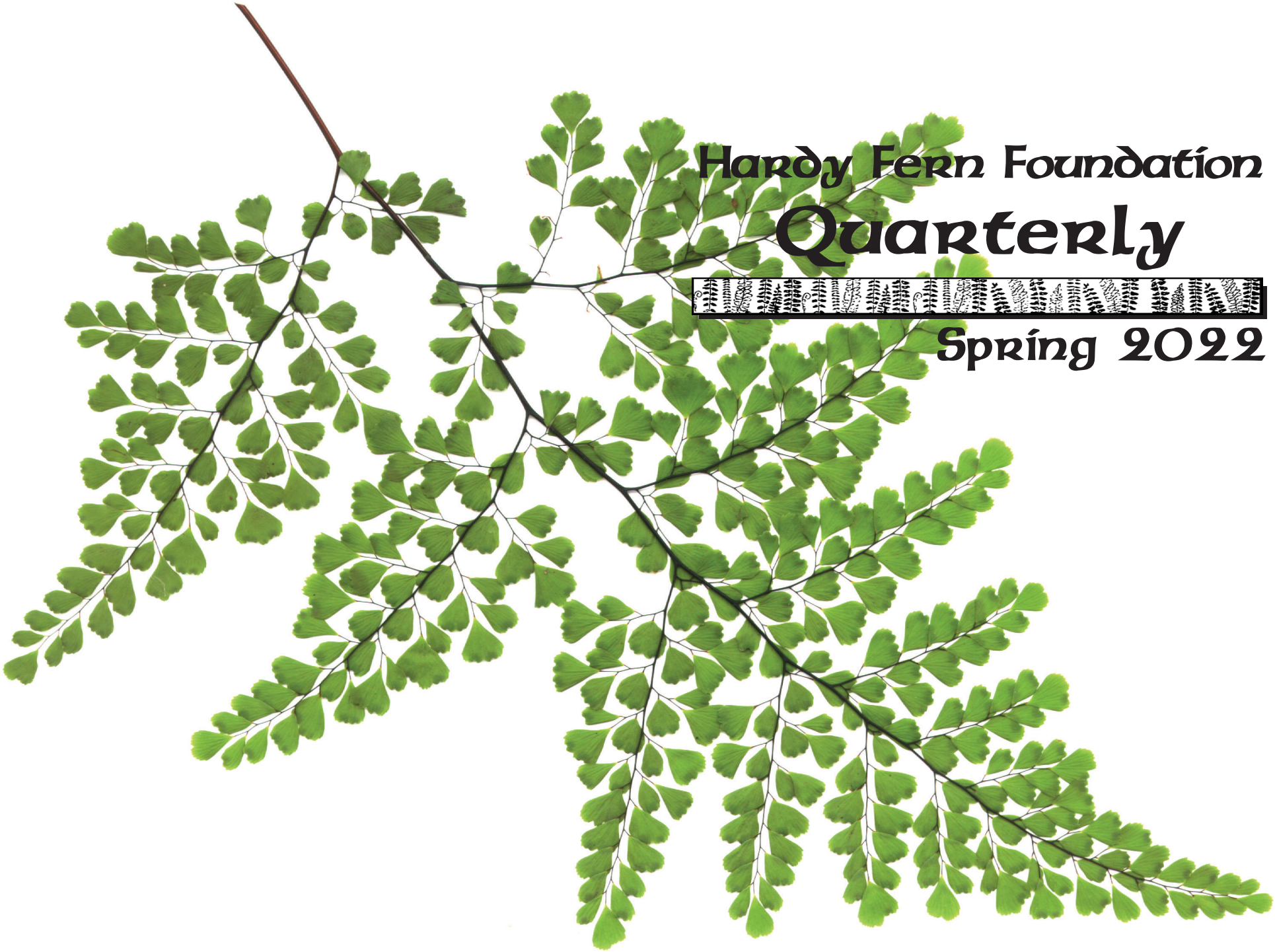

Hardy Fern Foundation Quarterly

Spring 2022

THE HARDY FERN FOUNDATION

P.O. Box 3797
Federal Way, WA 98063-3797
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;
Bartlett Arboretum & Gardens in Stamford, Connecticut;
Bellevue Botanical Garden, Bellevue, Washington;
Birmingham Botanical Gardens, Birmingham, Alabama;
Cornell Botanic Gardens, Ithaca, New York;
Dallas Arboretum, Dallas, Texas;
Denver Botanic Gardens, Denver, Colorado;
Dixon Gallery and Gardens, Memphis, Tennessee;
Ganna Walska Lotusland, Santa Barbara, California;
Georgia State University Perimeter College Native Plant Botanical Garden, Decatur, Georgia;
Heronswood, Kingston, Washington; ***NEW 2021!***
Inniswood Metro Gardens, Columbus, Ohio;
Lakewold, Lakewood, Washington;
Lewis Ginter Botanical Garden, Richmond, Virginia;
Powell Gardens, Kingsville, Missouri;
Rotary Gardens, Janesville, Wisconsin;
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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Please send your submissions to:

Sue Olsen
2003 128th Ave SE
Bellevue, WA 98005
foliageg@gmail.com

Editor:
Sue Olsen

Graphics:
Willanna Bradner
(cover design)
Lori Gibson
(quarterly design)

Website Administrators
Lori and Dave Gibson

Board of Directors

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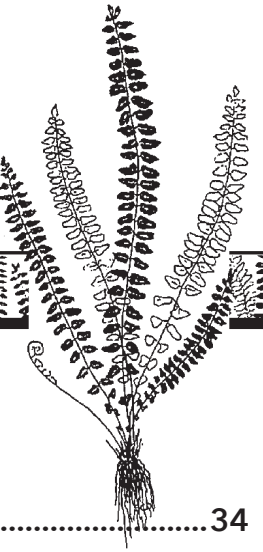


President's Message Spring 2022

HFF Quarterly – Spring Issue

There is something revitalizing and healing about the vibrant greens of new spring foliage. I love walking through the garden at this time of the year watching for new fronds to unfurl and revealing the intricate patterns and often fuzzy or colorful scales to contrast with bright green leaflets. I have been hard at work adding more ferns to the garden from late winter into spring. My large collector's garden can certainly use some repetition, so I have added several flats of young ferns to create a few drifts of lush foliage. This included making a ribbon of one of my favorite ferns, Athyrium otophorum, limelight fern or eared lady fern. The ghostly, minty white fronds with purple stems add a touch of brightness to my shady areas, and I love the graceful way it forms broad arching, vase-like clumps.

One fern I am particularly interested in seeing emerge this spring is my plant of Blechnum chilense (now Blechnum cordatum or Parablechnum cordatum depending on which taxonomic papers you subscribe to follow) with deep red new fronds. It can be found in the UK, but it is nearly absent from the US. My fern is from spore from a Chilean collection trip several years ago. Planted in the garden at the beginning of the pandemic, this summer will be the third year for it to settle in, and it looks like it will robustly take off this spring. The new growth can be slow to emerge, but I have already noticed the crosiers starting to rise from the crown. Unfortunately, this fern had a limited range of growability, probably only performing well in mild cool areas of the West Coast.

The member's winter lecture series jointly held with the British Pteridological Society (BPS) was a great success. I greatly appreciate the efforts of BPS members Alison Evans and Julian Reed to work with us to have monthly free talks for both of our organization's members from November to March. I especially want to thank our program manager, Dennis Beatty, for deftly handling the PR for these events as well as being our tech person for the webinars. I am also pleased to announce that we are already working with the BPS on the 2022–2023 winter lectures. I hope the members of both societies found inspiration from these online events.

Watch your email for more online programing through this spring and summer. I hope everyone finds some delightful surprises as your gardens burst into growth. I will be looking forward to seeing my ferns grow lush as the season progresses.

All the best,

Richie

Richie Steffen
HFF President

Happy Spring!

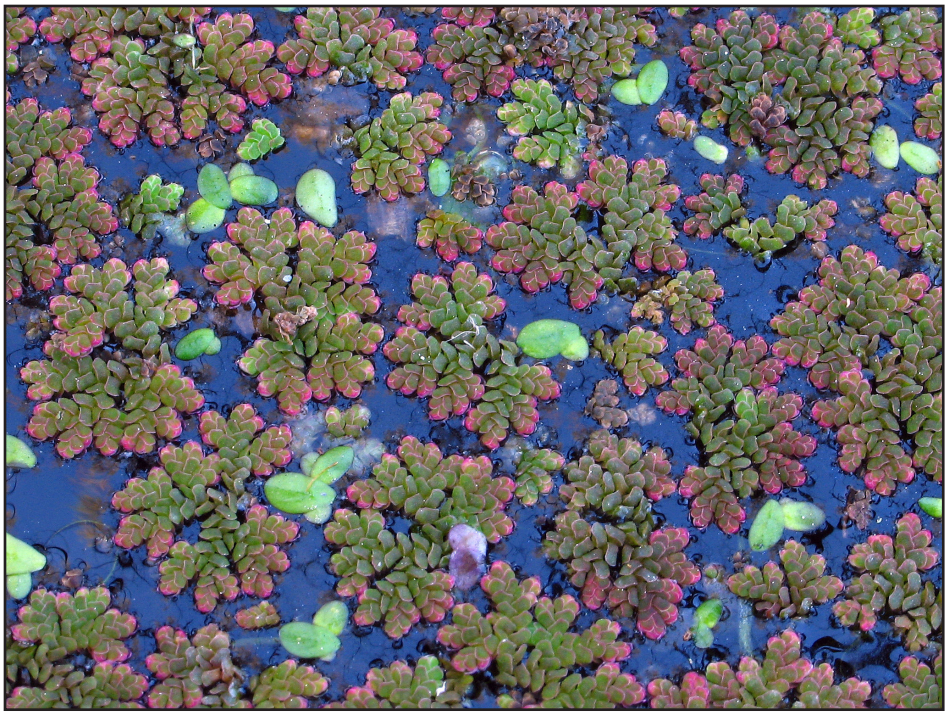
Can Azolla Save The Earth?

Joan Eiger Gottlieb
Wakefield, Rhode Island

Azolla caroliniana, River Bend Wildlife Management Area, Laurens County, Georgia. Photo by Alan Cressler

Thinking in geological time is not easy, but an emerging story starring the pixie aquatic fern *Azolla* may be worth the strain. Paleontologists (who study life through its fossil record) and palynologists (experts on pollen and other spores) have been joined by molecular biologists (wizards on DNA, RNA, and other large organic molecules) to build on a story that may have begun 50 mya (million years ago) in the Eocene, and may have significance for climate issues today.

The earth of that era appears to have been a much warmer place. Shallow basins of fresh water spread across the Arctic Circle, with extensive mats of *Azolla* covering their surfaces. In bright sunlight or at cooler temperatures the mats develop a striking bronze-pink color. This fast growing fern gets usable nitrogen for its rampant growth from a symbiotic,'nitrogen -fixing' cyanobacterium *Nostoc azollae,* formerly called a blue-green alga. That means *Nostoc* can absorb unusable, molecular nitrogen (N_2) from the air and convert it to nitrogen oxides (NO_2, NO_3) and ammonia (NH_3), the chemical fertilizers of plant and algal photosynthetic life. *Azolla,* for its part, grabs atmospheric carbon dioxide (CO_2 - the 'greenhouse gas' now increasing to climate changing levels) and takes nitrogen from the *Nostoc* in its special leaf cavities, for a



Azolla caroliniana, Savannah National Wildlife Refuge, Jasper County, South Carolina. Photo by Alan Cressler

maximized photosynthetic output that has been calculated to have pulled trillions of tons of CO_2 out of Eocenic air. *Azolla* may thus have been a key player in cooling a hot house earth into the chillier place it became as mammals (eventually humans) evolved, and earth headed into a series of ice ages in the Pleistocene. Asian farmers have used *Azolla* as a 'green' fertilizer in rice paddies for over 1,500 years, and the genus has a fossil record going back 100 million years. It has been a natural food for fish and other aquatic wildlife, including the Galapagos tortoise (personal observation).

Before delving into the rest of the story, a little closer look at this powerhouse fern is in order. There are 7 - 8 species of *Azolla* worldwide, popularly called 'mosquito ferns' for the way their tiny leaves (each the size of a gnat) overlap to form tight, mat-like colonies that, reportedly, prevent mosquito breeding. *Azolla* and *Salvinia* (water spangles) make up the Family Salviniaceae. Add the Family Marsileaceae (water clovers) with its three genera - *Marsilea, Regnelidium,* and *Pilularia,* and the list of aquatic ferns is complete. Only the quillworts (*Isoetes*), a parallel group of 'fern allies' have a majority of aquatic species and hybrids; with the rest in wet meadows of tropical alpine ecosystems.

Aquatic pteridophytes are a small group, and they share another common, independently evolved character; they are all heterosporous - that is, they produce two types of spores - tiny, dust-size 'microspores' that sprout into male gametophytes

Azolla Ocean Shores Photo by Sue Olsen

(bearing swimming sperms), and conspicuously larger 'megaspores' that contain well-insulated, nutrient-full female gametophytes and eggs. The nutrients help resulting embryos survive drying or freezing when the megaspore packages detach and sink to the sediments of ditches and ponds. *Azolla* megaspores also contain a small inoculum of *Nostoc* for the new generation.

In another pteridophyte lineage (fossils indicate it was most likely among the ferns, although the majority of extant ferns are homosporous), heterospory was a precursor trait that led to rapid evolution of now dominant seed plants. To be complete, it should be mentioned that the spike 'mosses' (*Selaginella spp.*), another parallel 'fern ally', are also heterosporous, albeit mainly terrestrial on damp soils. Heterospory has, in fact, been a popular lifestyle among vascular plants of many different lineages, and it would be beneficial to researchers if it were reliable in *Azolla* - for ease of dispersal and a dormancy option. Alas, the fern rarely makes spores or undergoes sexual reproduction in nature. Instead, it reproduces asexually by prolific branching and fragmentation. Recently, under laboratory conditions, spore and gametophyte formation have been induced in *Azolla* with bouts of far-red light. That is temptingly reminiscent of the photoperiod (dark night) exposures that initiate flowering hormone florigen production and converts foliar meristems to flowers in angiosperms.

Returning to whether *Azolla*, through rapid growth, nutrient access from its N_2-fixing symbiont, and ability to sequester excess atmospheric CO_2 from our warming planet, could reprise its purported role in reversing the similar heating of earth long ago - I

believe that climate change today will take an 'all hands on deck' effort, including the superpowers of *Azolla*. Personal and commercial/industrial conservation, energy efficiencies, a steady shift from fossil fuels to renewable energy sources, incentivizing advanced energy technologies, improving agricultural practices, slowing current rates of permafrost melting, and expansion of forests, trees, and other CO_2 sequestration partners must all play a part. There just isn't enough favorable habitat for *Azolla* cultivation or time for the research needed to maximize its genetic potentials. In addition, research takes expertise, money, and a lot of time to scale up promising discoveries.

In spite of these formidable hurdles, research efforts are coming to fruition on the genome sequencing of *Azolla* in the laboratories of Kathleen M. Pryer, Carl Rothfels, Erin Sigel, Fay-Wei Li and others. It is the first fern genome to be revealed, but it took a crowd-funding campaign to conquer the initial steps. With gene locations identified and open to editing by cutting edge technologies like CRISPR, we can expect new *Azolla* variants to be developed that can:

1. Sequester even greater amounts of atmospheric CO_2 to quell its effect on climate warming, if not actually reverse it.

2. Produce enough 'free' nitrogen oxides and ammonia-based fertilizers to help feed a human population projected to reach 10 billion by 2050.

3. Enhance the nutrition it supplies to animal feed mixes. High concentrations of toxic polyphenols (e.g. tannins) in current strains of *Azolla* limit using it to only 10% of poultry feed, 15% of pig chow, and 25% of tilapia food (to prevent digestive and weight problems). There is also a good chance of introducing higher quality protein into the feed.

4. Serve as a controlled biofuel, much the way peat does in some parts of the world, although that would add to atmospheric CO_2.

5. Absorb and break down waste antibiotics, pesticides, and heavy metals in polluted water.

6. Provide methane (CH_4 - a powerful greenhouse gas) mitigation from rice fields through oxidation (demonstrated for *A. microphylla* in laboratory and field studies).

7. Create an *Azolla* compost to enhance the carbon storage capacity of soil.

Azolla DNA has 720 million nitrogen base pairs (Mb) - considered a moderate size genome - (*Lycopodium clavatum* has 931 Mb). As the genes and the enzymes they control are identified and made available for research, new strains of *Azolla* could undoubtedly introduce greater efficiencies and environmental uses. Selective breeding and hybridizing are other 'tried and true' ways to enhance desirable traits.

I am eager to be 'saved' by a remarkable little fern and grateful to the many scientists who are working hard to make its potential a part of the climate solution. ***Go Azolla!***

10 Ferns that are easy to grow in Central Illinois

Article and Photos by Kay Dye
Mapleton, Illinois

As long as I have been gardening ferns have been included in my garden. They have special qualities that are often needed in shade gardens. Their texture sets off plants such as hostas. In our area deer, rabbits, and other pests avoid them. After they are established, many can do so without much water, but some can grow in wetter habitats, too. Cultivars can be large or small, grow in acidic or alkaline soils. The problem is our local greenhouses grow only a limited selection of ferns. When I joined the HFF I decided to try spores which opened a new source. In the spring and summer issues of 2021, you may have noticed inventories of the fern collection at RSBG. It was fascinating to see species I had grown from spore and compare notes and ratings. Some of the ratings I agreed with, some not, but seeing it in a spreadsheet format like that, it occurred to me that it would be great to have something like that where people from around the world could weigh in on species and cultivars. I sent a couple of emails and although the idea was solid, the maintenance of such an undertaking was not possible. The alternative plan was to have input from growers through articles in HFF. I was invited to participate and am reporting on ferns growing in my area and I hope in the future more will also report to HFF.

Polystichum acrostichoides

Growing Conditions

The location of my garden is in Central Illinois near Peoria. It is next to a wooded area with a steep ravine that usually has a little water running through from underground springs. Trees such as sassafras, red and white oak, walnut, wild black cherry, shingle oak, locust and a few more grow in the woods around my garden area. There is serious clay in many places. Ceramics is a hobby of mine and once I collected some clay to see if I could make something from it. It made a nice terra cotta pot! To amend the soil, I have tilled in composted wood chips and mushroom compost. The soil is acidic, so I plant ferns that like lime at the base of Martagon lilies (which also like lime) and add it to the soil around them.

Cyrtomium fortunei

In the woods I have found *Polystichum acrostichoides* clinging to many of the banks of the ravine, *Athyrium filix-femina*, *Asplenium platyneuron*, and *Onoclea sensibilis*. We are considered zone 5 or 5a and can have temperatures of -20 degrees Fahrenheit (-28.88 C.) with summer temperatures above 90 degrees Fahrenheit (32.22 C.). Our average yearly snowfall is 26.2" (66.54 cm) and rainfall 37.55" (95.37cm). We usually get an ample amount of rain until July and August when it can get hot and dry. Supplemental watering is done with sprinklers and hoses. In a good year, temperatures in summer stay around 85 degrees Fahrenheit and rain comes every couple of weeks even in July and August, while winter will have snow cover even if temperatures drop into the negative zero range. A bad year will have 90-100 degree temps with no water for a month or more and a winter with little snowfall and below zero temps. Another problem recently has been fluctuations of high and low temps in April and May when plants have begun to emerge. I like to try plants that are rated zone 6 and have had luck with many. Right now, one of my favorites is *Cyrtomium macrophyllum* I have it covered with floating row cover to hopefully add a little extra protection for its first year in the ground. I do this with a lot of the marginal plants.

The first top ten ferns I will report on are those that I have grown at different homes (one for 24 years, the other for 8) for a period of over 30 years. They are mostly easily found and grow well in our area.

A. scolopendrium 'Sagitatum Group'

Ten ferns that do well in my garden

Genus	Species	Rating	Comments
Cystopteris	bulbifera (3-9)	5	This goes first just because of its growth that is so vigorous it's invasive. I recommend it for difficult areas, but with the warning that it can take over. It's so pretty I have a hard time making myself dig it out, but last year I got serious about it.
Dryopteris	affinis (4-9)	5	Trouble free, growing in a shaded area that pretty much gets nothing: no sun, no water, but always looks perfect. I forget about it. It should be in a more prominent position.
Dryopteris	affinis 'The King' (4-9)	5	Big, bold, vigorous. Crests nicely.
Dryopteris	filix-mas 'Barnesii' (4-8)	5	This has been divided, moved around just because it is so attractive and easy to grow. Soil, light, water don't seem to affect it.
Dryopteris	filix-mas 'Parsley' (4-8)	5	A newer addition that has done well. As with others, vigorous and easy to please.

Dryopteris	X australis (5-9)	5	Vigorous, one in my garden that will reach 4 feet (D. marginalis gets close to that height)
Matteuccia	struthiopteris (3-7)	5	Not one of my favorites, but in our area most homes have it and it's easy to acquire because people are always needing to remove them from an area because they are so vigorous.
Adiantum	pedatum (3-8)	5	Beautiful and lush, undemanding, can be found growing in the wild in our area.
Athyrium	niponicum (3-9)	5	All cultivars do well here. Currently growing: Pictum, 'Ghost', 'Ocean's Fury', 'Applecourt', 'Ursula's Red', and a green crested one that I have never been able to name.
Athyrium	filix-femina var. angustum 'Lady in Red'	5	Years ago, I was given an A. filix-femina subsp. angustum f. rubellum before someone decided to give it a more marketable name. They both seem identical and are as easily grown as a common lady fern.

The ferns with which I have trouble or loss I usually attribute to either zone, water, ph, or unknown. Since growing from HFF spores, I have found that some of the ferns I have tried growing for years without success, such as *Dryopteris erythrosora*, have grown well for me from spores. Of the struggling ferns on this list the only one I have lost is *Dryopteris tokyoensis*. The others are either in an area I call my 'holding area' which is filled with compost and mulch or moved. I keep all my plant records and while researching for this article I found that in 2011 I ordered and planted (at my first home) *Arachniodes standishii*, *Cheilanthes lanosa*, *D. affinis* 'Revolvens', *D. championii*, *D. dilatata* 'Lepidota Cristata', and *D. filix-mas* 'Grandiceps Wills'. They must not have lived, or I would have brought them with me when I moved. I imagine dryness would have been the issue since I was on a well with six other families and couldn't water much.

Five ferns that didn't do well in my garden

Genus	Species	Rating	Comments
Dryopteris	complexa 'Stableri Crisped' (5-9)	2	Not growing well. Almost dead. Once I moved it to my holding area with better soil, it is coming around. It's been there a couple of years.
Dryopteris	dilatata 'Crispa Whiteside' (6-9)	3	This was also moved to my holding area for a couple of years and has rebounded well. I moved it out 2021. Could have been a zone issue on this one.
Dryopteris	tokyoensis (5-8)	died	Not sure, but probably just in a bad area and didn't survive the winter. I probably could have sited it better and will try it again.

Polysti-chum	makinoi (5-8)	3	This did poorly and has been moved. It seems to be doing better and hopefully will be more vigorous in 2022.
Woodsia	subcordata (5b-8)	2	I love this tiny little fern and placed two plants next to a rotting log with moss growing on it thinking it would be happy. It was HFF spore grown. I should maybe move it or grow it in a container in 2022.

Pellea atropurpurea

Some of the ferns that are prized possessions I have grown from HFF spores are new, so most are not on the list. They have made it through a winter or two in the ground and seem to be doing well. One is *Pellaea atropurpurea*. I only had one grow from spores, so I kept it inside under lights until it became large enough that it produced spores. I was then able to harvest those and ended up with a nice batch that could eventually be planted outside. The same happened with *Dryopteris sieboldii* and now I am working on *Asplenium aleuticum* 'Subpumilum' to grow enough to try outside. I am obsessed with *Phyllitis scolopendrium* and all its assorted forms and it's my quest to have every one I can possibly find. I planted quite a few of the 'Sagittatum Group' outside for the first time in 2021 and am anxious to see how they do. These were ferns I mentioned earlier planted at the feet of Martagon lilies or else with concrete chips planted around them for added lime and drainage.

Five ferns that are rare or are prized possessions

Genus	Species	Rating	Comments
Cyrtomium	fortunei (5-10)	5	If I could only have one fern this would probably be the one. I have had it many years and it has been outstanding. It was sold to me as C. falcatum and when I was corresponding with Sue Olsen about it being hardier than rated, she said it was probably C. fortunei. As far as hardiness, I sent a piece to a friend in Minneapolis years ago and contacted him to see if it was still alive. He reported it was doing well.
Polystichum	polyblepharum (6-9)	5	Such an outstanding fern. It still looks great in December after many days of freezing temperatures. It's such a perfect specimen and I'm thinking of moving it to a more prominent location in 2022.
Adiantum	venustum (5-9)	5	I received a clump of this in 2000 from a friend who was moving. I coveted it from the time I first saw it and was almost glad she was moving so she would sell it to me. It does well in various locations. The only problem I have is remembering to cut the dead fronds off in spring before the new ones sprout.
Phyllitis	scolopendrium 'Sagittatum Group'(4-9)	5	The curling and twisting leaves fascinate me. It's like each one has its own personality and I want to grow them all.
Pellaea	atropurpurea (4-9)	5	Seems strong and attractive. It's special to me because it's unusual and has been so willing as that single little plant to help me have enough to plant out. They are growing in a dryish area that gets quite a bit of sun under a sassafras tree, which seems to be working.

Ratings	
1 Didn't survive	3 Good performance
2 Poor performance	4 Attractive but not thriving
	5 Best performance

One of the first things I noticed about Dave Gibson's garden near Seattle article in the Winter 2022 HFF Quarterly was four of the ten ferns that did well in conditions radically different from mine are also are on my list. This is what will be fascinating to see if others contribute to future quarterlies. Notice that the picture I have of *Polystichum acrostichoides* growing rampantly in the woods behind my garden is one that doesn't do well for Dave as well as *Osmundastrum cinnamomeum*, which also is common in many Central Illinois gardens.

I have purchased ferns from Fancy Fronds in Washington, Plant Delights in North Carolina, and a few other places that are no longer in business. One of my favorite nurseries was Flower Factory in Wisconsin, but it has closed. I have also gotten plants from Far Reaches, but not sure if any were ferns. I'm looking forward to trying some that Dave mentioned. I just wish there were more nurseries closer to me. The shipping cost and time in a box makes it hard to give a fern a positive start.

I hope as you read this article, you'll think about writing about your ferns and your successes and challenges.

We Wish to Thank Our Donors for Their Generous Support Over the Past Year

March 2021 through February 2022

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Daniel Misner
Meagan Morrow
Riz Reyes
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Bryan Smith
Melissa Spearing

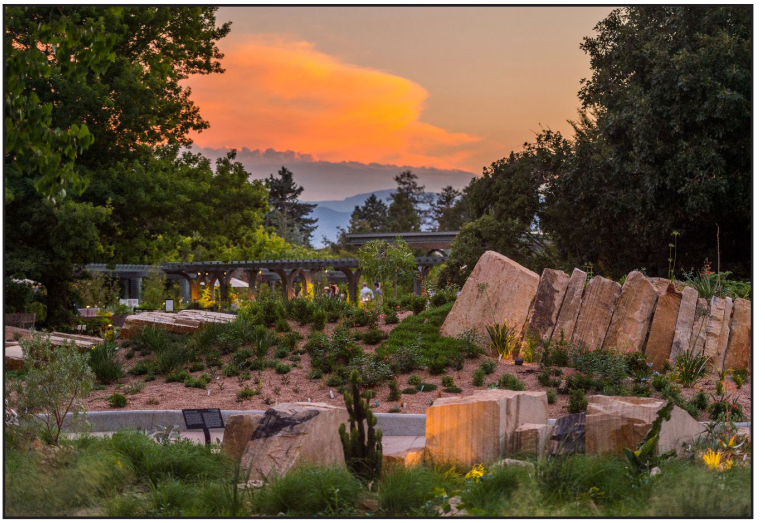
Fern Fest Plant Sale

will be held at UW Center for Urban Horticulture on Saturday June 4th from 11AM until 5PM and Sunday June 5th from 9AM until 3PM.
Ferns from the HFF production program as well as more ferns and companion plants from local growers will be for sale.

Hope to see you all there!

Denver Botanic Gardens 2021 Fern List

The mission of Denver Botanic Gardens is to connect people with plants, especially plants from the Rocky Mountain region and similar regions around the world. Denver Botanic Gardens strives to entertain and delight while spreading the collective wisdom of the gardens through outreach, collaboration and education. Our conservation programs play a major role in saving species and protecting natural habitats for future generations.



Scientific Name:	Performance (Great, Good, Fair, Poor, Dead)
Adiantum x mairisii	Alive and doing good.
Athyrium vidalii	Good. Has increased in size about 40% since planted.
Athyrium vidalii	Doing well. Has grown in size and is establishing despite being planted in a challenging area.
Dryopteris affinis 'Crispa Barnes'	Dead
Dryopteris championii	Received and planted in the late summer/early fall of 2021 in Mile High Garden Shrub Border. Looked healthy into holidays; now covered in snow.
Dryopteris championii	Newly received. Alive. To be planted in Oak Grove spring of 2022.
Dryopteris cristata	Newly received. Alive. To be planted in Oak Grove spring of 2022.
Dryopteris cristata	Newly received. Alive. To be planted in Oak Grove spring of 2022.
Dryopteris cristata	Newly received. Alive. To be planted in Oak Grove spring of 2022.
Dryopteris cycadina	No longer in this location
Dryopteris hondoensis forma rubrisora	Received and planted in the late summer/early fall of 2021 in Mile High Garden Shrub Border. Looked healthy into holidays; now covered in snow.
Dryopteris namegatae	Great. Has doubled in size since planted.
Dryopteris namegatae	Great. Has doubled in size since planted.
Dryopteris tokyoensis	Great. Has increased in size since planted. Has matured to 25" from crown to tip.
Dryopteris wallichiana	Doing good. Has matured and is well established.
Dryopteris wallichiana	Dead
Onoclea sensibilis	Fair. Has not grown much. Will increase water.
Onoclea sensibilis	Dead. Unfortunately did not come back in 2021. Extreme heat and drought may have palyed a role in its decline.
Phegopteris decursive-pinnata	Dead. Did not come back after last winter.
Phegopteris decursive-pinnata	Doing well. Has grown in size and is establishing despite being planted in a challenging area.
Polystichum setiferum	Great. Has more than doubled in size since planted.
Polystichum setiferum	Alive but not thriving due to current soil conditions. Working on amending.
Polystichum setiferum	Alive but not thriving due to current soil conditions. Working on amending.
Woodwardia unigemmata	Dead

Growing Ferns from Spores

Carolyn Dougherty
Puyallup, Washington

Reprinted from volume 23, 1, 2013

Growing ferns from spores sometimes seems almost magical. We all know ferns do not flower and, therefore, do not produce seeds, but many of us know very little about how ferns actually reproduce.

Ferns have a life cycle that is very different from that of flowering plants. Mature ferns produce spore on the undersides of their fertile fronds in clusters called sori. In the Northwest spores usually ripen between late May and October depending on the species. They may be green, yellow, brown or black.

The sori or spore cases are often covered with a membrane called an indusium. When this starts to pull away, it is the optimal time to pick the frond to harvest the dust-like spore.

When I pick the fronds, I rinse them under the faucet, and dry them with paper towels. I then lay them between two sheets of white paper sori-side down. If the spores are indeed ripe, they will drop overnight leaving a beautiful pattern on the paper. Other debris, called chaff, also drops. The spore is usually a slightly different color and texture, and clings to the paper more, so a careful tapping can encourage the chaff to come away and fall off the paper. This may take a little practice, so should be attempted at first with spore that is not too valuable.

When the spore has been cleaned by this method, they are ready to sow or store. Viability ranges from 2 days to 130 years or more. Green spore (Osmundas) is viable for a very short time, only 2 months at the most, possibly a little longer in the freezer. Blechnums have a shorter than average viability also so should not be stored very long. I store spore folded up in little paper packets carefully labeled and dated in the refrigerator.

Sowing spore begins with preparing the soil and containers. There are a variety of methods mentioned in the literature, but all stress careful sanitation. I use small clear deli containers about 6" by 8" with clear attached lids and no air holes. I dip them in a solution of ten parts to one part water to bleach to sterilize them. The soil I use is a good quality peat based seed starter mix combined with either vermiculite or fine sand at about a 3 or 4 to 1 ratio. This gets thoroughly dampened (but not to the point of being soaked), then heated in the microwave in a Corning Ware dish with a lid for 5 or 6 minutes until steamy. I try to get it to a temperature of about 160 degrees to kill rogue spores, etc. that could contaminate the spores.

When cooled this soil is placed in the containers about one inch deep. Dusting the spores evenly on top of this surface can be difficult because they are truly just like

Spores on right and chaff on left

dust. I have been water-sowing them with good results. In a clean salt shaker, I place 2 or 3 ounces of distilled or boiled water. Tap water may contain algae contaminants. To the water I add one drop of dish soap to break the surface tension and the tiniest amount of spores. A quarter teaspoon probably contains enough spore to sow 50 containers.

One thing I learned recently is that sowing too heavily actually produces poorer results. When the prothalli that grow from these spore are overcrowded, they produce only male offspring and consequently very few sporelings will grow. So – less is better when sowing spore!

After shaking the spores in the salt shaker over the soil surface, I close the lid tightly, label the container with the species, sowing date, and any other information I want to remember. I do this by placing a strip of blue painters tape on the front of the container, but regular plant labels also work.

These containers then go on my laundry room counter under grow lights for 14 hours a day. The temperature in the room is 70 degrees or a little more. I have read that 77 degrees is optimal and should be gradually reduced as they grow.

Time varies by species, but, in general, a green haze will appear on the soil in about 2 or 3 weeks. Some varieties may take considerably longer, so don't give up. This green haze will grow into prothalli, the next stage of fern reproduction. These prothalli are

Polystichum munitum spores and chaff dropped from fertile frond

small heart-shaped structures that resemble some liverworts. A single egg develops on the top surface of each prothallia and the sperm develop on the underside. At this time they should be misted liberally because water is essential in the fertilization process. Then, after a period of time baby ferns or "sporelings" will begin too appear like magic.

During this whole process the container should be regularly monitored to make sure it does not dry out or have mold appear. I have not had very many problems with mold, but if it starts to look dark and slimy, it may be too late to prevent or correct it. For this reason, I put a very dilute solution of Physan in my spray bottle (1/8th teaspoon Physan to 8 cups water) and mist all my containers with this. After prothalli appear half-strength liquid fertilizer may also be applied.

I usually let the sporelings continue to grow in the deli container until they nearly touch the lid, but if they seem overly crowded, they can be transplanted sooner.

Using the same soil and a clean 10" by 20" solid tray (no drainage holes) and sterilizing everything again, I lift and plant clumps about ¾" to 1" in size about one inch apart making sure they have good contact with the soil underneath. One 6" by 8" deli container can yield enough clumps to fill a black tray and eventually result in close to 100 new ferns.

These I dampen carefully with a mister, cover with a clear plastic dome, and place

back under the lights to continue growing. I check on them regularly, applying half-strength fertilizer. When they touch the dome they can be hardened off slowly by removing the dome a little longer each day and then easing them to a cooler place with less direct light.

At this stage, I transplant the clumps (containing more than one plant) into 4 inch pots using a bark-based potting mix. These plants can go into a greenhouse and, finally, when the weather is good, moved outdoors. While growing in the 4" pots, I feed them granular, time-release fertilizer and keep them well watered until they grow big enough to plant out into the garden. This may take as much as another year.

Growing ferns from spores takes some patience, but it can be done by anyone and is very rewarding.

Endangered Fern Found on Kauai

By Michael Brestovansky
Hawaii Tribune-Herald

DLNR photo

A pendant kihi fern grows on a Kauai tree.

A species of fern whose last known specimen died on the Big Island in 2015 has been found again on Kauai.

Adenophorus periens, the pendant kihi fern, is a native fern that only grows on the trunks of trees and was believed to be extinct for the last several years after all known specimens in the wild had died.

However, in May, a team from the Hawaii Plant Extinction Prevention Program found another specimen on Kauai, bringing the species back from the brink of oblivion.

"It brings a whole new chapter of hope to this plant," said Matt Kier, botanist with the state Department of Natural Resources' Rare Plant Program.

Kier said the survival of the pendant kihi fern is important for the preservation of Hawaii's ecosystems. Even a small plant like the fern provides habitats for local species and helps filter water through the environment.

However, Kier said the pendant kihi fern is also particularly frail. Botanists are still puzzling over exactly how the plant came so close to the brink of extinction, but Kier said there are several possible factors, ranging from invasive species such as goats and pigs eating or destroying it, to possible rain acidification brought on by the eruptions of Kilauea, or a broader drying effect of climate change.

In any case, there were 1,280 known specimens of the plant throughout the state in 1994. By 2012, there were only 31 on Kauai and fewer than 10 on Hawaii Island.

The last known Big Island specimen was found dead in 2015, and the species was listed as "critically endangered (possibly extinct)" that same year. With the discovery of new specimens on Kauai, the plant remains critically endangered, but the listing will drop the "(possibly extinct)" addendum.

With the new specimens — Kier said five plants have been discovered across three locations on Kauai — DLNR and PEPP will work to reproduce the fern through spores collected.

"The thing about rare plants is that there's not enough of them," Kier said. "So, we'll try to mass-produce them and hope- fully reintroduce them into the wild, which means we may bring them back to the Big Island."

On the other hand, Kier said there is a lot of jungle on the Big Island, and there still is a chance some specimens are alive somewhere on the island.

Welcome to our 2022 HFF Spore List!

Michelle Bundy
Des Moines, Washington

Thank you to everyone who has taken the time to collect and donate spore, it is very much appreciated. The Spore Exchange is available only to members of the Hardy Fern Foundation. Spore is collected by members and shared with other members as part of our mission to encourage the study, cultivation, preservation and propagation of ferns.

To order spore, please visit our website https://hardyferns.org to download our Spore Exchange list.

Email spore orders and questions to: hff@rhodygarden.org.
Include:

- Name
- Address
- City, State Zip
- Email Address
- Phone Number

Spore costs 75 cents per packet. You will be contacted with the total amount of your order after it has been calculated.

Once you have received that information, you will be able to pay through our website using PayPal or by check in USD payable to:

Hardy Fern Foundation
PO Box 3797
Federal Way, WA 98063-3797

Spore donations can be mailed to:

Michelle Bundy
206 S 216th Street
Des Moines, WA 98198

Please send cleaned spore if possible.

Thank you!

Updated 3/14/22					
Botanical Name	**2017 Spore**	**2018 Spore**	**2019 Spore**	**2020 Spore**	**2021 Spore**
Adiantum aleuticum			DOH		RSGB
Adiantum aleuticum 'Imbricatum'			RSBG		
Adiantum aleuticum var. subpumilum	DOH				
Adiantum hispidulum					KK
Adiantum raddianum 'Crested Majus'	FZ				
Anisocampium cuspidatum					EMBG
Arachniodes miqueliana			RSBG		RSBG
Asplenium scolopendrium			DOH		
Asplenium scolopendrium (Sagitatum Group)			HFF		
Athyrium filix-femina (Cristatum Group)					
Athyrium filix-femina (Cruciatum-cristatum Group)				RAS	
Athyrium filix-femina 'Corymbiferum'		JKL			
Athyrium filix-femina 'Minutissimum'		NS			
Athyrium filix-femina var. angustum f. rubellum 'Lady in Red'		NS			
Athyrium otophorum		NS	DOH		RSBG
Athyrium vidalii			RSBG	RAS	
Blechnum chilense					EMBG
Blechnum discolor				EMBG	EMBG
Blechnum hastatum			NS	HFF	
Blechnum niponicum					DG
Blechnum novae-zelandiae					EMBG
Blechnum nudum					EMBG
Blechnum penna-marina		JKL			
Blechnum spicant			DOH	RSBG	RSBG
Blechnum spicant 'Rickard's Serrate'				RAS, EMBG	
Blechnum montanum					EMBG

Cheilanthes leucopoda			ST		
Cyrtomium caryotideum		RSBG			RSBG
Cyrtomium fortunei		RSBG	KY		KD
Cyrtomium lonchitoides		NS			
Cyrtomium macrophyllum		RSBG			
Cystopteris bulbifera			JC		
Deparia hachijoense	BH				
Deparia lobato-crenata					EMBG
Dicksonia antarctica				JK	
Drynaria delavayi (SEH ex. Hubei)		SEH			
Dryopteris × complexa 'Stableri Crisped'		RSBG	RSBG		
Dryopteris × complexa 'Stableri'				EMBG	
Dryopteris affinis 'Polydactyla Dadds' (Polydactyla Group)			RSBG		
Dryopteris affinis					KD
Dryopteris affinis 'Cristata'					EMBG
Dryopteris affinis 'Cristata the King'			JKL,KD		
Dryopteris affinis 'Revolvens'			RSBG		
Dryopteris affinis 'Stableri Crisped'					RSBG
Dryopteris arguta		SO			
Dryopteris bissetiana					RSBG
Dryopteris championii					RSBG
Dryopteris clintoniana			RSBG		
Dryopteris crassirhizoma		RSBG			
Dryopteris crispifolia					RSBG
Dryopteris cycadina		RSBG			RSBG
Dryopteris cystolepidota					KD
Dryopteris decipiens				RSBG	RSBG, NS
Dryopteris dilatata 'Lepidota Cristata'					RSBG
Dryopteris dilitata (Grandiceps Group)					RSBG
Dryopteris erythrosora			RSBG		

Dryopteris erythrosora (ex DJHH 14224)				RAS	
Dryopteris erythrosora 'Prolifica'		NS			
Dryopteris expansa					RSBG
Dryopteris filix-mas (Grandiceps Group)		RSBG			KD
Dryopteris filix-mas 'Barnesii'		RSBG			
Dryopteris filix-mas 'Fluctuosa Cristata'			DOH		
Dryopteris filix-mas 'Linearis Polydactyla'			RSBG		
Dryopteris goldiana					RSBG
Dryopteris intermedia/West Greenwich, RI					AB
Dryopteris intermedia - cw Lewisberry, PA - #RAS 2021-001					RAS
Dryopteris lacunosa					KD
Dryopteris lepidopoda					RSBG
Dryopteris namegatae			NS	RSBG	RSBG
Dryopteris polylepis	NS		RSBG , NS		RSBG
Dryopteris pseudo filix-mas					RSBG
Dryopteris pulcherrima			RSBG		
Dryopteris pycnopteroides					RSBG
Dryopteris remota					RSBG
Dryopteris sacrosancta					RSBG
Dryopteris scottii					RSBG
Dryopteris sieboldii		RSBG, NS			RSBG, KD
Dryopteris stewartii				JKL	RSBG
Dryopteris sublacera		RSBG			RSBG
Dryopteris tokyoensis		RSBG			RSBG
Dryopteris uniformis 'Cristata'					KD
Dryopteris wallichiana (SEH ex China)				RSBG	
Dryopteris wallichiana ssp. coriacea			EMBG	EMBG	

Dryopteris wallichiana ssp. pachyphylla					RSBG, DM
Dryopteris x australis					RSBG
Dryopteris x complexa 'Stableri'				EMBG	
Dryopteris yigongensis					EMBG
Histiopteris incisa	BH				
Homalosorus pycnocarpon (prev. Athyrium pycnocarpon)					KD
Lomaria discolor					EMBG
Lygodium japonicum					DOH
Matteuccia struthiopteris			BT		
Microlepia strigosa		FZ			
Microsorum diversifolium		RSBG			
Nephrolepis biseratta 'Macho'		FZ			
Nephrolepis falcata 'Furcans'	FZ				
Notholaena candida var. copelandii		ST	ST		
Onoclea sensibilis					AB
Onychium japonicum				EMBG	EMBG
Osmunda claytoniana		NS			
Osmunda claytoniana (Ottawa Lake, MI)				SO	
Osmunda japonica				EMBG	
Osmunda lancea			EMBG	EMBG	EMBG
Osmunda regalis		RSBG		DOH	AB
Osmunda regalis var. brasiliensis				RAS	
Osmunda regalis 'Cristata'					RSBG
Osmunda regalis 'Decomposita'				RAS	
Osmunda regalis 'Purpurascens'			RSBG		
Osmunda regalis 'Decomposita'					RSBG
Osmunda regalis 'Laurin'				EMBG	EMBG
Osmunda regalis 'Purpurascens'					EMBG
Osmunda regalis 'Undulata'					EMBG
Osmunda regalis var. brasiliensis				RAS	

Osmundastrum cinnamoneum (syn. Osmunda cinnamomea)		NS			AB
Pellaea rotundifolia		NS			
Pellaea 'Silver Moon'	FZ				
Pellaea viridis		NS			
Pentagramma triangularis	DP				
Phlebodium aureum 'Blue Star'		FZ			
Polypodium interjectum				RSBG	
Polypodium scouleri			NS , JKL		
Polypodium vulgare		RSBG			
Polypodium vulgare 'Ramosum'		RSBG			
Polystichum acrostichoides					RSBG
Polystichum acrostichoides 'Cristata'					
Polystichum acrostichoides 'LSS Hurricane Watch'					EMBG
Polystichum acrostichoides (cw Lewisberry, PA, #RAS - 2021-002)					RAS
Polystichum acrostichoides/West Greenwich, RI					AB
Polystichum aculeatum			RSBG		
Polystichum aculeatum 'Cristatum'					RAS
Polystichum californicum	RSBG				
Polystichum dracomontanum					EMBG
Polystichum luctuosum		NS	NS		
Polystichum munitum		RSBG	BT		
Polystichum neolobatum (dark green form)					RSBG
Polystichum neolobatum (olive green form)					RSBG
Polystichum rigens		RSBG			
Polystichum scopulinum (Beverly Creek, Teanaway)				DM	
Polystichum tsus-simense					RSBG
Polystichum wilsonii	SO	SO		RAS	

Polystichum yunnanense				RSBG	
Polystichum xiphophyllum					RSBG
Pteris cretica 'Albo-lineata'	FZ				
Pteris cretica 'Mayii'	FZ				
Pteris cretica 'Ping Wu'				EMBG	
Pteris ensiformis 'Evergemiensis'		FZ			
Pteris wallichiana					RSBG
Pyrrosia sheareri			RSBG , NS , SO		EMBG
Woodsia subcordata				EMBG	RSBG
Woodwardia unigemmata					EMBG

Donors

AB	Alex Baranowski	RI
BBG	Bellevue Botanical Garden	Bellevue, WA
BH	Bart Hendrikx	Netherlands
BT	Brenda Townes	Kentucky
DOH	Carolyn Doherty	WA
DM	Daniel Mount	WA
DG	David Gibson	WA
DP	David Persarro	WA
EMBG	Elisabeth C. Miller Botanical Garden	WA
FZ	Lindee Fitzpatrick	Australia
HFF	Hardy Fern Foundation	WA
JC	James Cheshire	OH
JK	Jeanette Kunnen	WA
JKL	Jo Laskowski	WA
KK	Karma Kosmonaut	MA
KD	Kay Dye	IL
NS	Nancy Strahle	WA
RAS	Richie Steffen	WA
RSBG	Rhododendron Species Botanical Garden	WA
SEH	Steve Hootman	WA
SH	George Soule & Maurice Horn	OR
SUN	Sundquist Nursery	WA
ST	Susan Tracy	TX
WG	Wolfram Gassner	Germany

A Look at Fertility

Photos by Sue Olsen
Seattle, Washington

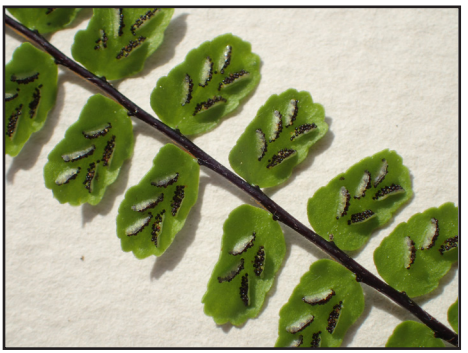
Spore

Adiantum

Athyrium

Arachniodes

Blechnum

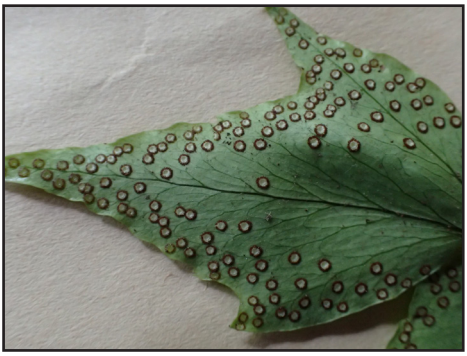


Asplenium
Note single flap

Cheilanthes small black spores
in the edge hairs

Coniogramme

Dryopteris immature



Cyrtomium

Dryopteris ripe

Cystopteris

Gymnocarpium

Doodia

Matteuccia

Osmunda

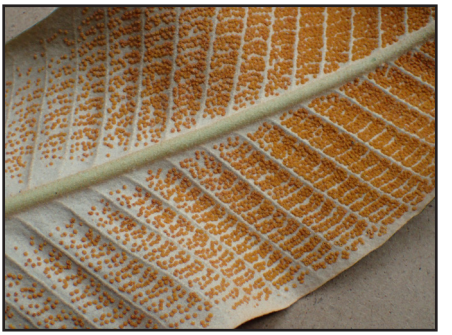
Polypodium

Polystichum immature

Osmundastrum cinnamomeum
green spores

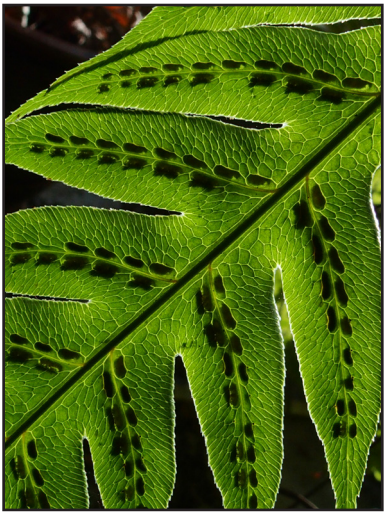
Polystichum mature

Phyllitis syn Asplenium
Note double flap



Pyrrosia

Woodsia



Woodwardia

Bulbils

Cystopteris bulbifera

Woodwardia orientalis bulblets

Polyistichum setiferum bulbils