Hardy Fern Foundation Quarterly

Winter 2018

THE HARDY FERN FOUNDATION

P.O. Box 3797

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Web site: 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.

Affiliate fern gardens are at the Bainbridge Island Library, Bainbridge Island, Washington; Bellevue Botanical Garden, Bellevue, Washington; Birmingham Botanical Gardens, Birmingham, Alabama; Coastal Maine Botanical Garden, Boothbay, Maine; Dallas Arboretum, Dallas, Texas; Denver Botanic Gardens, Denver, Colorado; Georgia Perimeter College Garden, Decatur, Georgia; Inniswood Metro Gardens, Columbus, Ohio; Lakewold, Tacoma, Washington; Lotusland, Santa Barbara, California; Rotary Gardens, Janesville, Wisconsin; Strybing Arboretum, San Francisco, California; University of California Berkeley Botanical Garden, Berkeley, California; and Whitehall Historic Home and Garden, Louisville, Kentucky.

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

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QUARTERLY

Volume 28 No. 1 Editor- Sue Olsen

ISSN 1542-5517

President's Message

I am delighted and grateful for the generous response to the annual funding appeal letter. Your support exceeded our goals and will make a substantial difference in fulfilling the mission of our organization. There is a very fun and ferny year ahead for us; preliminary plans are in place now for classes, events and other activities to bring together likeminded fern-loving folk to learn and share information about these interesting plants. I will be looking forward to meeting many of you as the year progresses.

I am particularly pleased to be lecturing at two of our affiliate gardens this year. I will be speaking for the Birmingham Fern Society on May 16th at the Birmingham Botanical Garden in Alabama. I visited the fern garden there several years ago and was quite impressed by its size and diversity. The society has been very dedicated in keeping this area looking great. I am very much looking forward to touring the Garden again. I will also be in Louisville, Kentucky at Whitehall Gardens. This lovely garden has a dedicated Jefferson County Master Gardeners volunteer crew who along with HFF members Leslie Pancratz and Michael Hayman maintain a great collection of ferns and a stumpery created by longtime HFF member Ralph Archer. I will be speaking at Whitehall in mid-June. I hope any members in the area will make time to visit these gardens and attend these lectures and events. Make sure you introduce yourself; I enjoy meeting members from across the country.

You should also keep an eye out for changes to our website. The HFF received a generous grant from the Pendleton & Elisabeth Carey Miller Charitable Foundation to fund a website overhaul and a new printer and labeling system for ferns grown for membership distribution and plant sales. Michelle Bundy, HFF vice-president, along with HFF member, Nancy Strahle, developed the grant application and defined the needs of the current website. They along with Lori and David Gibson will be working with a local website design firm that has excellent horticultural experience to improve the look and accessibility for the future.

Of special interest to me, this issue of the Quarterly features an article by Rolf Thiemann on hybridizing ferns. I had the pleasure of visiting Rolf's garden in Germany and seeing many of the hybrids he created. His devotion, curiosity and perseverance to this hobby was extremely interesting to see. I am happy he is sharing his thoughts with our members. On a final note, our annual rare plant sale, Fern Fest, due to a scheduling conflict, will be shortened this year to a single day, Friday, June 1 at the Center for Urban Horticulture, University of Washington, Seattle. The sale provides one of the best selections of ferns available, as well as, a number of choice rarities for that special place in the garden!
Enjoy the spring and I hope all of your crosiers emerge unblemished!!

All the best,
Richie

Richie Steffen

Polystichum andersonii x setigerum

(OR) The Hybrid That Almost Wasn't (OR) Maybe Isn't

James R. Horrocks ~ Salt Lake City, UT

This is a magnificent fern growing in my garden in Utah but never mentioned in any of the literature, except private letters from myself to Dr. Berndt Peters in Germany. It is not even found on the Internet. If you attempt to search it out, they, whoever they are on the Internet, will ask you if you mean *P. setiferum x P. andersonii*. The reply is always: "NO, This is not what I am looking for!"

This fern did not magically appear in my garden 15 years ago or so but was, as I said, sent to me by Dr. Peters. We had originally exchanged spores for a few years after he contacted me in 1996. He had gotten my name from Dr. Norio Sahashi in Japan and soon all three of us were exchanging spore in letters. It pays to save correspondence. I have every letter sent to me by Dr. Peters and Dr. Sahashi.

In Dr. Peters' letter to me in 1997, he writes: "I am cultivating some *Polystichum* hybrids which can only be propagated by bulbils, because these hybrids have *P. andersonii* or *P. proliferum* respectively as one parent. Are you interested in some bulbils?" Take a flying guess as to what you think my answer was? A resounding "YES!!!"

Dr. Peters "got the bulbils from Mr. Kohout, a fern collector in Germany. Mr. Kohout got them from Professor Tadeus Reichstein, a famous fern specialist (the ferns had a TR number from the collection of Professor Reichstein) who was in contact with (the late) Anne Sleep when she was working at her thesis and I am sure she gave some of her plants (or bulbils) to Professor Reichstein when it was completed."

Dr. Peters in a recent update asked me if in my garden *P andersonii x setigerum* and *P. andersonii* x *setiferum* are the same plant. He was worried that the labels may have been misread or confounded in the garden of Mr. Kohout or even in Professor Reichstein's collection. I assured him they are NOT the same fern. Not by a long shot!
Among the bulbils sent to me by Dr. Peters were: (and I'm naming them with the bulbil producing parent first)

Polystichum proliferum x *setigerum*
proliferum x *aculeatum*
proliferum x *acrostichoides*
andersonii x *braunii*
proliferum x *braunii*
(later named *Polystichum* x *dycei* in honor of the late Jimmy Dyce)
(see HFF article Vol.25, #3 Summer 2015)
andersonii x *setiferum*

Several of the above are mentioned in Sue Olsen's wonderful book. I might also mention that these bulbils were sent to me wrapped in damp paper towels in a flat little package with a customs label attached in German that read: "Fern bulbils without any soil" and "no commercial value". Imagine my astonishment as they came directly to me without a hitch. As for "no commercial value", I nearly choked. They were of great value to me—priceless! I reciprocated by sending him spore of *P. deltodon* and bulbils of *Cystopteris tennesseensis*, another hybrid which he received without any problem and hopefully was able to grow with success.

Polystichum andersonii x *setigerum* is the obvious artificial hybrid cross between *P. andersonii* and *setigerum*, the latter spelled with a "g" not an "f". In turn, *P. andersonii* is the hybrid between *P. munitum* and "a presumptive coastal northwestern ancestor, *P. kwakiutlii* which presumably sported a bulbil. *P. setigerum*, is the hybrid cross between *P. braunii* and *P. munitum*. Rush points out that not all spore of *P. setigerum* are fertile. Both parent plants are quite large and could easily produce this monstrosity. By the way, neither parent will grow here in Utah, even anywhere east of the Cascades, but the hybrid thrives!!! Figure that one out? Actually some hybrids will grow where the parent plants will not.

Left - *Polystichum andersonii* x *setigerum*
Right - *Polystichum braunii*

Description: The rhizome is massive, 2 to even 3 inches across, comparable to *P.* x *dycei*, but with very light scales, almost white to tan on the fiddleheads, not blackish-brown as in *P.* x *dycei*, the crown producing ten to twelve 3 to 4 foot fronds, very nearly three feet long here in Utah, quite impressive by any standard. The fronds are bipinnate and look like a huge *P. andersonii* or *P. braunii*. Think comparing *P. tsus-simense* to *P. rigens*. *P. rigens* is *P. tsus-simense* on steroids! By the way, two seasons ago, one of my *P. rigens* was damaged in a late spring snow storm and actually produced a large bulbil or better described as a "bud" that when later planted in a small pot in a terrarium, actually began to grow, but then aborted and later died after producing one tiny frond that I'm sure was more of a carrot to tease me. I almost made mention of it in a later article but decided not to, worried that some of my readers might think I had had one too many "Buds". The massive fronds of *P. andersonii x setigerum* taper in both directions, being widest in the upper third of the frond, 8 to 10 inches wide. The pinnae are also an impressive 5 to 6 inches in length. Auricles are present on the acroscopic side of the frond pinnae toward the apex. The auricles are more pronounced on the pinnules, also on the acroscopic side. Sori are present on the upper third of the fronds, more so near the apex where the bulbils will be found. The spores are sterile. The bulbils will take root in mild, humid climates but can be cut away, cleaned and pinned down in a terrarium setting in a pot in late fall. By spring you will have plants 2 to 3 inches or more high.

It should be mentioned that this is a hybrid and the bulbils are literally clones akin to apogamous reproduction where the hybrid is duplicated in every way. They are identical and in my experience, never revert back to either parent plant. As for size, *P. andersonii* x *setigerum* is the tallest and largest of all polystichums in my garden, even taller and larger than *P. munitum* and *P.* x *dycei*, although, the latter may prove to be the same or bigger at the crown. I doubt if it is taller. Another interesting observation which appears in Sue Olsen's book is that the bulbils are found on the underside of the fronds in *P. xdycei* which is not so in other hybrids, at least not any that I have observed. In all I have planted from my garden, they are on top of the frond. This is so in *P. andersonii* x *setiferum* and in *P. andersonii* itself. This is going to have to be checked out next season on other hybrids I have.

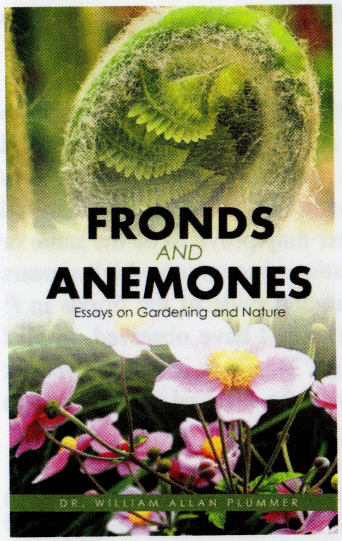
It should also be noted that *P. andersonii* x *setigerum* emerges uncomfortably early in spring, mid to late March here, along with another rebel, *P. wilsonii- sinense* (see HFF Vol.27 #3, Summer 2017) which may be diagnostic as *P. andersonii* x *setiferum* emerges much later as in late April.

This is yet another "controversial" article which almost didn't get written. It is literally the article that "Almost Wasn't". Obviously, the subject, believed to have originated in Great Britain from the efforts of the late Anne Sleep who produced in a laboratory at Leeds University artificial hybrids that would never occur naturally. They later appeared in Germany and maybe in some gardens in Great Britain and Europe. If it turns out to be simply a cultivar or variety of *P. andersonii*, I may end up back in the hospital. If it ends up being an entirely new plant, and named after a person, let it be after Anne Sleep. She would more than anyone deserve it.

Reference:

Horrocks, James R., 2015, 2017, HFF Articles, Seattle.
Hoshizaki, Barbara Joe, and Robbin C. Moran, 2001, *Fern Grower's Manual*, Timber Press, Portland
Peters, Berndt, personal communications to James R. Horrocks from 1996 to 2017. Suderbrarup, Germany.
Olsen, Sue, 2007, *Encyclopedia of Garden Ferns*, Timber Press, Portland.
Rush, Richard 1984, *A Guide To Hardy Ferns*, British Pteridological Society, London.

Ed. note -
There is some question about whether P. andersonii x setigerum actually exists however by whatever name Mr. Horrocks has a remarkable plant. Comments would be welcome.



Book Review

Fronds and Anemones. Essays on Gardening and Nature.

Dr. William Allan Plummer, 2017

iUniverse, 1663 Liberty Drive, Bloomington, IN 47403

Reviewed by Alan Ogden – Worcestershire, England.

Many years ago someone gave me "The Gardener's Bedside Book", a collection of short articles on various topics both informative and entertaining which came under the heading of natural history and gardening. At bedtime these would take ones thoughts away from the irritations of daily life into a restful state with thoughts of our favourite occupation.

Since then I have searched for a similar book without success until I received my copy of "Fronds and Anemones" which promised to be the very thing. The author has given us a collection of articles which describe his progress in the world of nature as his life has developed from a juvenile birdwatcher to the owner of a large woodland garden in New York which he has planted with a fascinating collection of both native and imported plants from around the world.

He has gathered together articles and what he calls 'essays' which he has written over many years for a number of publications from the local Nature Centre and several special interest societies including The Hardy Fern Foundation and the American Fern Society. This may be a quick way of putting a book together but it inevitably leads to a certain amount of repetition.

I did meet the author about fifteen years ago but now could not recall his appearance so I turned to the back of the book to the author's blurb but there was no photograph, in fact there are no photographs in the book at all!

There are several sections where a picture or two would have been helpful especially to someone unfamiliar with the local or native-American names of plants. I do know a few of them now, cohosh, shad and twinleaf which are all in our garden in England under different names. I also learned that there are two unrelated plants called Arbutus just to confuse us!

The section on the development of a garden from nearly an acre of uncultivated partially logged wooded hillside were of special interest to me as I have tried to create a similar

habitat for ferns and other plants but my head began to spin as I tried to imagine the paths, steps, walls and a small pond installed around the new property. A plan or map would have been very helpful but there are no graphics in the book either apart from a monochrome abstract design at the start of each section – such a shame. The author even manages to describe the life cycle of a fern without a diagram – this must be a first in any book dealing with the topic!

There is a lot of good advice and gardening lore in this book which is a sort of distillation of the years of gardening experience the author has accumulated and which he now shares with us. Advice on planting and pruning are particularly good and the choice of plants and shrubs for a New York woodland is superb. I would love to see the garden, especially his Trilliums but sadly my travelling days are over.

The author tells us of his own travels towards the end of the book where there are accounts of the botanical tours and gardens he has visited. I found this awakened a few memories as I went on one of these trips but I don't know how relevant this would be for the general reader. It was all such a long time ago but if it tempts new members to join the Hardy Fern Foundation it will be worthwhile.

The book ends with a series of garden quotes and a list of references and an index which is excellent. I wondered if there is index making software these days – it was a bit of a surprise to find my name in there!

To sum up, this is an interesting book to keep by the bedside – but it could have been so much better!

Reference. *The Gardener's Bedside Book* ed. Kenneth A. Beckett. B.T.Batsford 1973 London. ISBN 7134 0331 4

Hardy Fern Foundation Twin Falls Hike August 19th, 2017

Forrest H. Campbell

Bothell, WA

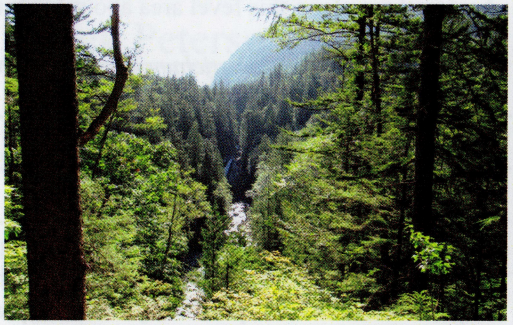


Photo courtesy of Forrest Campbell

Twin Falls is located southeast of North Bend, Washington. Off I-90, exit 34 in the Olallie State Park.

We gathered around 8:30 on August 19th, 2017 at the trailhead. We were greeted by a hiker and his friendly dog who were coming down from an early morning

hike. He kindly offered to take a group photo of the 7 of us and yes the dog too.

I went over information about the hike and plans for our day. The weather looked to be in the mid 70's in the afternoon which meant a slow rise in the 60's – a perfect day for our hike. Off on the trail we went looking for ferns and companion plants in their native environments.

The trail at the beginning runs near the South fork of the Snoqualmie River. This is sometimes called 'The Upper Falls' being above Snoqualmie Falls.

The first leg of our journey was a meandering path below towering broad big leaf maples (*Acer macrophyllum*), western red cedar (*Thuja plicata*), douglas fir (*Pseudotsuga menziesii*, western hemlock (*Tsuga heterophylla*), vine maple (*Acer circinatum*), cascara (*Rhamnus purshiana*) & dogwood (*Cornus nuttallii*)

There were several understory plants, here are a few:

Elderberry (*Sambucas racemosa*)

Snowberry (*Symphoricarpos albus*)

Salomon Seal (*Mainthemum stellatum*)

Devils Club (*Opopanax horridus*)

Salmonberry (*Rubus spectabilis*)

Salal (*Gaultheria shallon*)

Among them along this level area about 1/2 mile in were these ferns.

Western sword fern (*Polystichum munitum*). This fern I would call the 'King' of the ferns in the Pacific Northwest.

Better yet John T. Mickel in his book, *Ferns for American Gardens*, Timber Press refers to these as "Handsome".

These were sporadically located or in masses up hillsides with their 2 - 3' fronds standing tall and wide. When they break off and die they provide compost and along with the maple leaves and trees previously mentioned a tremendous amount of needed nitrogen and nutrients for all of the plants in this native area.

Next up was *Athyrium filix - femina* (lady fern). They were mostly located in the wet

areas from water coming off of the hillside leading towards the river. These deciduous ferns were in both shade and sun. They had erect fronds and an erect rhizome. All if not most had some fronds broken due to wind, hard rain or animals. This is very typical of this fern due to the structure of the stipe. Also it is probably the most variable species in the world with more than three hundred named English forms.

There were more than a few of *Pteridium aquilinum* (bracken fern). If there is a fern weed this is it. Ask any gardener. Of note: *P. a.* var. *pubescens* was the first plant growing on the slopes of Washington State's Mount Saint Helens after its eruption in May of 1980.

There were a few deer ferns (*Blechnum spicant*) which is sometimes referred to as hard fern. They had both sterile and fertile fronds.

After this level part of the trail we headed up a winding hillside where we found mostly sword ferns and bare ground.

When we reached the top there was a nice bench with a direct view to the falls in the distance. We lingered there for a 15-minute break with a snack & took some photos and then headed back on the trail.

Photo courtesy of Forrest Campbell

There were many other hikers both young and older on the trail coming up and down. They all seemed to be enjoying themselves.

The next leg consisted of a meandering trail on the side of a somewhat step hillside that went down and up leading to the bridge over one of the falls.

Along this stretch of the trail we found the following ferns.

Polypodium glycyrrhiza (licorice fern). These were high up on the trunks of big leaf maples. They are summer – deciduous and winter – evergreen. They were clearly visible at a distance sharing their perch with one form or another of Selaginella. The common name comes from a licorice flavor in the rhizome.

Asplenium trichomanes (maidenhair spleenwort) These were located in the crevices of large rocks. The fronds were about 4 to 7" long, arching and evergreen. In short it is one of the loveliest of all spleenworts.

Adiantum aleuticum (western maidenhair) These ferns were clearly visible from the bridge. Down the sides of the cliffs they seemed to flow like they were mimicking the waterfall. There were others on the trail coming up but nothing this spectacular.

When we arrived at the bridge we looked down at the water cascading below and looked

up at the river coming from above. The river was a constant medium roar. It is estimated that the average volume amount of water year around is 350 cubic feet per second on this South fork. And here in August the river was really flowing fast. I can only imagine what it looks like after the winter snow pack melts.

We continued on up the hill for another 10 minutes or so to a level area that looked like a good place to have lunch

As we enjoyed our lunch and conversation there were little chipmunks scurrying and chirping.

You could also hear I-90 which was near.

Photo courtesy of Forrest Campbell

After lunch we headed back down the trail revisiting some of the spots and ferns that we encountered on the way up. We took a side trail that led us to a wooden lookout high above the river. From this vantage point we were looking right at one of the falls coming over a steep rock cliff. It was very breathtaking.

We continued down the trail at a brisk pace until the elevation drop slowed our pace. And when we reached that level area at the bottom of the hill we walked back to our starting point.

All said we were on the trail just short of 6 hours and covered just under 5 miles.

We said our good byes and took with us our experience on this trail seeking ferns in the wild along with photos and memories.

We are planning another hike on August 18th, 2018. And will let you know where after we finalize the details.

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Fern Hybridization

First published in *Pteridologist* 2013 V5 Part 6. Reprinted with permission.

Rolf Thiemann

Altena, Germany

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, Anne 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!

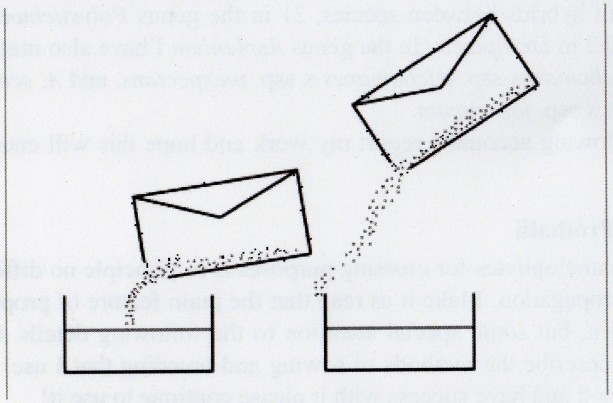
Harvesting the Spores

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.

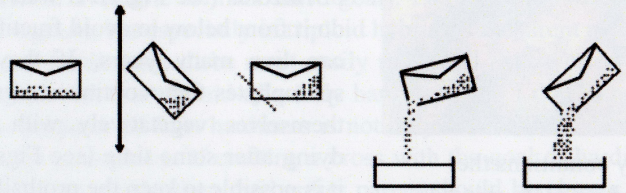


Keep the spore envelope close to the growing box to avoid draughts blowing the spores elsewhere.

Poor sowing technique

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.



1	2	3	4	5
usually settle along the bottom of the envelope	envelope at an angle to gather the spores in one corner	the other corner that is free of spores	keep the envelope almost horizontal in order to sow the spores thinly	envelope too steeply. The sowing will be too thick

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.

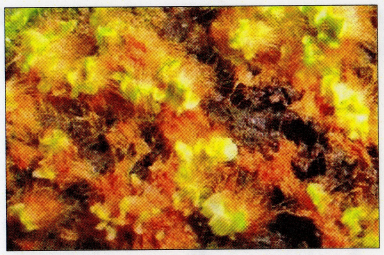


Fig. 4. In dry conditions the prothalli produce more rhizoids than usual. (*Dryopteris goldiana*)

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*)

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

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 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).

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

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.

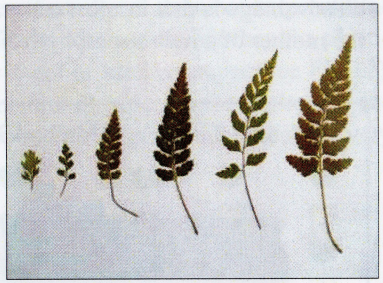


Fig. 9. Documentation of sporophyte growth, this example is *Polystichum drepanum*.

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 preferred 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.

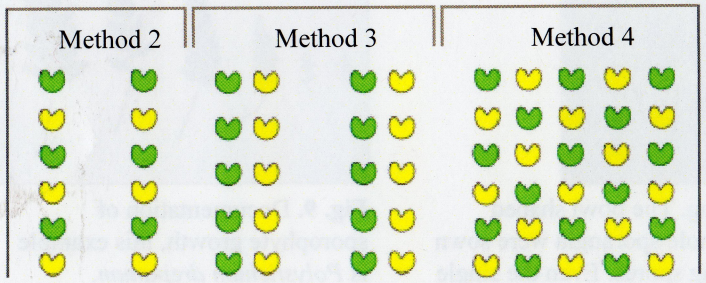


Fig. 10. Different ways of spacing the prothalli

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 gametophye 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.

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Fig. 13. Method 3. This is now my preferred method with the different sporophytes sown in pairs.

Breathing the Language of Plants

Jo Laskowski

Seattle, WA

Saturday, October 21, 2017. A great day for a Fall Social, don't you think? A perfect day for the Hardy Fern Foundation's Fall Social indeed, the organization's annual invitation to members and their guests to whip up a potluck dish and show up at the Bellevue Botanical Garden for socializing and entertainment. And why the Bellevue Botanical Garden? As an affiliate garden of the HFF, and located in the Seattle area, too, we've enjoyed a long relationship with this 25-year old garden—and the occasional use of some of their space…

A good day, too, to see a display of several dozen individual fern fronds, each one freshly picked and in a glass vase set in long lines down two rows of tables; all of them labelled with their common and scientific names. How rare to see such a diverse collection of fern fronds from one locale, and testimony to the unique growing area that is the Pacific Northwest. *Adiantum, Asplenium, Athyrium, Blechnum, Coniogramme, Cyrtomium, Dryopteris, Gymnocarpium, Matteuccia, Osmunda, Polypodium, Polystichum, Woodwardia*—most of the major temperate genera were represented, some with just a few species and others with lots and lots. And lots and lots of cultivars. There were pinnatifid *Blechnum*, tri-pinnate *Polystichum*, entire *Asplenium*, bifid *Polypodium*. Creepers and crawlers and crown-formers. A five-foot long *Woodwardia unigemmata* frond; some fronds showing their deciduous proclivity by their browning and crumbling structures. And *Equisetum hyemale*—what to say? I once pulled a single frond out of a *Cryptomeria japonica* 'Elegans.' I laid it out on the sidewalk and measured it. Nine feet. What to say? (see photo page 22)

Show up everyone did. By 11AM the room felt warm and convivial, with the low buzz of conversation and a loaded table of edible goodies. Someone told me that she drove a swath of yellow from the fall color of the big leaf maples along the road, an electrifying vista. When she came in to the Social, she found the room was a wash of green, and so serene. Such is a fall day. When everyone was seated and starting to dig in to their plates, the guest speaker began. John van den Meerendonk, HFF past-President and long-time board member, guided us into a weighty topic—"Botany in the New Age of Discovery."

To contemplate the tiny blip that we—as *Homo sapiens*—occupy on the timeline of life is sobering. In this very miniscule length of time, we've done a lot.

11,000 years ago: got "civilized," or started gathering in groups.

10,000 years ago: we became agriculturalists.

Someplace in here: black and white skins evolved. As ancient populations migrated into new areas, they were were exposed to different levels of light; vitamin D and folate levels are affected by light levels, and both are necessary to us. People settled in northern latitudes didn't get enough UV light to synthesize vitamin D in their skin, so natural selection favored two genetic solutions to the problem—evolving pale skin that absorbs the UV light more effectively, and favoring lactose tolerance to be able to digest the sugars and vitamin D naturally found in newly domesticated animal milk. Clever solutions.

8,000 years ago: wheat was hybridized. In first world countries today, only 3% of the population is required to feed the remainder; in third world countries 80 – 90% of the population is needed to do the same thing.

5,000 years ago: writing developed as a way to store information.

2 months ago: **since that date, our knowledge has doubled.**

This astronomical increase in knowledge shows us many things. There were occurrences of incomprehensible magnitude, some of which were extra-terrestrial, and some the hiccups and burps of our planet settling in after its tumultuous creation. Billions of life forms emerged and disappeared. Evidence of some of them was captured in fossil records, while the existence of others has been hypothesized. We've divined genetics and are studying DNA, where we've sussed out that four molecules alone, paired and arranged to form double helices, uniquely describe a life form. We know that we ourselves are a complex organism with over three billion of these paired molecules, or base pairs (bp). A lot of plants have around 12.6 million bp, although the cottonwood comes in with a surprising 556 million bp. Today more than 200 plants have had their genomes sequenced, which is to say that the ordering and placement of their bp—their unique biological signature—has been determined. Very recently we found that all organisms currently alive have a set of 355 genes that they share in common with each other. This was found to be true across all orders of life. We have much in common with ferns and slugs and slime molds.

We're starting to understand that events that occur to living organisms stress them, and that the genome responds to it by modifying itself to help cope. "Epigenetics," the effect of the environment on the genome, is laced with nuances that await our future decipherment.

And in this age of acceleration, of new discovery, what is it with plants? Studies are blurring the distinction between the plant and animal kingdoms by documenting learning behavior in plants. Plants may lack brains and neural tissues, but they possess a sophisticated calcium-based signaling network in their cells that's similar to animals' memory processes. A gene that allowed ferns to survive in dark forests came from the

hornwort, a mesmerizing little life form that grows in mats on streambanks or trees. The gene enables ferns to harvest light from both the red and blue spectrums, making them ever so much more successful in the low-light environments in which they evolved. This neochrome gene arrived about 180 million years ago, and is not found in those orders of ferns (Osmundales and Schizaeales) that evolved before then. We've discovered that a plant can determine the identity of a neighboring plant, or the identity of an insect that's chewing on it. It can release chemical compounds to attract other insects to remove the offender. In fact, plants make extensive use of aerosol communication, a phenomenon that we're only beginning to understand. Give us a couple more months. Just think—we're constantly immersed in a signaling process that we don't even understand.

And after several more "couple of months," what will we probably know? We may be able to isolate diseases, and genetically sequence all life forms to establish their signatures and decipher functions. We will garner reams of information, probably overwhelming ourselves while we're at it.

So head off this delirious descent into confusion. Get outside. Get into the woods. Get near trees. Spend time with your ferns. You're breathing the language of plants—the best way of all to take in information.

Photo courtesy of Jo Laskowski

Summer 2017 Fern Workshop

Greg Graves

Graham, WA

Back on July 13, 2017 the Hardy Fern Foundation and the Northwest Horticultural Society co-sponsored a fern workshop here at Old Goat Farm in Graham, Washington. This was the second year the two groups had worked together to put together an all day workshop focused on good ferns for Northwest gardens. It was an all day event running from 8:30 am until 3:00 pm. Each attendee had the opportunity to attend 3 separate classes. There were 2 groups with about 15 in each.

Luck was on our side and it was one of those perfect summer days with lots of warm sunshine and plenty of shade. We started with coffee and pastries followed by two classes. About mid-day it was time for a lunch break served in the garden and then the final class of the day.

Ferns, being quite different from many other garden plants, are a bit more challenging to propagate. Carolyn Doherty conducted a class on 'Propagating ferns'. Carolyn is the Hardy Fern Foundation's top propagator, Master Gardener and a long time HFF volunteer. (see photo above) She shared her expertise and experience in fern propagation methods from division to spore production. Each participant learned the ins and outs of sowing spores and had the chance to try their hand at sowing some spore to take home.

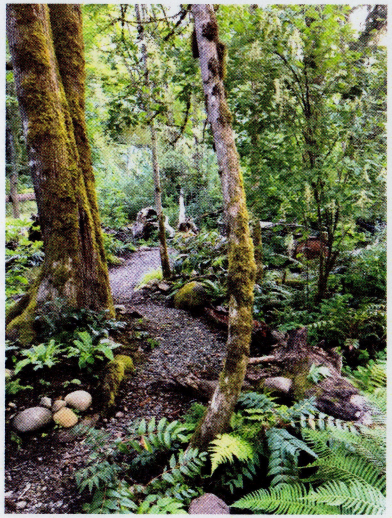
Next up was 'Making a Container Garden full of History and Beauty' with Richie Steffen. Richie is the Director/Curator of the Elisabeth C. Miller Botanical Garden and current president of HFF. (see photo below) I had a 6 foot by 2 foot stone table in the garden which Richie rebuilt into a spectacular fern table. Because of the size, he did half for the morning session and the other half in the afternoon. I'm fortunate to be able to still enjoy it every day. Ferns make excellent container plants and have a rich horticultural history. Richie demonstrated how to combine ferns with perennials and small shrubs into building a fern table for the shade. These same techniques can also be used for containers. Because of his horticultural knowledge Richie also shared numerous historical notes and interesting facts about each fern.

The third class was 'Using Ferns in the Garden and the Plants that Love Them' with me, Greg Graves. In

Completed fern table

the 13 years that I have been developing our garden I have used ferns as one of the main plant groups. There are about 35 different hardy ferns in the garden. I labeled them all for this event and had a corresponding handout. We did a walk through the garden so I could point each out and what plants I like to use with each fern and why. The second part of the walkabout was through our woods. I had recently installed a mini-stumpery or what I refer to as the 'Stumpette'. (photos below) I was inspired by the HFF signature garden at the RSBG and a friend's Stumpery on Vashon Island. I obtained about a dozen stumps from a neighbor and used them as the backbone for this separate fern garden in the woods. At the time of the class this little garden was less than a year old. I explained the process of how I built it. Hopefully everyone will be able to come back and see how it develops over time.

All combined I think everyone had not only an education day but a lot of fun. I was more inspired at the end of the day to continue to bulk up the ferns in the garden. What's not to like?



All photos courtesty of Greg Graves

Thank you to everyone who so generously donated to our Letter of Appeal!

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Ordering Spore

This Spore Exchange is available exclusively to members of the Hardy Fern Foundation. Spore will continue to cost 50 cents per species. However, I have found that it is impossible to know the exact shipping costs until they are actually mailed. For this reason, I would like members who order spore to either request it by mail to: Carolyn Doherty, Director of the Spore Exchange, 1905 43rd St. SE, Puyallup, WA 98372. Or by email to: fernspores@hotmail.com with the address where they want them sent. I will fill the order and reply by email with the exact cost of the spore, shipping, and a padded mailer if needed (75 cents) after mailing it. After the member receives this, they can pay for it by return mail at the above address or by PayPal to the Hardy Fern Foundation if it involves foreign currency. Hopefully, this will improve our system and eliminate shipping cost guessing.

Also, I would like to thank donors of spore who take the extra time to package the spore in individual packages. Please try to avoid using tape as spore sticks to it. Individual packaging saves me an enormous amount of time repackaging and labeling the spore when orders come in.

Updated 01/09/2018

***Adiantum aleuticum* '16, '17 DOH; '16 RSF**

***Adiantum aleuticum* 'Subpumilum' '13 RAS; '14 RSF**

***Adiantum raddianum* 'Crested Majus' '17 Fitzpatrick**

***Arachniodes affinis simulans* '13 EMBG**

***Arachniodes davalliaeformis* '16 RSF**

***Asplenium oblongifolium* '17 Fitzpatrick**

***Asplenium scolopendrium* '16 DOH**

***Asplenium scolopendrium* 'Saw Blade' '16 DOH**

***Asplenium trichomanes* '16 RSF; '17 Perasso**

***Athyrium alpestre* '17 Perasso**

***Athyrium filix-femina* 'Victoriae' '16 DOH**

***Athyrium otophorum* '14, '16, '17 DOH**

***Athyrium yokoscense* '16 Gassner**

Blechnum niponicum '14 RSF

Blechnum novae-zelandiae See *Parablechnum novae-zelandiae*

Blechnum nudum See *Lomaria nuda*

Blechnum penna-marina See *Austroblechnum penna-marina*

Blechnum spicant See *Struthiopteris spicant*

Blechnum spicant 'Rickard's Serrate' See *Struthiopteris spicant* 'Rickard's Serrate'

Blechnum tabulare See *Lomariocycas tabularis*

Cyrtomium caryotideum '16 RSF

Cyrtomium lonchitoides '15 RSF

Cyrtomium macrophyllum '14, '15 RSF

Diplazium hachijoense '17 Hendrikx

Dryopteris aemula '12 Gassner

Dryopteris affinis 'Stableri' '15, '16 RSF

Dryopteris affinis 'Stableri Crisped' '15 RSF

Dryopteris affinis var. *borreri* 'Furcans' '17 Hendrikx

Dryopteris carthusiana '14 Perasso

Dryopteris cashmiriana '15 RSF

Dryopteris championii '12, '14 RSF

Dryopteris chrysocoma '13 Gassner

Dryopteris clintoniana '12 Gassner

Dryopteris corleyi '12 Gassner

Dryopteris crassirhizoma '13, '15, '16 RSF

Dryopteris crispifolia '15, '16, '17 RSF; '16 RAS

Dryopteris cycadina '15 RSF

Dryopteris cystolepidota '17 Strahle

Dryopteris decipiens '17 Strahle

Dryopteris erythrosora '17 JKL

Dryopteris erythrosora 'Prolifica' '17 Strahle

Dryopteris expansa '12 Perasso

Dryopteris expansa var. *willeana* '12 Gassner

Dryopteris filix-mas '15 RSF

Dryopteris filix-mas 'Barnesii' '14 RSF

Dryopteris filix-mas 'Parsley' '16 DOH

Dryopteris lacunosa '17 Hendrikx

Dryopteris lepidopoda '15, '17 RSF; '17 JKL

Dryopteris marginalis '13, '16 RSF

Dryopteris muenchii '12 Gassner

Dryopteris namegatae '16 EMBG; '16 RAS

Dryopteris polylepis '17 Strahle

Dryopteris pseudofilix-mas '15 RSF

Dryopteris pulcherrima '16 JKL

Dryopteris remota '15, '16, '17 RSF

Dryopteris sieboldii '13, '14, '16 RSF

Dryopteris sublacera '13, '15 RSF

Dryopteris tokyoensis '16 RSF

Dryopteris uniformis 'Cristata' '16 JKL

Dryopteris wallichiana '13 RSF

Dryopteris wallichiana ssp. *coriacea* '16 EMBG

Gymnocarpium dryopteris 'Plumosum' '16 EMBG

Gymnocarpium fedtschenkoanum '16 Gassner

Gymnocarpium oyamense '17 Strahle

Histiopteris incisa '17 Hendrikx

Hypolepis millefolium '17 Hendrikx

Lomaria (formerly *Blechnum nudum*) *nuda* '16 EMBG

Lomariocycas (formerly *Blechnum tabulare*) *tabularis* '16 EMBG

Matteuccia orientalis '14 Olsen; '16 Gassner

Nephrolepis falcata 'Furcans' '17 Fitzpatrick

Onychium japonicum '13 Olsen; '14 DOH

Osmunda banksiifolia '16 JKL

Osmunda lancea'17 Olsen

Osmunda regalis '17 DOH

Osmunda regalis 'Decomposita' '16 RAS

Osmunda regalis 'Purpurascens' '17 RSF

Parablechnum (formerly *Blechnum*) *novae-zelandiae* '16 EMBG

Pellaea atropurpurea '15 Beuving

Pellaea sp. 'Silvery Moon' '17 Fitzpatrick

Pentagramma triangularis '17 Perasso

Polypodium scouleri '12 RSF

Polypodium vulgare Ramosum Group '17 Strahle

Polypodium vulgare 'Uulong Island' '17 Strahle

Polystichum acrostichoides 'LSS Hurricane Watch' '16 EMBG

Polystichum aculeatum Cristatum Group '13 EMBG

Polystichum californicum '15, '17 RSF

Polystichum deltodon '13, '16 Gassner

Polystichum makinoi '14 RSF

Polystichum mayebarae '13 Gassner

Polystichum microchlamys '15 RSF

Polystichum monticola '17 Olsen

Polystichum munitum '15, '17 DOH

Polystichum munitum 'Sword Play' '17 RSF

Polystichum neolobatum '14, '17 RSF

Polystichum proliferum '17 RSF

Polystichum rigens '15 RSF; '16 Gassner

Polystichum setiferum 'Lineare' '12 Olsen

Polystichum wilsonii '12 Gassner; '17 Olsen

Polystichum xiphophyllum '15 RSF

Pteris cretica 'Albolineata' '17 Fitzpatrick

Pteris cretica 'Mayii' '17 Fitzpatrick

Struthiopteris (formerly *Blechnum*) *spicant* '15 DOH; '16 RSF

Struthiopteris (formerly *Blechnum*) *spicant* 'Rickard's Serrate' '14 RSF

Thelypteris aurita '16 Gassner

Woodsia subcordata '16 EMBG

Woodwardia unigemmata '12 Mandeville

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Pyrrosia sorus - *Photo courtesy of David Gibson*

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