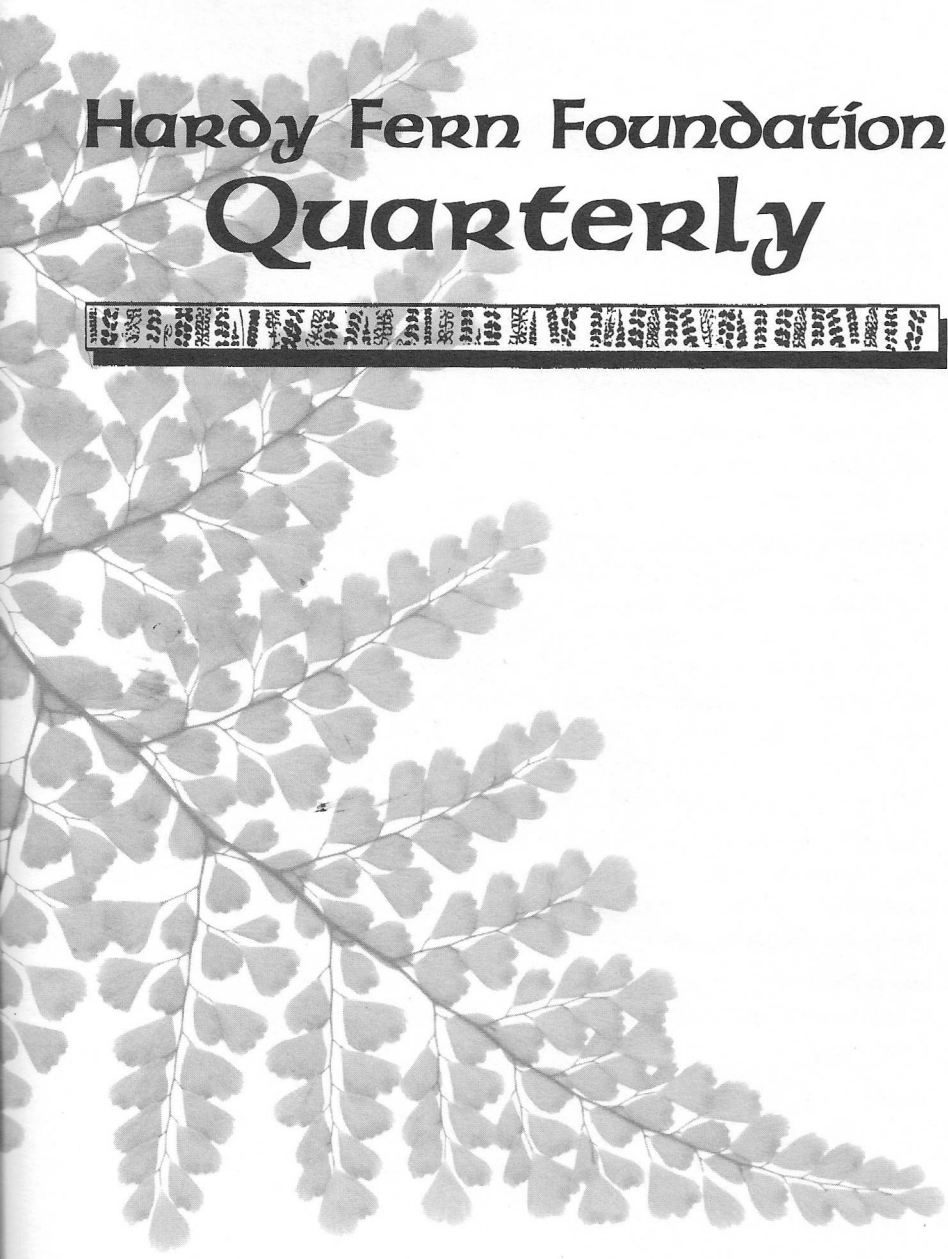
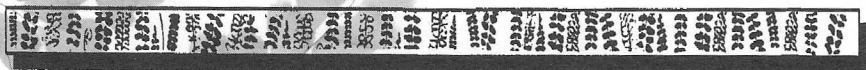


# Hardy Fern Foundation Quarterly



## THE HARDY FERN FOUNDATION

P.O. Box 166

Medina, WA 98039-0166

Web site: [www.hardyferns.org](http://www.hardyferns.org)

**The Hardy Fern Foundation** was founded in 1989 to establish a comprehensive collection of the world's hardy ferns for display, testing, evaluation, public education and introduction to the gardening and horticultural community. Many rare and unusual species, hybrids and varieties are being propagated from spores and tested in selected environments for their different degrees of hardiness and ornamental garden value.

The primary fern display and test garden is located at, and in conjunction with, The Rhododendron Species Botanical Garden at the Weyerhaeuser Corporate Headquarters, in Federal Way, Washington.

Satellite fern gardens are at the Stephen Austin Arboretum, Nacogdoches, Texas, Birmingham Botanical Gardens, Birmingham, Alabama, California State University at Sacramento, Sacramento, California, Coastal Maine Botanical Garden, Boothbay, Maine, Dallas Arboretum, Dallas, Texas, Denver Botanic Gardens, Denver, Colorado, Georgeson Botanical Garden, University of Alaska, Fairbanks, Alaska, Harry P. Leu Garden, Orlando, Florida, Inniswood Metro Gardens, Columbus, Ohio, Lewis Ginter Botanical Garden, Richmond, Virginia, New York Botanical Garden, Bronx, New York, and Strybing Arboretum, San Francisco, California.

The fern display gardens are at Bainbridge Island Library, Bainbridge Island, WA, Lakewold, Tacoma, Washington, Les Jardins de Metis, Quebec, Canada, University of Northern Colorado, Greeley, Colorado, and Whitehall Historic Home and Garden, Louisville, KY.

Hardy Fern Foundation members participate in a spore exchange, receive a quarterly newsletter and have first access to ferns as they are ready for distribution.

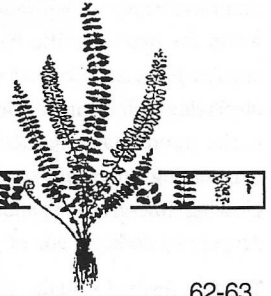
*Cover Design by Willanna Bradner*

**HARDY FERN FOUNDATION QUARTERLY**

THE HARDY FERN FOUNDATION

QUARTERLY

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**The Spore Exchange Needs You!**

*Please send your spores to our Spore Exchange Director:*

Katie Burki  
501 S. 54th St.  
Tacoma, WA 98408

## President's Message - Summer 2004

Summer is upon us, with sunny days and temperatures in the eighties, although a bit too warm for many Pacific Northwesterners especially when out in the open. Spring crociers have unfurled and expanded to their early summer glory - Osmundas already displaying their distinguishing cinnamon colored sporangia - Blechnums with their stately fertile fronds standing above nutritive producing deep green vegetative fronds - the reappearing Athyriums standing fully in their numerous species and varieties - and the glowing lime-green expanding fronds of the Cyrtomiiums slowly changing their hue to a deeper and darker shade of green as summer comes upon us.

The fern festival held this past June 4<sup>th</sup> and 5<sup>th</sup> at the Center for Urban Horticulture was a wonderful event. Over two thousand ferns representing over sixty species and varieties were sold over the two day period making it the largest number of ferns ever sold at this event. We had gotten wonderful publicity about the event throughout the region, but most notable was a wonderful article on fern gardening and the upcoming festival by Valerie Easton (garden writer for the Seattle Times) in the Northwest Magazine in the Sunday Edition the week before the event. An entertaining and informative lecture by garden designers Charles Price and Glenn Withey on ferns and plant combinations was most appreciated. All of us HFF members were quite taken by the numbers of people that came to the festival inquiring about what ferns are recommended for various situations and how best to grow the ferns they purchased. Almost every fern was sold by the festival's end. A sincere thank you to the HFF board, members and volunteers in putting together this event and making this Fern Festival such a wonderful experience.

HFF is receiving much praise for the installation of the Fern Habitat Garden located at the Washington Park Arboretum. The garden has generated a lot of attention to fern gardening in the region and to the HFF itself. Thank you Michelle Bundy and Richie Steffen for the updating, clarification and improvements on the brochure for this display garden. This past May, the HFF board members gave a class on ferns and fern gardening at the Visitor's Center which was well received with the Fern Habitat Garden used as center stage. The summer edition of the Washington Park Arboretum Bulletin features an article on the Fern Habitat Garden with absolutely gorgeous photographs of ferns by HFF board member Richie Steffen.

HFF board members attention these coming months will be focusing on ways to make the organization more effective and to improve in the areas where we are already involved. More on this in subsequent messages.

May this summer bring a few intermittent rains, may your ferns thrive and happy fern gardening.

Best regards,

*John van den Meerendonk.*



*(left) Fern Festival 2004.  
Photo by Bors Vesterby.*

*(below) Richie Steffen with the HFF  
Arboretum Signature Bed Fern Class.  
Photo by Bors Vesterby.*



## Welcome New Members

---

Robert Bagwill

John J. Brown

Carrie Cone

Jose' Escobar, PhD

Becca Fong

Dan Green Jr.

Elisabeth Griggs

Patricia A. Henderson

Cheri Jacques

Sara Little

Joann Lovelace

David Lyons

Stuart and Martyna Mandel

Sue Neill

Margaret Nimmo-Smith

Agnes Overbaugh

Maryann and Charles Pember

Lvana Richards

Robyn Ricks

Pat Riehl

James Senko

Ann Stewart

Bill Warren

Pamela Weil

Sally Williams

Bill and Cameron Wilson

Luellen Wolsing-List

Gretchen VanLom

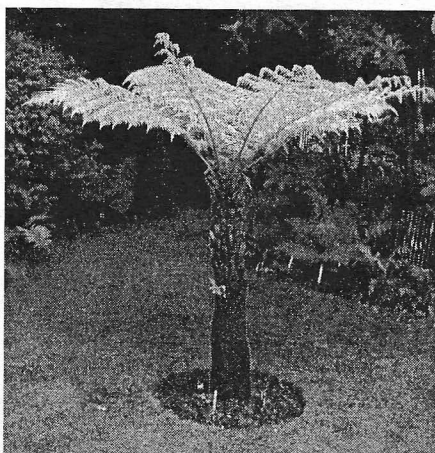
## At Last, an Excellent Book on Tree Ferns

*Tree Ferns* by Mark F. Large & John E. Braggins (2004), pp 359, Timber Press, Portland, Oregon & Cambridge, UK ISBN 0-88192-630-2; cover price: \$39.95 & £29.99.

*Reviewed by Alastair Wardlaw - Glasgow, Scotland.*

For me, a sentence in the *Foreword* sums it up: 'To study and to grow tree ferns is thus to associate with some of the most remarkable of living things'. Written from New Zealand by two professional botanists, this is the first published book on tree ferns. Mark Large has a background in fern evolution and paleobotany, and John Braggins is a tree-fern taxonomist and ecologist. Together they make an authoritative team.

The authors interpret 'Tree Ferns' liberally, to include all ferns with some kind of trunk. However the main focus is on the approx 600 species within the families Cyatheaceae and Dicksoniaceae, including the few species therein with no trunk. Outside of these families, several trunked species of *Blechnum* and *Sadleria* are illustrated and/or described, as well as *Angiopteris evecta*, *Osmunda regalis* and *Todea barbara*.



Mid-June: 2004: Croziers almost finished expanding on the *Cyathea australis* in the reviewer's garden in Glasgow, where it was planted in 1997 and has been wrapped each winter. This is one of the 4 species of *Cyathea* listed in the most frost-hardy category of Appendix 3.

### The book's cover states:

'This volume is *the* source of information on the living tree ferns. It surveys all the families, genera and species, including those that are suitable for the home garden. It offers up to date taxonomy and detailed descriptions as well as in-depth coverage of everything from tree fern use to conservation. In recognition of the horticultural importance of tree ferns, the authors provide extensive cultivation information, including propagation and diseases and pests.'

Does the book meet these claims? I would say yes. The authors *have* produced a comprehensive work on tree ferns, written in an accessible style, and with technical terms well defined. I would not describe it as a 'coffee-table book' partly because it is too substantial in content, but also because the majority of the 359 pages have no illustrations. The 60 pages of beautiful color plates – and tree ferns are excellent photo-

graphic subjects! - are all segregated in a centre section. The book will certainly appeal to tree-fern fanatics and to fern enthusiasts generally. Also gardeners of the more adventurous type, landscapers and conservationists will want to refer to it for reliable information about these primeval-looking plants. Taxonomists will find specialist information on nomenclature. Unusual for a book of 359 pages, there are only 3 chapters, of which Chapter 3 occupies 202 pages, or two-thirds of the text.

**Chapter 1, Introduction** with 18 pages, starts with the primeval tree ferns that lived 340 million years ago in the Carboniferous era, long before emergence of the dinosaurs or the flowering plants. Thus the tree fern 'habit', continuing as it has done to the present day, is extraordinarily persistent. Not only did tree ferns precede the dinosaurs, but they also survived the catastrophic event which caused the extinction of these creatures 65 million years ago. Tree ferns, in common with other ferns, have a life cycle with the alternation of generations between the tiny gametophyte stage and the eventually-massive sporophyte. The cycle starts with a wind-blown spore, or preferably several, landing close together on bare ground. Germination follows and leads to the inconspicuous and short-lived gametophyte on which fertilization takes place. The young sporophyte plant then emerges and, over a period of years, develops into a trunked fern. Thus the final tree fern is committed to growing on the spot where the spore originally landed several years previously. Horticulture changes this when the tree fern is removed to where the gardener decides to plant it. Even a well chosen site may not allow perpetuation of the life cycle, although the tree fern may grow there for many decades indeed, reportedly for more than 200 years.

*Tree Ferns* emphasises the essential anatomical differences between the trunk of a tree fern and the trunk of a tree. The non-ferny reader is also introduced, with line drawings, to the terminology for frond shape and degree of dissection of tree-fern fronds, most of which are highly divided. Only *Cyathea sinuata* has a simple strap-shaped frond like a hart's-tongue fern. An important diagnostic clue for distinguishing Cyatheaceae from Dicksoniaceae is in the scales and hairs that cover the base of the stipe. Members of the Cyatheaceae have scales, whereas Dicksoniaceae have jointed hairs - easy to tell apart under magnification. Line drawings of the different scale types within the Cyatheaceae allow identification of the sub-genera (also known as 'clades') within the family: *Alsophila*, *Cyathea* and *Sphaeropteris*. In the description of spores, and the astronomical numbers in which they are produced, Mike Large reports that a big specimen of *Cyathea medullaris* may release up to 2 kg of spores in a single year.

There is a useful summary of the evolution of tree ferns during the last 250 million years and the numerous genera in the fossil record. *Dicksonia* is the oldest of the genera still represented today, with fossil members occurring since the mid-Jurassic, around 160 million years ago. By contrast *Cyathea* as a genus, dates apparently only from the mid-Tertiary, of about 30 million years ago, and is still undergoing active speciation.

Conservation of tree ferns is considered but not in much detail. Forest clearance in tropical countries is endangering many species, as is the harvesting of trunks for horticultural fibre and rustic sculpture. However it seems that the massive export of common tree fern species from Australia for the horticultural trade is under effective government control in that country.

*continued on page 66*

## At Last, An Excellent Book on Tree Ferns *continued from page 65*

**Chapter 2, *Cultivation and Propagation***, with 12 pages, is relatively short. It points out the crucial importance of the apical area at the top of the trunk, without which the tree fern can not grow (except for a few species with lateral buds). It emphasises a normal requirement for high atmospheric humidity and, for most species, protection against cold, drying winds and freezing temperatures. In Appendix 3 only 7 species are listed as capable of 'surviving occasional snow and frosts of  $-5^{\circ}\text{C}$ '. Enclosed courtyards are described as giving good protection. From personal experience I can confirm this 'courtyard effect'. It is well demonstrated by the winter greenness of five otherwise unprotected *Dicksonia antarctica* in the interior courtyard of the administration building at the Royal Botanic Garden Edinburgh, a cold city. The authors emphasise that the watering of tree ferns should be done on the sides of the trunk and not directly into the crown, to avoid fungal rots. The relatively few bacterial and fungal diseases of tree ferns are described and how they are best avoided by attention to watering and drainage. Sapsucking insects are common on many tree ferns and where possible, manual removal is recommended rather than chemical treatment.

**Chapter 3** with 202 pages, entitled *The Tree Ferns*, makes up the major part of the book. It consists of a systematic account of the families, genera and species of Cyatheaceae, Dicksoniaceae, Osmundaceae and some other families with trunked ferns. It starts with Linnaeus and the several tree ferns to which he applied his pioneering binomial nomenclature. However his assignment of tree ferns to the genus *Polypodium* has long since changed. The chapter contains a blow-by-blow account of the 'taxonomy wars' between splitters and lumpers within the Cyatheaceae. Still controversial is whether the family should contain one genus or up to six. Kramer (1990) at one extreme, considers the Cyatheaceae to have a single genus *Cyathea* with 600-650 species. Other authorities, have split the family into as many as 6 genera. Large & Braggins settle for two: *Cnemidaria*, with 25 species, and *Cyathea* with '470+' species. The latter are then subdivided into the 'clades' (species numbers in brackets): *Alsophila* (230-235), *Cyathea* (120+) and *Sphaeropteris* (120+). Thus confusingly, the appellation *Cyathea* has several different meanings according to which assemblage of species it embraces. In the Kramer sense, it means the single genus of 600-650 species within the Cyatheaceae. As used by Tryon & Tryon (1982), *Cyathea* is one of 6 genera in the family, while with Lellinger (1987) it is one of 4. With Conant (1996), *Cyathea* is one of 3 'clades' within the family, whereas with Large & Braggins in this book, *Cyathea* has dual usage. Thus it is one of two genera within the Cyatheaceae and also one of the 3 clades within the genus *Cyathea*. Amid all this potential confusion, the book at least alerts the reader to the problem. I, for one, did not feel I had to throw up my hands in despair.

The descriptions of the families and genera of tree ferns are well done, with a taxonomic key down to the genus level. However, to provide keys to species level on a World-flora basis is not yet possible (as it is likewise impossible with other, more familiar, fern genera like *Dryopteris* and *Polystichum*, for example). Unsurprisingly therefore, Large & Braggins do not attempt species keys for either *Cyathea* or *Dicksonia*. Instead, by my count, 506 species of tree fern are described individually, in alphabetical order, from *Calochlaena dubia* on page 61, to *Todea barbara* on page 308. Each species gets at least a paragraph of description, sometimes up to a full page. These descriptions include taxonomy and synonyms, morphology of fronds, trunk and spores, geographic distribu-

tion and habitat, and advice on cultivation. Obviously this is a heroic undertaking, and not intended as easy bedtime reading. The authors are to be congratulated on such a substantial compilation, which will surely be a resource of detailed knowledge of tree ferns for many years to come.

Out of interest I counted the number of species thus described in each alphabetically-listed genus, and arrived at the following summary: *Caloclaena* (4), *Cibotium* (9), *Cnemidaria* (24), *Culcita* (2), *Cyathea* (432), *Cystodium* (1), *Dicksonia* (21), *Leptopteris* (3), *Lophosoria* (1), *Osmunda* (1), *Sadleria* (6), *Thyrsopteris* (1) and *Todea* (1). It is slightly strange that the trunked species of *Blechnum* are not given individual treatment in the alphabetical section, although several of them appear, nicely trunked, in the colored plates. *Angiopteris evecta*, likewise has a colored illustration showing a trunk, but does not get a text description. Yet *Osmunda regalis* gets both text description and a color picture.

With the Cyatheaceae, Large & Braggins describe a total of 467 species, comprising 24 *Cnemidaria*, 432 *Cyathea* and a further 11 Cyatheaceae 'requiring further study'. While this total of 467 described species is very impressive, it would seem to fall short, by something in the order of 130-180 species, of the 600-650 taxa suggested by Kramer. It leads me to wonder with this family of tree ferns if there has been either species inflation or taxonomist fatigue, or a bit of both. I was also reminded of Voltaire's quip that God must have loved the common man because he made so many of them. It was J.B.S. Haldane, I think, who made a similar remark about the innumerable species of beetle in the World. Question: has divine favour also been directed at the species of Cyatheaceae?

The book ends with several useful appendices. One provides a list of tree ferns arranged by the different geographic regions of their occurrence. Another lists the species suitable for cultivation in gardens, presented according to different categories of frost-hardiness. This latter compilation will encourage the seeking out and experimentation with a good few species not commonly available. There is a Glossary of technical terms, mainly relating to morphology. The book ends with a Bibliography of about 130 references and a 20-page Index.

Not discussed so far are the illustrations. The color plates are gathered into a centre section of 60 pages and comprise 131 full-color illustrations. Since tree ferns are such photogenic subjects, this section is very seductive and will have wide appeal. The pictures include tree ferns in their many types of wild habitat, and in botanical gardens. Close-ups of croziers, fronds, trunk anatomy and sporangia are also featured. There are about 15 b/w distribution maps of tree fern genera. Perhaps disappointingly, there are only a few line-drawings of frond anatomy, of the kind that can be so useful for identification.

In summary, this is a well-planned, well-written, well-produced and attractively illustrated book at a reasonable price. It successfully accomplishes the enormous task of describing over 500 species of tree fern in an authoritative and comprehensive way. It therefore deserves to be widely purchased by plant enthusiasts, amateur and professional, who have an interest in these fascinating plants.

*Alastair Wardlaw is the President of the British Pteridological Society and a keenly enthusiastic and accomplished grower of tree ferns in the challenging climate of Glasgow, Scotland....ed.*

## Frustration is the Mother of ...

Tom Stuart - Croton Falls, NY

When I would go out into the garden or the woodland, an unidentified fern often led me back to field guide or flora. Often enough, the answer was not obvious at the first stop. Or even the second. What to do?

Why is this so? Backtracking finds several answers, and most of them either have to do with language or with incompleteness.

When you encounter **adaxial**, do you pause? Yes, jargon is one impediment to identifying our plant. Jargon is seemingly embedded in the human condition, though one can sometimes find an author avoiding it; John Mickel comes to mind.

Though some use of jargon is certainly gratuitous, it is not particularly easy to argue against it, because many technical words — the polite name for jargon — either have subtly distinctive connotations or they have no correlative in simple language. An example of the former is **chartaceous**, used to denote a frond with a papery texture thicker than **papyraceous**. Most amateurs would be happier with **papery**. A word without an English equivalent is **anadromic**, indicating a venation pattern easy to show in a picture, but complicated to detail in words. Nonetheless, jargon always raises the barrier to understanding by the layman.

When you encounter **pinnatifid**, do you pause?

"Certainly not," she exclaimed!

But perhaps she should. Here are seven definitions, all from reputable sources:

**pinnatifid**. Pinnately cut, more than half way to the midvein, *Lower Vascular Plant Glossary*, Mickel.

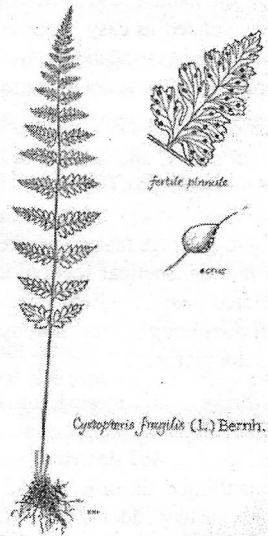
**pinnatifid**. Pinnately cleft, *Ferns and Fern Allies of Canada*, Cody and Britton.

**pinnatifid**. Deeply lobed, but not cut to the axis, *Ferns and Fern Allies of the United States and Canada*, Lellinger.

**pinnatifid**. Incised nearly all the way to the axis, with the segments not contracted at the base, *A Modern Multilingual Glossary for Taxonomic Pteridology*, Lellinger.

**pinnatifid**. Cut half to three-fourths to the rachis, *Fern Grower's Manual*, Hoshizaki and Moran.

**pinnatifid**. Once divided with the divisions extending one-quarter to half way to the rachis, *Encyclopaedia of Ferns*, Jones.



*Cyrtopteris fragilis* (L.) Bernh.  
Illustration by Edgar Paulton, from  
"How to Know the Ferns and Fern  
Allies", John T. Mickel, © 1979  
Wm. C. Brown Co.

**pinnatifid:** Cut deeply (but not to midrib) into lobes that are spaced out along the axis, *Flora of Australia*.

As sure as you were 15 seconds ago? A basic word in our vocabulary is not as firmly rooted as we might wish. Well, surely our authors, our basic sources, agree on particular ferns and fern parts. Let's look at rhizomes.

Among the many terms for rhizome forms are clumping, shuttlecock, ascending, erect, creeping, stoloniferous, running, rosette, and tufted. Their meanings overlap to varying degrees; how much? These terms never appear in glossaries, because they are simple English words you can look up in the dictionary. It is easy to find different terms used for the same plant even by one author; it is almost rare to find the same term used by several authors. It is no exaggeration to call this terminology just plain muddy.

Let's look at a particular fern, one of the commonest ferns in the temperate world, *Cystopteris fragilis*. This has been called:

**bipinnate-pinnatifid**, *Ferns for American Gardens*, J. Mickel

**usually bipinnate**, *The Plantfinder's Guide to Garden Ferns*, M. Rickard

**finely bipinnately or more divided**, *The Ferns of Britain and Ireland*, C.N. Page

**bipinnate to bipinnate-pinnatisect**, *Scandinavian Ferns*, B. Øllgaard

**blades bipinnate; pinnae pinnatifid to lobed**, *Ferns and Fern Allies of Canada*, W.J. Cody and D.M. Britton

**2-pinnate**, *An Illustrated Fern Flora of the West Himalaya*, S.P. Khullar

**bipinnatiparted to bipinnate**, *Flora of Japan*, J. Ohwi

I am not sure what every one of these descriptions mean, but I am sure they are not all in agreement. Jargon, wobbly language, muddy language, poor eye sight, where does it end?

When descriptions are complete, they can be confusing. How much more confounding, then, when they are incomplete. Most fern books, and especially species-comprehensive books, are terribly short on diagnostic facts. The prime cause of this is probably the cost of complete descriptions and sufficient illustration. A notable, superb exception is *Scandinavian Ferns*, B. Øllgaard, illustrated by K. Tind, Rhodos, 1993.

Floras frequently include only enough to distinguish one plant from the others within their territory, not sufficient information to evaluate a candidate that may or may not reside therein. Monographs on a single genus are thorough, but are infrequently produced, not readily available at your local library, and suffused with technical terms.

Frustrating, isn't it? So, it was time to do something about it. I sat down last winter and began constructing a web site to bring together diagnostic information on hardy ferns. Perhaps you will be as surprised as I was at how much is already available now on the net, and its growth every day.

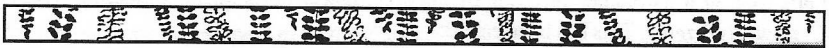
*continued on page 70*

## Frustration is the Mother of ... *continued from page 69*

I imposed several arbitrary limits to bring the project down in size. It's confined to **hardy** ferns, and at the start **hardy** means Zone 7. It's confined to ferns **in cultivation**, mostly in North America and Europe. It's confined to **species**; subtaxa are frequently mentioned, cultivars not at all. It's confined to **fertile** or self-reproducing ferns, not sterile hybrids. At this, the site opens with about 170 species. Features are still being added, notably a searching facility still on the drawing board.

Built into the site is a capability for fern fanatics to add fern facts and fern photos. Come, banish frustration:

<http://hardyfernlibrary.com>



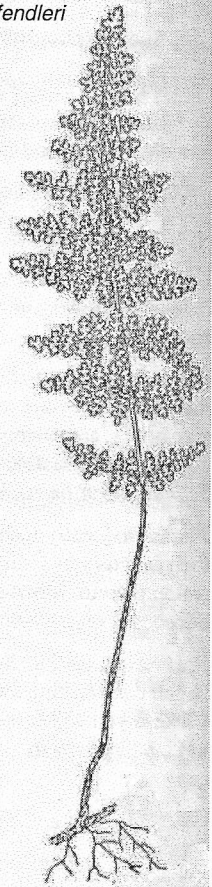
*Cheilanthes fendleri*

### ***Cheilanthes fendleri***

#### **Fendler's Lip Fern**

*James R. Horrocks - Salt Lake City, Utah*

*Cheilanthes* is a large genus of ferns, the name referring to the position of the sporangia beneath the lip-like false indusium. This is a small somewhat evergreen fern epipetric in crevices of igneous rocks or on dry ledges and under boulders, in acid to sub-acid soils. Hoshizaki describes it as evergreen while Mickel has it as deciduous (*It is evergreen in the Seattle area...ed.*) These observations may be due to climate, as it may very well be deciduous in colder areas. It is hardy to zone 5. It is occasional in its distribution ranging from Oklahoma, western Texas, and southern Colorado into the southwest and Mexico. It grows in full sun in well drained moist to dry soils. It is similar to *C. covillei*, but has loose scales rather than strongly appressed ones. This species is often confused with several other *Cheilanthes*, especially *C. lanosa* and *C. tomentosa* and is often mislabeled in the nursery trade. From a short distance, a large colony of its stiff, upright fronds looks rather like a forest of miniature conifers.



**Description:** The rhizomes are long-creeping with the fronds mostly scattered along them, but sometimes closer together. The stipes are chestnut-brown to purplish-black in color, scaly, and comprise half the length of the fronds. Scales are lanceate, of basically one uniform color but occasionally faintly bicolorous, being whitish to reddish-brown. The scales have long teeth near the base. There are also long hair-like scales present. The laminae are oblong-lanceolate to ovate-triangular, tri-pinnate to even four times divided. They are from six to twelve inches long. The blade is glabrous on both sides but there may be some scales present on the lower surface near the base. The primary and secondary costae of the pinnae and pinnules are densely scaly, often covering a portion of the segments. The fronds are acuminate at the apex, that is, the pinnae are attached to the rachis at less than 30°. The margins of the pinnules are strongly under rolled, forming a false indusium which is continuous along the edge. The sori are obviously clustered at the margins.

**Culture:** This attractive species is at its best in sub-acid soil, having a liking for igneous rock. This may be why it has been a strong performer in the northwest. It should be grown in a high light situation, as too much shade may cause the fronds to be spindly and the plants to be short-lived. With its long-creeping rhizomes, it can form extensive colonies which are quite attractive with their upright growth. There is a beautiful photograph in Barbara Joe Hoshizaki's revised and expanded edition of *The Fern Grower's Manual* (plate 22). *Cheilanthes fendleri* is easily grown from spore. Many *Cheilanthes* are apogamous, a trait found among many ferns inhabiting arid regions. This is a candidate for the sunny rock garden, but all species of *Cheilanthes* should be planted between large rocks or next to boulders to give their roots a cool uniform habitat. Fluctuations in moisture content of the soil can wreak havoc with some species. This is a charming little addition to any sunny garden and is well worth seeking out, although it is not very often available.

## References:

- A Field Manual of the Ferns and Fern Allies of the United States and Canada* (1985), David B. Lellinger, Smithsonian Institute Press, Washington D.C.
- Fern Grower's Manual* (2001) Barbara Joe Hoshizaki and Robbin C. Moran, (Revised) Timber Press, Portland, OR
- Ferns for American Gardens* (1994) John Mickel, Macmillan Publishing Co., New York

## Fern Visit To Sao Miguel, Azores 2004

*Pat Acock - St Mary Cray, England*

The Macronesian Islands have long been a place of fascination for members of the fern fraternity. In the late 1940s an expedition raised interest further when a party from Leeds University led by Professor Irene Manton visited Madeira and new cytological research on *Aspleniums* and *Dryopteris* brought back started to reveal information on the ancestry of much of the European fern flora. Many people started to visit the islands as a whole from Britain and Europe and much work was done on the overall flora with many fern specialists making a contribution to the checklists and floras with further research being carried out on living material brought back. This work continues to this day.

In 1995 the BPS organised a tour for the BPS led by Andrew Leonard and Graham Ackers and the amateurs had arrived! We had on the team Dr Mary Gibby from the Natural History Museum who was able to guide us and also collect material for her work and disseminate her knowledge of the region, which further gripped the imagination of the general members of the society. During the meeting plants of a sub-tropical nature were seen that were not so dissimilar to ones that members were either familiar with or grew in their gardens. Potential for members to add to their collections by growing from spores and offering these spores to the wider membership added to the interest.

Since this time a few other visits have been made. Some of these have been official BPS meetings and others have been visits by those who have attended or shown interest in visiting the islands and have been invited. All of them have been lead by the BPS Treasurer, Andrew Leonard who since he took an interest in ferns in the late 1980s has travelled extensively in search of ferns.

After another visit to Madeira at the end of October 2003, he proposed to those attending a visit to Sao Miguel in the Azores, to much popular approval. The Azores are an archipelago of nine main islands on the Mid Atlantic Ridge about one third of the distance from Europe to America. They are therefore of volcanic origin. The main islands are in three groups, the eastern, the central and the western groups and are separated by 400 miles from one extreme to the other. They are also more northerly than some of the other island ranges and being quite tall often have snow down to 1800 feet as well as frosts. This gives an added interest in the prospect of growing many of the ferns in the milder parts of Europe and America.

Our leader decided to take us to the largest island with the most ferns, Sao Miguel, which is also capital of the group. Aeroplanes do leave Sao Miguel on regular patterns for the other islands all of which apart from Corvo have well-established business and tourist accommodations.

We spent ten days on the island in early May and the weather was pleasantly warm and unusually dry for the time of year the residents told us. Our leader's objects were to see as many of the ferns known from the islands as possible and to compare their status with that found by Wilmanns and Rasbach in April 1972 (1973).

Because of the nature of people's work commitments some stayed eight days others nine and a handful for the full ten days but all managed to arrive on the first day so we

were able to all eventually meet up for a briefing at around nine o'clock on the first evening. Despite a late approach to bed our leader insisted on an early rise with breakfast at 8 o'clock sharp and this tended to be the pattern of the time we spent in the Azores.

On our first day we headed slowly westward towards the lakes at Cete Cidades. Our slow progress was twofold. Firstly a number of new roads had been added not featuring on our maps and secondly whenever we stopped to check the eager pteridologists were out to explore the fascinating new terrain. We were especially taken with the walls at first, which were covered in spleenworts and other wall ferns. Eventually we made it to our destination in time for lunch. An ethnic meal at lunch has also become a tradition. This usually allows us a breather from the exertions although some days it is impossible to be close to civilisation for the recharging of batteries.



Matthan Schout, Tim Pyner, Pat Acock, Andrew Leonard (leader and provider of first photo), Martin Rickard, Alison Evans, Mike Hayward and Lizzie Evans.

The walk between the lakes proved to be very lucrative on the quantity of ferns observed with seventeen found. We clocked up eleven sites on this first day and it gave us an overall impression of the problems of the island with regard to alien plants. Certain plants were becoming ubiquitous. *Cyrtomium falcatum* was nearly everywhere and taking the place of native ferns, especially *Asplenium marinum*. *Adiantum hispidulum* was colonising rock faces but perhaps was not such a menace. The most threatening plant however was a ginger, *Hedychium gardneranum*. This pernicious weed was filling the understorey through the woodland edges and out into full sun. It was moving into remote valleys and has such a stranglehold of many of the ferns niches that it is difficult not to expect extinctions in the near future. The plant is well beyond the possibility of removal by weeding and probably got a hold as people enjoyed its bright colours before being aware of the problem; it is even noted in the tourist guides for its attractiveness.

The following day found us at the seashore to find that where *Cyrtomium falcatum* was not replacing *Asplenium marinum*, opuntias were. Now we were to experience our first taste of the volcanic nature of the islands at Caldera Velha. A waterfall filling a natural hot tub poured really hot water and I was a little disappointed that something really exotic was not growing behind it but we did see *Stegnogramma pozoi* and a little *Trichomanes speciosum*. Martin Rickard and I after the rigours of bathing now took an interest in all the cyatheas surrounding us. We became aware of another tree fern besides *Cyathea*

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## Fern Visit to Sao Miguel *continued from page 73*

*cooperi* that looked superficially like *Cyathea medullaris*. It had very dark stipes, was much larger in the frond and had large numbers of thin dark scales in contrast to the large numbers of straw-coloured wide scales with a few dark thin scales of *C. cooperi*. However there seemed to be a grading with some plants half way between the extremes. We thought that it must be natural variation. Outside the bathing area there were two large plants that were at the extremes. We began to wonder if we had two plants again.

We now made our way to one of the peaks where in the sparse vegetation we were surprised to find many ferns but then as we searched around we were even more surprised in this place frequented by snow in winter there was *Culcita macrocarpa* and *Cyathea cooperi*.

In Furnas we were taken to another volcanic bathing area in a most fabulous botanic garden. Some chose to bathe after dinner and others chose to have a second look at the plants. We were fortunate to have the man who looked after the ferns track us down. It was claimed there were over 140 ferns in the garden. There were not but that is to be pedantic for there were scores of them especially in the fern garden where they were laid out in clumps to maximum effect. We were able to correct a few labels and disagree about some. I did enjoy tracking down *Woodwardia areolata* at last and seeing so many ferns naturalised in various parts of the garden. Gardens around the area also took an interest in ferns and we saw *Sadleria cyatheoides* and *Cyathea leichardiana* in two gardens close to the botanic garden.

Another full day saw us take in Lagoa do Congro and Lombados. We might not have had any dinner that night if we had not eaten out on the road as we had a two hour journey home and it was already dusk when we finished ferning. We hoped to find the elusive *Dryopteris crispifolia* while circumnavigating the volcanic lake of Lagoa do Congro but although we knew it was sixteen feet above the lake's edge we were not able to track it down but did track down eighteen other ferns.

At the hot water springs in the aptly named Caldeiras we saw most of the ferns we had seen so far in the small area of the village. It is a very strange experience to be able to put your hand into a river so hot you have to take it out and to sit on a wall looking into a pond in which you could be boiled if you fell in. However *Pityrogramma calomelanos* seemed to enjoy growing just above the waters. With twenty-six ferns in this small area including the alien *Diplazium esculentum*, we made our way on to Lombados where Martin and I enjoyed seeking out the cyatheas and also a number of *Dicksonia antarctica*. Time was short and we wished we had more to wander further up the valleys but our leader was concerned that we were becoming unruly and had set a time of returning to the cars. When we did we found that our eagle-eyed colleague from Holland, Matt Schout had found a new fern for the week in *Cystopteris diaphana*.

The next day we were weary but that did not stop us assaulting Pico da Vara. This was mainly by default as we were stalling after a long drive. Our leader eventually gave in and allowed coffee and cake. What he never hinted at however was that we were to press on up a mountain without any lunch. However around one o'clock we had a feeding of the five-thousand experience when all we could do was take out what little we had and share it. This turned out to be more than sufficient for our needs and all agreed they had eaten well. On the way up we found *Elaphoglossum semicylindricum* albeit only a few plants.

Near the summit we found a really pleasant spot in the open moorland. Martin managed to track down *Hymenophyllum wilsonii* and Matt came across a strange *Dryopteris* that we believed could not be *Dryopteris azorica*. We hoped it was the rare in the Azores, *Dryopteris dilatata* but we forgot between us to bring back a specimen for the experts to look at. On the way down, we were further exasperated by the second most invasive alien, *Cryptomeria japonica*. This tree related to the sequoias had been introduced to help the local economy but was now rampant. Unfortunately it rains scales and twigs and larger debris and fails to have horizontal footholds for the epiphytic, *Elaphoglossum semicylindricum*. This once quite common epiphyte was now reduced to living on old culcita stumps and was then bombarded by debris from above.

The next day also saw us in the Northeast but before we reached the mountains along the coast we came across two ferns of special interest. One was *Asplenium hemionitis*, a lovely shaped plant that seems to be succumbing to the ginger and the other *Blechnum appendiculatum*. This unusual *Blechnum* is confined to this Northeastern part of the island but is thought to be an escaped alien related to *Blechnum occidentale*. Once again around Pico Verde we were frustrated by the *Cryptomeria japonica* which forms an almost impenetrable barrier through the forest and one was reminded of how difficult it must have been for Lewis and Clark exploring the Northwest of the USA. We found very few new *Elaphoglossum semicylindricum* apart from the few Martin had found at the woodland edge as we were finishing our picnic lunch.



*Hymenophyllum tunbridgense*

*continued on page 76*

## Fern Visit to Sao Miguel *continued from page 75*

After an hour we switched to auto-ferning. As we descended we would hop out of the cars for a brief foray before continuing. It was on one of these stops that our leader discovered on a ledge about nine feet from the ground *Dryopteris crispifolia*. What a site that was to see him being launched vertically to get a closer look by the strongest member of the party Tim Pyner. I was next to go and Martin joined us by the less demeaning route. Photographs taken we returned home weary but excited by the fact we had found a plant rarely seen by anyone on this island.

On the following day we retraced our journey of the first day towards Cete Cidades. In Nascent Park we took a few extra trails marvelling once again at the size of the *Culcita macrocarpa* and the quantity of *Hymenophyllum tunbrigense* climbing up the trees and to the height it attained. Travelling back we found the old barn that eluded us on the first day and were able to find and count eighty plants of *Asplenium monanthes*, which is confined to this small area of the island.

Our wish for a return to Lombados, the following day saw us break into three or four groups to do our own thing in the valleys around the old mine. We did not add to the list at Lombados but did find another extensive colony of *Diplazium esculentum* on the way up. The following day reduced to just four of us we were above Lombados in the mountains. Here we were rewarded by a large colony of mature *Dicksonia antarctica* in a gully almost as high as you could go. We wondered whether spores from plants at this altitude might be more frost resistant than those most of us grow.

After pottering for most of the rest of the day we decided to retrace our first day attempts at finding *Asplenium aethiopicum* on a dusty road. At length we tracked it down confined to a twenty-yard section of wall and in a poor condition. The road was being improved with much earth movement. The plants were covered in dust and dehydrated for lack of water. We searched other neighbouring walls, all to no avail.

Altogether we had a very successful meeting stopping and recording at 71 sites, confirming the earlier records of our forbears and speculating on the standing of many of the critical fern species. The next day three of us returned home while our leader flew out to two of the other islands for reconnaissance work for another trip. That's keen!

## REFERENCES

Wilmanns, O and Rasbach, H 1973, British Fern Gazette 10(6): 315-329



## Pots will never really replace a BIG garden, but can almost be as much work

*Ralph Archer - Shelbyville, KY*

By the middle of the nineteenth century, gardeners had learned that many alpine and rock plants did not grow well in wooden or clay containers. The principle reason turned out to be that many of these plants like to have their roots growing near or against stone. Collectors learned that the stone cattle troughs and stone cottage sinks used in rural England made wonderful containers for this type of plant. After plant collectors had purchased all the available troughs and sinks, Hypertufa troughs were developed to replace them. The original troughs were large, being two to four feet long and almost as wide. They were commonly set in a garden on blocks for good drainage, usually among rocks, or in display houses when it was necessary to protect the plants from the weather.

It was soon learned that the Hypertufa trough, made of peat moss, sand and cement, was a wonderful container for many plants other than just alpine or rock plants. The material is porous, which allows for good drainage and air to the roots and also holds water, somewhat like a sponge. In addition to providing a supply of moisture, this water also cools the roots by evaporation. The cement provides an ideal source of lime for many lime-loving rock and desert ferns. The potting soil can be amended in various ways for a wide variety of plants. Use of a pine bark soil amendment provides suitable conditions for many plants that need acid soil such as dwarf conifers and *Asarum*. A potting soil for plants requiring sharp drainage can be obtained by adding washed sand to the basic potting soil. This allows the gardener to plant creeping thyme, sedum and other succulents as well as a wide variety of desert plants for sunny locations.

One effective use for a Hypertufa container is to copy the original use by setting large troughs (2ft. X 3 ft X 1 ft or larger) on bricks or coarse mulch under the shade of shallow rooted trees. This is a good way to display plants in areas where tree roots would seriously compete with plants in the ground. The drawback is that such troughs are very heavy and difficult to handle. They are not easily moved, even by several people. In order to make a trough this large with enough strength to have a reasonable life, it is necessary to make a wire basket to fit inside the mold to reinforce the trough. This obviously significantly increases the work and time required to make a trough. For those who would like to make a large container, the plastic mortar mixing tubs available at home supply stores make a good mold. The basket is generally made of hardware cloth, with dimensions two inches less than the mold's inside dimensions. The finished trough will then have, at a minimum, two inch thick walls with the basket buried in the center of the trough. When making the trough, it is necessary to pack the mixed material tightly around the wire. This generally requires tamping material between the mold and wire with a wood board and then applying the inner coat, packing the material tightly to assure a good bond to the outer coat.

For the average gardener, a smaller pot on a deck or patio makes a good display pot. For this purpose, troughs fourteen inches wide by sixteen inches long or bowls fourteen inches in diameter can be made without the need for wire reinforcement. This article will deal only with the non-reinforced smaller pots.

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## **Pots will never really replace a BIG garden... cont. from page 77**

Containers used for molds can be plastic bowls or dishpans purchased at any discount store that carries a broad line of housewares. One of my favorite molds for round pots is a large plastic salad bowl from Target. I also like a dishpan that is about sixteen inches by twelve inches by ten inches deep. It makes a nice rectangular pot. When selecting molds, it should be remembered that the finished pot will have an outside shape the size and shape of the inside of the mold. Further, the finished pot will have a planting area that will be about two inches smaller in diameter or in width and in length than the inside of the mold. Fortunately, most plastic pans or bowls are reasonably the same shape on the inside as the outside so usually the only mental adjustment needed is for the size difference.

The other necessary material and equipment is readily available at home supply stores like Home Depot or Lowe's. The usual material blend for the pot is a mix of Portland cement, coarse builder's sand and peat moss. It is necessary to use the pure Portland cement, not the concrete mix that includes the gravel which is sold for instant concrete. It is also desirable to use the builder's sand and not play sand, which is much finer and has a fluffy texture. This relates to good bonding of the sand by the cement, which is what gives the pot its strength. A good rule of thumb is that two cubic feet of peat along with the recommended amount of sand and cement will make about seven reasonably sized pots.

### **The basic recipe for pots is:**

One part Portland cement

One part builder's sand

Two parts peat moss

Some people recommend screening the peat moss to remove coarse pieces of wood and other trash. It has been my experience that screening the peat or buying high quality (and very expensive) screened peat results in the pot having a very smooth, concrete-like surface texture. Some people prefer the smoother surface, so screened material is the way to go. I personally prefer the rougher surface that unscreened peat provides. To me, it looks more like weathered rock. If you do not screen, it is necessary to have the peat moss particles as fine and loose as practical. For that reason use only dry material and rub the clumps with your hands to break them down. Pick through the peat moss as you are breaking down the clumps and remove the big pieces of wood or other contamination. Perlite is sometimes recommended as a substitute for sand. It does result in a lighter trough. However it causes small bumps all over the surface. Some people seem to like it, but I do not think it looks natural and avoid using it.

It is an interesting exercise to play with the recommended ratio of peat moss and the degree of cleanliness of the peat moss. Less peat moss and/or cleaner peat moss results in a surface that more and more looks like an ordinary concrete pot. More peat moss and/or less clean peat moss increases the weathered rock appearance and in my opinion gives the pot a more pleasing brownish color, especially when wet. But it also results in a pot that is less strong. Consequently, it is harder to handle without damage, especially when removing from the mold, finishing and planting.

It is important to follow the recommended safety procedures and wear the recommended protective items when making pots. You will be working with dry cement and sand. Both contain extremely fine particles and readily create dust. Both can cause very serious damage to lungs and eyes. Handling the dry and especially the wet material can cause skin irritation. PLEASE WEAR THE RECOMMENDED SAFETY ITEMS DURING THE PROCESS! I like to work outdoors, on a day with a light breeze, when mixing the dry material. I always stand up-wind from the wheelbarrow or mixing tub so that any dust is blown away from me.

I have found that the following procedure works best when making pots. First, gather the following items in a good work area.

#### Molds

Large plastic garbage bags to line molds

Gallon bucket or other means to measure dry material

Wheelbarrow or plastic mortar mixing tub

Long handle shovel

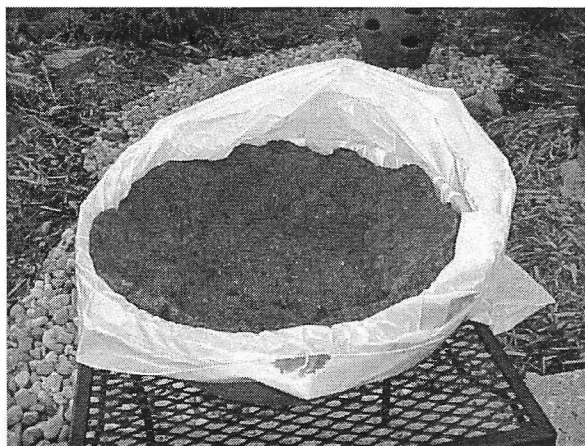
Wood dowel for drain holes

Water supply

Line all the molds with the plastic bags by placing the bag over the mold with the outside surface of the bag against the mold surface and the bag opening draped around the mold. (*figure 1*). This is so pulling the bag up and over the mold opening can cover the fresh pot.

Put on the following safety items before starting to handle any of the pot material..

1. Plastic shields for eye protection-should include side shields for dusty conditions
2. GOOD dust mask — rated for protection from fine dust particles such as the ones recommended for indoor drywall sanding
3. Heavy rubber type abrasion and tear resistant long sleeve gloves
4. Cap for hair cover



*Figure 1*

*continued on page 80*

## Pots will never really replace a BIG garden... cont. from page 79

First, measure out sufficient peat moss into the wheelbarrow or tub for the number of pots to be made. Figure using one cubic foot of peat for three pots and two cubic feet for six or seven. Add sand and mix well, breaking up any peat lumps into powder. If you are making a large number of pots, using a large wheelbarrow is very helpful and the mixing can be done using the shovel. For a small batch, mixing by hand is sometimes more effective. When well mixed, add the cement powder and mix well again. Start adding water in small amounts, mixing well between each batch of water. For big batches, I use a hose with a nozzle set for a mist spray. For small ones I use a two-and-a-half gallon sprinkling can with a fine rose. Continue adding water and mixing until the mixture is uniformly damp and takes on the consistency of good garden soil just barely too wet to work. Do not add so much water that the mixture is sloppy wet. It should hold together when squeezed but not drip any water. When the mixture is ready, pack it into the molds starting at the bottom, making the layer about an inch thick. When the bottom is finished, start working up the sides, packing the material as tightly as possible into the curves and up the side. Press down hard, to make the material as dense as possible, keeping the thickness about one inch.

There are several ways to make the top edge of the pot. Many make the wall thickness uniform to the top with a flat or slightly rounded top an inch thick. This is to prevent the edge from breaking off and leaving a depression. I like to bevel the edge as I think the thin edge is more attractive. If the edge breaks in later handling, as sometimes happens, I will plant something like creeping thyme or sedum to fill it in for a sun pot or use an arching fern like *Asplenium trichomanes* for a shade pot. The empty pot in the previous picture is about the largest round pot that I make without reinforcement. I made the edge too thin and it broke off in a number of places, when removing the pot from the mold.. I plan to plant it with some desert plants and plunge it into the river gravel in the courtyard bed in the background of the picture. I think it will look very natural with the rough edges in what I hope is a pleasing simulation of western desert and mountain country. This is, in some ways, very much in keeping with the original way Hypertufa troughs were used.

When finished, the drain holes can be made by pressing a dowel rod through the bottom layer or by using a finger to poke through. Another way, which I use, is to wait until the pot is cured and drill the holes using an electric drill and a masonry bit. Wrap the pot by pulling the plastic bag over the pot and mold so that the pot is inside the bag. Tuck the open end under the mold to seal it. Store the pot in a garage or under cover and protect from freezing if made in the winter.

Three days after the pot is formed, it can be taken out of the mold. Gently pull the bag off the pot. The outside will be very slick and shiny. I use a wire brush to break the shine, but I leave traces of the lines from the folds in the plastic bag on the pot surface. I like to use a long handle welder's stainless steel brush. They can be found in the tool section at building supply stores. Be careful not to use excessive force as the pot is still very fragile. After you achieve the desired roughness on the outer surface, put the pot back in the bag and again fold it to seal. Let the pot sit about four weeks in the bag to finish curing. The bag can then be removed and the drain holes cleaned out, if necessary, or drilled.

The pot should sit out for three to four weeks, hopefully in rainy weather. Sprinkle it regularly with water when there has been no rain. This is to let any excess chemicals from the cement to leach out. The pot may be too chemically active to plant safely until this is done.

Until this year, my pots have held two general types of plants: dwarf conifers with creeping thyme as a ground cover for sun and *Asplenium trichomanes* species and cultivar ferns, various cultivars of miniature Hosta and species of Asarum for shade. For both types of pots, I used a pine bark soil amendment to cover the bottom of the pots for drainage.

The conifers and thyme were planted in a soil of one part peat-based potting soil, one part washed sand and two parts of the pine-bark soil amendment. The conifers were given monthly feedings of a weak solution of an acidic fertilizer during spring and early summer, with the thyme getting the overflow. Several have grown satisfactorily for two to three years. Apparently the potting mix and fertilizer more than make up for any lime from the pot material. Possibly the peat moss in the pot also reduces the effect of the lime, too. I moved all of them to plastic pots this spring. They are now plunged in mulch in my little courtyard garden around rocks to simulate tree covered hillsides.

The shade pots have been planted using potting soil tailored to the specific plants. The fern species likes lime conditions, the ginger acid conditions and the Hosta a good clay loam. The peat-based potting soil was amended with perlite to increase drainage for the fern. The soil for the Asarum was one part of the same potting soil and three parts fine pine-bark soil conditioner. The Hosta was planted in two parts potting soil and one part garden clay loam soil with a bit of perlite for drainage improvement.

Two *A. trichomanes* species ferns were planted in pots last spring. Based on these pots, the idea that the greater the root contact with lime-based pot material the better *A. trichomanes* will grow, appears valid. The one planted near the center of a round pot did not survive. The other one in (figure 2) was packed into the corner of a rectangular pot. It emerged about two weeks ago, which is very late for this area. It seems to have very good vigor and the growth appears to be good. Its companion plant is a gold miniature Hosta cultivar. This picture also shows an interesting aspect of Hypertufa pots when grown in shade where moisture is ample. The discoloration just above the soil line on the

pot's vertical surfaces is from moss that grew during the previous year, and is starting to grow again on the pot. Moss seems to love Hypertufa and grows readily whenever moisture and shade are present.

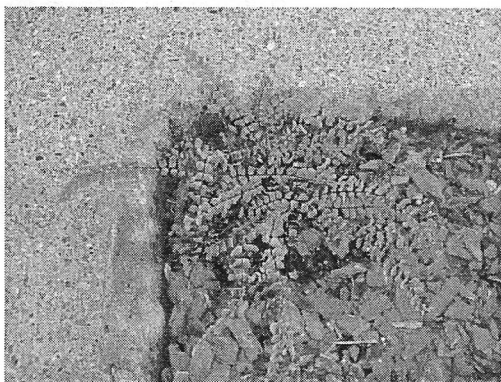


Figure 2

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## Pots will never really replace a BIG garden... cont. from page 81

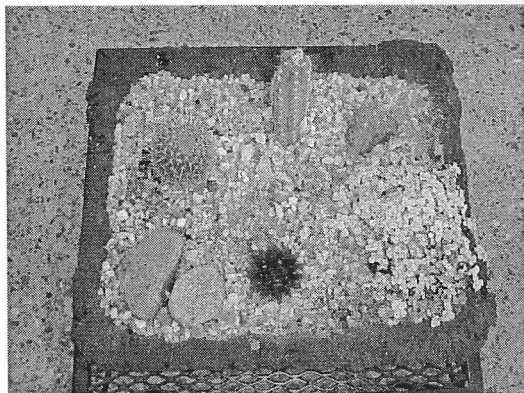
A cultivar, *A. trichomanes* 'Incisum' (figure 3) was planted along the circumference of a round pot. It does not seem as vigorous and was even later to emerge. It was planted with an *Asarum naniflorum* 'Eco Decor' as well as a miniature Hosta cultivar. I am not sure if the seeming lack of vigor is due to the fern being a cultivar or potted somewhat away from the wall or feeling the result of the acidic effect of the large amount of pine-bark



Figure 3

soil amendment in the planting soil of the adjacent *Asarum* or a combination of two or more of these conditions. It does appear feasible, though, to plant different soil type plants in the same pot using soil tailored for each plant. Whether it would be best to separate the various soils by physical barriers, like a piece of plastic, remains to be seen.

Plants such as *Sedum*, cactus, *Sempervivum*, and *Echeveria* are new to me as I never had a place for full sun plants before this year. I planted two pots using a soil consisting of about six to eight parts washed sand and one part peat-based potting soil that seems to work very well. I used a half inch of gravel with no screen at the bottom of the pot to cover the drain holes. The pots are doing very well so far. Pot (figure 4) has received very favorable comments from visitors. I particularly like the *Sempervivum* 'Royal Ruby', which seems to have very little green coloration compared to some, and *Sedum makinoi* 'Ogon', which is a lovely gold color. The two cacti are from a plant sale rack and had no name tags. It will be interesting to see how these pots look as the plants start to grow. My principal plans for the future are to start to plant the dry-land ferns, especially the various species of *Cheilanthes*. They will make a fine addition to the pot



collection. It is especially exciting to have a new fern area to explore, with so many things to learn and new plants to try to grow.

Hypertufa pots are easy to care for. One of the nice things about them is that the color is a good indicator of the moisture condition of the potting soil. It is relatively easy to learn by watching the color

Figure 4

changes when the empty pot is sitting out to cure. The darkish color, from watering, changes to a lighter and lighter shade as the pot dries. Further, after planting, as the pot topsoil dries, it is easy to see a horizontal area on the pot that indicates the location of the boundary between moist and dry soil. The water retention property of Hypertufa makes these pots tolerant of irregular applications of water.

For winter storage, planted Hypertufa pots should be treated as any unglazed pot that contains plants. It is difficult to quantify a temperature where planted Hypertufa pots need protection from cold, as plants do vary in the temperature at which there is root damage. Further, repeated freezing and thawing should be avoided, particularly if the pot is subject to winter precipitation. The surface can spall (break off in layers parallel to a surface) like any unglazed pot if subjected to these conditions. If the reader is uncertain about what to do, I suggest caution about leaving the pots out until seeking out and receiving good advice from a reliable source. Generally the local County Extension Service has a very good feel for what is needed in their area. Here in north Zone 6, I overwinter the planted pots in an unheated garage. The garage has an east facing window and the blinds are kept closed, but there is usually good indirect light during the day. The soil is kept damp, but not wet, which could lead to root rot. Mine seem to go through the winter and start the spring in good condition.

The following listings are plants I have tried and which have done well in Hypertufa troughs here in the Louisville area. By no means, do they exhaust the possibilities now available at any good garden center.

**Dwarf Conifers**—Use plenty of fine pine bark chips in the potting soil.

*Chamaecyparis obtusa* 'Baldwin Variegated'

*Chamaecyparis obtusa* 'Dainty Doll'

*Chamaecyparis obtusa* 'Hage'

*Chamaecyparis pisifera* 'Tsukumo'

*Cryptomeria japonica* 'Compressa'

*Cryptomeria japonica* 'Tansu'

*Cryptomeria japonica* 'Vilmoriniana'

*Picea abies* 'Little Gem'

*Picea glauca* 'Jean's Dilly'

*Picea glauca* 'Pixie'

*Picea omorika* 'Pimoko'

*Pinus mugo* 'Mops'

*Tsuga canadensis* 'Minuta'

Not a conifer, but a wonderful, woody plant in a trough.

*Pieris japonica* 'Little Heath'

### Ferns

*Adiantum pedatum*, especially the various varieties and cultivars.

*Asplenium scolopendrium*

*Asplenium trichomanes*

*Asplenium x ebenoides*

*Asplenium rhizophyllum*

*Woodsia polystichoides*

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### Miniature Hosta Cultivars

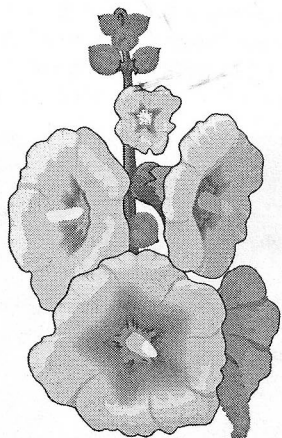
Baby Bunting  
Bill Dress's Blue  
Blue Ice  
Cat's Eyes  
Pandora's Box  
Shining Tot


And my especial favorite for shade pots!

*Asarum naniflorum* 'Eco Decor'

The cultivar 'Eco Decor' is a very nice plant! A pot is about the only place this plant will flourish here and return year after year. It is especially nice near an upright fern like the smaller *Adiantum pedatum* cultivars or varieties, a vertical growing conifer like *Picea glauca* 'Jean's Dilly' or *Pieris japonica* 'Little Heath'. A wide variety of the plants in the numerous genera that make up the "wild gingers" make wonderful pot plants. I plant most of mine in glazed pots as they are worthy of display as individual plants in or out of bloom.

When we decided to down size and move to a patio type home, I wondered about the loss that comes with losing sole ownership of a garden. I find that the challenge of pots has fulfilled my hopes and desires to create a garden of my own. I suggest, if you have not already planted pots, you think about giving it a try. You just may love it too!





**THE HARDY FERN FOUNDATION**  
**QUARTERLY**

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Articles, photos, fern and gardening questions, letters to the editor, and other contributions are welcomed!

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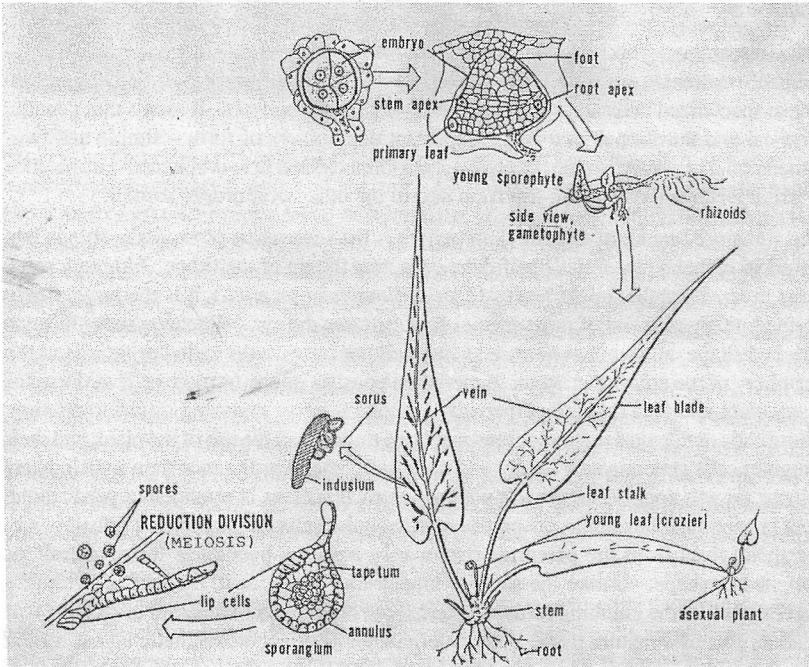
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## Ferns in Research – II. The Sporophyte

Joan Eiger Gottlieb - Pittsburgh PA

Say “fern” and it is the sporophyte that leaps to mind – the familiar, long-lived plant with land-lubber adaptations like roots, stems, leaves, conducting tissues (xylem and phloem) and spore-protecting jacket cells (the sporangium wall). The subtle, seductive beauty of the fern sporophyte belies its asexual, spore-bearing lifestyle. It is so different, physically, from the tiny, sexual gametophyte (see Part I of this series in the Spring, 2004 Quarterly) that it is hard to believe these are merely two phases of the fern life cycle. In fact, gametophyte and sporophyte are developmental expressions of the same genome. The cells of a fern sporophyte usually contain two sets of chromosomes – the diploid or “2n” number. These parental sets are “shuffled” and then “reduced” in a special, double division called meiosis inside each young sporangium. The resulting spores and gametophytes that grow from them have a single set of chromosomes – the haploid or “n” number. The gametophyte, in turn, forms sperms and eggs, and it is their union that restores the 2n number in the fertilized egg (zygote) and in the embryo, sporeling plant and mature sporophyte that develop from it.



Sporophyte development in walking fern (*Camptosorus rhizophyllus*).

### Developmental Research

Research into the developmental mysteries of the sporophyte began in earnest with Lang's hypothesis (1909) that environmental conditions greatly influence development.

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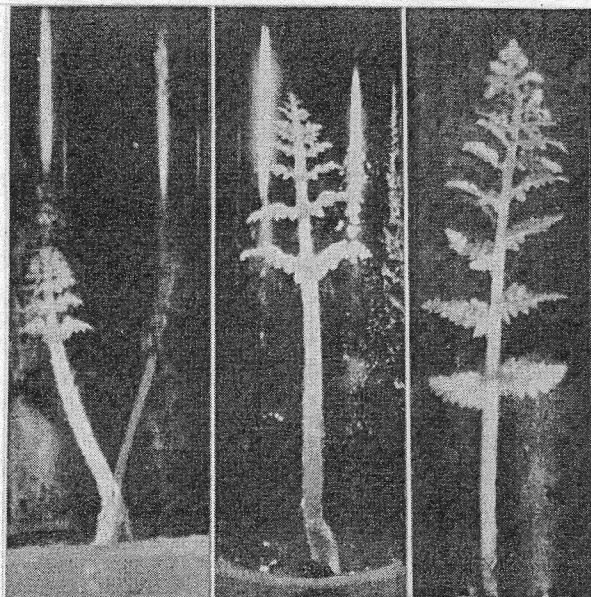
## Ferns in Research - II. The Sporophyte *continued from page 85*

Chemically, the nutrition of the spore is completely contained within the storage capacity of its cytoplasm, while the zygote can draw nutrients on a continuing basis from the gametophyte to which it is attached. Physically, the spore is a free-living cell, while the zygote is constrained by its archegonial jacket. Perfecting the microsurgical technique of others, DeMaggio (1961)<sup>1</sup> managed to remove undivided zygotes of *Todea* from their parent gametophytes. He grew these excised cells for several weeks in a liquid medium. The resulting "embryos" were irregular, 2-dimensional and thalloid – essentially gametophyte-like! They produced antheridia, but not sperms, and ceased development in that immature state. Freeing the fertilized egg from the girdling effect of the archegonium thus appears to re-program its development. DeMaggio speculated that the orientation of long-chain, structural proteins in the mitotic spindle determines division planes and the eventual shape of the developing plant. In normally "contained" embryos a ball of cells is produced with shoot and root meristems eventually forming – the sporophyte. In "free" spores, an initial filament grows and expands into a flat tissue – the gametophyte. Whittier and Steeves (1960)<sup>2</sup> experimented with the nutritional component of these growth patterns. When they increased the sugar supply to older gametophytes in culture apogamous sporophytes were produced directly from ordinary gametophyte cells.

Other researchers working with cultured gametophytes were able to induce the development of tracheids (water-conducting cells of xylem tissue) near their apical notches. These specialized cells are normally found only in sporophytes. It seems that genetic, physical and nutritional factors are important determiners of form – simple and two-dimensional in gametophytes; complex and 3-dimensional in sporophytes. The balance is like a teeter-totter that can flip from one to the other with proper stimuli.

The signature feature of any fern sporophyte is the succession of exquisite fronds that unfurl in sequence from fist-like fiddleheads near the tip of the shoot. Although some ferns produce small, simple leaves (*Azolla*, *Camptosorus et al.*), it is the large, finely divided, feathery frond of most species that captures the eye. Whatever their ultimate size and shape, all true leaves arise as tiny cellular outgrowths called primordia at the periphery of the apical meristem. A meristem consists of one or more cells at the tip of every stem and root that are perpetually juvenile – never maturing or differentiating. These cells divide on a regular or seasonal basis throughout the life of the plant, and their daughter cells generate new tissues and organs; in other words a meristem is an indeterminate growth zone. The growth pattern for each species is remarkably predictable. Leaf primordia, for example, are produced in a regular helix or "phyllotaxis", distinguishing themselves from the parent meristem very early by becoming "dorsiventral" or flattened in shape. Unlike the stem or branch that produces it, the leaf is (with rare exceptions like the climbing ferns) a determinate organ. That means all of its cells will become part of a mature tissue like epidermis, palisade (photosynthetic layer), xylem and phloem, although fern leaves retain their meristematic potential longer than those of seed plants. The coiled crozier is related to this extended growth and development phase.

Researchers have focused on the fern frond in an effort to understand how a primordial nest of ordinary cells takes on such architectural complexity. Steeves and Sussex (1962)<sup>3</sup>

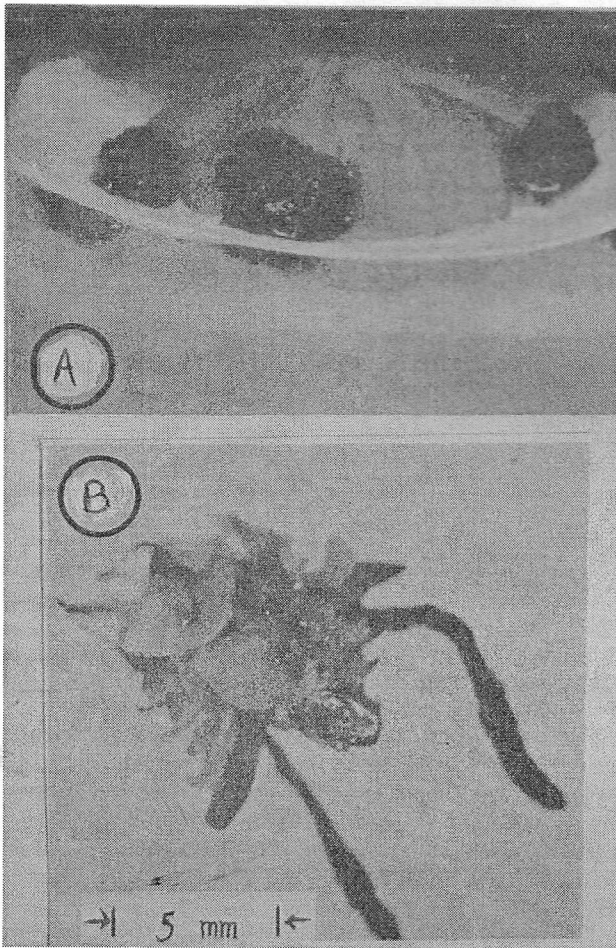


Cinnamon fern (*Osmunda cinnamomea*) fronds grown from young, unformed primordia in nutrient culture containing 2% (left), 4% (center) and 6% (right) sucrose (from Steeves, 1962)<sup>3</sup>.

excised juvenile leaf primordia of *Osmunda cinnamomea* and grew them in tissue cultures containing mineral salts and sucrose. All but the very youngest (closest to the shoot meristem) underwent normal development, producing miniature, but architecturally mature leaves. Primordia of *Todea barbara* even produced fronds with sporangia when cultured on media containing 6% sucrose, an effect that could be enhanced by adding a good nitrogen source, like ammonium sulfate. Conversely, very low concentrations of sucrose led to reversions in form to the small, simple leaves of young sporelings. It appears that once a leaf primordium is initiated in the apical bud, and becomes spatially separated from the meristem through further cell production, or by removal and transfer to tissue culture, its fate is inherent (genetically determined). The influence of the parent plant or the culture medium is principally nutritive until the crozier emerges into the light and can photosynthesize on its own. For fern growers the lesson is that wintergreen leaves should not be trimmed away prematurely. They are still producing photosynthetic products that nourish the next sets of developing leaf primordia.

Some fern leaves (*Ceratopteris*, certain species of *Asplenium*), while determinate, retain nests of primordial growth cells along pinna edges or tips. The "reserved" generative cells on *Ceratopteris* fronds form detachable plantlets when the parent leaf reaches mature size – a great way to propagate each successful, serendipitous fertilization and embryo. In fact, rapidly proliferating *Ceratopteris* clones can choke waterways and canals in the tropics. The writer (1972)<sup>4</sup> designed a series of experiments to uncover the nature of these foliar "buds" and the role of hormones in regulating their growth. It was

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A) *Ceratopteris* pinna on nutrient medium with kinetin added, showing three callus growths from marginal leaf "buds".

B) *Ceratopteris* plantlets regenerating from a small piece of callus removed from kinetin (from Gottlieb, 1972)<sup>4</sup>.

quickly determined that excised, dormant leaf buds (no visible signs of organ formation) either died in tissue culture or produced wispy, aposporous gametophytes with abundant antheridia and swimming sperms. If, however, a ring of adjacent leaf tissue (or even a single vein) was left surrounding the excised bud, normal, small plantlets were induced within four weeks. Low concentrations of adenine (a N-base in DNA and RNA) or the plant growth hormone indoleacetic acid (IAA) had the same effect and could be substituted in the medium for the attached leaf tissue. Kinetin (a cell division promotor) induced a frothy proliferation of the excised nests into a callus – a mass of normal, but undifferentiated cells that continue to proliferate and increase in size. (A tumor, which may look similar, consists of mutated, abnormal cells that may, in time, spread and become invasive.) When *Ceratopteris* callus was removed to a medium lacking kinetin, it exploded into lots of normal plantlets that could be separated surgically and grown to

maturity. Callus culture techniques are common in plant propagation today. As with seed plants, it appears that growth factors are important in fern sporophytes - both in timing and position - keeping juvenile tissues, like buds, dormant at high concentration and then releasing them to develop normally when that influence is diminished. Similar patterns of repression or inhibition were demonstrated by the writer (1965)<sup>5</sup> for the leaf-bearing short shoots of *Pteridium* rhizomes.

## Genetics Research

Scientists applying modern genetic tools to ferns have begun to uncover some of the most elusive secrets of heredity in this group of plants. An excellent paper by Chris Hauffler (2002)<sup>6</sup> reviews what is known about the genetics of homosporous ferns - from the careful crosses of the Victorian fern craze (Anderson-Kottö, 1929)<sup>6</sup> and the inbred gene marker studies of Hickok (1978)<sup>6</sup> to the elegant isozyme/electrophoresis analyses of Chapman, Klekowski, Werth, Soltis and others (1979-1999)<sup>6</sup>. Isozymes are enzymes that are similar functionally but different structurally, indicating DNA inheritance from genetically distinct parents. This extensive body of work can only be summarized here. It appears that 95% of extant ferns are probably polyploid, having three or more multiples of the haploid ("n") number for the species. However, most follow Mendelian, diploid patterns of inheritance during spore formation through successful pairings of chromosomes from "same species" parents and from "different species" parents. Polyploids have more genes per trait than diploids do, so harmful mutations are more easily masked since only one normal gene needs to be active and dominant. Thus, polyploidy is believed to be a principal pathway by which ferns have stored and then released variability. Polyploids occur most often when sterile hybrids, with mostly abortive spores, produce a few viable, but unreduced spores. The diploid gametophytes that develop from these spores generate fertile, polyploid sporophytes through self-fertilization.

Haploid gametophytes typically outcross; that is sperms from one plant fertilize eggs of another, genetically distinct plant. Diploid gametophytes from polyploid sporophyte parents, with their better-buffered genomes, often inbreed; that is, sperms and eggs of the same plant unite. In the wild this means that polyploids can establish new sporophyte plants from single spores, whereas diploids require at least two gametophytes in close proximity to generate a new sporophyte. Disturbed or marginal habitats are, therefore, well suited for colonization by polyploids. Hybridization can be rampant in such areas as well since gametophytes of many taxa may be growing in close proximity, making promiscuous matings (hybrid swarms) between closely related species almost unavoidable, and setting the stage for the polyploidization of some.

Gene flow - the sharing of genes among individuals and populations - can be extraordinary in ferns. Conant (1978)<sup>6</sup> and Peck (1990)<sup>6</sup> showed that most released spores remain near their parent sporophyte. But, a significant percentage travel long distances, even thousands of miles, to populate other continents and remote islands like those of the Galapagos and Hawaii. Ranker (1994)<sup>6</sup> used enzyme analysis to show that the inbreeding, polyploid *Asplenium adiantum-nigrum* arrived and survived in Hawaii at least three, and possibly as many as seventeen separate times. Soltis and Soltis (1987)<sup>6</sup>

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found that the frequency of “private alleles” (genes responsible for rare protein variations) is extremely low in *Polystichum munitum*, indicating a very high rate of gene sharing. Wolf (1991)<sup>6</sup> discovered an extraordinary gene flow in Britain’s bracken populations (*Pteridium aquilinum*), and concluded that the “neighborhood” for this fern was essentially the entire country. The effectiveness of fern spore migration is further illustrated by studies of endemism in Hawaii. 80% of Hawaii’s angiosperms, but only about 6% of its ferns are found uniquely on single islands. It is clear that prodigious production of spores by ferns has generated notable gene spread and species dispersal, keeping population geneticists busy for many generations.

### Ecological Research

Ferns have left their mark on ecological research as well. As do all living things, ferns survive and reproduce in habitats and communities that are both complex and competitive. One adaptive response by fern sporophytes is the production of a wide variety of chemicals that suppress the growth of other plants or poison foraging animals. Phenolic leachates from bracken insure that no other species can live beneath the fern’s canopy (Gliessman, 1976)<sup>7</sup>. Such leachates are also common in tropical rain forests, an important factor in the regulation of species density in forest fern communities. The chemical output of bracken has been investigated most thoroughly since it has implications for ranching. This one fern produces a formidable array of compounds, including a known carcinogen, a powerful mutagen, a bovine bone-marrow toxin, an enzyme that destroys thiamine and induces neurological abnormalities – even death – in horses and pigs, tannins and an intercellular cement that makes its mature tissues indigestible. Ferns have had a long ecological history of co-evolution with grazers and herbivores – plenty of time to hone their biochemical defenses. Most gardeners know that ferns are excellent, herbivore-resistant perennials, although deer will sometimes nibble at young fronds after a harsh winter. Snails and slugs can be a problem however, especially for ferns in the *Asplenium* complex. They are the only animals with an enzyme capable of digesting fern intercellular cement. An interesting relationship exists between a few genera of epiphytic, tropical ferns (*e.g. Solanopteris, Lecanopteris*) and certain ants that live in hollow cavities within or underneath their rhizomes. Radioactive tracer studies in the 1990’s proved that these ant-house ferns receive and use scarce nutrients brought in by their foraging insect guests, an association that is ecologically similar to the carnivorous flowering plants.

### Evolutionary Research

Bringing fern research up to the minute, the past decade has seen a flurry of activity in DNA sequencing where cutting edge botanists are unraveling the evolutionary relationships among the main groups of land plants – bryophytes, pteridophytes and spermatophytes. Stein (1992)<sup>8</sup>, working with highly conserved (very slowly changing) DNA from *Osmunda* chloroplasts, compared inversions and other mutations to that same DNA in four other fern families - Adiantaceae, Dennstaedtiaceae, Dryopteridaceae and Cyatheaceae. Her results indicate that changes within an inverted/repeated gene

region common to all 5 families occurred prior to the emergence of the Osmundaceae back in the Permian era. Another shared chloroplast gene provides strong support for the common origin of the four families above the Osmundaceae from an ancestor in the Upper Jurassic or Cretaceous periods. Gene analysis of this sort can be used to construct a molecular "clock" to track incredibly ancient events.

The most recent work in this field uses new DNA sequencing technology to tackle the evolutionary relationships of 35 species representing all the major groups of land plants. One nuclear and three chloroplast genes common to all 35 taxa were chosen for sequencing based on their conservative natures and important functions. Coupling this with morphological data, researchers like Pryer *et al.* (2001)<sup>9</sup> are making excellent progress showing, for example, that horsetails (*Equisetum*), higher ferns and seed plants are monophyletic (share a common ancestral clade or branch). This is quite different from what we learned in school about horsetails and ferns being merely "dead end" or transitional lines. (See Alan Smith's article "Horsetails and Whisk Ferns Re-examined..." in the Winter 2002 Quarterly.) Pryer proposes three major vascular plant lineages – 1) lycophytes – *Lycopodium* (combined sense), *Selaginella* and *Isoetes* – a distinct group "only distantly related to other extant pteridophytes and seed plants"; 2) seed plants – gymnosperms and angiosperms; 3) all other non-seed lineages of vascular plants, including horsetails (*Equisetum*), eusporangiate ferns (e.g. *Marattia*, *Ophioglossum*, *Botrychium*), leptosporangiate ferns (e.g. *Polypodium*, *Dryopteris*, *Polystichum*) and whisk ferns (*Psilotum*, *Tmesipteris*). To those of us imprinted on older phylogenies, this new "tree" seems strangely wonderful – with seed plants, ferns and horsetails now regarded as parallel lineages derived from a common ancestor. And forget the old image of *Psilotum* as a depauperate relic of the earliest vascular plants. It appears that it shares a common ancestor with *Ophioglossum* and *Botrychium*, and should probably be reclassified as a eusporangiate fern.

Schneider *et al.* (2004)<sup>10</sup> argue that while the diversification of flowering plants in the Cretaceous/Tertiary eras (80-100 million years ago) lead to the decline of many lineages (e.g. horsetails, cycads) it also created spatially complex, diverse habitats newly available to others. Fossil analysis from the era plus new molecular data from living species indicate that ferns and some lycophytes underwent an evolutionary "reawakening" during the Cretaceous, opportunistically responding to these new "ecospaces". Polypod ferns like *Adiantum* that had a low-light photoreceptor pigment thrived under canopy shade; other polypods and some lycophytes moved up into the trees finding their places in the light as epiphytes. This new evidence tells us that ferns are not "evolutionary cul-de-sacs" - mere remnants of a once important, dominant, arborescent assemblage of plants. They are proved to be dynamically evolving, expanding and competing parts of our modern flora.

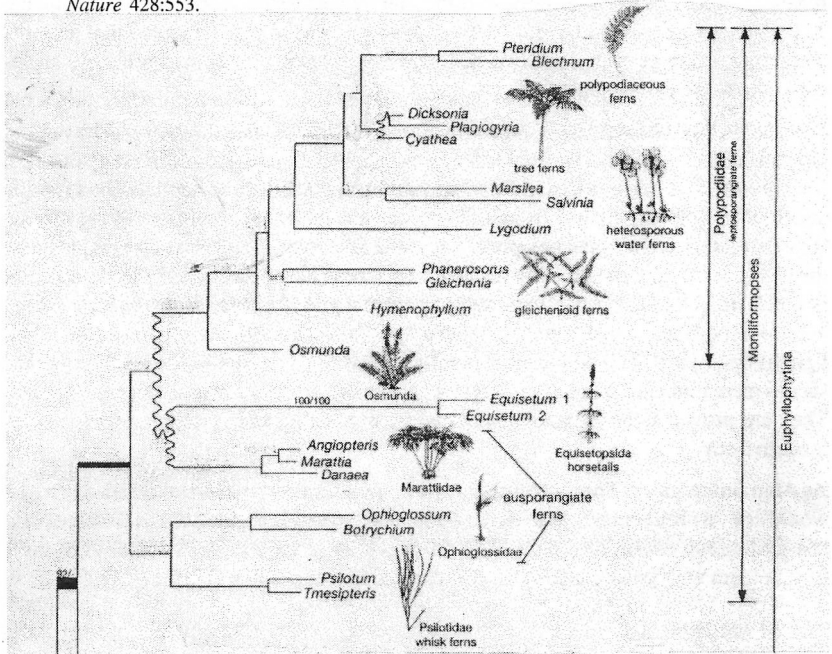
As Alan Smith says, "This is definitely an exciting time to be a fern specialist..." and I would add "a proud time". No longer do we need to feel marginalized as devotees of a last-gasp group of obscure plants. Not only do I enjoy my ferns as much as ever, but I look at them with greater admiration for their continuing lessons on life!

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Modified section of "Tree of Life" (from Pryer, 2001)<sup>9</sup>.

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