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Fiddlehead Forum

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Pyrrosia

by Tom Stuart
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Pyrrosia is an Old World genus of polypods, mainly tropical, mainly epiphytic, and mainly with simple, entire fronds. Each of these characteristics have exceptions.

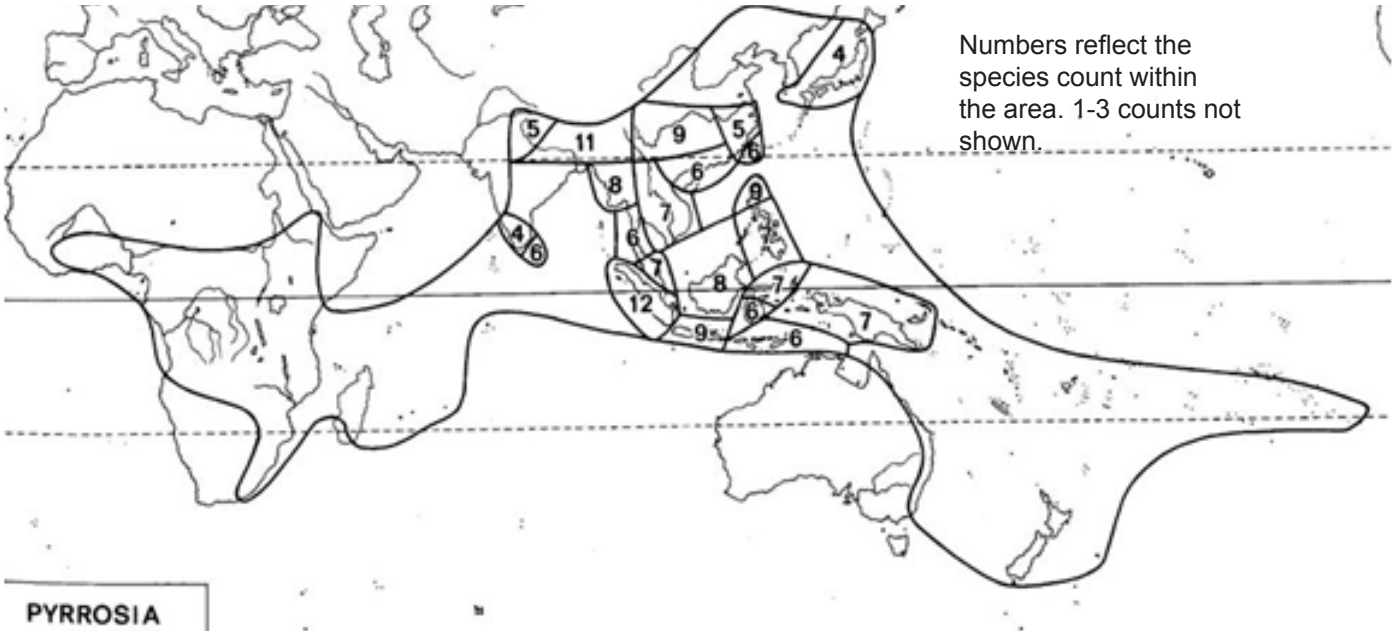
Peter Hovenkamp's 1986 *A Monograph of the Fern Genus Pyrrosia* reduced the number of species from over a hundred to fifty-one. It also subsumed several genera, among them *Cyclophorus, Drymoglossum*, and some *Niphobolus* species into *Pyrrosia*. He brought coherence to a chaotic assemblage.*

Pyrrosia is distributed from the West Coast of Africa to Madagascar, to India, across the Himalayas, northeast to Russia, southeast into Malaysia, Australia, and on into the Pacific as far east as the Pitcairns. Henderson Island of the Pitcairns is almost directly south, far, far south of Juneau, and is the easternmost outpost. *Pyrrosia serpens* is epiphytic on *Pisonia grandis*–a tree in the four o'clock family, dominant on the island. This coral mount is inhabited by nine ferns, 54 seed plants and occasional typhoons. Among the other ferns are the Bird's Nest, *Asplenium nidus*, epilithic on limestone outcrops or again as an epiphyte on *Pisonia*, the Whisk Fern, *Psilotum nudum*–leafless and rootless as ever, but strictly terrestrial here, oddly never on trees as elsewhere, the Giant Hare's-foot Fern, *Davallia solida*–again epiphytic in *Pisonia* forests–and two *Nephrolepis* species–both rock-dwellers.

At the western end of the *Pyrrosia* range, *P. schimperiana* has an African distribution centered on the equator and encompassing half of the continent. *Pyrrosia schimperiana* is principally an epiphyte, but also found on exposed or lightly shaded rock outcrops. In between *P. schimperiana* in Guinea and *Pyrrosia serpens* on Henderson–15,000 miles–are 49 other epiphytic or epilithic Felt Ferns.

Just for a moment, look at the Old World map and the distribution of species on the next page. Would you like to hazard a guess as to the center of distribution of *Pyrrosia*? Would you expect perhaps Malesia (biogeographically the Malaysian peninsula, Indonesia, New Guinea and the Philippines) or Southeast Asia or would you favor the Himalayas? Hold onto that thought.

* Another view was expressed by Shing and Iwatsuki (1997). Though not dealing with the entire genus, the treatment clearly leads to a larger number of species. This circumscription appears to dominate in the currently developing Flora of China; see volume 3 at http://flora.huh.harvard.edu/china/.



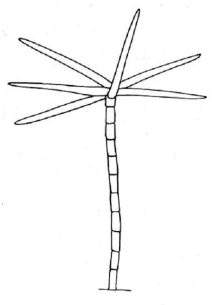
What makes a Pyrrosia a Pyrrosia? Among other characteristics, simple leaves.

(Hovenkamp, Peter. 1986)

They can be quite varied in outline; here is *P. abbreviata* of Sumatra and Java. Besides many frond forms we see a typical rhizome, this one long-creeping. Other species are short-creeping, branching, and congested. The long-creepers like this are slow to form good horticultural specimens. All *Pyrrosia* have hard, dense, often brittle rhizomes. These have a high composition of sclerenchyma cells. Sclerenchyma cells are dead at maturity, composed solely of thick cell walls; tree ferns have a lot of sclerenchyma, too. The presence of sclerenchyma is sparse in other polypods, except for *Platycerium*. That's another story. The presence or absence of schlerenchymatous (strengthening) tissue and patterns shown by these cells are of diagnostic help for taxonomists.

The rhizome (lower left) is always covered with scales (example upper left). These scales differ greatly from species to species as to attachment, size, shape, and margins. You can use these diagnostically with a hand lens and a description. Though scales on rhizomes are not accessible on many ferns, since they are subterranean, *Pyrrosia* rhizomes are mostly just touching or barely immersed in the substrate.

Of course all polypods have naked sori, and *Pyrrosia* is no exception. Most species also have round sori as with the majority of polypods; sometimes they are elongated or multiple sori are fused into long chains called **coenosori.**



(Hovenkamp, Peter. 1986)

A particularly distinctive characteristic of *Pyrrosia* is the presence of **stellate hairs,** shown schematically here. All Pyrrosia spp. have these hairs, sometimes two kinds in two layers. Most often they are sparse on the upper surface and dense on the lower surface. The dense mat gives the genus its common name, felt fern. You can see these hairs with a hand lens, though sometimes they are only evident on young fronds. They vary from one species to another in color–white, translucent, tan, or red– or form–needle-like or boat-shaped or woolly rays.

Platycerium also have these hairs. Yes, another story.

In addition, some *Pyrrosia* have excretions of calcium on the upper surface. These are visible as white dots called **hydathodes.** Hydathodes are found on other ferns, but not commonly, so it can be a good indicator character. To round out the indument account, a few other characters are useful for their exclusionary value: **venation:** always netted, but quite varied in details and often obscured; **phyllopodia:** (stump-like extensions above the rhizome to which the fronds are jointed) are always present–common in the Polypodiaceae–and are covered with the same scales as the rhizome. Characters of little value in establishing the genus include the **stipe:** it varies from none to longer than the lamina; **frond dimorphism:** *Pyrrosia* range from monomorphic to strongly dimorphic; **paraphyses:** (indument within the sorus –here always stellate hairs) vary from undifferentiated (compared to nearby hairs) to slightly modified to absent.

Lastly, the **felt.** A majority of the species do exhibit a feltiness in one degree or another, but there are exceptions. For example, *Pyrrosia piloselloides* of southeast Asia, China, Japan, and Sri Lanka is succulent. Though it has sparse stellate hairs on young fronds, the hairs soon fall, and one is left with a shiny surface. (As an aside, this fern exhibits Crassulacean Acid Metabolism just like the jade plant. Looking for a dissertation subject? Explain why CAM shows up in some ferns. Or a preliminary question: did it arise independently?) The felt-like texture has two origins. The fine hairs, particularly when they include woolly ones, can support a felt description on their own. However, the laminar surface in most *Pyrrosia* species is not two-dimensional but cobbled or pebbled; I think this light-scattering surface is contributory to a felt-like appearance.

Even if you are not a pteridologist, you can distinguish a *Pyrrosia* because it has creeping, surface-dwelling, scaly rhizomes, simple fronds jointed to the rhizome, naked sori, stellate hairs, and sometimes sports hydathodes. This combination of characters is unique.

Where does *Pyrrosia* fit into the tree of life?

Two methods are commonly used to demonstrate next of kin. The traditional method compares the morphology of taxa. In *Pyrrosia* the unusual characteristics are stellate hairs on the fronds and sclerenchyma in the rhizomes. Stellate hairs are found scattered in the vascular plants. In the flowering world they are occasional in the Brassicaceae and rare elsewhere. Among ferns one finds them in a few Hymenophyllaceae members, and otherwise singularly, for example, in *Astrolepis sinuata* and *Dicranopteris linearis.* There is no genus outside the Polypodiaceae sporting stellate hairs unanimously. Among the polypods, there are two: *Pyrrosia* and *Platycerium.*

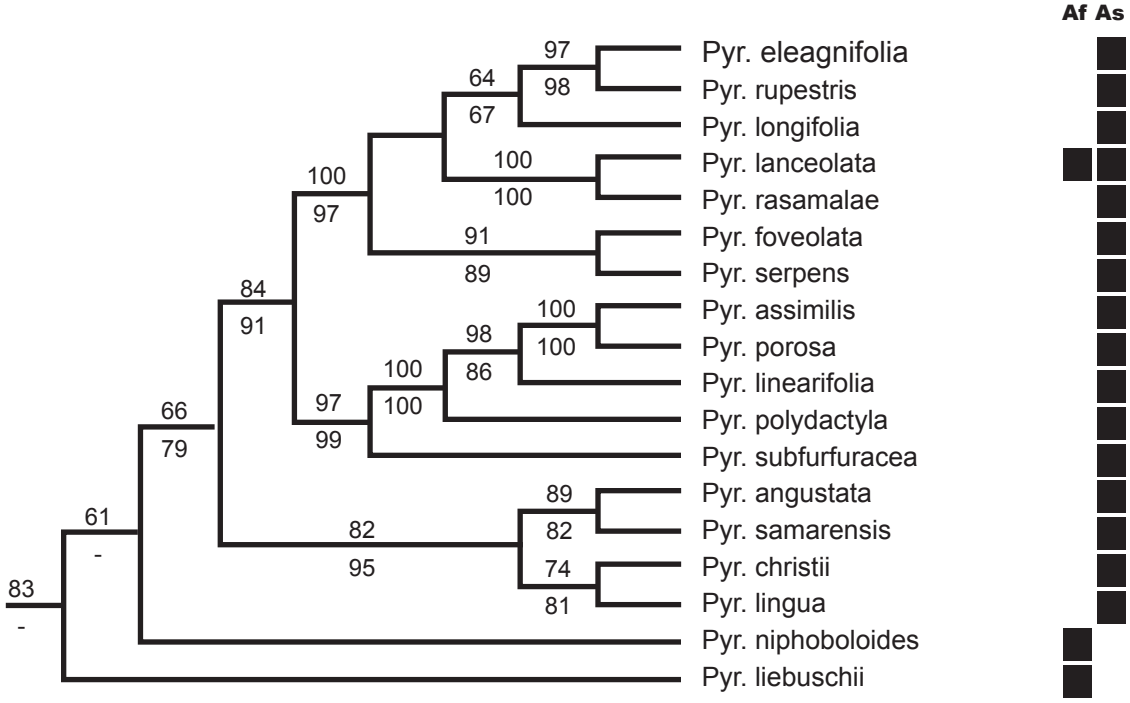
A massively sclerified rhizome is also a shared character for these two genera. We do not think of the rhizome in *Platycerium* because it is thoroughly hidden within the base fronds, but cut open a staghorm fern, and there is a hard, dense rhizome. Despite the dissimilarities of *Pyrrosia* and *Platycerium,* these two characters attest to a common heritage.

When looking at species within a genus, or more generally any closely

related taxa, a large number of characters are examined in the context of evolutionary development. Choosing characters is an art: Hovenkamp eliminated several on the basis of fragmentary data, variability, or lack of a convincing transformation (i.e., from primitive to evolved), in the end choosing 24 characters for examination. A simple example is the rhizome morphology: short and thick in the primitive case, somewhat elongated as a later development, and long-creeping in the derived/evolved case. Why are creeping rhizomes later in evolution than short, thick ones? Looking at related taxa, one finds the "primitive" case widespread, the derived case localized.

The next step is to characterize each of the 51 species with respect to the 24 traits. From this data a cladogram, an evolutionary tree, is created. At the base of the tree are found the earliest evolving taxa. In the case of Hovenkamp's tree, the two basal species, *Pyrrosia africana* and *P. schimperiana*, are both found in Africa. Now, did you hold onto Malesia or did you hold on to the Himalayas? Sorry.

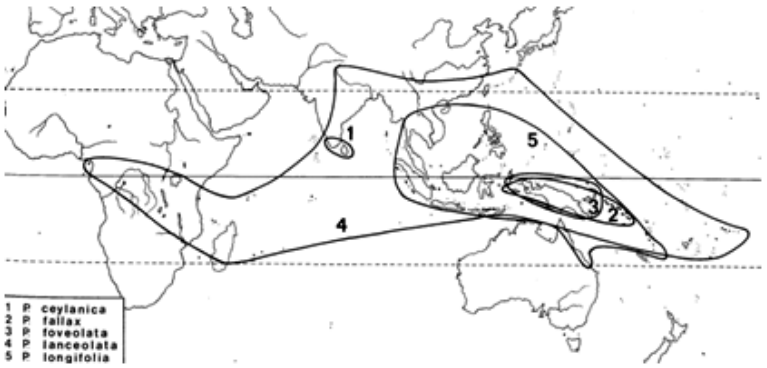
Is this finding credible? The other, more recent, method to show evolutionary relationships is by looking at DNA or RNA sequences. Nucleic acid sequences take all the artistry and fun out of determining phylogeny, but the goal here is objectivity, yes? Janssen *et al.* (2007) did precisely this for a number of fern genera in Africa. Their results supported *Pyrrosia* and *Platycerium* as sister genera. Here is the portion of their cladogram embracing *Pyrrosia*.



The numbers above and below the branches indicate the probable support for the branch using two statistical procedures; weak support (less than 50) is omitted. On the right hand side are noted the continents (**Af**=Africa-Madagascar; **As**=Asia-Australia) where the species are found. Three are native to Africa.
This study encompasses about one-third of the species. *Pyrrosia liebuschii* is treated by Hovenkamp as a synonym of *P. schimperiana* so that places this species at the base of the *Pyrrosia* tree in both methods. *Pyrrosia africana,* the other basal species from morphology, is not in this Janssen study.

Pyrrosia niphoboloides, second in lineage descent in the molecular phylogeny, is part of a small group with particular characteristics: pronounced frond dimorphism, coenosori, a distinct venation pattern, and, uniquely within *Pyrrosia,* a homogeneous laminar tissue –species outside this group exhibiting distinct layers. Other members *(P. piloselloides* and *P. heterophylla)* of this clade (a group with the same parent, i.e., a monophyletic grouping) are missing above. The prediction from morphology is that they will be more closely related to *P. niphoboloides* than to any other *Pyrrosia* species. In Hovenkamp's morphological treatment, these group characters were judged as evolving later, rather than early on.
Pyrrosia lanceolata is the other species of the cladogram in Africa and it is nowhere near the cladogram root. It is also in Asia. Its distribution is on the next page.

It is extraordinary that species number 4 has nearly the same distribution within the tropics as the genus itself. *Pyrrosia lanceolata* is distantly related to *P. liebuschii/ schimperiana.* Its closest relatives in the cladogram–six other clade members at the top–are all confined to southeast Asia and eastward. This suggests *P. lanceolata* has apparently extended its range through long-distance dispersal.



What might make this species amenable to migration? Production of a sporophyte from a single spore is fairly common among pteridophytes, but takes place only under certain conditions. One possibility is apogamy. Apogamous ferns produce spores that germinate and quickly initiate the sporophyte, bypassing the sexual phase. This seems improbable here as apogamy has only been demonstrated once in the entire Polypodiaceae and never in *Pyrrosia.*

A second pathway is suggested by Chiou *et al.* (2002) who studied epiphytic polypods and found polyploidy characterizes the selfing species, whereas the mating taxa are diploid. Polyploids can travel. Of the 51 *Pyrrosia* species, chromosome counts are available for 26. Of those, 23 are strictly diploid with 74 chromosomes (allowing for a few odd measurements off by one or so). Three remaining species are polyploid: *Pyrrosia lanceolata, P. niphoboloides,* and *P. porosa. Pyrrosia porosa* is also a very widespread species, extending from Sri Lanka and India to Japan and the Philippines. *Pyrrosia niphoboloides* has long been regarded as endemic to Madagascar, but has recently been suggested from Sri Lanka (Ranil *et al.*, 2006). *Pyrrosia lanceolata* has a diploid form in New Guinea among the other six members of the clade while both diploid and polyploid forms were found in India. Did *Pyrrosia lanceolata* travel **back** to Africa? If so, odds are cytology will show a polyploid there.

With these provisos the two methods are mutually supportive in terms of African origin. We might also look for confirmation in the fossil record, but that is no help whatsoever: there is no fossil record for either *Pyrrosia* or *Platycerium.*

Finally, how do we explain the low diversity in the African center of distribution and the high diversity from the Himalayas to Malesia? One aspect of geography found in the Himalayas, Southeast Asia and Malesia and not in Africa is mountainous territory. As Moran (1995) explains:

> The most important way that mountains affect pteridophytes is by promoting species richness. This effect can be seen worldwide; all countries or regions with more than 500 species of ferns are mountainous.

As to why this is so,

> Presumably, [speciation] result[s] from the variety of habitats created by different elevations, slopes, exposures, soils, rock types, and microclimates.

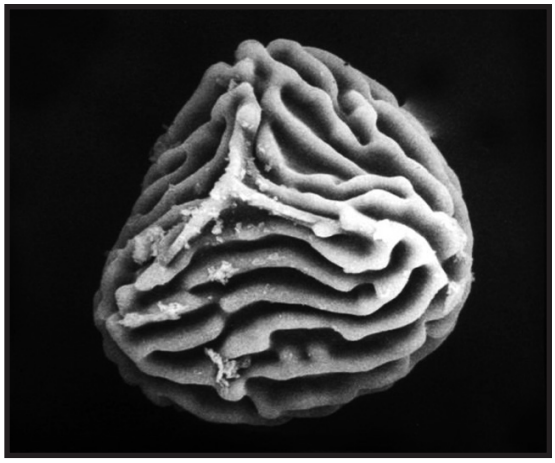
Exercise for the reader: get up early tomorrow and work out why this is so.

Chiou, W.-L., D. R. Farrar and T. A. Ranker. 2002. The mating systems of some epiphytic Polypodiaceae. Amer. Fern J. 92: 65-79.
Hovenkamp, P. 1986. *A Monograph of the Fern Genus Pyrrosia*. Leiden University Press, Leiden, Illustrations from the monograph used with permission.
Janssen, T., H.-P. Kreier and H. Schneider. 2007. Origin and diversification of African ferns with special emphasis on Polypodiaceae. Brittonia 59: 159-181.
Moran, R.C. 1995. The importance of mountains to pteridophytes with emphasis on neotropical montane forests. Pp. 359-363, *in Biodiversity and Conservation of Neotropical Forests*. New York Botanical Garden.
Moran, R.C. 2004. *A Natural History of Ferns*. Timber Press, Portland, chapter 27.
Ranil, R.H.G., D.K.N.G. Pushpakumara and T. Sivananthawerl. 2006. Variation of *Pyrrosia heterophylla* (L.) Price and evidence for occurrence of two other *Pyrrosia* species in Sri Lanka. Tropical Agricultural Research 18: 244-254.
Shing, K.-H. and K. Iwatsuki. 1997. On the fern genus *Pyrrosia* Mirbel (Polypodiaceae) in Asia and adjacent Oceania. J. Jap. Bot. 72: 19-35 and 72-88 (1997).

I am indebted to Alan R. Smith and Peter Hovenkamp for comments.
For those interested in growing the temperate *Pyrrosia* species, an article will appear shortly in the Hardy Fern Foundation Quarterly.

How to Collect Fern Spores

Wen-Liang Chiou and Donald Farrar,
Taiwan Forestry Research Institute and Iowa State University
– from AFS website



Fern spore of Anemia mexicana

Sowing spores and culturing gametophytes is one of the major means of propagating ferns. Every year fern enthusiasts collect and mail spores to the AFS Spore Exchange. The Exchange is glad to get identified spores, in any condition, however, if possible it is better for everyone if the spores are properly cleaned. Contamination by fungi or bacteria is more likely when the spores are not separated from the chaff. The extra chaff also makes it difficult to estimate the number of spores sown. Following are instructions for cleaning spores to minimize these problems.

1. Place two pieces of clean white paper inside a clean single fold of newspaper. Position the spore-bearing frond, spore side down, between the white papers. If the frond is attached to a large rhizome (root), leave the rhizome outside of the paper (or remove it if you have no use for it). Place the newspaper between two pieces of cardboard and put a hard sided book on the upper cardboard. The cardboard flattens the frond and allows air to reach the frond. The specimen must not be pressed so tightly that moisture cannot escape resulting in sporangia that will not open.

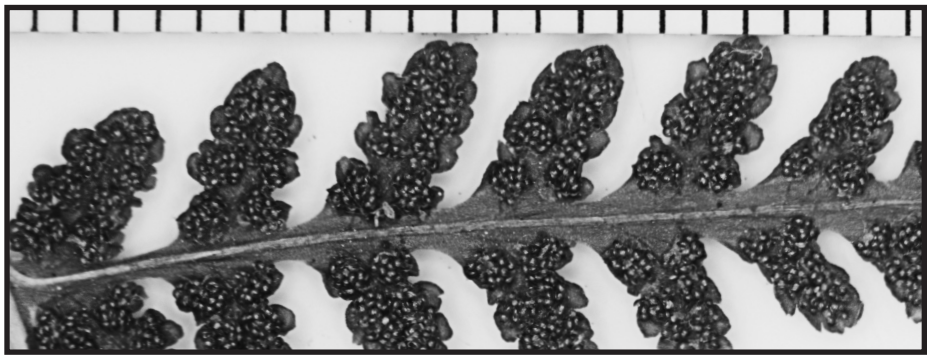
2. Keep the specimen at room temperature in a dry place. A few days later (depending on humidity), most of the spores will have been released from their sporangia and will be lying on the white paper. If necessary, additional spores may be obtained by lightly brushing the frond with a small watercolor paintbrush. The spores will usually be mixed with chaff. The spores, distinguished with the naked eye, are tiny and colored yellow, brown, or black, whereas chaff is much larger and is usually a lighter brown than spores.

3. With one hand holding and slightly tilting the paper, take a pen with the other hand and tap lightly on the backside of the paper. The fiber of the paper holds the spores allowing the chaff to run down the paper faster than the spores. Discard the chaff.

4. With vigorous tapping, the spores can be dislocated from the white paper onto a smaller piece of clean paper that can be folded into a packet and mailed to the exchange. Fold this paper in a boat like fashion so that there are no places for spores to leak out. Place the folded packet into a regular envelope to mail to the curator. (Do not put the spores directly into a regular envelope; the spores stick to most envelops.) Glassine envelopes (like those used by stamp collectors) are ideal for spore packets, though be sure to tape the seams to keep spores from leaking out.

5. Label the packet with the species name, where it was collected, and any other relevant information. Species information that is helpful is size, common name, habitat, and the hardiness zone where the fern was growing.

6. Mail the spores to: Denia Mandt (address on opposite page)



Woodsia obtuse, leaflets with sori and sporangia, one unit = one millimeter

Detail: Woodsia obtuse, leaflets with sori and sporangia

Pleopeltis polypodioides

The Spore Exchange

Denia Mandt, Spore Exchange Curator
– from AFS website

The American Fern Society Spore Exchange is an important part of the American Fern Society. One of the goals of the AFS is to cultivate ferns. The Exchange makes hundreds of ferns available that would otherwise be unobtainable for most members. Our collections can be easily expanded and diversified. Often times members can share spores from rare or endangered ferns thereby safeguarding the species so that our grandchildren may also enjoy these beautiful plants. The Exchange was begun in the early 60's and has been successfully swapping ferns ever since. We are in need of fresh spores. If you are interested in donating spores, please follow the instructions below for how to collect fern spores or at the AFS website.

The spores from the ferns listed in the exchange have been donated by the members of the AFS. Members of the AFS may order the ferns listed by sending a self-addressed stamped envelope, plus 50 cents for each fern ordered to:

Denia Mandt
AFS Spore Exchange
12616 Ibbetson Ave.
Downey CA, 90242
deniamandt@verizon.net

So that we will be able to keep as many different species on the exchange as possible, non-members may participate in the AFS Spore Exchange by donating spores. Send a donation, and 50 cents for each package of spore requested. Be sure to include self addressed stamped envelope.

The information listed with each fern was compiled by Robert Loius Muller, Brian Aikens, and Bubba Baxter. The listings are not guaranteed, we simply forward on what members send in. The ferns listed in this index are available to members of the American Fern Society. If you are a member you may Print an Order Form from the AFS website.
Updated 4-6-2008

#PKTS	YR	GENUS	SPECIES	VARIETY	ZONE	MORPH	SP	CLTV	RANGE
10	2004	Adiantum	aethiopicum						2
6	2001		caudatum						2
6	2007		hispidulum		8				g 1
3	2006		macrophyllum		0				1
4	2004		pedatum						4
2	2006		peruvianum		0				12
2	2005		tenerum	col. f. Puerto Rico	0	25c		dsvx	1,2w
2			tetraphllum						
1	2006	Aglaomorpha	coronans						
1	2005		meyeniana						g
2	2005	Anemia	adiantifolia						1
6	2006		phyllitidis		0				12
9	2004		tomentosa			14	8	tyz	1 & 2
5	2007	Angiopteris	evecta						g
2	2001		lygodiifoli						
20	2007	Arachniodes	davalliaeformis						g
6	2006		simplicor	'Variegata'	8				4g
5	2006	Asplenium	adiantum-nigrum		8	18E		drtv	123589g
10	2006		antiquum						g
50	2007		australasicum						g
3	2006		flexiuosum?						
2	2005		juglandifolium	col. f. Puerto Rico	0	30c	3	bsv	1,2w
10	2006		nidus						g
10	2004		nidus	'Endau Rompin'					
4	2007		phyllitidis						g
10	2006		oblongifolium						7g
1	2006		scleroprium						g
3	2006		scolopendrium	syn. Phyllitis					g
7	2005		surrogatum	syn. Asp.mayii	8				8g
1	2006		terrestre						g
1	2006	Asplenosorus X	kobuyushii		7				
20	2005	Astrolepis	sinuata	syn, Cheilanthes					
10	2006	Athyrium	alpestre		8				34w
3	2003		dissitifolium						04w

Key to the AFS Spore Exchange List

 # PKTS the number of packets on hand

GENUS, SPECIES VARIETY all self explanatory

ZONE Hardiness zones 1-9; tropical/ greenhouse =0

MORPH

Mature size in inches +Rhizome
Creeping=c,
Erect/ascending=E,
Wide creeping=W
Tree fern=T

SPECIFICS

Rare=1
Few spore=3
Green spore=4
Easy=6
Hard=7
High humidity=8
Invasive=9

CULTIVATION

Habitat
Aquatic=a
Ephiphytic=b
Climbing=c
Terr/epipet=d

Periodicity
Deciduous=g
Evergreen=h;

Soil Type
Loamy=o
Sandy=p
Soil-specific=q
Rocky=r

Exposure
Shade=s
Partial sun=t
Full sun=u

Soil Details
Moist=v
Alkaline=x
Dry=y
Acid=z

GEORANGE

No.Amer.=0
Cent.Amer/Antill.=1
So.Amer.=2
Eur.=3
No.Asia=4
So.Asia=5
Malesia=6
Australia=7
Pacif.Isles=8
Africa=9
Garden=g
Wild=w

#PKTS	YR	GENUS	SPECIES	VARIETY	ZONE	MORPH	SP	CLTV	RANGE
30	2005		filix-femina		4				1235
1	2001		filix-femina	'Frizelliae'					
4	2006		filix-femina	Lady in Red'	8				g
4	2003		filix-femina	tsjechie	4				3w
5	2004		filix-femina	'Victoriae'					
15	2005		niponicum						
5	2005		niponicum	'Burgandy'					g
10	2006		niponicum	'Ghost'					g
2	2003	Athyrium	niponicum	'Metallicum'					
25	2006		niponicum	pictum	3				
1	2004		otophorum			24	6	dstv	4
1	2008		otophorum	var. okunum					
20	2004		pycnocarpon						
2	2006		rupestre?						
5	2005		sp.	col f. China		8 25 E		dsv	4w
3	2005		sp.	Burgandy color					g
1	2006		subtriungulare						
3	2003		thelyperoides	syn. Deparia acrosticthoides	3				
15	2004		thelyperoides	silvery spleanwort					
16	2006	Blechnum	australe		8	20Ec		dt	9g
15	2006		australe	Red Form	8				g
16	2006		brasilience						
5	2002		chilense						2w
5	2002		costaricense						
5	2005		discolor						7w
8	2005		divergens	col. f. Puerto Rico	9	12E		dsv	1w
8	2005		fragile	col. f. Puerto Rico	0	25W		bsv	1w
10	2007		gracile						g
2	2005		lineatum	col. f. Puerto Rico	0	50E		dtv	1w
10	2002		magellanicum						2w
15	2001		spicant						34
3	2005		sp.	south Africa					g
6	2001		wattsii						7
10	2004	Botrychium	dissectum		4			w	0g
30	2002		dissectum	'Spring'	4				
15	2005		virginianum		3				134
10	2003	Campyloneurum	brevifolium						1
4	2004		phyllitidis						123
4	2006	Cheilanthes	alabamensis						
1	2006		lendigera		8				9
20	2006	Cibotium	glaucum			T			g
15	2007		barometz			T			
5	2003	Crypsinus	hastatus						
3	2006	Culcita	coniifolia	syn. Selliguea					g

#PKTS	YR	GENUS	SPECIES	VARIETY	ZONE	MORPH	SP	CLTV	RANGE
4	2005	Cyathea	arborea	col. f. Puerto Rico	0	180T		dtv	12wg
2	2002		aramaganesnsis	syn. Shaeropteris		T			
25	2007		brownii	syn. S. excelsa		T			
10	2005		copperi	syn. Shaeropteris		T			
4	2006		cooperi	'Brentwood'		T			g
10	2007		dealbata	syn. Alsophila tricolor		T			7g
30	2006		felina			T			g 7
30	2006	Cyathea	incisosserrate			T			g 7
1	2006		latebrosa			T			
50	2005		lepifera	syn. Shaeropteris		T			
25	2006		lunulata	syn. Shaeropteris		T			g
25	2007		medullaris	syn. Shaeropteris		T			
20	2007		myosuroides						
2	2006		new caledoniae	(new)		T			
20	2007		noae-caledoniae		0	80T		dtv	1g
15	2003		princeps	syn. S. horrida		T			
50	2005		robusta	syn. Shaeropteris		T			
30	2006		sp. #1	Blue stipes		T			g 7
30	2006		sp #2	slow & small		T			g 7
10	2006		smithii			T			
15	2006		spinulosa			T			g
8	2006		tomentisissima			T			g
3	2001	Cyclophorus	sunsyloaes	(Pyrrosia)					
4	2007	Cyrtomium	macrophyllum						g
3	2004		falcatum						457
10	2006		falcatum	'Mayi'					045g
15	2001		falcatum	'Rockfordianum'					
15	2006		fortunei						g
2	2001	Cystopteris	cycyopteris x alpina						
1	2002		fragilis	green form					239
2	2003		regia						
2	2001		virdula						9
30	2002	Deparia	thelpterioides	syn Athyrium	3				

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10	2007	Dicksonia	antarctica			T			7
10	1001		blumei			T			5
20	2006		fibrosa			T			7
5	2005		sellowiana			T			12
3x	2006	Didymochlaena	truncatula						g
1	2006	Diplazium	australe						7g
2	2005		I'herminieri	col. f. Puerto Rico	0	60E	3	dsv	1w
1	2004		pycnocarpon						0
20	2006	Doodia	sp.	from S, Africa					g
2	2006	Doryopteris	palmata		0				1
10	2007		pilosa	Antenna Fern					g
15	2007		uniformis						g
3	2004	Drynaria	fortunei						
1	2006		quercifolia						
4	2006	Dryopteris	affinis	'Crispa Gracilis'					3
20	2004		affinis	'Furcans'					
2	2006		affinia	coriacea"					
20	2006		bissetiana						5g
2	2001		buchiana						
100	2002		carthusiana		2				3
2	2004		celsa		5	50c	6	dgtvz	0
6	2001		complexa						
3	2005		corleyi		8	25E	8	dsvgh	3g
10	2003		crassirhizoma		5				4
5	2005		cristata						3
4	2003		cycadina		6	4			4 & 5 g
8	2003		dilatata	'Recurvata'					3
6	2004		erythrosora		5	36	6	dhsy	3g
12	2001		erythrosora	'Koidzumiana'	5	36	6	dhsy	5w
10	2007		erythrosora	Red Form from China					g 4
4	2004		expansa						3
4	2004		filix-mas		5	60	6	syz	34
10	2006		fuscipes						
4	2005		fusco-altra		8	40E		dsvhg	g 8
2	2003		goldiana		3				0
20	2006		hawaiiensis						8g
2	2006		indusiata		7				
100	2002		intermedia						
10	2002		juxta-posita						
6	2006		marginalis		3	25	6	dhsv	0g
4	2001		marginalis	'Pleasant Valley'					
10	2007		muenchii						g
10	2002		odontoloma						5
4	2004		pacifica						45

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2	2004		palmata						
30	2004		pulcherima						
50	2006		purpurella		9				4g
50	2004		sieboldii						45
30	2004		spinulosa	syn. Dry. carthusiana	2		16	g	
30	2005		spinulosa	intermedia					
10	2003		spinulosa						g
15	2002		stewartii		6			g	
10	2006		submentana						g
6	2006	Dryopteris	tokyoensis		8				45g
20	2006		wallichichiana						1245
1	2002	Edanyoa	difformis	syn. Bolbtis	0				
4	2005	Elapoglossum	crinitum	col. f. Puerto Rico	0	20E		bsv	1&2
10	2006		decoratum		0		8		12g
2	2005		simplex	col. f, Puerto Rico	0	12CE		bsy	1w
10	2002		sp.	col. f. Puerto Rico	0		8	bsy	1,2w
5	2006		sp.	Brazil Blue Form	0				
7	2002	Gymnocarpium	robertianum		3				34
2	2004	Hemidictyium	marginayum						12
7	2004	Hemionitis	arifolia						
12	2004	Hypodematium	crenatum		0	18E		dtyx	56g
5	2004	Hypoderris	brownii		5				7
20	2006		millefolium		7	w	6	gsv	g 7
25	2002	Hypolepis	tenuifolia						1
15	2007	Lastreopsis	effusa						g
5	2003	Llavea	cordifolia						0
2	2004	Lonchitis	hirstuta						1
3	2004	Lophosoria	quadripinnata	col. f. Puerto Rico	9	15E	3	duv	1&2w
30	2002	Lycopodium	dendroideum		2				0
100	2002		digitatum						0
15	2004	Lygodium	japonicum		9		6	csy	45
10	2002		microphyllum		9		69	csy	45789
15	2004		scandens	syn. L.microphyllum			6	csy	45789

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10	2007	Macrotheypteris	torresiana						
20	2004	Matteuccia	struthiopteris		2				3
2	2004	Microgramma	lycopodioides	sys. Polypodioides					129
3	2003		piloselloides						12
30	2007	Microlepia	platyphylla						g
4	2006		speluncae						89g
30	2006	Microsorum	palmatopedatum						4
10	2006		vieillardii	syn . Phymatodes				dhosv	8
3	2003	Mildella	intramarginalis						
1	2004	Nephrolepis	exaltata						
10	2004	Neurodium	lanceolatum						1
30	2006	Niphidium	crassifolium						12
1	2005	Nothoperanema	rubiginosum	syn. Ctenitis	0				8w
4	2005	Onoclea	sensibilis						
10	2007	Osmunda	banksifolia	GREEN SPORE					G
10	2006	Pellaea	cordifollia						0
15	2006		ovata		8	35Ec		drty	01g
*2	2004		rotundifolia				3		12
4	2003	Pellaea	viridis						789
2	2006		viridis	marcrophylla	8				9g
15	2004	Phanerophlebiopsis	caduca		2				4
2	2003	Phebodium	aureum	syn. polypodium					1789
2	2004	Phyllitis	scolopendrium		5	24	6	3450	2
2	2002		scolopendrium	'Angustifolia'	5	24	6	dhrsv	3450
4	2000		scolopendrium	'Capitatum'	5	24	6	dhrsv	3450
2	2000		scoloprndrium	'Sagitatim Crista-tum'	5	24	6	dhrsv	3450
13	2004	Phymatosorus	grossus						
5		Pityrogramma	austroamericana						
7	2003	Platycerium	andinum						2g
10	2003		bifurcatum	'Majus'					g
10	2004		cass Robusta						g
12	2004		cass Ropa						g
3	2006		coronarium						
10	2006		Ellisii						
6	2006		Hillii						
1	2006		Hillii	Hula Hands					
1	2006		Hillii	Ballia					
3	2006		holttumii		O				
5	2004		lanciferum						g
2	2007		ridley						g
2	2006		stemmaria						
3	2004		Sumbowense						g
15	2007		superbum						g
25	2004		wandae						g

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3	2006		willinckii		0				
10	2007	Pleconemia	macrodontor						g
2	2001	Pleopeltis	astrolepis						12
15	2006	Pneumatopteris	pennlgera?						g 3
4	2005	Polypodium	glycyrrhiza	'Licorice Fern'	5	8c	6	ov	0
7	2004		loriceum						12
2	2003		pellucidum			12		duy	8
8	2003		squamatum						8
1	2001		vulgare	'Macrostachyen'					1
20	2005	Polystichum	acrostichoides						0
20	2004		aculeatum		4				3
8	2004		andersonii		6	36	1	dsr	0
10	2004		australis						
3	2001		braunii		4	28	6	dhsv	34
30	2002	Polystichum	herenhausen						
6	2006		lonchitis		3	20E	7	dtv	034g
2	2004		loriceum						
20	2005		microchlamys						45
30	2004		munitum		7	58		dhsv	0
4	2003		neolobatum		5				4
10	2005		plicatum	col. in Chile					2w
10	2002		richardii		7				1
6	2006		rigens		5				45
100	2004		setiferum			40	6	dtv	3
20	2004		setiferum	'Dactylis'					
20	2004		setiferum	'Filigrani'					
20	2004		setiferum	'Rolundatum'					
2	2006		stenophyllum		7				
10	2006		tetragonum						2g
9	2004		tsus-simense		6				
10	2004	Pronephrium	simplex						78
6	2004	Pteridium	aquilinum						379
50	2004	Pteris	biaurita						256
100	2004		buchananii						0

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20	2004		cretica						23678
3	2005		cretica	'Parkeri'	8	12E	6	dsy	g
50	2005		fauriel						45
3	2006		gallinopes		8				4g
3	2006		pauriei ?						
3	2005		semipinnata		8	30E	6	dsv	56g
15	2005		vittata						1thru9
10	2004		vitata	macrophylla					
10	2006		wallichiana						g 5
6	2007	Pyrrosia	gallinopes		8				g
6	2005	Rumohra	adiantiformis	col. in Chile					12789w
2	2004	Schaffneria	nigripes						1
2	2006	Selliguea	feei						g
15	2006	Sphaeropteris	lunulata	syn. Cyathea		T			g
2	2006	Stegnogramma	mollissima		7				
50	2003	Stenochiaena	tenuifolia						g
3	2001	Tectaria	beccariana						4
4	2004		cicutaria						124
2	2001		heracleifolia						1
3	2007		hilocarpa	terrarium	0				8
1	2005		sp	Col. fr. Puerto Rico	0	20E	8	dsv	g
6	2007	Tectaria	trifoliata		0	20E	8	dsv	g
20	2006		zeylanica	syn. Quercifilix	0	6E	c,8	hosv	g
4	2003	Thelypteris	decursive-pinnata						
6	2007		guadalupensis		0				
4	2004		kunthii	syn. T. normalis					
3	2004		limbosperma	syn. Oreopteris limboserma	5	45E		dsvz	03w
10	2004		palustris						3
2	2004		patens		9				2
3	2003		phegopteris						
1	2004		poiteana	syn. Goniopteris	9				2
20	2007		puberula	var. sonariensis					
20	2006		sp						
12	2007	Woodsia	pseudopolystichoi-des		9				g
4	2005	Woodwardia	areolata	netted chain fern					0g
10	2003		orietalis	oriental chain fern					45g
12	2007		semicordata						g
20	2007		subcordata						g
3	2006		unigemmata						g
4	2004		virginica						0
20	2006	Woodwardia	X semicordata						1g

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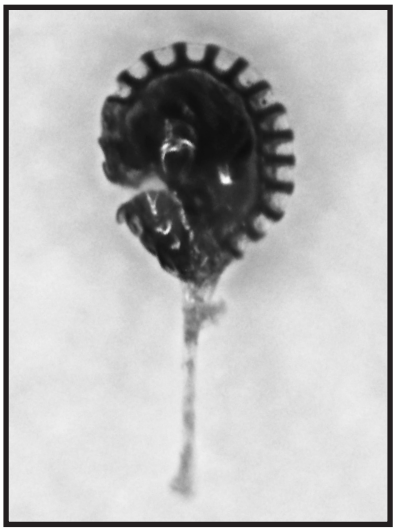

Sporangium of Thelypteris kunthii

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