nutrient and water exchange. Moreover, throughout the life of the plant, the roots draw upon the same area of the substrate, which might become depleted of essential elements. Thus perhaps in old plants the aerial parts become increasingly starved of mineral nutrients, while transport of photosynthetic products to the roots is also restricted. In tree ferns with much taller vertical rhizomes, there may be additional limitations imposed on the water and mineral supply to the crown above a certain height. Druery (1913) suggested that that the life-span of a tree fern was usually limited by its ability to support the weight of the fronds at the apex, but he also claimed that the crown did not die after the trunk fell and could still grow. He also states that in ferns with a short 'pseudo-trunk' (caudex' or 'root-stock') such as Lady Fern, individual crowns could "last for a great many years – an indefinite number indeed", and those with spreading horizontal rhizomes were "without any definite life limit". However, even in ferns with a finite life-span, individuals might live longer than any human observers, so objective data will depend on historical documentation.

Even though it may not be possible to obtain definitive data on the potential life-span of ferns, the accumulation of documented information about the age of individuals and, where applicable, clones of as many species as possible will reduce our ignorance. At least it would provide minimum values for the recorded longevity of a range of species, and might even confirm whether some species are intrinsically more short-lived than others. To this end, the editor, or myself, would be pleased to receive details of individuals or clones known to be older than about 40 years. Records for British native species would be particularly welcome. ❐

References:

Allen, F. J. (1923) 'Longevity in a Fern.' *Nature* CXI, 742.
Druery, C. T. (1913) 'Ferns.' *British Fern Gazette* 2 (16), 82-85.
Merryweather, J. and A. Wardlaw, (1998) 'Restored Victorian fernery on the island of Bute.' *Pteridologist* 3, 22-24.
Page, C.N. (1997) *The Ferns of Britain and Ireland.* CUP, Cambridge.
Parks, J. and C. Werth (1993) 'A study of spatial features of clones in a population of bracken fern, Pteridium aquilinum (Dennstaedtiaceae).' *American Journal of Botany* 80, 537-544.
Rickard, M. (2002) *The Plantfinder's Guide to Garden Ferns.*David & Charles, Newton Abbot.
Rumsey, F. J. and E. Sheffield (1990) 'British Filmy Fern Gametophytes.' *Pteridologist* 2, 40-42.
Sheffield, E., P.G. Wolf, and C.H. Haufler (1989) 'How big is a bracken plant?' *Weed Research* 29, 455-460.

Fern trees.
The impacts of DNA sequencing on fern taxonomy

Paul Sharp
50 Liberton Brae, Edinburgh. EH16 6AF. Scotland.
e-mail: paul.sharp@ed.ac.uk

Yes, "fern trees", meaning the evolutionary trees that depict the ancestral relationships among different ferns (if you started reading this the article *only* because you are interested in "tree ferns", go no further!)

Our understanding of the evolutionary relationships of all organisms has been revolutionised by the application of developments in molecular biology (see Box 1). This began a little over 50 years ago, and has continued at accelerating pace. Comparing the gene sequences of different species, we can infer how they are related to one another, and estimate when they shared a common ancestor (see Box 2). The use of these techniques to understand fern taxonomy has lagged behind their application in many other branches of the tree of life. However, in the last 10-15 years, molecular evolutionary genetics has been applied to provide some fascinating insights into fern evolution, including addressing fundamental questions such as which groups should be called "ferns", and when did the various groups of ferns first evolve.

Much of the research reviewed below reflects the efforts of Kathleen Pryer, working at Duke University (in North Carolina, U.S.A.), who together with a number of colleagues has been especially active in bringing these molecular techniques to bear on pteridological issues.

What are "the ferns and their allies"?

Pteridologists have traditionally been interested in both ferns and their "allies". These allies include clubmosses (such as *Huperzia* or *Lycopodium*), spike mosses (*Selaginella*), quillworts (*Isoetes*) and horsetails (*Equisetum*). In traditional taxonomies, the ferns and their allies are often all grouped together (e.g., Cobb 1963; Jones 1987), implying that they share a common ancestry separate from other land plants.

Pryer and her colleagues set out to re-examine the phylogenetic relationships among the major lineages of ferns, and between these and other forms of land plants. In particular, they included representatives of the four groups of fern allies listed above, as well as the four recognised distinct clades of ferns: the leptosporangiate ferns (Polypodiopsida, comprising most of the familiar fern taxa), the whisk ferns (Psilotopsida), and two classes of eusporangiate ferns, Marattiopsida and Ophioglossopsida (see Fig. 2, overleaf.). They also included representative seed plants (including gymnosperms and angiosperms, cycads and ginkgo), and used bryophytes (mosses, liverworts and hornworts) to anchor the root of the tree.

Sequences from four different genes were compiled and compared to yield the phylogenetic tree shown in Fig. 1. Extant species lie at the tips of the tree at the right.

Box 1. Genes and proteins

DNA (DeoxyriboNucleic Acid) is the genetic material used by all cellular organisms, whether bacteria, plants, animals or any of the numerous other diverse taxonomic groups that make up life on earth. DNA is passed from parent to offspring as a chromosome, a (very) long double-stranded chain of nucleotides. There are four kinds of nucleotides, universally symbolised by the letters A, C, T and G, depending on the base they contain. The two strands are held together by bonds between pairs of bases; lengths of DNA are usually expressed in base pairs.

The cellular machinery knows to recognise short regions within the chromosomes as genes. Within a gene, each triplet of consecutive nucleotides is translated, using the genetic code, into one of 20 amino acids, and this chain of amino acids comprises a protein. These gene products have diverse roles in the structure and function of cells; some are structural proteins, such as collagen, while others are enzymes that catalyse reactions to make or break down other molecules. Below is is a fragment of the sequence of the *rbcL* gene from *Osmunda regalis*. This gene encodes a subunit of RuBisCO, an enzyme involved in carbon fixation during photosynthesis; the amino acids encoded here are shown below the DNA.

```
GGTATCTATTTCACCCAGGATTGGGTATCTATGCCAGGTGTACTTCCTGTG
Gly:Ile:Tyr:Phe:Thr:Gln:Asp:Trp:Val:Ser:Met:Pro:Gly:Val:Leu:Pro:Val
```

The complete set of genes is responsible for the make-up of an organism, so that it is differences in the sequence of nucleotides within a gene that determine whether a fertilised egg cell turns into (for example) a human or a rabbit. To give a numerical example: the first (non-bacterial) organism where the complete set of chromosomes (the "genome") was fully characterised was that of the yeast *Saccharomyces cerevisiae*, strains of which are used in brewing and baking. This yeast has 16 different chromosomes, ranging in size from 231,000 to over 2 million base pairs (bp), and this genome contains around 6,000 genes, encoding proteins ranging in length from 25 to nearly 5,000 amino acids. The human genome contains more genes (perhaps 25,000) and is a lot larger, at around 3,000 million bp (3 Gbp). Genome sizes in many ferns are even larger: for example, *Dicksonia antarctica* is estimated at 11 Gbp, and *Osmunda regalis* at 14 Gbp. The horsetail, *Equisetum hyemale*, has 26 Gbp. (See http://data.kew.org/cvalues/ for more examples.)

The invention of methods, first in the 1950s to determine the sequences of amino acids that make up proteins, and then in the 1970s to read the sequences of nucleotides that make up DNA, represent two great landmarks of 20th century biology. The British biochemist Fred Sanger was instrumental in the development of both techniques, and is one of the very few scientists to have been awarded the Nobel prize twice. DNA sequencing has largely supplanted protein sequencing, because it is easier, faster and cheaper, and knowing the genetic code allows us to infer the protein sequence directly from the gene sequence. In fact, driven by the impetus to know the sequence of the entire human genome, and then to compare genome sequences between individuals with different health conditions, the techniques of DNA sequencing have developed at a phenomenal pace. For example, 30 years ago, it might have taken a year for a researcher to sequence a gene comprised of 1,000 bp, at a cost of £10,000. In 2013, a complete bacterial genome of 5 million bp can be determined in a few days at a cost of £50. Even without factoring in inflation, this represents a million-fold reduction in the cost of sequencing per nucleotide.

The branches are drawn roughly to scale, representing the amount of change that has occurred in the sequences used. Moving left from the tips along the branches is equivalent to undoing genetic change and going back in time. Branches meet at nodes which represent the common ancestors of all species lying to the right of the node. At the far left, all branches have converged at the root of the tree: the oldest point, and the common ancestor of all species in the tree.

As expected, all of the Leptosporangiate ferns (with 11 representatives here, from *Blechnum* down to *Osmunda*) form a single group with a common ancestor at the node labelled 7. This clade comprises fern species of great morphological diversity, currently classified into seven orders: Osmundales, Hymenophyllales (filmy ferns), Gleichenales (here *Gleichenia* and *Phanerosorus*), Schizeales (including climbing ferns, such as *Lygodium*), Salviniales (water ferns including *Salvinia* and *Marsilea*), Cyatheales (tree ferns) and Polypodiales (here represented by *Blechnum* and *Pteridium*). The last three of these orders are clearly more closely related to each other, sharing a common ancestor at node 8. Most of these seven orders comprise relatively few families, whereas the Polypodiales include more than 80% of fern species. As had been suggested previously, the earliest diverging lineage among these Leptosporangiate ferns leads to *Osmunda* species, meaning that they comprise the most distantly related taxon within this clade.

The next node back in the tree (6) is the common ancestor of these Leptosporangiate ferns plus two other lineages: the horsetails (*Equisetum* species) and the Marattiopsida (represented by *Marattia* and *Danaea*). It has proved difficult to determine the precise branching order among these three lineages with confidence, implying that the eusporangiate ferns in the *Marattia* lineage are not substantially, if at all, more closely related to the leptosporangiate ferns than are the horsetails. The other eusporangiate fern lineage, the Ophioglossopsida (*Botrychium* and *Ophioglossum*), share a separate common ancestor (at node 5) with the Psilotopsida (the whisk ferns, *Psilotum* and *Tmesipteris*). Going further back in time, all five of these lineages converge at node 4. This node represents the common ancestor of all four groups referred to as "ferns", as well as the horsetails. Thus, to the extent that these "ferns" share fern-like characteristics, we must deduce that the common ancestor at node 4 most likely already had these traits, with the further implication that the horsetail lineage subsequently lost them.

The other "fern allies", i.e., the lycophytes (clubmosses, spike mosses and quillworts) all share a common ancestor (node 2) quite separate from the fern lineage. In fact, the ferns are more closely related to the seed plants (sharing a common ancestor with them at node 3) than they are to the lycophytes. Thus, from an evolutionary perspective, the seed plants have more reason to be considered fern allies than do the lycophytes. However, despite their names, the clubmosses and spike mosses are not closely related to true mosses; rather they share a common ancestor with the ferns and seed plants (at node 1) subsequent to the divergence from bryophytes.

In summary, this phylogenetic analysis has had a major impact on our understanding of the evolutionary history of land plants, and has particular implications for pteridologists. Among the groups previously referred to as "fern allies", the horsetails are in fact ferns (of a specialised nature), while the other "allies" are not really allied to the ferns at all.

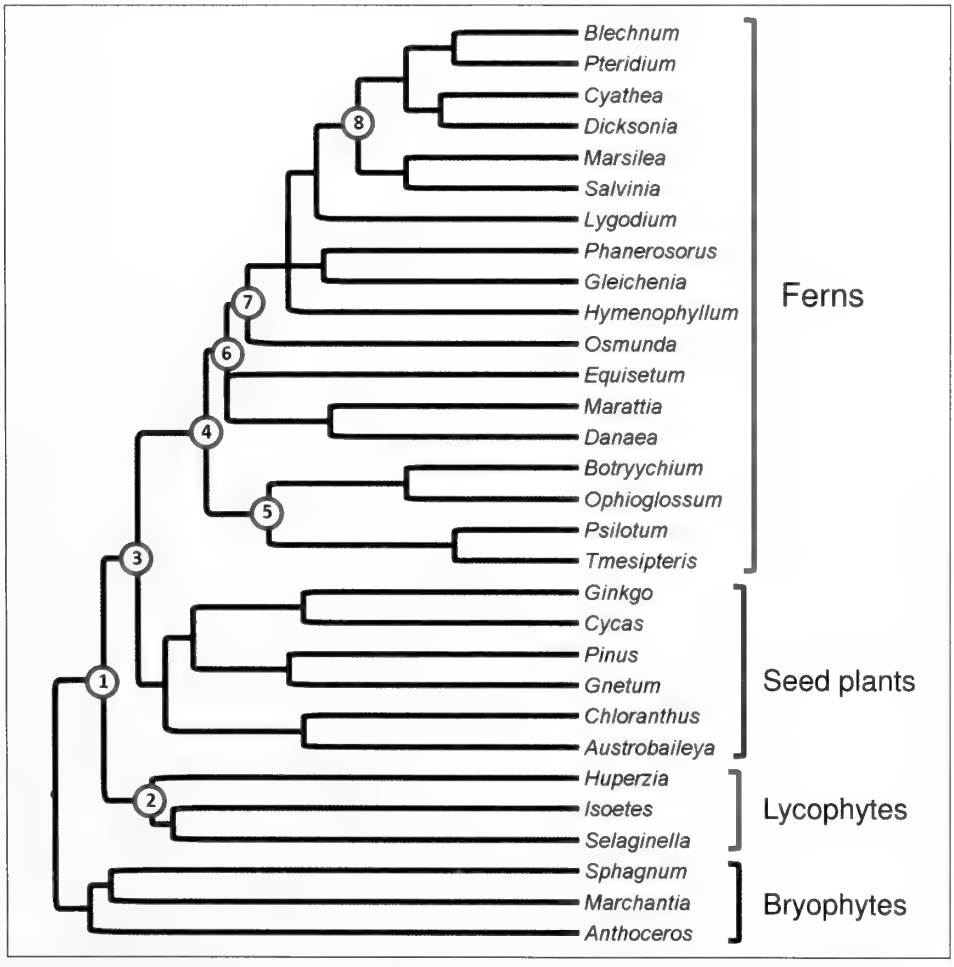


Fig. 1. The evolutionary relationships among vascular plants: ferns, their allies, and seed plants. Bryophytes are included, as an outgroup to indicate where the most basal part of the tree lies. Numbered nodes are referred to in the text. Adapted from Pryer *et al.* (2001).

When did modern ferns evolve?

Pictorial reconstructions of dinosaurs, or even earlier forms of land vertebrates, often show them roaming among forests of ferns. Fern fossils date back to more than 350 million years ago (Mya), whereas the first confidently identified angiosperm is found in rocks dating to 125 Mya. The fossil record points to two early radiations of fern lineages, the first during the Carboniferous period which lasted from 359 to 299 Mya, and a second spanning the boundary (at 250 Mya) between the Permian and Triassic periods. To put this in context, fossil reptiles are found from around 310 Mya, while dinosaurs first appeared about 230 Mya. Perhaps

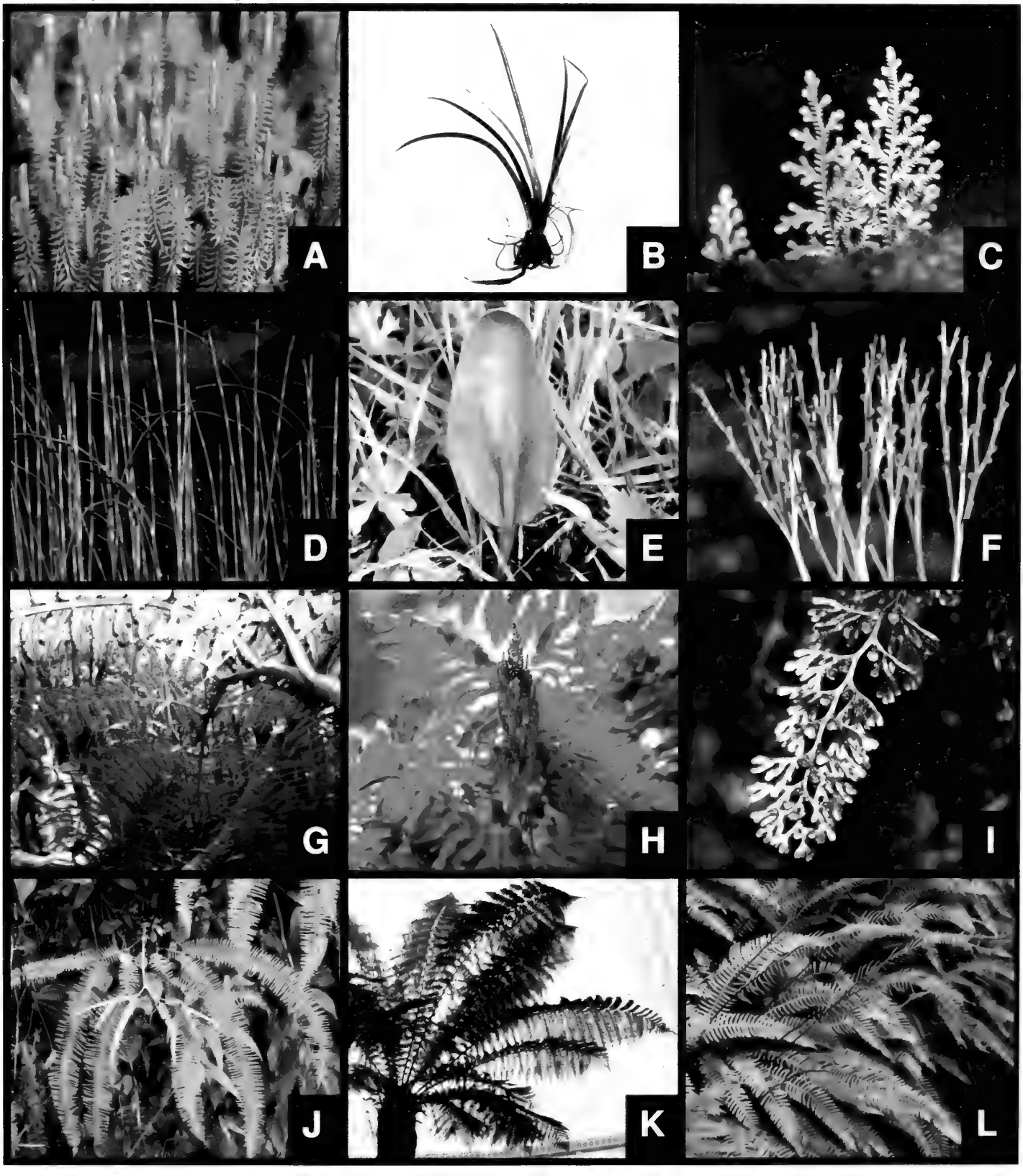


Fig. 2. The major groups of ferns and their allies. **A** Clubmosses (represented by *Lycopodium annotinum*). **B** Quillworts (*Isoetes lacustris*). **C** Spike mosses (*Selaginella*). **D** Equisetopsida - horsetails (*Equisetum hyemale*). **E** Ophioglossopsida (*Ophioglossum vulgatum*). **F** Psilotopsida - whisk ferns (*Psilotum nudum*). **G** Marattiopsida (*Marattia fraxinea*). **H** Osmundales (*Osmunda regalis*). **I** Hymenophyllales - filmy ferns (*Hymenophyllum tunbrigense*). **J** Gleicheniales (*Sticherus*). **K** Cyatheales – tree ferns (*Dicksonia antarctica*). **L** Polypodiales (*Blechnum spicant*).

Photo credits Roger Golding (B, E, I), Bridget Laue (G)

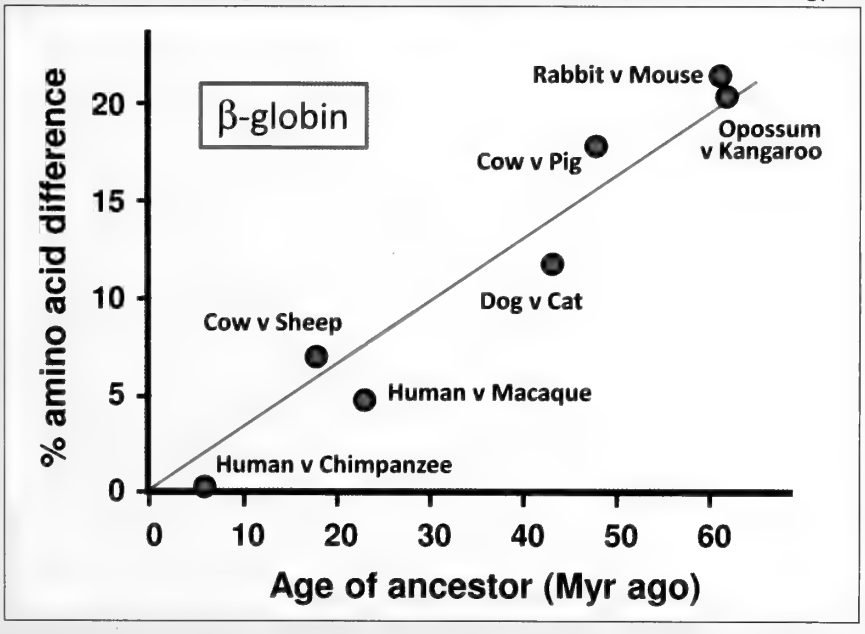
the most famous geological landmark is the more recent boundary between the Cretaceous and Tertiary periods, at 65 Mya; at that point there was a major extinction event, thought to be due to the impact of a large asteroid in the region near the Yucatan in central America, which likely cloaked the earth in an ash cloud for a very long time. Whatever the cause, more than three quarters of all species, including all of the dinosaurs (except birds), disappeared at that time. The major groups of mammals had first appeared before 65 Mya, but it was not until then that they began to predominate, and they did so in a vegetational landscape dominated by the angiosperms. In light of this fossil record, the ferns are often regarded as being ancient relics of a bygone age.

Pryer and her colleagues have asked what the molecular evidence reveals about the timescale of fern evolution (Schneider *et al.* 2004). They constructed detailed phylogenetic trees of both ferns and seed plants, and used molecular clocks in conjunction with the dates of fossil ferns to estimate when the various ancestral nodes within each of these trees existed. The common ancestor of ferns and seed plants (at node 3 in Figure 1) was placed at 380 Mya (mid-Devonian), based on the fossil record. Then the ancestor of the fern lineages (at node 4) was placed at 354 Mya, near the beginning of the Carboniferous. The common ancestor of leptosporangiate ferns (node 7) was estimated to have existed 307 Mya, more than 25 Myr earlier than the oldest fossil assigned to this clade. This is the point of divergence between the lineage leading to *Osmunda* and the ancestor of other leptosporangiate ferns. These are indeed ancient events, long pre-dating the origins of (for example) mammals.

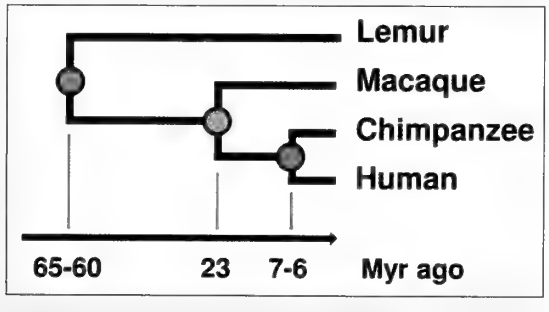
Box 2. Molecular evolution

The first protein sequence elucidated by Sanger was that of insulin, a small protein (51 amino acids) involved in the control of blood sugar levels. Initially, he investigated the cattle protein. Subsequently, when he examined the insulin of sheep he found it differed at only one amino acid, while that of pigs differed at two. This high degree of similarity can only be explained because the common ancestor of cattle, sheep and pigs had a gene encoding insulin, and over the 50 or so million years (Myr) since that common ancestor, this gene has been continuously inherited by the members of each evolutionary lineage leading to these ruminant species today. The process of copying this DNA has been remarkably faithful, but over time a small number of mutations have occurred which have had consequences for the protein sequence; hence the differences in the sequences today.

In the 1960s, as numerous protein sequences accumulated, it became apparent that the number of differences between homologous proteins from different species is often roughly proportional to the time since those species shared a common ancestor. This phenomenon became known as the "molecular clock" because the rate of accumulation of sequence changes can be used to time the evolutionary past. The dates of ancestors used to calibrate the molecular clock came from the fossil record, but this fossil record is very patchy; however, if we have the sequence of the same protein from two species, and we know the rate at which the molecular clock for this protein ticks, we can estimate the date of their common ancestor. Here, the sequences of beta globin, a component of haemoglobin, are compared between 7 pairs of mammals; the fraction (%) of amino acids differing are plotted against estimates of the minimal age of their common ancestor from the fossil record (dates taken from M.J. Benton & P.C.J. Donoghue, Paleontological evidence to date the tree of life, Molecular Biology & Evolution, 24:26-53, 2007). In this case, two species differing at 10% of sites would be estimated to have shared an ancestor about 30 Myr ago



A corollary of the molecular clock is that we can also use sequence comparisons to estimate phylogenetic trees showing the evolutionary relationships among species. For example, we might compare the sequence of a human gene to that of its counterpart in the chimpanzee, and see that 2% of the nucleotides are different. Then we find that the distances between the human sequence and those from a macaque and a lemur are 7% and 19%, respectively. These values imply that human and chimpanzee are the most closely related, i.e., share a common ancestor most recently. Furthermore, we would estimate that 1% of sites changed on the evolutionary lineage from that common ancestor to humans (and similarly, 1% of sites changed on the lineage from that ancestor to chimpanzee). Building the evolutionary tree by progressively looking further back into the past, the next most closely related species is the macaque, and the deepest divergence was the split of the lemur lineage. Then, if the date of one of the ancestral nodes is known, we can use the molecular clock to estimate the dates of the other ancestors. For example, if we take evidence from the fossil record that the common ancestor of humans and Old World monkeys (like the macaque) existed about 23 Myr ago, then the rate of divergence is estimated at 1% per 3.3 Myr. Then the common ancestor of humans and chimpanzees would be estimated to have lived 6-7 Myr ago, and the common ancestor of lemurs, monkeys and apes around 60-65 Myr ago.



However, Pryer and colleagues focused on the timing of diversification within the polypod ferns, since these comprise the vast majority of extant fern species. The common ancestor of *Blechnum* and *Pteridium* (the first node at the top of Fig. 1) was estimated at around 155 Mya. More than two thirds of living fern species fall into two groups, rather unimaginatively termed eupolypods I and II. Among familiar U.K. ferns, *Dryopteris*, *Polystichum* and *Polypodium* are included in eupolypods I, while *Asplenium*, *Athyrium*, *Blechnum*, *Cystopteris*, *Gymnocarpium*, *Oreopteris*, *Phegopteris*, *Thelypteris* and *Woodsia* all belong within eupolypods II. The common ancestor of these two lineages was estimated at about 107 Mya, and most of the divergences among major lineages within these groups seem to have occurred between 100 and 50 Mya. On the geological timescale, these events were comparatively recent. Importantly, most of the major divergence events among angiosperm lineages were estimated to have occurred prior to this diversification among polypod lineages. This raises the possibility that it was the emergence of the angiosperms that provided new opportunities for ferns, by creating new habitats that they could thrive in. Thus, the headline interpretation was that "Ferns diversified in the shadow of angiosperms".

This late Cretaceous diversification of polypods can be thought of as the third major radiation of ferns. More recently, it has been suggested that there was also a fourth, due to burgeoning numbers of species of epiphytic ferns (Schuettlpeltz & Pryer 2009). A disproportionate number of plants living as epiphytes (i.e., growing on other plants) are ferns. Thus, while 3% of plant species in general are epiphytic, 10% of ferns have this lifestyle. The great majority of epiphytic fern species occur in the canopies of tropical rain forests.

Once an evolutionary tree has been constructed, it is possible to think about the characters that might have been found in ancestral species. For example, if two species that are each other's closest relatives are both epiphytic, it is likely that their common ancestor was an epiphyte too. So Schuettlpeltz and Pryer reconstructed an evolutionary tree encompassing 400 fern species, estimated the dates of ancestral species at each node in the tree, and deduced whether that ancestor was likely to have been an epiphyte. The results indicated that diversification of lineages within groups of ferns that are epiphytic occurred somewhat later than those of other leptosporangiate ferns. Rapid diversification seems to have begun about 55 Mya when there was a marked rise in both temperature and precipitation. Again the angiosperms, dominant in the tropical rain forest canopy, seem to have provided the opportunities for ferns to go forth and multiply.

Complexities

A standard evolutionary tree assumes that, over time, species have continuously diverged from their relatives. However, more complex patterns can exist. In particular, among ferns a major complication arises from hybridisation between species, so that two divergent branches of an evolutionary tree converge and unite. As a result, the apparent evolutionary relationships among species can vary, depending on which genes are used to derive the phylogenetic tree. Fortunately, from the perspective of trying to unravel evolutionary histories, hybridisation is only likely to be successful when the two species are not too distantly related, and so these complexities are only likely to arise when examining close relationships; i.e., hybridisation is unlikely to have muddied the view of the broad scale evolutionary relationships addressed in Fig. 1 above.

Different genes, from the same species, may have different evolutionary histories because plants have multiple genomes, inherited in different ways. Most genes lie in the nuclear genome, i.e., on the chromosomes present within the nucleus of each cell. However, plants also have two other genomes. Two intracellular organelles, the mitochondrion (responsible for generating energy) and the chloroplast (where photosynthesis takes place) each have their own small chromosome. Although these organelle genomes contain rather few genes, these have been the focus of many evolutionary studies. In particular, one gene (*rbcL*) lying in the chloroplast DNA has routinely been used to investigate evolutionary relationships among plants. Whereas nuclear DNA is inherited from both parents, organelle genomes are typically transmitted from only one. In most groups of organisms, mitochondria and chloroplasts are inherited from the female parent (notable exceptions include gymnosperms, where one or both organelles may be passed on paternally). This means that comparisons of nuclear and chloroplast gene sequences can provide different perspectives on the evolutionary history of ferns.

These complexities are well illustrated by members of the genus *Dryopteris*. Some species of *Dryopteris* are diploid, having (like humans) two copies of each chromosome, one copy inherited from each parent. However, many other species of *Dryopteris* are polyploid, resulting from hybridisation between two divergent species, whereupon the offspring retained two sets of chromosomes from each parent. Hybridisation between two diploid (2x) species can generate a tetraploid (4x); subsequent hybridisation between a diploid and a tetraploid can generate a hexaploid (6x) species, and so on. In a diploid species the two copies of a gene, known as "alleles", may differ slightly reflecting genetic variation within the species. However, generally, the two alleles are likely to be much more similar to each other than to the sequence of the corresponding gene from a different species. Thus, a tetraploid species is expected to have two distinct, divergent copies of a gene from the nuclear genome. However, because organelles are inherited from only one parent, a tetraploid has only one form of each gene from the chloroplast genome.

Comparisons of the evolutionary trees derived from chloroplast and nuclear genes can help unravel the history of hybridisation events. In a recent investigation of the *Dryopteris* genus, Sessa, Zimmer and Givnish (2012) have done just this. They examined 35 different species of *Dryopteris*, but the trees shown in Figure 3 focus on just nine, six of which are diploid and three of which are tetraploid. In the tree (Figure 3A) derived from sequences of a nuclear gene (*pgiC*)

the three tetraploid species each appear twice. One of the tetraploids is *D. dilatata*, with two distinct *pgiC* genes, one closely related to *D. intermedia* and the other closely related to *D. expansa*. *D. intermedia* and *D. expansa* are both diploid species, and it is likely that *D. dilatata* arose from a cross between the two. In the chloroplast DNA tree (Figure 3B), *D. dilatata* is closely related to *D. intermedia*, indicating that this species was the female parent in the hybridisation event. The other two tetraploids, *D. carthusiana* and *D. cristata*, are closely related to each other in the chloroplast DNA tree, and share one closely related *pgiC* gene copy; however, no very closely related sequences are known from any diploid species. Thus it is thought that *D. carthusiana* and *D. cristata* share a common female parent, but that that species has not been found, perhaps because it is now extinct; this hypothetical parent has been termed "*D. semicristata*". The sequences of the other nuclear gene copies in *D. carthusiana* and *D. cristata* are quite distinct from each other, but very similar to *D. intermedia* and *D. ludoviciana*, respectively, implicating these species as their probable male parents.

Barcodes for fern identification

Since we can exploit differences in gene sequences to place fern species in an evolutionary tree, it follows that it is also possible to use DNA probes for identification. In recent years there have been concerted efforts by many researchers to define a particular gene (or combination of genes) that can be used a "barcode", that is the unique identifier for each species..

Pryer *et al.* (2010) have advocated using the barcode approach to ensure that ferns available in the horticultural trade are accurately identified.

They illustrate the use of this approach with an example of a fern that was being marketed, by one of the major American suppliers, under the wrong name. *Cheilanthes wrightii* (Wright's lip fern) is a dry-adapted species found in the deserts of the south west U.S.A. and northern Mexico. It was noticed that plants being sold as *C. wrightii* did not resemble plants of this species found in the wild. Of course, plants grown under different environmental conditions may develop to look somewhat different. However, the DNA sequence of a barcode does not change in response to the environment or growth conditions. In this case, it was found that the DNA sequences of the (chloroplast) *rbcL* gene of the commercial plants differed from those of bona fide *C. wrightii* at nearly 5% of sites (64 nucleotides out of 1309). To put this in perspective, the *rbcL* sequences of *D. dilatata* and *D. expansa* (as in Figure 3B) differ at fewer than 2% of sites, while those of oak fern (*Gymnocarpium dryopteris*) and beech fern (*Phegopteris connectilis*) differ by 4%. So this is clear evidence that the commercial plants are not *C. wrightii*, but to make a positive identification then requires a match to some sequence in a database of diverse species.

Pryer and colleagues did have *rbcL* sequences from various *Cheilanthes*, and found that the mystery plants were identical to *C. distans*, a species found in Australia, New Zealand and some Pacific islands.

C. wrightii and *C. distans* are clearly morphologically

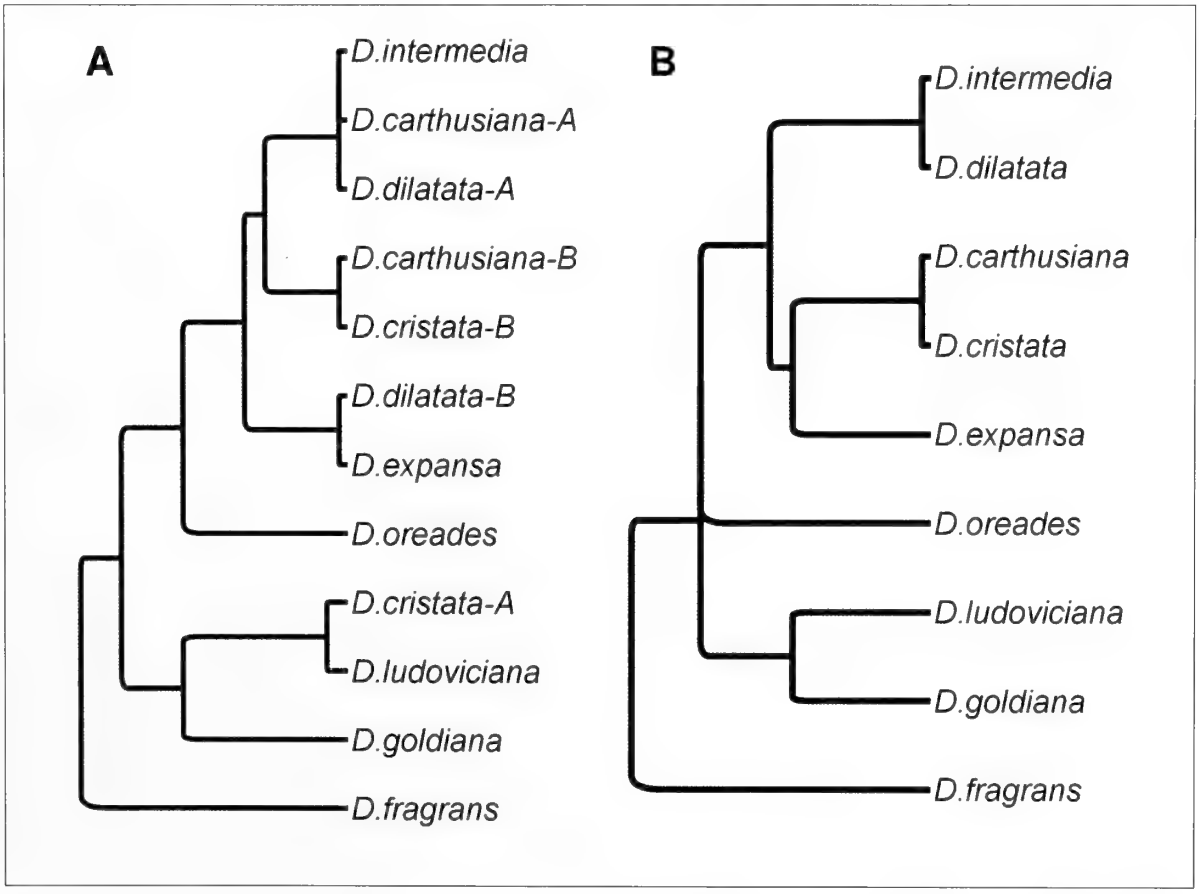


Figure 3. Evolutionary relationships among some *Dryopteris* species. **A** Based on a gene (*pgiC*) from the nuclear genome; three tetraploid species have two distinct (A and B) copies of the gene. **B** Based on chloroplast DNA sequences. Adapted from Sessa *et al.* (2012).

different – it was the odd appearance of the commercial plants that prompted this study – and so DNA sequences are not really required to tell them apart. (For pictures of both species, see Olsen 2010.) However, other species may be more difficult to distinguish, and barcodes could be especially useful for identifying fern gametophytes. For plants in general, an international consortium has recommended the use of two gene sequences, *rbcL* and *matK*, as the official DNA barcode. Pryer and colleagues have recently (Li *et al.* 2011) trialled the use of these barcodes in discriminating among fern species and found they work well; for example, the combination of the two gene sequences uniquely characterised each of 28 *Deparia* species included in the study. Nevertheless, there are limitations, since both *rbcL* and *matK* are part of the chloroplast genome. Thus, for the reasons discussed in the previous section, these barcodes are not expected to be so useful in groups where there are polyploid species due to hybridisation. Indeed, of 17 species from the *Cheilanthes marginata* group, which includes two polyploid species complexes, only 8 were uniquely identified. Attempts to use these chloroplast DNA barcodes would obviously run into difficulties with various *Dryopteris* species, including those discussed above.

Conclusions

In recent years, DNA sequences have been used to investigate the evolutionary relationships among the major groups of ferns and their allies, and to estimate the evolutionary timescale over which the major groups of ferns emerged. More detailed studies have focused on the relationships within particular families or genera, such as the *Dryopteris* example given above. The costs of DNA sequencing have plummeted, meaning that the same techniques can be applied more and more widely to elaborate on the complete taxonomy of ferns, and to unravel the sometimes complex origins of hybrid species.

The increased availability of DNA sequencing could ultimately lead to a complete catalogue of barcodes for fern species, using both chloroplast and nuclear DNA, so that any specimen can be identified by its match to a sequence in the database. It is possible to imagine that, in the not too distant future, combination DNA barcodes could be read in a matter of seconds by hand-held machines carried in the field. But, having witnessed numerous prolonged debates among BPS members during the attempted identification of members of the *Dryopteris affinis* species complex, perhaps such technology should be avoided, since it seems it might take the fun away - views anyone?

Acknowledgements

The initial impetus for this article was an invitation from Alastair Wardlaw. I am especially grateful to Roger Golding, Bridget Laue and Frank McGavigan for comments on a draft of the article. They have tried to keep me straight on ferny issues, but I must take the blame for any remaining mistakes.

References:

Cobb, B. (1963) *A field guide to the ferns and their related families of northeastern and central North America.* Houghton Mifflin, Boston, Massachusetts.

Jones, D.L. (1987) *Encyclopedia of ferns.* Timber Press, Portland, Oregon.

Li, F.-W. et al. (2011) *rbcL* and *matK* earn two thumbs up as the core DNA barcode for ferns. *PLoS ONE* 6:e26597.

Olsen, S. (2007) *Encyclopedia of garden ferns.* Timber Press, Portland, Oregon.

Pryer, K.M. et al. (2001) 'Horsetails and ferns are a monophyletic group and the closest living relatives to seed plants.' *Nature* 409:618-622.

Pryer, K.M. et al. (2010) 'DNA barcoding exposes a case of mistaken identity in the fern horticultural trade.' *Molecular Ecology Resources* 10:979-985.

Schneider, H. et al. (2004) 'Ferns diversified in the shadow of angiosperms.' *Nature* 428:553-557.

Schuettlpeltz, E. & Pryer, K.M. (2009) 'Evidence for a Cenozoic radiation of ferns in an angiosperm-dominated canopy.' *Proceedings of the National Academy of Sciences U.S.A.* 106:11200-11205.

Sessa, E.B., Zimmer, E.A. & Givnish, T.J. (2012) 'Reticulate evolution on a global scale: A nuclear phylogeny for New World *Dryopteris* (Dryopteridaceae).' *Molecular Phylogenetics and Evolution* 64:563-581.

BPS members debate the identity (and age) of a very large speciman of *Dryopteris affinis* agg. at Arduaine Garden

Yorkshire Fern Collections

Jack Bouckley

209 Woodfield Road, Harrogate. N.Yorks. HG1 4JE

e-mail: j.bouckley@yahoo.com

There are four collections of ferns which are open to the public in Yorkshire and all are well worth a visit if you are in this part of the country.

Going back a few years, the head gardener of Brodsworth Hall, not far from Doncaster, rang me up said that they had an old quarry-like area in the Brodsworth estate and did I think it would be suitable for a few ferns, as there were a few strap-like plants growing in different parts. Immediately I guessed that they were scollies. We arranged a meeting at the site and I was truly amazed. I think there had been a small fernery there before. Naturally, he had to get permission from English Heritage to look into the possibilities and I left him to contact me when he had convinced them.

Sometime after, Mr Eric Baker, a very keen pteridophyte, died and left a garden full of exquisite ferns which he had collected from various places over the years. I had seen these on various occasions and thought how careful he had been in the planning and planting. He even had a type of grid system for recording plant names. His wife Rita eventually contacted me and told me that she realised that she would be unable to maintain the collection and would like to dispose of all the ferns. I told her that I knew somebody who would be interested.

Fig. 2. Brodsworth Hall fernery. Looking down into the quarry area, with members of the BPS admiring the ferns. Photo: Bruce Brown

My next action was to ring Brodsworth to see if permission had been granted for the project. The answer was yes, with certain provisions, so I arranged a meeting with the head gardener at Rita's home so that the ferns could be seen, along with the possibilities. Martin Rickard had agreed to come over and the four of us went to the local inn for a meal and to discuss the details. A price was provisionally agreed and Brodsworth were to be responsible for removing the plants and transporting them back to the hall. It took four men three days to do the job. Unfortunately the grid system plan was lost in the move so some of the plants were unnamed. However, they still looked fantastic.

The second collection is at R.H.S. Harlow Carr, Harrogate. Clive Jermy said to me one day, "Why don't you mention to the committee that it would be a good idea if a National Collection of *Dryopteris* and *Polypodium* could be housed in their grounds?" This I did at the next meeting and the idea was accepted within certain cost restrictions. I left it to them to inform the NCCPG, who accepted the idea. I got packets of *Dryopteris* spores from the spore exchange and shared them out between members of the Yorkshire group to grow so that a couple of plants would be given back to Harlow Carr. This worked a treat and eventually plants were brought to my house as a collecting point and I took them all down to Harlow Carr. Unfortunately, all the plants were put in a shade house and left there on a very hot weekend when the gardeners forgot to turn on the water sprays. You can guess what happened!

Meanwhile, Leeds University were closing down part of their Botany Department and the fern collection was to go. Dr. Sledge rang me and told me that there were some very good *Dryopteris* which we could have if we collected them quickly as orders had been given to spray and kill. The curator of Harlow Carr and I went to Leeds and took a very large collection back, many of which had been collected by Dr. Sledge himself.

These special plants were placed in the ground where they grew well, but the name tags have now been lost or stolen and some of them now do not have the correct name. Despite this the collections are well worth a visit. A small point worth mentioning is that when the collection was planted there was a very fine lady fern in the area which was left to be moved at a later date. I wonder if that happened?

Fig. 3. Harlow Carr. Members of the BPS examining and discussing the fern collection. Photo: Alison Evans.

No doubt some members have read, some years ago, about the York Cemetery effort. James Merryweather and I had been invited to the opening of the heather collection at the cemetery and we both thought how good it would be to have a fern collection here. This would need agreement from the trustees and James offered to talk to them himself in order to save me having to make a special journey to York. The result was that the cemetery staff and volunteers would prepare a very nice bank which was rather overgrown and we could then proceed.

An appeal for spare plants from BPS members was a total failure so, not to be deterred, I dug up quite a number from my garden. With the help of James, another group of about 30 – 40 ferns were also dug up from my allotment plot which had been grown for sale at the local gala. Previous Gala takings were then earmarked for buying ferns from nurseries. We bought from Martin Rickard and Neill Timms. In the meantime Julia Wilkins and Azu Fletcher had been helping with all the work.

Eventually the grand opening day came round, which was attended by the Lord Mayor and Lady Mayoress,

together with the Sheriff's wife. My old friend Geoff Smith performed the opening ceremony, the dignitaries each planted a fern which were well and truly watered in by the persistent heavy rain that had obligingly continued throughout the proceedings.

This collection has been looked after during the last few years by the Yorkshire Fern Group who, I have been told, have made a very good job of controlling the weeds.

The final collection is also in York. Before James Merryweather, the previous editor of the *Pteridologist*, decided to move to 'Bonnie Scotland' he was approached by York Museum about making a fernery in their garden. Before anything could be done, he left and I was unable to take up the project so I thought that it had been forgotten. Fortunately, the matter was brought up again with the Yorkshire Fern Group and they, together with Neil Timm, who is a member of the group and who also owns a very nice fern nursery in Binbrook, Lincolnshire, have now planted quite a large number of plants in an area which is open to the public near the centre of York and it is certainly well worth a visit.

So anyone holidaying in Yorkshire has a very nice chance of spending a couple of days calling in at any or all of these four collections.

Fig. 5. York Cemetry. A fine collection of ferns alongside one of the many paths through the area. Photo Bruce Brown

Fig. 6. York Museum. A large number of ferns to be seen, courtesy of the Yorkshire Fern Group. Photo: Bruce Brown

Xerophytic ferns of California and Arizona.

Sophie Walwin
Temperate House, Royal Botanic Gardens, Kew,
Richmond, Surrey, TW9 3AA
e-mail: S.Walwin@kew.org

There are pteridophytes that grow in deserts. It is incredible but true. They are beautiful plants. Often diminutive and not always very visible but they are there. I've seen them.

Ferns have recently become a passion of mine. I have always admired them for their beauty but the xerophytic species have particularly drawn my attention as they are so very pretty, and for their clever adaptations. They live in dry habitats where we do not expect ferns to survive, which makes them all the more delightful.

Often dwelling in rocky outcrops, they colonise the seams and grow beneath boulders. Some prefer granite, others limestone and metamorphic types. The roots reach far under rocks and the stipes extend the fronds to the light. Hairs, scales, farina, beaded segments and small pinnae are morphological adaptations to the harsh conditions they contend with. Desert areas are frequently windy and the sun's rays are not obstructed by a tree canopy. The rocks and shrubs are the ferns shade giving companions.

California is host to many species of these extraordinary plants. This is demonstrated by the wonderful collection of drought tolerant pteridophytes at the University of California Botanical Garden, Berkeley (UCBGB). I spent three days with the staff at UCBGB, learning about their fern collection and how they maintain it. They have 500 fern accessions, 10% of which are xerophytic. They are thriving, tolerating the winter cold and summer watering. They have created a planter specifically for them, alongside the Cacti and Succulent House on the south facing side. It is a deep, long raised bed with many species present. This bed gets quite a baking in the summer. These ferns are also included in other areas of the garden; the New World Desert, growing amongst cacti and succulents; South Africa; California and Mexico, to great effect. I found many of the staff were interested in these plants. UCBGB have recently received funding to enable them to start a xeric fern propagation project with the intention of introducing them into plant sales.

Fig. 1. The xerophytic fern planter at UCBGB. South facing with a deep long bed. The Botanical Garden is intending to introduce xerics into the plant sales.

A highlight was seeing the beautiful *Astrolepis sinuata* plants in the planter and Mexican section (Fig.2). The fronds are narrow and long (15cm) and the grey/green, ever so slightly bluish pinnae have lobed margins. Later I saw this species growing in Arizona in the Santa Catalina Mountains near Tucson but unfortunately they were brown and crispy as the rains had been a few months ago. To also see South African *cheilanthes* species in the garden was an unexpected treat too.

Fig. 2. *Astrolepis sinuata (wavy scaly cloakfern)*

After my time in Berkeley I drove North-west to Mount Tamalpais, north of San Francisco in Marin County. Here I found *Cheilanthes intertexta* (Fig.3) and *Pellaea mucronata subsp. mucronata* on a large granite boulder near the Mountain Theatre at 2020 feet of elevation on the south side of the mountain. They were slightly shaded by coast live oak (*Quercus argifolia*). On the Matt Davies trail I saw the natural hybrid *Aspidotis carlotta-halliae* growing in full sun. At the East Peak along the Verna Dunshee path (2300 ft elevation) *Cheilanthes gracillima* (Fig.4) was growing in rock crevices in abundance. The fronds are narrow and a vivid green. It has a lovely pendant habit

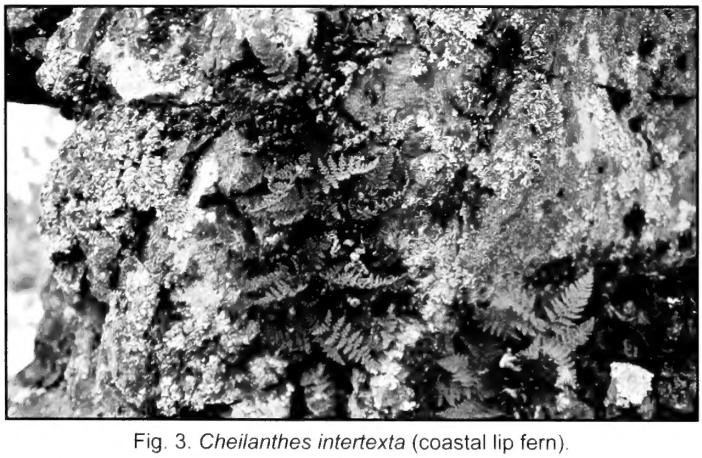


Fig. 3. *Cheilanthes intertexta* (coastal lip fern).

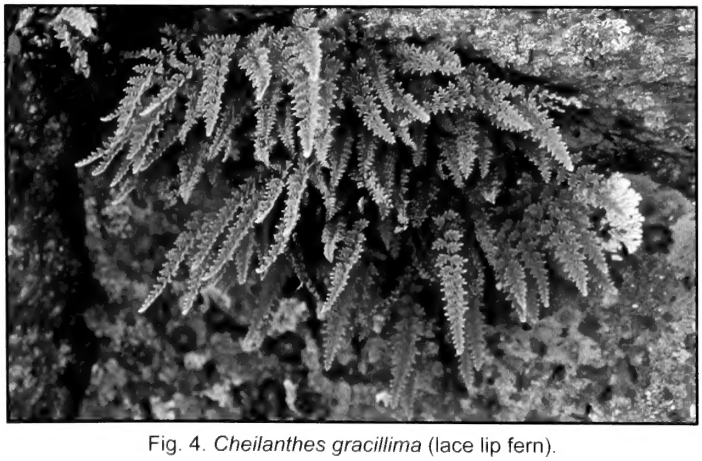


Fig. 4. *Cheilanthes gracillima* (lace lip fern).

and fronds are tomentose on their underside.

It was a great realisation that I could combine two things that I love to do; rock climbing and looking at ferns. When I travelled with David Schwartz around his home county of Kern and down to Palm Springs and east to Arizona we did a lot of climbing. Often the ferns were not far away from the road side, but they often required a scramble up a rocky outcrop to get a good look at them. David Schwartz is a xerophytic fern genius. He grows them, knows their habitats and can spot them at quite a distance away. His garden hosts some lovely specimens, particularly a

Fig. 5. *Bommeria hispida* (copper fern).

gorgeous clump of *Bommeria hispida* (Fig.5).

Kern County is large but we saw most of its drought tolerant species in a day, a few hours away from David's hometown of Bakersfield. Our first site was east along Highway 155, a beautiful drive in spring with its rolling green fields and lush California horse chestnuts. We climbed up and over large boulders of granite to find a fern with a ghostly beauty, *Pentagramma pallida* (pale golden back fern, Fig. 6). The tri-pinnate fronds are completely covered with a dusting of white farina. The stipes are near black, very lovely indeed. Endemic to the foothills of the Sierra Nevada we found it at an elevation of 3000 feet. They were growing at the base of granite boulders

Fig. 6.*Pentagramma pallida* (pale golden back fern).

in abundance. Growing with them were *Pentagramma triangularis* and *Pellaea mucronata*.

Then we make our way east into the Sierra Nevada range, through Seqouia National Forest and towards Lake Isabella. We found *Argyrochosma jonesii* on a limestone rock face. This charming little fern was growing prolifically in the seams of the rock. We drove further up the valley and found an area above a river where *Cheilanthes gracillima*, *Cheilanthes intertexta* and *Cheilanthes covellei* all inhabited the same south facing spot. The genus

Cheilanthes (lip fern) contains some of the prettiest xerics around. And they are some of the easiest to cultivate. Their fronds are made up of many interconnecting beads which prevent total desiccation during their growing season after the moisture from the spring rains has gone. We also found *Pellaea andromedifolia*, which we would see again at various sites. Later that day we drove out to the Mojave Desert to find *Cheilanthes viscida* (sticky lace fern) in Last Chance Canyon. It had newly emerging fronds which was surprising considering how dry it has been there this year (average winter rainfall 200mm).

Fig. 7. *Cheilanthes newberryi* (Newberry's lip fern).

The next day we found *Cheilanthes newberryi* (Fig.7) and *Cheilanthes clevelandii* in granitic areas on the north west slopes of the San Jacinto Mountain near Hemet in San Bernardino National Forest. They were both in full growth and looked wonderful. In the afternoon we travelled to Indian Canyon in Palm Springs. We followed the Andreas trail, flanked by a stream and a swathe of petticoat palms (*Washingtonia fillfera*). Unfortunately the ferns did not look as green as the palms. *Notholaena californica var. californica* and Notholaena *californica var. leucophila* were present but curled up and dormant in full sun.

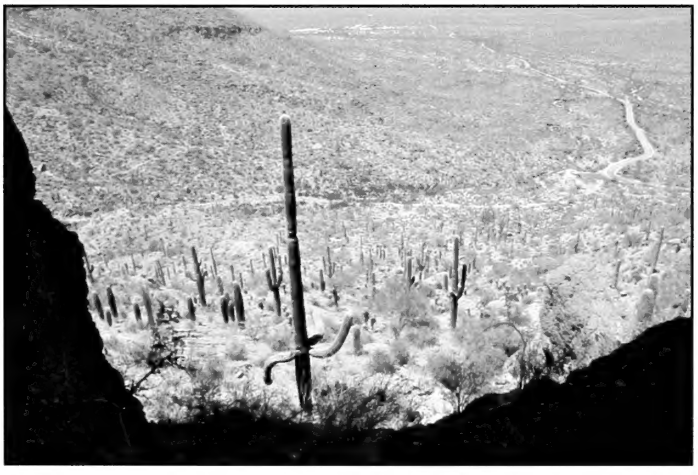


Fig. 8.The Tucson Mountain Park

Arizona has many species of desert ferns and the mountains surrounding Tuscon are particularly rich. In the Tucson Mountain Park (Fig.8), west of Tucson, surrounded by an imposing army of saguaro cactuses (*Carnegeia gigantea*), we hiked a short way up Golden Gate mountain to find *Notholaena standleyi*. A lovely fern with red stipes, pinnae rich green on top and glowing yellow farina covered beneath. The best of them were inaccessible without climbing shoes, but I tried anyway with no success. *Cheilanthes pringlei* inhabited the soil pockets, colonizing them with their long, creeping rhizomes. It was here that I first saw one of my favourite ferns in the wild. *Cheilanthes lindheimeri* (Fig.8). It is a common fern but very attractive. The broadly triangular fronds are very upright. The adaxial side is covered in white hairs, on the abaxial side they are tan. This dainty plant grows along the fringes of boulders. *Astrolepis cochisensis* was present further down on a limestone outcrop.

Fig. 8. *Cheilanthes lindheimeri* (Lindheimer's Lip Fern) and Agave.

In the Molino Basin in the Santa Catalina Mountains, north east of Tucson I was delighted to see so many ferns. We found *Pellaea truncata, Pellaea wrightiana, Cheilanthes lindheimeri, Cheilanthes tomentosa, Cheilanthes bonariensis, Cheilanthes yavapensis, Cheilanthes wootonii, Cheilanthes eatonii, Cheilanthes fendleri, Astrolepis integerrima and Bommeria hispida. Cheilanthes fendleri* is a beautiful species. It enjoys the shade of shrubs. The fronds are tall, up to 30cm high and the fronds are sparser than other *Cheilanthes* species.

In the field it was a little late in the season, but we saw many green plants, some starting to curl and go dormant which was good to see as that information will be useful for identification at all times of year.

I had the pleasure of spending time with Janet Keyes, a member of the Los Angeles Fern Society when I visited L.A. Janet introduced me to Takashi Hoshizaki, husband of the late Barbara Joe Hoshizaki. Tak showed me around Barbara's collection. We found 3 drought tolerant species in the garden doing well and I found the location data using Barbara's collection catalogue. It was great to see the garden and all the filmy ferns in jars in the kitchen.

I hope to grow these ferns at home and at Royal Botanic Gardens, Kew where I work. It would be wonderful to introduce them into the arid plant displays as beautiful, surprising additions. ❐

Acknowledgements:

Funds kindly donated by the BPS Centenary Fund enabled me to take this inspiring trip, thank you. I also received funding from the Merlin Trust, RHS and Hardy Plant Society. Thank you to John Game and Dr Alan Smith at University of California, Berkeley for their location suggestions and enthusiasm for my trip. Thank you to the staff at University of California Botanical Garden, Berkeley for being so welcoming and sharing their knowledge. I would not have seen all these plants without the help and dynamism of David Schwartz, I am very grateful to him.

Useful website- http://www.mineralarts.com/ferns/DesertFernsGuide.html

THE BRITISH PTERIDOLOGICAL SOCIETY

Registered Charity No. 1092399

Patron: HRH The Prince of Wales

Officers and Committee from April 2013

President:	**Prof. J. A. Edgington**,19 Mecklenburgh Square, London. WC1N 2AD President@eBPS.org.uk
Vice Presidents:	**A.R. Busby**, **R.J. Cooke, Dr A.F. Dyer, R. Golding, Miss J.M. Ide, R.W. Sykes**
General Secretary:	**Dr Y.C. Golding,** 7 Grange Road, Buxton, Derbyshire. SK17 6NH Secretary@eBPS.org.uk
Committee Secretary:	**Post Vacant**
Treasurer:	**Mrs G.J. Smith,** Rookwood, 1 Prospect Road, Oulton Broad, Lowestoft, Suffolk. NR32 3PT Treasurer@eBPS.org.uk
Membership Secretary:	**Dr A.J.Evans,** Springfield House, Salterforth Rd, Earby, Lancs. BB18 6NE Membership@eBPS.org.uk
Meetings Secretary:	**B.D. Smith,** Rookwood, 1 Prospect Road, Oulton Broad, Lowestoft, Suffolk. NR32 3PT Meetings@eBPS.org.uk
Conservation Officer:	**Dr H.S. McHaffie,** Royal Botanic Garden, 20A Inverleith Row, Edinburgh. EH3 5LR Conservation@eBPS.org.uk
Conservation Officer & Recorder:	**Dr F.J. Rumsey,** Angela Marmont Centre, The Natural History Museum, Cromwell Road, London. SW7 5BD; e-mail: Recorder@eBPS.org.uk
Project Officer:	**A.C. Pigott,** Kersey's Farm, Mendlesham, Stowmarket, Suffolk. IP14 5RB Projects@eBPS.org.uk
Education Officer:	**Dr A.J. Evans,** Springfield House, Salterforth Rd, Earby. Lancs. BB18 6NE Education@eBPS.org.uk
Publicity and Marketing Officer:	**Miss E. Evans** Springfield House, Salterforth Rd, Earby. Lancs. BB18 6NE Publicity@eBPS.org.uk
Publications Secretary:	**M.H. Rickard**, Pear Tree Cottage, Sutton, Tenbury Wells, Worcs. WR15 8RN Publications@eBPS.org.uk
Editor of Pteridologist:	**A.E. Greening,** Pear Tree Cottage, Burton-in-Kendal, Cumbria. LA6 1NN Pteridologist@eBPS.org.uk
Editor of the Bulletin:	**Miss A.M. Paul,** Dep. of Life Sciences, The Natural History Museum, Cromwell Road, London. SW7 5BD; e-mail: Bulletin@eBPS.org.uk
Editor of The Fern Gazette:	**Prof. M. Gibby,** Royal Botanic Garden, 20A Inverleith Row, Edinburgh. EH3 5LR Fern Gazette@eBPS.org.uk
Editor of BPS Website:	**A.C.Pigott,** Kersey's Farm, Mendlesham, Stowmarket, Suffolk. IP14 5RB Webmaster@eBPS.org.uk
Elected Committee Members:	**I.J.Bennallick, P. Blake, Mrs A. Haskins,Dr S.L.Jury, F.McGavigan, J.P.Reed**
Booksales Organiser:	**Dr F. Katzer,** Highfield House, Muirburn, Biggar. ML12 6HL Booksales@eBPS.org.uk
Horticultural Information Adviser & Archivist:	**A.R. Busby,** 16 Kirby Corner Road, Canley, Coventry. CV4 8GD HorticulturalInformation@eBPS.org.uk, Archivist@eBPS.org.uk
Merchandise Organisers:	**Mr B.D. & Mrs G.J. Smith,** Rookwood, 1 Prospect Road, Oulton Broad, Lowestoft, Suffolk. NR32 3PT Merchandise@eBPS.org.uk
Plant Exchange Organiser:	**J.P. Crowe,** Kellys Cottage, Tredilion, Abergavenny, Gwent. NP7 8BB PlantExchange@eBPS.org.uk
Spore Exchange Organisers:	**Dr B. & Dr S.C.Dockerill,**19 Westfield Road,Glyncoch, Pontypridd, Mid Glamorgan CF37 3AG Spores@eBPS.org.uk
Trustees of Greenfield & Centenary Funds:	**President, General Secretary & Treasurer**

The **BRITISH PTERIDOLOGICAL SOCIETY** was founded in 1891 and is still a focus for fern enthusiasts, its wide membership including gardeners, nurserymen and botanists, both amateur and professional. It provides a wide range of information about ferns through its publications and website, and also organises indoor and field meetings, garden visits, a plant exchange, a spore exchange and fern book sales. The Society's journals, *The Fern Gazette*, *Pteridologist* and *Bulletin* are published annually. *The Fern Gazette* publishes matter chiefly of specialist interest on international pteridology, the *Pteridologist*, topics of more general appeal, and the *Bulletin* deals with Society business and meetings reports.

Membership is open to all interested in ferns and lycophytes. **SUBSCRIPTION RATES** (due on 1st January each year) are Full personal Members £25, Personal Members not receiving *The Fern Gazette* £21, Student members £12.50, Subscribing Institiutions £42. Family Membership in any category is an additional £2.50. Applications for membership should be sent to the Membership Secretary (address above) from whom further details can be obtained. **Airmail** postage for all journals is an extra £10, or for those not receiving The Fern Gazette, £5.00. **Standing Order** forms are available from the Membership Secretary and the BPS website

WEBSITE: www.eBPS.org.uk

Back numbers of *The Fern Gazette, Pteridologist* and *Bulletin* are available for purchase from P.J. Acock, 13 Star Lane, St Mary Cray, Kent. BR5 3LJ; e-mail: BackNumbers@eBPS.org.uk

FERN NURSERIES

FIBREX NURSERIES LTD

www.fibrex.co.uk

Honeybourne Road, Pebworth, Stratford-upon-Avon CV37 8XT Tel: 01789 720788

Hardy and tender ferns, Begonias, Gloxinias, Hederas, Hydrangeas, Primroses, Arum Lilies and plants for the cool greenhouse.

BOWDEN

Hostas, Ferns and Grasses

Incorporating Rickards Ferns

Hardy and non hardy ferns, tree ferns and ferneries planted

Cleave House, Sticklepath. Devon. EX20 2NL

Tel: 01248 600385 www. bowdenhostas.com e-mail: tim@bowdenhostas.com

FANCY FRONDS

North American and British hardy ferns.

"World-wide selection of temperate, semi-tropical, xeric and tree ferns, including Selaginellas, Equisetums and British cultivars"

U.S.A. orders only

www.fancyfronds.com e-mail: judith@fancyfronds.com

FOLIAGE GARDENS - Sue Olsen

Hardy Native and Exotic Ferns

USA orders only

www.foliagegardens.com e-mail: Foliageg@juno.com

HARDY FERNS - R.N. Timm

www.fernnursery.co.uk

The Fern Nursery, Grimsby Road, Binbrook, Lincs. LN8 6DH Tel: 01472 398092

Please send stamped addressed envelope for catalogue

DICKSONIA DIRECT - Billy Alexander

www.dicksonia.ie

Specialising in Southern Hemisphere tree ferns and ground ferns from Australia, New Zealand, South Africa and Chile to both the wholesale and retail trade.

28 Mount Eagles Rise, Leopardstown Heights, Dublin 18, Ireland.

e-mail: billy@dicksonia.ie Tel: ++353 8 7777 6666

LE MONDE DES FOUGERES - Olivier Ezavin

www.pepinieres-ezavin.com

Over 100 fern taxa available for cultivation at -10 to +30^{0}C

955 chemin de puits, 06330 Roquefort Les Pins, France (the nursery is near Nice)

e-mail olivier.ezavin@wanadoo.fr

IVYCROFT PLANTS

www.ivycroft.freeserve.co.uk

Ferns, snowdrops, herbaceous, alpines

Ivington Green, Leominster HR6 0JN - Tel: 01568 720334 e-mail: roger&sue@ivycroft.freeserve.co.uk

PAN GLOBAL PLANTS

www.panglobalplants.com

Ferns, grasses, bamboos, climbers and exotics from around the world

The Walled Garden, Frampton Court, Gloucester. GL2 7EX

Tel: 01452 741641 e-mail: info@panglobalplants.com

Please send 6 x 1st class stamps for catalogue

BENTLEY PLANTS

www.bentleyplants.pherber.com

Specialist growers of Ferns and Japanese Maples.

1 Bentley Wood Cottages, West Tytherley,

Salisbury, Wiltshire, SP5 1QB

Telephone/Fax: (01794) 340775 e-mail: john@bentleyplants.co.uk

PTERIDOLOGIST is published by **THE BRITISH PTERIDOLOGICAL SOCIETY**
c/o Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Pteridologist Volume 5 Part 5 was published on 31st July 2012