

THE HARDY FERN FOUNDATION

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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.

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

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

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

Cover Design by Willanna Bradner

HARDY FERN FOUNDATION QUARTERLY

THE HARDY FERN FOUNDATION

QUARTERLY

Volume 12 • No. 1 • Editor - Sue Olsen



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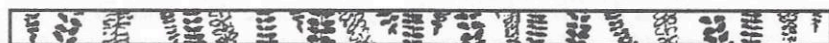
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The Spore Exchange Needs You

Please continue to send spores to:

Shannon Toal
4717 SW Graham Street
Seattle, WA 98136



President's Message Winter 2002

It is with great sorrow that I report the recent passing on October 12, 2001 of Harry Olsen. Harry has been an inspiration and extremely supportive of the Hardy Fern Foundation since its inception. He was a strong personal friend and a loving husband. We will all sorely miss him.

Winter activities have been slowed by recent tragedies and a somewhat mild but rather wet fall and winter. It is probably a good time to protect the less hardy ferns and treat certain ones for "leafhoppers" if you are unlucky enough to have them.

The October meeting of the Board of Directors was held at Lakewold Gardens in Lakewood, WA. We are pleased to once again establish a beneficial relationship with this lovely facility through the cooperative efforts of Nancy Dillworth the new Executive Director. A new irrigation system has been installed and we are directly involved with the rejuvenation of the existing fern garden. John van den Meerendonk will be providing liaison, design expertise and guidance. Katie Burke and Barbara Carman were kind to help with a tour and overview of the garden ending with a refreshing lunch.

On November 6, 2001 the Board assembled at the Washington Park Arboretum in Seattle, WA. Deborah Andrews, Executive Director of the Arboretum Foundation met with us briefly and it appears possible that the Hardy Fern Foundation will be able to establish a relationship after conducting further discussions.

As always at this time of the year we are looking forward to the Northwest Flower and Garden Show, February 6 - 10, 2002 at the newly expanded convention center in Seattle. We are again planning to have an outstanding display featuring an interesting assortment of hardy ferns set in a natural backdrop of moss and logs. There will be printed material concerning care and propagation as well as a list of sources for ferns. We can use your help in a number of areas - please contact Michelle Bundy at (206) 870-5363 or e-mail at thebundys4@attbi.com. Remember that volunteers who help staff the booth also received free admission to the show for the entire day. It is fun and an excellent opportunity to share and spread enthusiasm for ferns.

Upcoming events also include the Annual Fern Festival sale and meeting at the Center for Urban Horticulture on Friday May 31 and Saturday June 1. Richie Steffen will be our Friday evening speaker and we look forward to his presentation. We will have printed announcements with more information at our Flower and Garden Show booth and in our Spring Quarterly.

Last spring a number of our members from throughout the country participated in a Fern Frond Emergence Study coordinated by Ralph Archer. The first report from that study is a feature of this issue. Participants enjoyed the learning experience and all felt that to be more scientifically significant the study should continue again this year. As you can see in the article the reporting system will be streamlined so as to be a minimum imposition and we invite and would welcome more participants. Please

contact Ralph for the proper forms at P.O. Box 43036, Louisville, KY 40253-0036, by phone at (502) 245-3161 or e-mail at ralpharcher@worldnet.att.net.

On behalf of the Hardy Fern Foundation I would like to thank you all for your help and generous contribution of time and wish you a Very Happy New Year.

*Pat Kennar, President
Bellevue, WA*



IN MEMORIAM

*The Hardy Fern Foundation Board
and your editor extend our sincere
thanks for the gifts received in
memory of Harry C. Olsen.*

Emily and Fleet Bone

Diggs and Jack Docter

Sylvia C. Duryee

Maryanne and David Fournier

Joan and Milton Gottlieb

Jocelyn C. Horder

Ann Jacobs and Eric Rahkola

Bobbie and Loyd Jacobs

Kitty and Paul Jacobs

Dale and George Johnson

Marilyn and Pat Kennar

Sue and Jim Lane

Kiki and Dave Lewis

Paula and Jim Melby

Carol and John Mickel

Janice and K Norman

Fred Olsen

Alice and Dan Tanabe

Shirley and Gerry Tweed

Trees Planted at the Rhododendron Species Botanical Garden

Acer palmatum Emerald Lace

Ralph Archer and Del Loucks

A .p. Japanese Sunrise

Jean and Ralph Archer

Joyce and Fred Descloux

Joan and Milton Gottlieb

Catharine Guiles

Betty Hamilton

Kindest thanks to you all.

Sue

New Members

The Berry Botanic Garden

Fred Hausman

Terry Hay

Sharon Johnson

Peter Minnich

Benjamin Moulton

Laddie Munger

Nathan Myhrvold

Fred Phillips

Alston M. Quillin

Richland Creek Herb Farm

Horsetails and whisk ferns re-examined: when a “fern ally” is really a fern.

by Alan R. Smith, Univ. Herbarium, 1001 Valley Life Sciences Bldg. #2465,
Univ. California, Berkeley, CA 94720-2465

If you learned your botany a few years ago, *Equisetum*, the genus of the horsetails, and *Psilotum*, the genus of the whisk ferns, were considered separate and isolated lineages of plants, dating well back into the Paleozoic era. This made intuitive sense because both genera appear very different from other vascular plants (Tracheophytes), “simple” in construction and growth and lacking true leaves. Horsetails and whisk ferns were considered “fern-allies”, primitive vascular land plants having well differentiated special tissues (xylem and phloem) for transporting food and water. Vascular plants also include the lycophytes (club mosses and quillworts), *Selaginella* (spike mosses), as well as all conifers (gymnosperms) and flowering plants (angiosperms). Altogether, the ferns and so-called fern-allies were considered to be “pteridophytes” — organisms having vascular tissue that reproduce by spores and having somewhat independent life-cycle phases, a very small gametophytic phase and a generally much larger sporophytic phase. Pteridophytes were thought to be among the “lower” branches of the genealogical tree, just above the bryophyte lineages (mosses, liverworts, and hornworts) in the land plant tree-of-life. But the exact interrelationships of these early branches has remained enigmatic, until very recently.

The first of these classical ideas of kinship to be altered were the relationships of *Psilotum* and *Tmesipteris* (family Psilotaceae). Because of their sometimes dichotomous stem branching, rootless and leafless conditions, and unusually large sporangia, this group had been thought to be closely allied to the Rhyniophytes, a group of early fossil vascular plants having forked stems and large terminal sporangia. Rhyniophytes are known to have arisen in the Lower Devonian period, about 400 million years ago. However, evidence is now accumulating that *Psilotum* and *Tmesipteris* are really more closely allied to the group of ferns known as Adder’s-tongues (*Ophioglossum*) and Moonworts (*Botrychium*). Several recent studies show that these two families, the Psilotaceae and Ophioglossaceae, are probably sister groups, that is, they diverged from a common ancestor (Hasebe et al., 1995; Manhart, 1995; Pryer et al., 2001). The timing of this event is unknown, since these groups are not ones that fossilize readily, but the event likely occurred more than 300 million years ago, in the Carboniferous period (or earlier) of the Paleozoic era.

Even more recently, there is evidence that *Equisetum* should be added to the mix, that its affinities also lie with the ferns, possibly with the eusporangiate fern family Marattiaceae or with some of the higher leptosporangiate ferns. The evidence suggests that *Equisetum* and the ferns are also sister groups, lineages that diverged from each other early in their history, probably about 350 million years ago. Moreover, these two lineages together form the sister group to all of the seed plants, both flowering plants and gymnosperms (conifers, cycads, and relatives). In other words, ferns and horsetails make up one genetically related group, which evolved in parallel to all seed-producing plants. This research reflects the latest major rearrangement of the plant tree-of-life, and calls for rethinking the family tree of green plants. This result can be depicted in Figure 1, a simplified version of the tree published by Pryer

et al. (2001). Ninety-nine percent of vascular plants living on the earth today fall into two major lineages, with separate evolutionary histories dating back nearly 400 million years.

Studies utilizing DNA sequencing have also proven useful in placing problematic genera and families in the evolutionary tree. For example, studies by Wolf et al. (1999) show that the fern families Lophosoriaceae (*Lophosoria quadripinnata* of the America tropics) and Hymenophyllopsidaceae (a bizarre group of eight species restricted to the Venezuelan tepuis, otherwise known as "The Lost World") have their closest relationships with the tree ferns. In fact, *Hymenophyllopsis*, small herbaceous plants growing on sandstone rocks and resembling filmy ferns, appears to be the sister group of the Cyatheaceae, the tree fern family, sharing with it a common ancestor.

The most recent research on the relationships of land plants is based on both morphological and DNA sequence data from 35 carefully chosen taxa representing all of the main groups of land plants — bryophytes, pteridophytes, and seed plants (Pryer et al., 2001). In this study, DNA sequences, involving a total of over 5000 nucleotide base pairs (the units making up genes and ultimately DNA strands) were obtained from all 35 species. Of the thousands of genes within each plant cell, four were chosen for study, and these included three chloroplast genes plus a nuclear gene. The genes were chosen for sequencing because of their slowly evolving nature and their function in key biosynthetic and developmental processes. For example, one of the chloroplast genes chosen, a gene called *rbcL* codes for a protein that helps plants use carbon dioxide to make sugar during photosynthesis. In addition, Pryer et al. (2001) scored 136 characters from traditional morphology, characters that relate to all parts of the plant body and all stages of the life cycle, from macroscopic leaf characters like leaf venation and stem symmetry to microscopic characters dealing with the shape and wall structure of the spores. Because the mode of inheritance of most of these morphological characters is believed to be complex and the characters and character states themselves are controlled by many genes, it was hoped that data based on morphology might augment the results obtained from the DNA sequence data. This approach of integrating both morphological and molecular data to hypothesize relationships was first attempted in ferns by Pryer et al. (1995). In that study, combining of independently derived data sets resulted in evolutionary trees that were more robust (having greater statistical support) than trees produced using single data sets.

Pryer and coworkers are continuing their efforts to understand the relationships of all spore-bearing vascular plants. One project now receiving special attention is an attempt to unravel the relationships of all living horsetails, a genus comprising 15 species, mostly in north temperate regions of the world (Des Marais et al., 2001). In addition to being a very interesting group morphologically, horsetails have an extensive fossil record that makes them desirable for further genealogical study. DNA samples have been obtained from all 15 species of *Equisetum*, and comparison of the nucleotide sequences have produced a tree that supports the traditional separation into two main subgenera, subg. *Equisetum* (e.g., *E. arvense* and *E. telmateia*) and subg. *Hippochaete* (e.g., *E. hyemale* and *E. giganteum*). This same tree also shows, somewhat surprisingly, that the basalmost member of the tree is one of the few tropical species in the genus, the Andean *Equisetum bogotense*; this result was completely

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Horsetails and whisk ferns re-examined *continued from page 5*

unexpected on the basis of traditional morphological analysis, which had postulated that *E. bogotense* was one of the most derived species in the genus. In addition, researchers are attempting to produce trees for some of the most derived (more recently evolving) families of ferns, including the polypod family, whose members include the familiar staghorn (*Platycerium*), licorice (*Polypodium*), and rabbit's foot (*Phlebodium*) ferns (Haufler et al., 2001).

This work builds on the so-called "Deep Green" project, a collaboration of researchers around the world and dedicated to uncovering the interrelationships and evolution of all green plants, in short, a genealogy of plants. In 1999, Deep Green, a project spearheaded by Dr. Brent Mishler, Director of the University and Jepson Herbaria in Berkeley, California, reported at an international botanical congress that DNA analysis indicates that all green plants — from the tiniest single-celled algae to the grandest redwoods — descended from a common single-celled ancestor about a billion years ago. Others at the same congress presented evidence that hypothesized that the basalmost branch on the flowering plant lineage was the genus *Amborella*, a little known shrub restricted to the island of New Caledonia, near New Zealand and Australia.

Most of the 450-million-year history of plants on land belongs to the bryophytes (mosses, liverworts, and hornworts), pteridophytes (ferns and fern allies), and gymnosperms. The angiosperms (flowering plants) are relative newcomers on the scene and came into ecological dominance about 90 million years ago. For over a century botanists have been trying to understand the relationships among these four major groups of plants. In the past, pteridophytes have often been considered a transitional evolutionary grade leading to the so-called "higher" plants, those producing flowers and seeds, or naked seeds. A consequence of this traditional view is that many aspects of seed plants are commonly regarded as having been derived from fern ancestors. The implication of the work reported by Pryer et al. (2001) is that the familiar plant organs and development we normally associate with seed plants can not be derived from ferns. This should ultimately lead to a re-interpretation of the development of structures like leaves and branching patterns in the two groups.

This is definitely an exciting time to be a fern specialist or evolutionary biologist, because there are now the tools and techniques to be able to piece together the tree-of-life. Not only has the human genome been sequenced, but the genome of many organisms, representing many different branches in the tree of life, have now been sequenced and compared. This avenue of research will eventually lead to improved understanding of developmental patterns in plants and how traditional morphological characters have evolved, re-evolved, and sometimes disappeared. In addition, the evolutionary trees produced, although only a best estimate (hypothesis) of the actual evolutionary events, will help us understand how better to interpret the sometimes meager fossil evidence, and then to produce a time line for estimating when certain lineages arose, or went extinct.

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For additional information, see the following web sites:

http://www.fieldmuseum.org/research_collections/botany/botany_sites/ferns/index.html

http://phylogeny.arizona.edu/tree/eukaryotes/green_plants/embryophytes/filicopsida/filicopsida.html

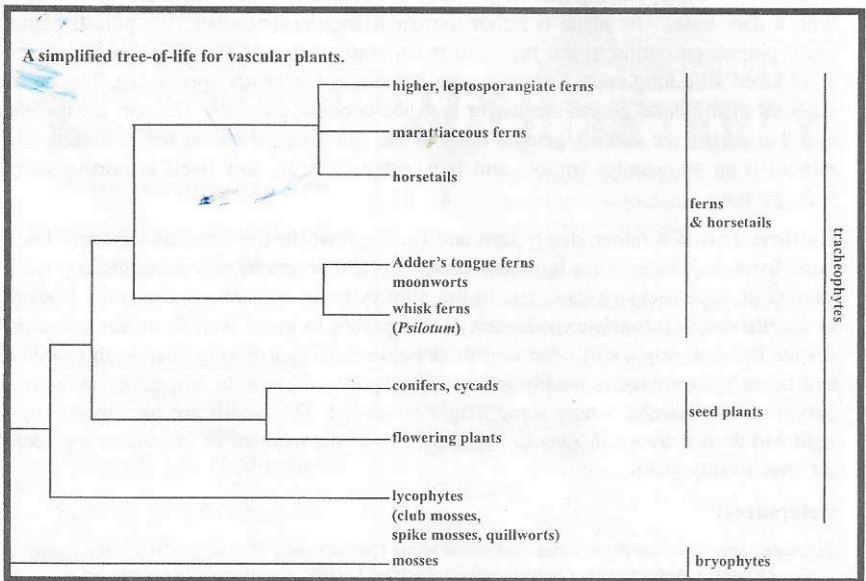


Fig. 1. A slightly simplified version of the results presented in Pryer et al. (2001).

Dryopteris remota

Scaly Buckler Fern

James R. Horrocks

Salt Lake City, Utah

The species name "remota" denotes "remote, with parts distant" referring to the space between the pinnae. This is a subalpine European fern of hybrid origin which grows near forest streams. Martin Rickard calls it a "tough fertile hybrid" believed to be a cross between *D. affinis* subs. *affinis* and *D. expansa*. It is certainly a robust plant growing to three feet high. There are no modern records of it in the British Isles but it was once found in both Scotland and Ireland. It is scattered throughout Europe and Western Asia, although it is considered somewhat rare. *D. remota* could be confused at a glance with several species of *Dryopteris* including *D. dilatata*, *D. intermedia*, *D. filix-mas*, and with one of its parents, *D. expansa*. Fraser-Jenkins mentions that *D. blandfordii* was confused with *D. remota* before the two were recognized as separate, distinct species. In appearance *D. remota* is morphologically intermediate between the assumed parents, with the shaggy stipe of *D. affinis* and the thinner texture of *D. expansa*.

Description: The rhizome is erect and ascending, forming a distinct crown which produces offshoots occasionally. The fronds are two to three feet long and held erect. In milder climates they are evergreen but in colder climates the fronds are quite deciduous, although they can remain green if covered with snow. The stipe is $\frac{1}{4}$ to $\frac{1}{2}$ the length of the blade, bearing narrowly triangular-lanceolate scales which are light brown with a dark base. The blade is rather narrow triangular-lanceolate, the pinnae being twice pinnate-pinnatifid at the base and twice pinnate above. The pinnules are somewhat lobed with long acute teeth that give it a somewhat bristly appearance. The basal pinnules of the basal pinnae are longer than the opposite pinnules. The sori are medial and the indusia are lacking glands. Both viable and abortive spores are produced. *D. remota* is an apogamous triploid and is reported to freely sow itself in northeastern U.S. gardens.

Culture: This is a rather stately fern and easily grown in the woodland garden. Like most ferns, it is happy in a humousy damp soil and seems to appreciate the companionship of large rocks or boulders. In the nursery trade, it is often mistakenly labeled as *D. filix-mas* (author's experience). It is reported to grow well in milder climates despite being mostly a subalpine fern in its native habitat. It is long lived in the garden and being apogamous, is readily grown from spores. *D. remota* is a rather attractive hybrid and is valuable where some height is needed. The fronds are held mostly upright and do not droop. *D. remota* has been a welcome member of the author's garden for over twenty years.

References:

Cultivated Species of the Fern Genus Dryopteris in the United States, Barbara Joe Hoshizaki, Kenneth A. Wilson, American Fern Journal, Vol 89, Number 1, 1999, American Fern Society.

Ferns for American Gardens, 1994, John Mickel, MacMillan Publishing Co., New York.

The Plant Finder's Guide to Garden Ferns, 2000, Martin Rickard, Timber Press, Portland, OR.



Dryopteris remota.
Photo by Richard Young

**Spring Work Parties
Volunteers Welcome**

Plant, Groom, Learn
Bellevue Botanical Garden
March 1, 10:00am



Lakewold Gardens
Gravelly Lake Rd.
Tacoma
March 12, 11:00am

Sign up with Michelle at
(206)870-5363 or the
bundys4@attbi.com

Look forward to seeing you!



THE HARDY FERN FOUNDATION

QUARTERLY

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

Please send your submissions to
Sue Olsen
2003 128th Ave SE,
Bellevue, WA, 98005.

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A Report of the Emergence of Fern Species in the United States during the Spring of 2001

Ralph C. Archer - Louisville, KY

A study of the time of emergence of ferns in various areas of the United States was proposed to members of the Hardy Fern Foundation. The intent of the study was to determine when both individual and groups of fern species emerged in different parts of the United States. Eight members responded with data for fern emergence in their gardens during the spring of 2001.

I wish to express my gratitude to the following members who took valuable time and expended considerable effort to record data and respond to questions. I also would like to thank Dr. Betty Hamilton of South Bend, IN and Mr. Nick Donnelly of Binghamton, NY for their valuable suggestions for improvement in the reporting of findings.

The eastern United States, east of Rocky Mountains

1. Mary Ellen Tonsing of Denver, CO.
2. John Schieber of Holland, PA
3. Tim Kessenich of Madison, WI
4. Catharine W. Guiles of New Gloucester, ME.
5. Joan Gottlieb of Pittsburgh, PA
6. Joyce Descloux of Randolph, NJ

State of Washington

1. Sue Olsen of Bellevue, WA
2. John Mello of Coupeville, WA



A number of conclusions have been drawn from the data. Each is stated in summary form. They will also be discussed in some detail in the body of the report. Two numerical measures offer a useful criterion for evaluation of fern emergence.

The first is a measure of when the "average fern" emerges at a given location. The average emergence date is an average of several estimates of the center date of the total time span for emergence of all of the fern species at each location.

The second is a measure of the total time span required for a group of different species of ferns to emerge at each location. The total emergence time is the time period for all fern species in the group at each location to emerge throughout the spring.

People familiar with statistical analysis recognize these as the familiar statistics used to describe populations in general. They are the measures of the center of a distribution of individuals and how it is spread out. Lists of fern species in order of emergence

and a discussion of the method of data analysis will be provided at the end. Due to limited data and extreme variability, cultivars were excluded from the data analysis and only reports for species were used. Conclusions and remarks apply only to initial emergence of the crozier or fiddlehead as first noted by the observer. The definition of emergence for a fern, given with the report sheet, was full emergence from ground or full separation from crown of the first fiddlehead.

The conclusions apply only to this year and are based on limited data. The statement that the difference is statistically significant means that the observed difference is probably a result of an assignable cause and is not due to mere normal fluctuation. A section devoted to discussion of the statistical analysis is appended with a more detailed discussion of the terms and analysis.

CONCLUSIONS:

1. There is, as would be expected, a statistically significant difference between southern and northern regions of the eastern United States for the average emergence date for groups of fern species. The average fern emergence date was 21 days later for Maine than Kentucky.
2. There is a statistically significant difference for groups of fern species for total emergence time between Washington State west of the Cascade Range and the part of the country east of the Rocky Mountains.
3. The difference in total emergence time for groups of fern species between most eastern sites was statistically significant. The difference in total emergence time appears to depend on one or more of at least four factors. They are major climate differences, interruptions in emergence due to weather, significant growing condition differences between sites and the total number of ferns grown at a site.
4. The study did not resolve the questions regarding the emergence of individual cultivars compared to the species. In order to study the relationship of species and cultivars, it is necessary to have the species and the cultivars in the same cultural conditions in a number of different gardens. There was insufficient data for individual cultivars to reach any conclusions regarding their performance relative to the species. Information noted relative to cultivars will be discussed later.
5. Data from Coupeville, WA showed two of the factors which affect fern emergence. One is moisture and the other is exposure to sun.

There was evidence that lack of moisture delays fern emergence. This was confirmed by the Pittsburgh, PA observer. She described her garden as generally uniform in site and shade, and stated that the main condition that made a difference in emergence time appeared to be moisture. She estimated that dry conditions delayed emergence by a week. The data from Coupeville, WA showed a delay of ten days for dry shade vs. shade with moisture.

The data from Coupeville, WA also showed that exposure to three to four hours of sun promoted earlier emergence. The Denver, CO observer confirmed that, saying "Emergence seems to depend on how much sun reaches a particular fern." It may be that the

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A Report of the Emergence of Fern Species *cont. from page 11*

additional soil warmth triggers early fern emergence. However exposure to morning sun is detrimental to the growth during the summer for *Dryopteris marginalis* in Louisville, KY.

DISCUSSION

The observed total emergence time for groups of fern species in Bellevue, WA was approximately 50 percent longer than for Pittsburgh, PA. This is based on the standard deviation of the time distributions of thirty-eight fern species common to both locations. This difference is statistically significant. The number of fern species, which were common to a large number of the different locations, was small. For this reason, as well as the difference in total emergence time, the analysis was divided into the eastern part of the Country, east of the Rocky Mountains, and Washington State, west of the Cascade Range. For reasons discussed in the statistical analysis section, no statistical study of the magnitude of any of the differences was made.

There is, as would be expected, a statistically significant difference between southern and northern locations in the eastern United States for the average emergence date of groups of fern species. The following table shows the average emergence date for each location. The table also shows the time differences of average emergence dates for the various locations using Louisville, KY as a zero date. The average emergence date this year was twenty-one days later for Maine compared to Kentucky. A statistical analysis showed this difference is statistically significant.

The total emergence time range, listed in the table, is the difference between the first and the last fern to emerge. This is easiest for most people to understand and gives a feel for garden performance. The statistical analysis, which used the standard deviation of the data, showed that the difference in total emergence time between Louisville, KY compared to Madison, WI, or to Denver, CO, or to New Gloucester, ME is statistically significant.

Location	Average Emergence Data	Difference from Louisville (Days)	Time for Total Emergence (Days)
Louisville, KY	Apr. 14, 2001	0	48
Pittsburgh, PA	Apr. 18, 2001	4.2	83
Holland, PA	Apr. 19, 2001	5.6	32
Madison, WI	Apr. 24, 2001	10.1	21
Randolph, NJ	Apr. 26, 2001	11.8	43
Denver, CO	May 1, 2001	17.3	20
New Gloucester, ME	May 4, 2001	20.7	12
Bellevue, WA	Apr. 7, 2001		91
Coupeville, WA	Apr. 17, 2001		115

The difference between sites for total emergence time appears to depend on one or more of at least four factors. They are interruptions in emergence due to weather, significant growing condition differences between sites, the total number of ferns grown at a site and major climate differences. Each will be discussed in some detail.

It appears that the total emergence time is sensitive to site and to weather. This is based on the data from New Jersey, Colorado and Coupeville, WA. It is likely that the long total emergence time and late average emergence date for New Jersey is due to a combination of a late spring, the specific garden site (very dry shade) and dry weather for three weeks during late April into the middle of May. Additional complications at the New Jersey site are discussed later. The Colorado observer reported freezing weather and snow in the midst of the emergence time. The observed total emergence time for Colorado appears to be long compared to other data, especially when the number of ferns is considered. The Coupeville, WA data will be discussed later at some length as it provided clues to factors that affect garden performance.

Several regression analyses of the total emergence time data were made to evaluate cause and effect relationships. If only data for Kentucky, both Pennsylvania locations, Wisconsin, Maine and Bellevue, WA was considered, the difference in total emergence time appeared to be primarily related to the difference in the number of fern species grown at the various locations. That analysis showed that the larger the number of fern species grown, the longer the total emergence times. When data from Colorado, New Jersey and Coupeville, WA was included in the analysis, the effect of the number of fern species per location was not strongly significant. As previously discussed, a direct comparison for an identical group of fern species grown at Pittsburgh, PA and Bellevue, WA showed a significant difference in total emergence time. A second regression analysis was made for Kentucky, both Pennsylvania locations, Wisconsin and Maine, omitting Bellevue, WA. It showed a stronger correlation between numbers of fern species and total emergence time than the first analysis discussed above. These analyses suggest several possible conclusions. They suggest that there are factors, in this case possibly the general climate, that cause different performances by the same groups of fern species. They also suggest that once conditions are favorable for emergence, regardless of the location or spring start time, an identical group of fern species may emerge over a time scale directly related to the number of different fern species, unless affected by growing conditions at the site or weather. To summarize, the data suggests that a difference in total emergence for similar groups of fern species may occur because of major climate differences (such as between Washington State and eastern areas), interruptions in emergence due to weather (such as for Colorado and New Jersey) and strong cultural growing-condition differences (such as for New Jersey and Coupeville, WA).

The specific reasons for the difference between Washington State and the eastern areas are not clear. Obviously the climate differences are considerable. One suggestion is that the difference may result from a longer, slower, more uniform warm-up of the soil. It is likely that there may be others. The effect of different site conditions in terms of sun and moisture will be discussed in some detail later.

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Data from additional locations, northern and southern, with larger numbers of the same fern species, is necessary to resolve the questions regarding the relationship of total emergence time and the number of ferns grown. It is possible that the true relationship is being hidden due to the northern locations reporting fewer ferns than the southern. An analysis of variance for several sites using six common fern species showed that there is a statistically significant time order in which specific fern species emerge after emergence starts. It also showed that the six Kentucky ferns took twice as long to emerge as the Maine ferns. It was not statistically significant but it does appear that this difference might be real.

The emergence chart shows the percentage of ferns emerging over the season at all locations. Each box represents a two-week time period. The date in the box at the bottom is the last day of the two-week time period. The number in the boxes for the various locations is the percentage of ferns for the location that emerged during that two-week time period.

In general, the ferns greeted spring with a sporadic emergence of a few fern species over several weeks. This was followed by a burst of emergence which exceeds 50 percent in the first or second two-week period in the eastern areas. This burst was followed by a period where emergence is at a relatively low rate and then tapered off to sporadic emergence.

The New Jersey data shows the effect of the observer being away from May 1 to May 13. An unknown number of ferns in the last group of 29 percent actually emerged in the time period for the group shown ending May 11, but they were reported as of May 14. This was confirmed by the observer and was evident from the results of an analysis of variance for locations including New Jersey. The total time span is not changed, however, as some ferns did emerge during the last time period. Only the percentages would be affected. It does affect the statistical analysis, however. This is discussed later in the statistical analysis section.

Pittsburgh, PA data shows the effect one fern can have, as it increased the range by four weeks. This is why it is important to use a measure for variability, such as the standard deviation, that is not dependent on a few individuals. The increased length of time seems to be due in a large degree to the larger number of ferns reported compared to other sites.

The data for Washington State also shows how a few sporadic ferns, at both the start and end of the emergence time frame, increased the range by several weeks. The two locations in Washington State had significantly different total emergence times based on a number of different analyses. It appears that this is caused by significantly different cultural conditions. Finally, the difference between eastern and western ferns is evident. The time frame for active emergence was longer for western ferns. In addition, the percentages for the peak periods were lower and the sporadic emergence before and after the active time periods occurred over a longer time.

EMERGENCE CHART

ME										100%
CO										45% 55%
NJ										3% 50% 18% 29%
WI										91% 9%
PA-Holland										29% 58% 14%
PA-Ptsbrgh										3% 33% 49% 5% 9% 1%
KY										53% 35% 10% 2%
WA-Coupevl	9%	3%								33% 30% 12% 6% 3% 3%
WA-Blvue										6% 20% 38% 23% 5% 3% 1% 3%

03/02 03/16 03/30 04/13 04/27 05/11 05/25 06/08 06/22 07/06

The Coupeville, WA site, which reported fern emergence coded by plant bed condition, had significant differences in emergence times for various beds. In general, exposure to three to four hours of sun and a supply of moisture during the previous year was the most favorable situation for early appearance of ferns. Moisture, during the previous year, seems to be important in promoting early emergence. Dry shade appears to be the most unfavorable condition, but data is very limited for this situation. The table shows average dates of emergence for the various cultural conditions. Medium Sun is defined as three to four hours of direct sun with tall Douglas fir and alder bordering the area. The difference between Bed 1 and all the others is statistically significant as well as the difference between Beds 2 and 4 and between Beds 3 and 4.

Bed	Sun exposure	Water	Avg. Date	Number of Ferns
1	Medium	Irrigated 2000	01-Apr	12
2	Medium	Fairly Dry	17-Apr	16
3	Shade	Irrigated 1999-2000	19-Apr	22
4	Medium	Driest	27-Apr	18
5	Shade	Dry	29-Apr	3

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The fact that Bed 3 is third is somewhat surprising. It would be interesting to see if this pattern holds true for southern areas such as Louisville or is true only for northern gardens. A number of garden publications mention that the detrimental effect of direct sun in far northern gardens is less severe for a range of shade plants than in the south. *Dryopteris marginalis* grow much better in the Louisville garden in the shade with water than in three hours of morning sun with and without irrigation. The New Jersey garden, described below, would fit the description of dry shade. This may help explain the later than expected average emergence date and the longer than expected total emergence time reported by the New Jersey observer.

The study does not resolve the questions regarding the emergence of specific cultivars compared to the species, and growth of the fiddlehead to full frond size. There was insufficient data for emergence of cultivars to draw any significant conclusions for cultivar performance in this respect. The limited data was not consistent from species to species and from site to site. The differences in emergence times compared to the species, as reported by various observers, were very large and did not show a pattern. There were some interesting findings, however. The average time difference between the emergence for all the species and cultivars was zero for all ferns studied. The total emergence time for cultivars followed the same pattern as that of ferns in general. The time for total emergence was approximately double for fern cultivars in Washington State compared to eastern areas. None of these effects were significant statistically. Because of the large variation and a desire to reduce the number of variables in the study, cultivars were excluded from the data analysis. A limited analysis of full extension of the frond from fiddlehead was made. Due to time limitations, this portion of the study was rescheduled for the coming winter.

The following details the numbers of ferns reported by totals, by species, by cultivars and by locations.

Location	All	WA State	Eastern
No. of Locations	9	2	7
No. of species reported	193	130	122
No. of cultivars reported	93	73	45
Total ferns reported	286	203	167

Emergence data for the following number of fern species was reported by the observers.

Location	Number of species
Bellevue, WA	115
Coupeville, WA	33
Louisville, KY	49
Pittsburgh, PA	79
Holland, PA	59

Madison, W	23
Randolph, NJ	34
Denver, CO.	11
New Gloucester, ME.	26

The following describes the contributor's gardens and summarizes their comments.

The eastern United States, east of Rocky Mountains

1. Mary Ellen Tonsing of Denver, CO.

Most ferns are planted under deciduous trees with heavy pine needle mulch. The observer commented that "Emergence seems to depend on how much sun reaches a particular fern." During the latter part of April the day time temperature was in the 70's (F). On May 2, it turned cold (30's F) and the area experienced a rain-snow mixture for four days. On May 6, the temperature went back up into the 70's. The observer commented that "everything has really "shot up." On May 20, the temperature dropped from 80 to 30F in a few hours with sixty mph winds and six inches of wet snow. The *Athyrium* species and cultivars suffered the most damage from frost and had crushed and broken fronds. The *Dryopteris* were untouched.

2. John Schieber of Holland, PA

Both *Polystichum polyblepharum* and *P. retroso-paleaceum* require frost protection to prevent frond damage. Both emerged the middle of April this year and *P. retroso-paleaceum* was damaged. In this area, there is a fifty-fifty chance of a 32F frost on May 1.

The observer commented as follows:

- a. "Older plants of the same species generally leaf out sooner."
- b. "Plants of the same species 5 feet apart can sometimes leaf out three or four days differently."
- c. "More mulch or cover results in sooner emergence"

The observer also reported that *Asplenium trichomanes*, *Dryopteris bissetiana* and *D. expansa* in protected locations emerged from two to six days sooner than those same ferns in a less protected area.

3. Tim Kessenich of Madison, WI

Nearly all the ferns are growing on north facing slopes or on the north side of buildings. The ferns grow under mixed trees, mainly deciduous, but with some smaller evergreen trees. The last frost date is April, 30.

The observer noted that a group of *Dryopteris marginalis* planted about 15 years ago emerged later by more than three days than a group that is about three years old. The observer reported that these were the only ferns that had a significant difference. The early group grows about three feet from the house under a large

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Teaway Field Trip

L-R Lyman Black,
Susan Black,
Bors Vesterby,
Sharon Pohlman,
Mareen Kruckeberg,
Rob Leitner, Shannon
Toal, Art Kruckeberg,
Jeannie Taylor, Sylvia
Duryee, Harry Olsen,
Steve Hoitink,
Sue Olsen, Marilyn
Mahon, Rowland
Adeniyi, Pat Kennar,
Michelle Bundy,
Richie Steffen,
Rick Peterson.

Photo by Toni Leitner



Award Winning Display



Northwest
Flower
and
Garden
Show

Photo by Pat Kennar

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yew. The later group grows about eight feet from the house under a hickory and a dogwood tree. The observer commented that he usually groups the same species together in generally uniform exposure conditions.

4. Catharine W. Guiles of New Gloucester, ME.

The fern garden is on a gentle east-facing, very shady slope subject to wind. The date of normal last frost is May 13 although no frost was experienced this year after plant growth started. It was a very severe winter with a deep snow cover. It was necessary to water the garden regularly throughout April and through the first three weeks of May. Leaves are generally used for mulch although wood chips are used for the various *Osmunda* species.

5. Joan Gottlieb of Pittsburgh, PA

The fern garden is about one-third acre with uniform shade, except for a few areas which are sunny. In general all ferns receive good, uniform but shaded light except for *Osmunda* species which are in the sunny areas. The observer reports that ferns of the same species in drier areas emerged about a week later than those in moist conditions. Ferns are heavily mulched in fall and crowns are uncovered in spring from any excess still present. There are a large number of cultivars and species not in general cultivation, with a considerable number not included in the report.

6. Joyce Descloux of Randolph, NJ

The fern garden is on a steep, southeast-facing slope at an altitude of 1000 feet. The soil is dry and consists of glacial stone over bedrock. Shade is provided by deciduous trees, predominately oak. Rain, fog and dew provide the only moisture for established plants. Limited supplemental water is provided only to newly planted ferns. Snow-cover lasted until mid-March as spring was late and cold. No rain occurred from April 21 to May 16. The observer reported that "Siting does not seem important. Weather does. Few came out during the dry spell. When it turned rainy and cool many showed and grew." The observer was away from May 1 to 13, so specific emergence dates for this period are not available and these ferns were reported as of May 14.

7. Ralph Archer of Louisville, KY

The fern garden is on about an acre of land which is bisected by a creek. Beds are along both sides of the creek in various areas as well as on both east and west-sloping land up from the creek. Shade is provided by large deciduous trees, mainly oaks, hickories, ash and maple. All of the beds are relatively new and consist of mixtures of ferns and ferns /shade plants ranging from one to six years in age. The frost free date is generally considered to be during the first week in May. It is usual for a hard freeze to occur during the spring in the latter part of April after a several week period of warmth. The area is USDA Zone 6a on the edge of Zone 5. This year the garden escaped the late April freeze with no damage.

State of Washington

1. Sue Olsen of Bellevue, WA

The fern garden is on an east-sloping suburban almost half acre. The garden is shaded by conifers and a deciduous canopy of mostly dogwood and maple trees. The exposure is quite uniform with some variance for those ferns under the deciduous cover. These trees generally leaf out in early April which is also usually the time of the last frosts. The observer commented that the *Adiantum* genus ferns in particular seemed to emerge at considerably different times with no apparent explanation. There are a large number of cultivars and species not in general cultivation.

2. John Mello of Coupeville, WA

The fern garden is on an island in Puget Sound about half way from Seattle to Victoria, BC. It is on the lee side of the island sheltered by a hill and about a forth of a mile from the ocean on the east. It is the site discussed above where the observer provided extensive data on a variety of ferns in a variety of beds with various conditions.

The following lists show the average emergence date for fern species for the eastern area and for the Washington State area. Only ferns where there were reports from three or more eastern locations and both Washington State locations have been included. The times are an average of the three or more reported dates for the eastern area and two reported dates for the western area. The lists are sorted by average emergence time and are in ascending order by date. An analysis of variance for six ferns common to five eastern locations showed the time of emergence differences for the different species to be statistically significant. The dates in the lists are given only to show the observed average time differences between fern species and the average time order in which the species emerged. The dates and the order may change due to additional data and so are for this year only.

EASTERN AREA

<i>Polystichum</i>	<i>polyblepharum</i>	04/10
<i>Dryopteris</i>	<i>clintoniana</i>	04/13
<i>Dryopteris</i>	<i>intermedia</i>	04/14
<i>Athyrium</i>	<i>cyclosorum</i>	04/14
<i>Matteuccia</i>	<i>struthiopteris</i>	04/15
<i>Adiantum</i>	<i>venustum</i>	04/16
<i>Dryopteris</i>	<i>celsa</i>	04/17
<i>Onoclea</i>	<i>sensibilis</i>	04/17
<i>Dryopteris</i>	<i>erythrosora</i>	04/17
<i>Polystichum</i>	<i>braunii</i>	04/18

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<i>Polystichum</i>	<i>setiferum</i>	04/18
<i>Thelypteris</i>	<i>phegopteris</i>	04/18
<i>Dryopteris</i>	<i>expansa</i>	04/18
<i>Thelypteris</i>	<i>decursive-pinnata</i>	04/18
<i>Dryopteris</i>	<i>carthusiana</i>	04/19
<i>Athyrium</i>	<i>filix-femina</i>	04/19
<i>Polystichum</i>	<i>acrostichoides</i>	04/20
<i>Osmunda</i>	<i>cinnamomea</i>	04/20
<i>Cystopteris</i>	<i>bulbifera</i>	04/20
<i>Gymnocarpium</i>	<i>dryopteris</i>	04/21
<i>Athyrium</i>	<i>angustum</i>	04/21
<i>Athyrium</i>	<i>thelypteroides</i>	04/21
<i>Dryopteris</i>	<i>complexa</i>	04/22
<i>Dryopteris</i>	<i>x australis</i>	04/22
<i>Dryopteris</i>	<i>filix-mas</i>	04/24
<i>Dryopteris</i>	<i>goldiana</i>	04/24
<i>Dryopteris</i>	<i>remota</i>	04/24
<i>Adiantum</i>	<i>pedatum</i>	04/25
<i>Dryopteris</i>	<i>namegatae</i>	04/25
<i>Dryopteris</i>	<i>championii</i>	04/25
<i>Osmunda</i>	<i>regalis</i>	04/25
<i>Adiantum</i>	<i>aleuticum</i>	04/25
<i>Dryopteris</i>	<i>marginalis</i>	04/26
<i>Arachniodes</i>	<i>standishii</i>	04/28
<i>Dryopteris</i>	<i>cristata</i>	05/01
<i>Athyrium</i>	<i>otophorum</i>	05/02

WASHINGTON STATE

<i>Dryopteris</i>	<i>expansa</i>	03/11
<i>Polystichum</i>	<i>polyblepharum</i>	03/13
<i>Woodsia</i>	<i>polystichoides</i>	03/20
<i>Polystichum</i>	<i>neolobatum</i>	03/22
<i>Polystichum</i>	<i>squarrosum</i>	03/30
<i>Matteuccia</i>	<i>struthiopteris</i>	04/01
<i>Polystichum</i>	<i>tsus-simense</i>	04/03
<i>Athyrium</i>	<i>otophorum</i>	04/05
<i>Adiantum</i>	<i>aleuticum</i>	04/06

<i>Polystichum</i>	<i>braunii</i>	04/07
<i>Dryopteris</i>	<i>crassirhizoma</i>	04/10
<i>Cyrtomium</i>	<i>macrophyllum</i>	04/11
<i>Dryopteris</i>	<i>wallichiana</i>	04/12
<i>Cystopteris</i>	<i>bulbifera</i>	04/12
<i>Polystichum</i>	<i>setiferum</i>	04/13
<i>Phyllitis</i>	<i>scolopendrium</i>	04/14
<i>Polypodium</i>	<i>scouleri</i>	04/24
<i>Dryopteris</i>	<i>erythrosora</i>	04/27
<i>Dryopteris</i>	<i>championii</i>	04/29
<i>Dryopteris</i>	<i>pseudo-felix-mas</i>	05/02
<i>Dryopteris</i>	<i>sieboldii</i>	06/17

STATISTICAL ANALYSIS.

All the reported dates for fern emergence from each individual location were added together and divided by the number of ferns reported from the location to determine the Arithmetical Mean or average. A Median date was found for each individual location by looking at the data and finding the date where fifty percent of the reported dates were greater and fifty percent were less. These are different estimates for the central value of the data (the average of the dates) for each of the various locations. From these listings of average dates for the locations, time differences between the sites were calculated. A third way of calculating the difference between sites was to use what is called analysis of variance, which is a statistical analysis calculation used for data analysis. It provides a way of directly calculating the difference between sites and between fern species at the same time. This provided a third estimate of the time difference between sites. From these, an average difference was calculated for each site. There were not enough common ferns for Colorado, New Jersey and the Washington locations to be included in the ANOVA (analysis of variance). It requires that each fern species used be reported by all sites in the analysis. Their average difference was based on the mean and median averages. The grand average dates listed for the various sites were then calculated from the average differences. The ANOVA provided confirmation that the difference in average emergence dates between sites was statistically significant in addition to other statistical tests for differences between sites.

The differences between locations for both average emergence date and variance (total emergence time) were tested for statistical significance by assuming that the reported emergence times for each site were normally distributed. The standard t test for differences of means and F test for differences of variances were used to compare the various sites to each other. The data variance was calculated using the population estimate of the standard deviation (s). From inspection of the data it appeared that the underlying data distribution for the reported data is that of a Binomial distribution. The grounds for assuming a normal distribution are treated in a number of texts on statistical quality control. E. L. Grant (*Statistical Quality Control* 2nd edition) dis-

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cusses the subject in some detail. Two of the more important criteria are that the distributions are generally symmetrical about the means and the sample sizes are relatively large. The largest differences between the arithmetic mean and the mode were three days in the case of Colorado and six days in the case of New Jersey. The Colorado sample size of eleven is below what is generally considered necessary. These differences make the projections involving New Jersey and Colorado less reliable than the others. The calculated test statistics exceeded the t critical=.1 and F critical=.1 for all comparisons between Kentucky and the other sites. This comparison means that the chance of the difference being due to random chance is less than one in ten. The difference in average emergence date was confirmed by the results from the ANOVA calculation which does not assume the normal distribution. The assumption of a normal distribution becomes less valid when calculating extremes, as for calculating certainty ranges for the numerical size of differences, than for the direct comparison of central values. Thus, no calculation was made regarding probability ranges for an average emergence date or total emergence time using the normal distribution assumption.

A regression analysis was used to evaluate the effect of number of ferns reported by each location on total emergence time. It used the number of ferns reported as the independent variable and the standard deviation as the dependent. The possibility that the observed time reduction was due to the decreased number of ferns reported by the northern observers compared to the southern was considered important. It showed that the correlation between the number of fern species grown and the standard deviation for data from Kentucky, both Pennsylvania locations, Wisconsin and Maine was high. The analysis showed the R squared value to be .87. Including all the data significantly reduced the R squared value. An analysis was made of fifty-nine fern species where three or more locations reported emergence. This reduced the difference in sample size, but the variance was similar. A regression analysis of this selected data showed that sample size was not a factor for differences when all locations were considered. It did show a similar strong correlation when only the five eastern locations that did not report weather events or strong cultural differences were used.

The ANOVA showed the following emergence time sequence for the six ferns, mentioned in the discussion of the fern emergence sequence, using *M. struthiopteris* as the zero point. Emergence time differences from the above listing for eastern ferns is compared to the results of the analysis. All numbers are days later than *M. struthiopteris*.

		ANOVA	Average Emergence List
<i>Matteuccia</i>	<i>struthiopteris</i>	0	0
<i>Polystichum</i>	<i>acrostichoides</i>	4.4	4
<i>Cystopteris</i>	<i>bulbifera</i>	3.8	5
<i>Athyrium</i>	<i>thelypteroides</i>	6.2	6
<i>Dryopteris</i>	<i>goldiana</i>	6.4	9
<i>Dryopteris</i>	<i>marginalis</i>	10.8	11

The ANOVA showed the difference between these ferns was significant at the $F_{crit}=.1$ level. Only data from Kentucky, both Pennsylvania locations, Wisconsin and Maine were used in this analysis due to the need for data on all ferns involved from all locations in the analysis. The total emergence time for these six ferns showed that the Kentucky ferns took twice as long to emerge as the Maine ferns. There was not enough data to justify an assumption of normality and show that this difference was statistically significant. It does show that the difference in emergence time between northern and southern areas may be real and is worth further evaluation.

General Comments and Recommendations Regarding the Study

Ralph C. Archer

The frond emergence study provided information regarding emergence and growth of ferns under various conditions at different geographical locations. Obviously emergence is dependent on spring weather and varies from year to year. The average emergence dates as well as the fern emergence order lists are preliminary and may change with additional data. In order to clarify the questions regarding total emergence time and to add to the information on emergence dates and fern emergence order, it is suggested that the study be continued.

Several things are clear from the past year's data and the analysis.

1. The number of ferns reported from each location can be significantly reduced. It is suggested that only the ferns from the following list of forty-two ferns be reported in the next year. They are the ferns grown and reported by four or more of the current reporting locations. This should reduce the time required to record fern emergence.
2. In order to establish an emergence base line for the various locations and fern species, additional information on cultural conditions is needed in addition to date of emergence. The effect of water during the previous year and exposure to the sun appear to have an important effect on times of emergence. This needs to be clarified and taken into account when evacuating date sequences. It would be beneficial if cultural conditions were reported such as sun exposure and watering practice in addition to weather events such as freezes, spring drought or cold weather lasting more than two or three days after ferns have started emergence.
3. Establishing a valid listing of fern emergence requires a better understanding of what cause's emergence of the same species to vary and by how much. To accomplish this, data for a number of ferns of the same species from several locations in a number of different gardens under various conditions is required. It would be useful for observers to report on all ferns of the same species in their garden.

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General Comments and Recommendations Regarding the Study *continued from page 25*

4. I will be happy to send a report form in the mail to those who wish to participate. For those whose gardens are uniform, the needed information will be very similar to that requested for the past year other than reports for more than one fern of a given species. It would also provide a means for listing ferns by various locations in the individual gardens so that cultural conditions would be easier to describe. If data for sufficient ferns common to a number of locations and conditions is available, an analysis of variance would provide a useful analysis method to evaluate various cultural conditions.

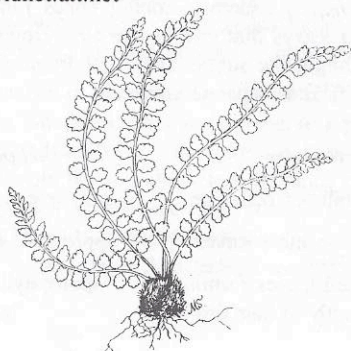
The "Total NO." column is the number of locations that reported data on the fern from all nine locations. The "WA NO." column is the number of locations that reported data on the fern from the two Washington State locations. The "East NO." column is the number of locations that reported data on the fern from the seven eastern locations.

Genus	Species	Avg.			Date
		Total NO.	WA NO.	East NO.	
<i>Polystichum</i>	<i>polyblepharum</i>	6	2	4	04/02
<i>Dryopteris</i>	<i>expansa</i>	5	2	3	04/03
<i>Woodsia</i>	<i>polystichoides</i>	5	2	3	04/03
<i>Dryopteris</i>	<i>clintoniana</i>	4	1	3	04/08
<i>Dryopteris</i>	<i>celsa</i>	5	1	4	04/09
<i>Adiantum</i>	<i>venustum</i>	5	1	4	04/09
<i>Dryopteris</i>	<i>crassirhizoma</i>	4	2	2	04/11
<i>Dryopteris</i>	<i>pycnopteroides</i>	4	1	3	04/13
<i>Matteuccia</i>	<i>struthiopteris</i>	8	2	6	04/13
<i>Polystichum</i>	<i>braunii</i>	6	2	4	04/14
<i>Thelypteris</i>	<i>decursive-pinnata</i>	5	1	4	04/15
<i>Polystichum</i>	<i>setiferum</i>	6	2	4	04/15
<i>Gymnocarpium</i>	<i>dryopteris</i>	4	1	3	04/16
<i>Cyrtomium</i>	<i>macrophyllum</i>	4	2	2	04/16
<i>Blechnum</i>	<i>spicant</i>	4	1	3	04/16
<i>Dryopteris</i>	<i>carthusiana</i>	5	1	4	04/17
<i>Thelypteris</i>	<i>phegopteris</i>	4	0	4	04/18
<i>Cystopteris</i>	<i>bulbifera</i>	8	2	6	04/18
<i>Dryopteris</i>	<i>remota</i>	4	1	3	04/18
<i>Dryopteris</i>	<i>x australis</i>	4	1	3	04/18
<i>Adiantum</i>	<i>aleuticum</i>	6	2	4	04/19

<i>Athyrium</i>	<i>filix-femina</i>	4	0	4	04/19
<i>Arachniodes</i>	<i>standishii</i>	4	1	3	04/19
<i>Polystichum</i>	<i>acrostichoides</i>	7	1	6	04/19
<i>Dryopteris</i>	<i>intermedia</i>	5	0	5	04/20
<i>Phyllitis</i>	<i>scolopendrium</i>	4	2	2	04/20
<i>Dryopteris</i>	<i>complexa</i>	5	1	4	04/20
<i>Athyrium</i>	<i>otophorum</i>	6	2	4	04/21
<i>Dryopteris</i>	<i>erythrosora</i>	5	2	3	04/21
<i>Onoclea</i>	<i>sensibilis</i>	5	1	4	04/21
<i>Dryopteris</i>	<i>filix-mas</i>	6	1	5	04/22
<i>Athyrium</i>	<i>angustum</i>	5	0	5	04/23
<i>Osmunda</i>	<i>cinnamomea</i>	6	1	5	04/23
<i>Adiantum</i>	<i>pedatum</i>	7	1	6	04/24
<i>Osmunda</i>	<i>regalis</i>	5	1	4	04/25
<i>Athyrium</i>	<i>thelypteroides</i>	6	0	6	04/25
<i>Dryopteris</i>	<i>championii</i>	6	2	4	04/26
<i>Dryopteris</i>	<i>pseudo-filix-mas</i>	4	2	2	04/27
<i>Dryopteris</i>	<i>goldiana</i>	7	0	7	04/27
<i>Dryopteris</i>	<i>marginalis</i>	6	0	6	04/29
<i>Dryopteris</i>	<i>cristata</i>	4	0	4	05/04
<i>Dryopteris</i>	<i>sieboldii</i>	4	2	2	05/24

If you have comment or wish further information, feel free to contact me.

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Lycopodium lagopus – The “One-Cone Club- Moss” – New in West Virginia

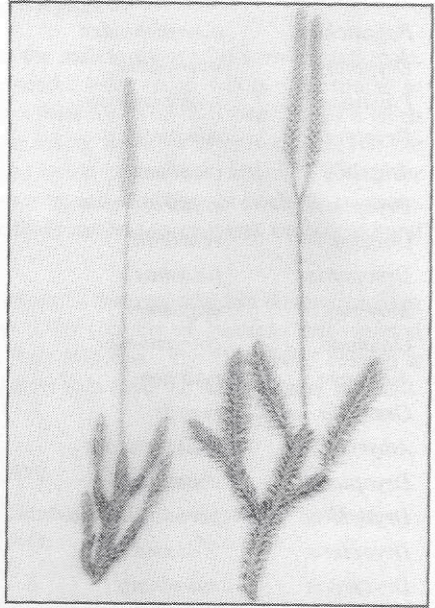
Joan Eiger Gottlieb – Pittsburgh, PA

It is easy to get depressed about disappearing habitats and declining biodiversity, but I can offer a small ray of optimism in reporting my second new fern find of the year. In the spring 2001 HFF Quarterly I wrote about a disjunct, new location for male fern (*Dryopteris filix-mas*) in western Pennsylvania. Now I offer the same for one-cone club-moss (*Lycopodium lagopus*) in Tucker County, West Virginia.

The highlands and bogs of West Virginia’s “Allegheny Front” - the edge of the newer (westernmost) Appalachians – attain an elevation of 1482m (4,862’) on Spruce Knob, with ten

peaks in the area that are over 1430m (4,692’). The state is thus a southern outpost for many northern, even boreal species, e.g. larch (*Larix laricina*) that are relicts of the last glacial retreat. *Lycopodium lagopus*, also more northern in its reported distribution, is here as well. A small, healthy population of this rare fern ally was found in mid-July, 2001 in Blackwater Falls State Park near the town of Davis, in the north-eastern part of West Virginia. It grows on the flat top of an abandoned coal strip mine, at an elevation of about 1070m (3,510’).

L. lagopus is a sister species of the familiar, widespread, “common club-moss” *Lycopodium clavatum*. The two plants are often found in the same locations within their boreal distribution, but remain distinct despite sharing many characters, including general growth and branching patterns, strobili (“cones”) that are held high on slender stalks (peduncles), and leaves that end in hair-tips. However, the comparisons and illustrations below highlight the subtle, albeit important distinctions that make them easy to identify in the field as separate taxa.



Lycopodium lagopus *Lycopodium clavatum*
Single, upright, fertile branch of each

Lycopodium clavatum

two or more strobili per peduncle
spreading, long (4-6 mm) leaves
sporophylls (modified leaves forming
“cone”) end abruptly in hair tips

Lycopodium lagopus

only one strobilus per peduncle
appressed, short (3-5mm) leaves
sporophylls tapered gradually
to hair tips

No hybrids are known between these two lycopods despite their close relationship and their frequent cohabitation. In the highlands of West Virginia *L. clavatum* is one of the commonest club-mosses, growing under a wide variety of environmental conditions from dry, sunny, sandy or gravelly slopes to moist, shady forest soils, with large populations in the immediate area of the *L. lagopus* colony. In fact, no well-documented hybrids are known between any other species within the genus *Lycopodium*, although promiscuity prevails, and many hybrids are known, within the related genera *Huperzia*, *Lycopodiella*, and *Diphasiastrum*.

Lycopodium lagopus has been reported from Alaska to Newfoundland, Greenland, Scandinavia, and northern Eurasia. In the contiguous 48 states it occurs in Maine, Michigan, Minnesota, Wisconsin, New York, New Hampshire, Vermont, and now West Virginia. Michigan would be the closest recorded neighbor of the West Virginia population, about 650km (400 miles) distant.

Blackwater Falls State Park was established in 1937 after mining operations ceased within its borders. Coal mining continues in areas immediately adjacent to the park, creating new pits, highwalls, spoil banks, and drainage patterns. It is difficult to predict the long term impacts of these activities on the fragile ecosystems of the park, but it is good to remember that many opportunistic species, including fern allies, frequently colonize disturbed habitats, and that human activities, along with natural changes, often open up non-competitive areas in which they can spread and thrive. Within the protected park a remarkable assemblage of plants is currently reclaiming the mined area that is now part of the Dobbin House cross country ski system.

In cool ravines there is *Tsuga canadensis*. On the open, sunny, coal-strewn areas *Picea rubens*, *Acer rubrum*, *Rhododendron maximum*, *Kalmia latifolia*, and *Vaccinium* species dominate the woody flora. Three orchids are prominent among the herbaceous plants – *Cypripedium acaule*, *Platanthera clavellata*, and *Spiranthes cernua*. Many grass, sedge, and *Sphagnum* species grow in the boggy soils near two drainage ponds at the intersection of the Dobbin House and Woodcock ski trails, not far from the *L. lagopus*. A pot pourri of lycopods has also reclaimed this disturbed, acidic habitat, including *Lycopodiella inundata* on moist soil near the ponds. *Diphasiastrum digitatum*, *D. tristachyum*, and their hybrid *D. xhabereri* are abundant on exposed tailings. *Lycopodium obscurum*, *L. dendroideum*, and *L. hickeyi* are denizens of the wooded edges. And, as already noted, *L. clavatum* grows throughout the area. Several *Dryopteris* species and *Pteridium aquilinum* (with some rare, fertile colonies) are also common. *Asplenium montanum* thrives on granite rocks on the nearby Pase Trail and *Vittaria appalachiana* (Appalachian gametophyte) is spreading under a sandstone ledge near the prominent waterfall for which the 683 hectare (1688 acre) park is named.

The *L. lagopus* colony consists of about a dozen long rhizomes, three occurring on exposed soil adjacent to the Woodcock Trail and the rest in a protected area about 6m into low spruce woods beyond the trail. The colony is probably clonal and is quite fertile, nearly all upright shoots bearing characteristic single strobili. There remains the question of the origin of this colony here. It is possible that the species was more widespread in the state's highlands during the Pleistocene, and the Davis population is a surviving remnant. If it came from Appalachian mountain spores, other colonies

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Lycopodium lagopus continued from page 29

must have lived in the area as recently as the second half of the 20th century to “seed” it when the coal mining ceased. Perhaps some of these other colonies still exist and remain to be discovered. In any event, *L. lagopus* is not the only disjunct, rare pteridophyte in West Virginia. The western species *Asplenium septentrionale* has been found in Hardy and Monroe counties, as has its hybrid with *A. trichomanes* (*A. xalaternifolium*). There truly is something wild and wonderful about this mountain state.

Note of correction:

In Appendix 1 of the article, “The Fern Trail at Mohonk Mountain House,” by Catharine W. Guiles, published in the Fall 2001 issue of the Hardy Fern Foundation Quarterly (pp. 87-92), the following names should have been printed in bold-faced type: Northern maidenhair, Silvery glade fern, Lady fern, and Hayscented fern. The author would appreciate it if readers would indicate these corrections in their copies.

Montane Ecuador – Ferns and Flowers for All (Part I)

Joan Eiger Gottlieb

Those of us who live in temperate regions are quickly saturated by the biodiversity overload of the New World (Neo-) tropics. Ecuador, the smallest of the Andean countries (about the size of Colorado), has a larger flora than all of North America north of Mexico, with roughly 1400 pteridophyte and 16,000 angiosperm species. Furthermore, species new to the country, even some new to science, are discovered every time botanists gather there to work. During ten days in late August, 2001 our group saw 240+ species of ferns and fern allies plus a cross section of the flowering plants. And all of those were within a 30-40 km (19-25 mi) radius of the capital Quito (pop. ca. 1 million).

The city, which is named for its indigenous Quito people, has a colonial-era “old town” that is a UNESCO-designated “cultural heritage site”. It is located 22km (13.7 mi) south of the equator, in a central Andean highlands valley at 2850m (9300’), an elevation that induces altitude sickness, but gives the city a cool, spring-like climate. From the seventh floor restaurant of the historic Hotel Quito we had eye-popping views of the city and its surrounding volcanoes. We also saw evidence of the “slash and burn” practices whereby the hills were cleared for growing and grazing, creating serious erosion and air pollution. During our travels we smelled choking fumes from uncontrolled, diesel-powered vehicles, and we got painfully close to the abject poverty of all too many people in this third world country (the second poorest in South America).

Our “Montane Ecuador” trip in August, 2001 was sponsored by the Jepson Herbarium at the University of California (U.C.). Dr. Alan Smith (U.C., Berkeley), who led a similar-sized group to Costa Rica three years ago (see HFF Quarterly, Summer,

1999), once again provided the fern expertise, with the extra dividend in Ecuador of seed plant specialist Dr. Grady Webster (U.C., Davis). Bob Nansen, a Betchart Expeditions coordinator and biologist, rounded out our leadership team.

August 21 – Our group of 15 set out in a single van for Pululahua Crater, about 20 km (12.4mi) north of Quito. Traffic and poor roads (dirt tracks everywhere except in the cities or on the north-south Pan-American Highway) made even modest trips seem like major journeys. A stop at the Equatorial Monument provided an irresistible photo-op with our two feet straddling the putative hemispheric divide. Pululahua Crater is a deep depression, several kilometers wide, flanked by metamorphosed volcanic rock. On its rim we found 10 ferns, including, *Niphidium albopunctatissimum*, a genus distinguished by single rows of sori “militaristically”-aligned between sharply angled lateral veins – an image evoked by Alan Smith that was not easily forgotten. Among the interesting angiosperms was the magenta-flowered *Barnadesia parviflora*, considered the most primitive genus within the Asteraceae (Compositae). Typical of elevations below 1500m (5000’) in Ecuador, the crater and its rim were developed for farming, ranching, and limited building. The plants we found were but harbingers of the vast botanical riches that lay ahead in nature reserves. El Restaurante perched on the rim served a multi-course lunch that started, as did all our meals in Ecuador, with a delicious local soup.

After lunch we headed west, about 30km (19 mi) to the Bosque Protector Maquipucuna (Ma-kee-poo-koo-na), a private biological reserve on the western slopes of the Andes. The paved road ended near the reserve’s checkpoint entrance, where guards and district police did their best to enforce a lumbering ban. Group members scrambled along the dusty roadbank to pick up 19 ferns, 15 of which were not seen at our previous stop. Five different *Elaphoglossum* species were collected, along with curly-dry *Cheilanthes myriophylla*, the only time we saw a member of this xeric genus. Angiosperms included *Epidendrum* and *Oncidium* orchids and two small trees: *Freziera canescens* (Theaceae), whose leaves had striking bronze hairs, and *Roupala obovata* (Proteaceae). It was obvious we were going to become acquainted with some plant families generally unfamiliar to northerners. A long, bumpy ride into the reserve ended at the Umachaca Lodge at 1250m (4100’), named for the fast-flowing river that runs past its entrance. We were in the Cerro Sosa at the base of fairly pristine montane cloud forest - ours to explore for the next four days. The lodge, completed in 1995, and built open-air style mainly of local bamboo, offered comfortable rooms, excellent food, and rather impressive, but benign roaches. Before sunset, a short km (0.6 mi) walk on the self-guiding nature trail revealed at least 29 pteridophytes (27 new for the trip), including *Adiantum pulverulentum*, a new listing for the reserve. This beautiful maidenhair had but one sorus per pinna-segment. The spiny palm *Aiphanes erinacea* (Arecaceae) was a distinctive tree species along the trail.

Our hosts, Rodrigo Ontaneda and Rebecca Justicia (founders of the Maquipucuna Foundation in 1988), along with an expert cadre of assistants, workers, and students, supervise all activities at the reserve. “Maquipucuna” is a Quicha Indian word meaning “Gentle Hand” or “Green Thumb”. The Foundation owns 4452 hectares (11,000 acres) here – one of the few remaining examples of unspoiled, tropical cloud forest (like Monteverde in Costa Rica) in the Neotropics. Its mission is: 1) to contribute to

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biodiversity conservation and responsible use of natural resources, 2) to work toward a habitat-continuous Choco-Andean Rainforest Corridor all the way to the Pacific coast, and 3) to promote the sustainable development of Maquipucuna, the nucleus of that corridor, through eco-tourism and other projects involving local peoples. In the nearby Marianitas settlement, for example, the Foundation has used grant money and contributions to build an impressive, bamboo-framed Community Center which will also house training and administrative facilities. The building serves as an architectural model for the villagers on the use of renewable, local materials. The Maqui Reserve buys eggs, milk and other supplies from the settlement, employs many of its residents, and does environmental education for children, thus bolstering the village economy and building support for a conservation ethic. The Foundation has a website – www.Maqui.org – for more information on ways to support their mission; see also www.arches.uga.edu/~maqui.

During our stay at Maquipucuna there was a moving ceremony to honor Grady Webster for his decade-long devotion to the discovery and documentation of the botanical riches within the reserve. Grady's book (in collaboration with Robert Rhode), **Plant Diversity of an Andean Cloud Forest**, Berkeley, UC Press, 2001, contains an excellent analysis of the geology, climate, topography and floristics of Maqui, as well as a checklist of its vascular flora. I am honored to have known Dr. Webster since he was a post-doctoral fellow at Harvard U. back in the mid-50's.

August 22 - A morning field outing took us through lower montane rain forest (1500-2000m; 4920-6560') in the Cerro Sosa (Montaños de Maquipucuna) via the Sendero Tranquilo (Gentle Trail) behind the lodge. We saw the dark-scaled tree fern *Cyathea caracasana*, its growing tip overtopped and protected by young croziers (as is characteristic of the genus), and large, egg-shaped leaf scars on its trunk. By contrast, a second tree fern here, *Alsophila erinacea*, had an apex projecting well above the fronds, sharp, black spines, and conspicuous buds on the trunk. Both genera are in the Cyathaceae, a large, pantropical family. Lots of epiphytes adorned the trees, including the ubiquitous *Elaphoglossum* (at least three species, including the Lilliputian, fertile *E. pygmaeum*). All elaphs are dimorphic (separate fertile and vegetative fronds) and have acrostichoid sporangia (fertile fronds completely covered with sporangia in no particular pattern). We saw 30+ species of *Elaphoglossum* during the trip, only a fraction of those that are known, with 50 or so (according to Dr. Smith) yet to be described from Ecuador. The Creator certainly loved elaphs – as well as beetles! Polypodiaceous epiphytes in the lower montane forest included *Polypodium fraxinifolium*, *Pecluma* (whose fronds curl inward when dry), two *Microgramma* species, and *Campyloneurum chlorolepis*, new to the reserve, with two rows of sori between the lateral leaf veins (thus distinguishing it from *Niphidium*). Grammitids were represented by *Lellingeria suspensa*. Most exciting (to me) among the epiphytes was the primitive club-“moss” *Huperzia linifolia*, with its lax arrangement of long, needle-like leaves.

On the ground, we began to see what was to become a dizzying array of *Thelypteris* and *Diplazium* species. Flowering plants included several species of *Columnea*

(Gesneriaceae), some with bright-red leaf tips to guide pollinating hummingbirds to the relatively pale flowers hidden on the stems. *Siparuna aspera* (Monimiaceae,) a cauliflorous fig with pink, malodorous fruits and *Gasteranthus quitensis* (Gesneriaceae), with velvety, deeply-veined leaves and bright-red flowers, added more color. Occasional openings in the trail provided sharply contrasting views of cleared hillsides planted with pasture grass below 1500m (4,922'), and intact montane rain forest above that. The lower elevations of the montane forest supported a high diversity of ever-green flowering trees that grew straight up to the canopy (about 35m – 115' tall). Tree ferns and palms were part of the mix. The forest was also characterized by many epiphytes, including bryophytes, selaginellas (spike "mosses"), ferns (already noted above), bromeliads, and orchids – a rich and breathtaking flora. Fern finds for the morning foray: 51 species; 33 new for the trip, and 4 not previously listed for Maquipucuna.

The afternoon was spent hiking a riparian zone along the Umachaca River. *Diplazium chimborazense*, an Ecuador endemic, is recognized by its tan scales with black margins, and, of course, the back-to-back, linear sori characteristic of this large genus. It was one of at least six different *Diplazium* species along the river trail, several of which had a bud or developing plantlet near the tip of the rachis. *Diplazium divisissimum* was a striking beauty with deep green, frilly, three-dimensional fronds. Three *Thelypteris* species were found, including *T. clivalis*, new to the reserve. Epiphytic filmy ferns, with their translucent, one-cell thick fronds, were well represented. We found *Trichomanes collariatum* and *T. radicans*, along with *Hymenophyllum plumieri* and *H. fucooides*. Other tree-dwellers included the hemi-epiphytes *Polybotrya polybotryoides* and *Blechnum ensiforme*, both sporting large, dimorphic, fertile and vegetative fronds as they grew up tree trunks from origins on the ground. Among the flowering plants *Ardisia websteri* (Myrsinaceae), a tiny tree with reddish fruits, was discovered only recently and named for Grady Webster. *Heliconia* sp. (Heliconiaceae) flaunted the colorful bracts of its lobster-claw inflorescence near the riverbank, where we paused to refresh ourselves before retracing our steps to the lodge. The afternoon had rewarded us with 55 fern species, 37 new for the trip, and 5 new for the Maqui Reserve.

August 23– This was our day to conquer the upper montane cloud forest of the Cerro Sosa (2400-2800m or 7,870-9190') via the Sendero Principal (Main Trail). We attained 1800m (5900'), an elevation high enough to see the magnolia that grows here – *Talauma gilbertoi*. Had we gone a bit higher we might also have seen dogwood – *Cornus peruviana*. These trees thrive on the equator, but only at elevations where the climate suits their temperate adaptations. The trail started in pastureland abandoned 8 years ago, revealing successional plants, e.g. the composites *Baccharis*, *Vernonia*, and *Mikania*. *Begonia*, *Columnea*, *Clematis*, *Desmodium*, and *Dioscorea* species also thrived in the mix. The scarlet, sickle-shaped flowers of *Centropogon* (hummingbird pollinated) and the lush blooms of *Sobralia* orchids flashed at us from trailside. Dr. Webster said that the yellow-flowered *Solanum juglandifolium* we saw was the closest wild relative of the tomato eaten in salads. Balsa trees (*Ochroma pyramidale* - Bombacaceae) spread their huge leaves in the transitional forest, and leaf cutter ants criss-crossed the trail.

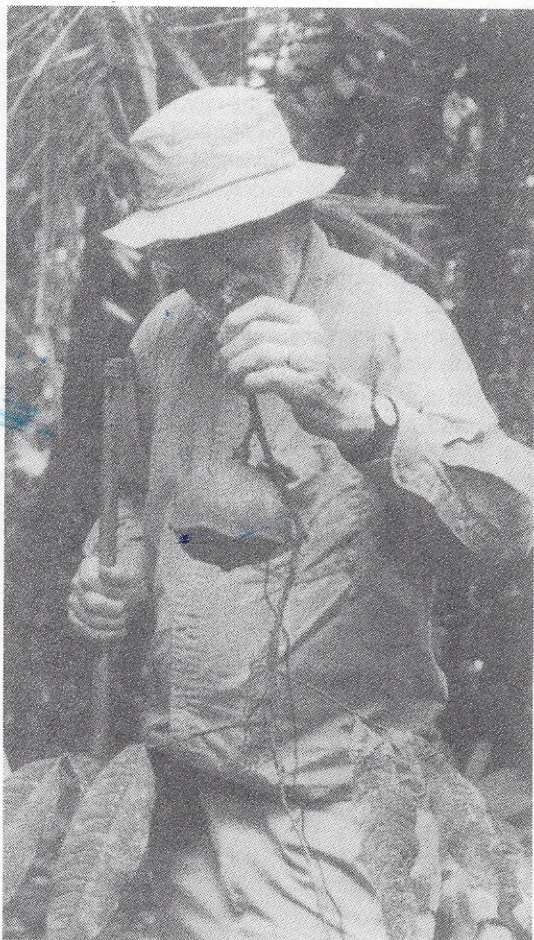
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Dr. Alan Smith with *Thelypteris decussata* frond *daguense* and *Terpsichore senilis*. Several specimens of *Cyathea halonata*, a recently described species of tree fern, displayed abundant, orange-yellow scales. Blue morpho butterflies charmed us as they fluttered near the trail. It was an incredibly rich adventure to treasure forever. We had uncovered 52 ferns on this day, 30 for the first time on our trip, and 6 new for Maqui.

Pteridophytes at these lower elevations included *Thelypteris cheilanthoides*, with pinnule edges inwardly rolled, and the gleichenaceous fern *Diplopterygium bancroftii*, with huge, dichotomously (equally) forking fronds. As we climbed higher, open vistas allowed us to see small farms and mountain ranges receding north toward Colombia. At the site of the *Talauma* one of our Ecuadoran guides shimmied up the prized tree to retrieve a branch with leaves that had the grooved petiole bases characteristic of magnolias. While reflecting on this find, we enjoyed the lunch that our indefatigable guides had carried there for us. The fruit of a native nutmeg tree, *Otoba gordoniiifolia* (Myristicaceae) was split to reveal the golden aril surrounding its seed. In the commercial species *O. fragrans* the aril is red and yields the spice mace. On the way down the trail we noticed large, blooming plants of *Anthurium striatipes* (Araceae) with white spathes embracing large spadixes. Ferns putatively new to Maqui, along the trail included *Danaea moritziana*, *Thelypteris patens*, *Dennstaedtia vagans*, *Polybotrya* sp., and the epiphytes *Micropolypodium*

August 24 - our second all-day outing in the Maqui. Reserve, this time going from 1525m (5000') to 1920m (6300') in the upper montane forest on Lodge Mountain. We were hauled several kilometers in the open back of a pickup truck over a punishing, rutted, dirt track to the beginning of the trail. Gratefully on foot once more, Dr. Smith soon spied nearly half of the 11 species of *Thelypteris* we would find during the day. We reveled in the red hairs and abruptly reduced basal pinnae ("mere nubbins") of *T. rudis*, the hairy fronds of *T. amphioxipteris* tapered at both ends, the very scaly Ecuadoran endemic *T. paleacea*, and the broad-fronded *T. clivalis*. *Thelypteris germaniana*, a species found higher on the trail, may be a new discovery for the country. *Tectaria incisa* was spotted on several occasions, but is not on the list for the reserve. It had the basicopically developed lower pinnae of most members of the genus, but featured distinctively netted, anastomosing veins and large, reniform indusia.



There are three New World genera of tree ferns – *Alsophila*, *Cyathea*, and *Sphaeropteris*. We had seen them on other trails, but they were particularly impressive here, especially the very large *Sphaeropteris quindiuensis*, with abundantly scaly petiole bases. Its leathery, abaxially (lower surface) glaucous fronds were 5m long, looking like our temperate *Dryopteris marginalis* on serious steroids. Also new for the trip was a beautiful *Cyathea* species with soft, hairy, oppositely pinnate fronds and aerating white areas (analogous to lenticels) on the trunk. Another *Cyathea* (new for Maqui) had what appeared to be tiny sprouts all over its crown. According to Alan Smith, these were "aphlebiae"- abortive and skeletonized basal pinnae!

Dr. Grady Webster with
brazil-nut, *Eschweilera*

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Montane Ecuador *continued from page 35*

One of the largest filmies, *Trichomanes radicans*, grew epiphytically in the forest, revealing unusual 3-4mm thick, rope-like rhizomes.

At the top of the mountain we were grateful for the sight of the rustic Santa Lucia Lodge, reachable only by the long, steep trail we had just conquered. Our lunch was waiting to be enjoyed at tables inside the building or on benches outside that had great views of the Maquipucuna Ridge and the Cerro Campana. On the way back Dr. Webster showed us specimens of *Bomarea pardina* (Alstroemeriaceae), a vine that had showy, rose-pink flowers. Blooming specimens of *Xanthosoma undipes* (Araceae) were quite literally trees – the largest aroids in Ecuador. Local people make a medicine for sore muscles from parts of the plant, one of many herbal remedies made from rain forest species. We found *Eschweilera integrifolia* (Lecythidaceae), a brazil nut that has the hardest known fruits. Grady Webster dangled one of these amazing, rock-hard capsules while our cameras flashed. Alan Smith provided a photogenic moment when he held up a 2+m (7') long, spiny-based frond of *Thelypteris decussata*, another new find for Maqui. *Campyloneurum serpentinum*, also new for the area, had green rhizomes and calcareous hydathodes on its adaxial (upper) leaf surfaces. Three species of the dennstaedtioid fern *Hypolepis* were dubbed “spiny, sticky, and hairy.” At least two were new for the area. The sticky one had glandular hairs reminiscent of those on the North American *Dryopteris intermedia*.

A side trail (Sendero Segundo) led some members of the group to a sunny swamp where a small, rose-colored orchid grew along with *Polypodium funckii*, another new find for Maqui. The fern scampered over hummocks with long, thin, green rhizomes and well-spaced, small fronds. A spectacular, white-flowered amaryllis, *Eucharis moorii*, new to Maqui, was also found there. Totals logged for the day's productive adventure: 77 fern species, 24 of them seen for the first time on the trip, 7 of them new for the Maqui Reserve, and 1 new for Ecuador. It would have been easy to surrender to satiety that night, but there was specimen processing to do. In addition to the nightly plant pressing, Dr. Smith clipped 1-2cm pieces of fresh, young fronds for fast drying in silica gel. DNA analysis of these samples should help resolve relationships in taxa like *Polypodium*. It is likely that this is a polyphyletic (multiple evolutionary origins) taxon.

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