

# **Flora of the Carolinas, Virginia, and Georgia**

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by

**Alan S. Weakley**

University of North Carolina Herbarium  
North Carolina Botanical Garden  
University of North Carolina, Chapel Hill

Mail: Campus Box 3280,  
418A Coker Hall,  
University of North Carolina,  
Chapel Hill, NC 27599-3280

Telephone: 919.962.0578  
E-mail: [weakley@unc.edu](mailto:weakley@unc.edu)  
website: [www.herbarium.unc.edu](http://www.herbarium.unc.edu)

# Flora of the Carolinas, Virginia, and Georgia -- Current Status

The publication nearly forty years ago of the *Manual of the Vascular Flora of the Carolinas*, by A.E. Radford, H.E. Ahles, and C.R. Bell, was a landmark. It was the result of an extraordinary effort to document the flora of the Carolinas, and after its publication, the existence of "the *Manual*" helped generate an interest in and further studies of the flora of the region. Since its publication in 1968, many additional species have been documented as part of the region's flora, additional alien species have become naturalized, new species have been described, monographs have given new taxonomic insights into groups, nomenclature accepted in 1968 has been found to be invalid, new and more reliable keys have been developed, and systematic treatments have (one hopes) generally advanced. Increasingly, identification of the flora of our area (and other states of the Southeast and Mid-Atlantic) by academic researchers, agency personnel, and advanced amateurs is hampered by the lack of an up-to-date flora. Without such a flora, identification must involve reference to herbaria and thousands of monographs, papers, and other floras -- resources not readily available to many people who need them. The absence in the region of a single-source modern standard for the systematic treatment, nomenclature, and identification of the flora compromises scientific studies, ecological research, and agency inventory, management, and monitoring of ecosystem and species biodiversity.

**Current Status.** Since 1990, I (and collaborators) have been working on a new treatment of the flora of the Carolinas, Virginia, and Georgia, to fill the need for a new standard reference to aid in the consistent identification of the flora of the region. While building on the tradition of the *Manual*, the *Flora* is not a revision or second edition; it takes some different approaches, has features the *Manual* lacks, lacks features the *Manual* has, and has an expanded geographic scope. Initial draft treatments are now complete for about 90% of families, genera, and species, based on extensive research in the field, library, and herbarium. Prior to publication, additional herbarium research and annotation (based primarily at the UNC Herbarium, but involving other collections with regional coverage) and field testing will be completed. This work will of course result in changes to draft treatments.

The *Flora* will include treatment of all species in **Virginia, North Carolina, South Carolina, and Georgia** (the primary flora area), with less detailed treatment of species occurring east of the Mississippi River and south of the Ohio River and Mason-Dixon line, excluding Florida (the secondary flora area of **Alabama, Tennessee, Kentucky, West Virginia, District of Columbia, Maryland, and Delaware**). A selection of taxa occurring in a tertiary area including southern **Pennsylvania**, southern **New Jersey**, **Mississippi**, the Florida Parishes of **Louisiana** (those east of the Mississippi River), and northern **Florida** (especially the Panhandle and counties adjacent to Georgia) has also been included; this selection emphasizes native taxa and species believed to be potentially present in the primary or secondary areas. Approximately 5600 species and infraspecific taxa are recognized for the primary flora area (Carolinas and Virginia), with an additional 1000 taxa from the secondary flora area. **Approximately 6600 taxa will be keyed and treated.** Originally, Georgia was part of the secondary flora area, but has been added to the primary area. The treatments are being revised gradually to reflect this change, and some process "messiness" will be apparent to the user.

Publication of the first edition is projected to occur in several years, and to be intermediate in format and content between a "guide" (such as Wofford, Clewell, or Wunderlin) and a full "manual" (such as Radford, Ahles, & Bell, Fernald, or Gleason & Cronquist). For instance, full descriptions of each genus and species will not be included in the first edition, but detailed discussion of taxonomy, habitats, and rarity, comparison to unrelated but similar species, extensive bibliography (providing access to systematic, ecological, and population biology literature), and illustrations will be included. A "county dot map atlas" for the flora area is planned (and initial steps are underway), but will be issued as a separate publication at a later date.

**Current review copies are available at any time from the author** (over 1000 have already been distributed). These are being distributed in order to improve the quality of the formally published edition, by generating substantial review and comment prior to publication by a wide variety of users. Copies are provided at cost of xerox reproduction. The *Flora* can also be downloaded in pdf files from the website of the University of North Carolina Herbarium ([www.herbarium.unc.edu](http://www.herbarium.unc.edu)).

## Features

**Taxonomic treatment.** Taxonomic treatments generally follow recent monographic and revisionary work, but an effort is made to provide a certain rough consistency of "splitting" vs. "lumping" across different taxonomic groups. As is generally true in recent treatments, generic and family concepts are often narrower than those used in the "RAB Manual", based on new evidence, including (but not limited to) cladistic methods applied to morphologic and molecular data. Ironically, these results have often resulted in a validation of earlier, narrower generic (and familial) concepts espoused by Small, Rydberg, and others. Varieties are less frequently recognized than by Fernald, though a considerable number of species and infraspecific taxa "lumped" by RAB are recognized (generally following more recent monographic or revisionary work). Some taxa not formally recognized are discussed and characters for their recognition provided.

**Detailed keys.** Keys are subjected to rigorous testing in the field and herbarium, by hundreds of users. To the degree feasible, keys are structured to emphasize characters that are readily observable and available for long parts of the year, such as vegetative characters (of course, this is not possible for all groups). Multiple characters are provided. Terminology strives to avoid abstruse technical terms which do not significantly add meaning (for some genera, an introduction to morphological characters and terms used is provided as "Identification notes" preceding the key). Geographic distributions and habitats are sometimes included in the keys as pragmatic, useful, secondary "characters," but are placed in brackets to indicate that they are not "true" characters. The keys include all species from the primary flora area (North Carolina, South Carolina, and Virginia), as well as all species occurring in a broader secondary area. The inclusion in the keys of taxa from the broader, secondary area will facilitate the discovery of range extensions, as well as extending the usefulness of the *Flora* to a broader geographic area. In some cases, several alternate keys are provided. The primary emphasis of the keys is pragmatism -- effective and efficient identification. For this reason, a key to a genus sometimes includes closely similar taxa not in the genus that may be mistaken for it. Another example is that the "family key" to ferns and fern allies is actually a key to genera, allowing an emphasis in the key on readily observable characteristics, rather than

the technical characters often needed to distinguish fern families. Keys are based on herbarium specimens, though reference is made when live characters may differ from those of pressed specimens. Some keys have been adapted from literature cited; where the adaptation is particularly close, credit is given to the source by specific citation. All keys should be regarded as "draft"; many will be substantially altered prior to publication, based on additional field and herbarium testing.

**Habitat.** Information is provided about the habitat of the taxon. Especially for more localized, specialized, or rare taxa, the habitat is described in considerable detail. Supplemental habitat information for GA rare species is taken from online information posted by the Georgia Natural Heritage Program.

**Native status.** The native or alien status is stated. If there is a question, that is mentioned or discussed. For aliens, an opinion is given as to whether the taxon is naturalized, persistent, waif, etc. in the primary flora area.

**Flowering/fruiting dates.** Flowering and fruiting dates are provided for the primary flora area, in a format similar to the Manual. These are derived from herbarium specimens viewed by the author (collected from within the Flora area), from field observations by the author (within the Flora area), and from literature cited.

**Distribution of species.** A statement of the rangewide distribution of each taxon treated is provided. This is based on published distribution maps and distribution statements in other floras, amended and improved by additional herbarium specimens and published records (such as the "Noteworthy Collections" section in Castanea). The distribution within the primary area is provided by state and physiographic province.

**Literature.** Nearly all genera have citations to recent, pertinent systematic literature, as well as more limited citations to literature on ecology and population biology. The intent is to provide the user with access into more detailed literature, and to document the literature basis of the treatment followed in the *Flora*. So far, about 1500 references are cited, and more will be added prior to publication.

**Synonymy.** Cited synonymy is provided to regional floras, monographs, revisions, and other significant floristic treatments. This allows comparison of the treatment in the Flora to other treatments, and convenient access to the other treatments. Synonymy is provided comprehensively for the following floras: Radford, Ahles, & Bell (1968); Small (1933); Fernald (1950); Gleason and Cronquist 1st edition (1952); Godfrey & Wooten (1979, 1981); Vascular Flora of the Southeastern States (Cronquist 1980, Isely 1990); Wofford (1989); Gleason and Cronquist 2nd edition (1991); Kartesz (1999); and Flora of North America (1993, 1997, 2000). Also, cited synonymy is provided for some families to other important and influential works, such as Hitchcock & Chase for grasses, Correll for orchids, Luer for orchids, Mackenzie for *Carex*, Wilbur for legumes (1961), etc. Synonymy used in recent monographs and revisions is also cited. All names attributed to the *Flora* area in other floras, monographs, and revisions are accounted for.

**Rarity.** Species monitored as rare, threatened, or endangered by the state agencies of North Carolina, South Carolina, and Virginia, or by the U.S. Fish and Wildlife Service, are so indicated. While the details of rarity status will change, this will still provide the user a preliminary indication that the taxon is one of conservation concern.

**Comments and discussion.** Miscellaneous comments and discussion are provided for many species and genera, including discussion of biogeography, more details on distribution of rare species, additional notes on identification not included in the keys, information of particular interest on species biology and ecology, habitat, uses, discovery in the flora area or a state, etc. These "idiosyncratic comments" (as they have been called) add to the general usefulness and interest of what is intended to be a rigorous, practical, and interesting flora.

## Introduction

The understanding of the flora of the Carolinas, Virginia, and Georgia has progressed substantially since the publication thirty years ago of the landmark *Manual of the Vascular Flora of the Carolinas*, by A.E. Radford, H.E. Ahles, and C.R. Bell. Many additional species have been documented as part of the region's flora, additional alien species have become naturalized, new species have been described, monographs have given new taxonomic insights into groups, nomenclature accepted in 1968 has been found to be invalid, new and more reliable keys have been developed, and systematic treatments have advanced. Increasingly, identification of the flora of our area (and other states of the Southeast and Mid-Atlantic) by academic researchers, agency personnel, and advanced amateurs is hampered by the lack of an up-to-date flora. Without such a flora, identification must involve reference to herbaria and thousands of monographs, papers, and other floras -- resources not readily available to most people who need them. The absence in the region of a modern standard for the systematic treatment, nomenclature, and identification of the flora compromises scientific studies, ecological research, and agency inventory, management, and monitoring of ecosystems and rare species.

I intend this new flora for the Carolinas, Virginia, and Georgia to fulfill part of the need, until a thorough revision of the *Manual* is feasible. The emphasis of the *Flora* is on workable and detailed keys to all taxa, emphasizing vegetative characters where possible (to extend the period of the year in which species can be identified), detailed description of known habitats in the 3-state region, additional characters or hints useful in discrimination from similar species (including species not closely related but superficially similar and therefore confused), reference to the body of recent literature various aspects of the flora of our area, and discussion of abundance, phytogeography, and ecology. Our knowledge of the flora of our region is far poorer than is generally recognized, and past floras have sometimes contributed to this impression, by obscuring taxonomic judgments or "lumping" poorly known taxa. An attempt is here made to draw attention to taxonomic questions or controversies, while at the same time presenting (as best as possible) a useable, current, consensus treatment. In making taxonomic decisions, I have generally relied strongly on recent monographs and revisions and the checklist of Kartesz (1999) (reviewed by hundreds of experts), but have tempered published treatments with field knowledge, examination of herbarium material, and consultation with other botanists in the region. While reluctant to disagree with recent monographs (by authors who have studied the groups in more detail than I have), I have also attempted to impose a somewhat consistent concept of taxonomic categories (family, genus, species, subspecies, and variety), so

as not to have a very uneven treatment, with some genera divided finely and others coarsely.

The geographic scope of the *Flora* is Virginia, North Carolina, South Carolina, and Georgia. The three recent atlases of the Virginia flora (the most recent being Harvill et al., 1992) have done much to elucidate the state's flora, and to encourage a new wave of floristic exploration. The addition of the state of Virginia to the geographical scope covered by Radford, Ahles, & Bell offers a number of advantages. The four-state region is a compact and relatively natural unit; Virginia, with its strong representation of Southern Appalachian and Southeastern Coastal Plain species, has stronger floristic affinities to the Carolinas than to states to its north and west, with which it has often been treated in the past (as in Fernald, Gleason & Cronquist, etc.). The four-state coverage will provide botanists working primarily in one state with a greater regional perspective, and should promote an increased knowledge of each state's flora, by making readily available information on species nearby.

## Taxonomic Philosophy

The concept that floras should be "conservative" (i.e. should take a "lumping" approach) strikes me as dangerous. Horton (1972), for instance, states "manual treatments in general should be conservative, leaving the fine points of distinction among taxa, especially infraspecific ones, to the monographer." Floras become the standard used by the great majority of users in an area, and taxa that are "lumped" are lost to the consciousness of all botanists other than a few specialists. Thus, two parallel taxonomies are established, one in common use and one (based on the best judgments of experts in the groups) not used, except by a few, interested in (and able to) seek out the papers of specialists. Ecological studies, species lists for parks or natural areas, rare species surveys, and assessments of the ecological significance of potential conservation areas are all flawed if not based on the best current information available. Moreover, from the standpoint of information theory and information management, a species list using a "lumped" taxonomy has lost information; if a "split" taxonomy has been used, the information is retained.

Even a casual perusal of the synonymy listed under the species of nearly any substantial genus in our flora will reveal taxa that have been variously treated as species, infraspecific taxa (variety or subspecies), and included within another taxon. Further studies, sometimes based on different techniques, sometimes simply by a different taxonomist with a different taxonomic philosophy, often result in the overturning of a previous taxonomic judgment. The basic categories of our taxonomy still do not have generally accepted, consensus definitions and criteria. With the taxonomy of our area still in such flux, I am inclined to provisionally accept some infraspecific taxa (or at least mention their alleged characters in the discussion under a species) so that they are not "lost in the shuffle."

The problem of the infraspecific categories variety and subspecies is a vexing one. A recent study of current practice in the use of various infraspecific categories showed that the usage of variety and subspecies was profoundly muddled, with regional traditions as important as taxonomic philosophy in determining usage (Hamilton & Reichard 1992). Anderson, Crum, & Buck (1990), in a recent checklist of North American mosses, concluded "we have been unwilling to list both subspecies and varieties because the differences between them are not clear to us. As far as we can judge, a subspecies and a variety are the same thing. The varietal designation has long been used in botany, more specifically in bryology, and we see no particular gain, at least at this stage of our knowledge, in attempting to erect more than the single infraspecific category, variety". Holmgren (1994) has also presented a strong argument for use of the varietal rank. The International Code of Botanical Nomenclature provides a strong basis for the use of "variety" as the primary taxonomic level below species, and "subspecies" only when an additional intervening level is desired. "4.1. The secondary ranks of taxa in descending sequence are tribe (tribus) between family and genus, section (sectio) and series (series) between genus and species, and variety (varietas) and form (forma) below species. 4.2. If a greater number of ranks of taxa is desired, the terms for these are made by adding the prefix "sub-" to the terms denoting the principal or secondary ranks. A plant may thus be assigned to taxa of the following ranks (in descending sequence): regnum, subregnum, divisio or phylum, subdivisio or subphylum, classis, subclassis, ordo, subordo, familia, subfamilia, tribus, subtribus, genus, subgenus, sectio, subsectio, series, subseries, species, subspecies, varietas, subvarietas, forma, subforma" (Greuter et al. 2000).

While I strongly agree with this sentiment, standardizing all infraspecific taxa recognized in our area to either variety or subspecies would involve hundreds of new combinations; such proliferation of combinations (not based on new knowledge of the taxa) seems undesirable, though such an approach was taken by Dorn (1988) in the considerably smaller flora of Wyoming. For now, I am primarily using variety where choices exist, but accepting subspecies where an equivalent varietal name does not exist. Occasionally (following recent monographers), I have accepted subspecies as an infraspecific category indicating a more distinctive taxon than variety. This is not a happy solution, since it means that the categories of subspecies and variety are not used consistently to indicate a different level of taxonomic distinction. I have been disinclined to use quadrinomials, as, for instance, *Chamaecrista nictitans* (Linnaeus) Moench ssp. *nictitans* var. *aspera* (Muhlenberg ex Elliott) Irwin & Barneby, because they generally strike me as unwieldy, impractical, and unnecessarily confusing, without providing sufficient compensating benefits (our state of knowledge rarely warranting or supporting such finely distinguished classifications of relationships).

In general, the user or reader will find the following general differences in taxonomic treatment, as compared to other floristic treatments of the area, such as Radford, Ahles, & Bell (RAB), Fernald (F), Gleason and Cronquist, 1st and 2nd editions (G, C), Small (S), Godfrey & Wooten (GW), the treatments so far published as part of the vascular flora of the southeastern states (SE), Kartesz (K), Wofford (W), and Harvill et al. (H). Family level taxonomy generally follows Cronquist's recent work (reflected in C and K), with a few groups split more finely; this represents a generally somewhat finer splitting than RAB, F, G, GW, W, and H, substantially coarser than S. Generic level taxonomy has for the last several decades been generally headed towards finer divisions; this treatment reflects that trend, with genera split somewhat more than RAB, F, G, W, and H, about the same as C, GW, K, and SE, and more coarsely than S. It is interesting to note, though, that our generic concepts are now perhaps more than halfway back to Small and Rrydberg! At the species level, the treatment is about equivalent to C, K, and SE, slightly more finely split than F and G, substantially more finely split than RAB, GW, H, and W, and substantially coarser than S. Infraspecific taxa are recognized much more frequently than RAB, H, and W, somewhat more frequently than GW, about the same as C, G, K, SE, and much less frequently than F (probably less than half of Fernaldian varieties are recognized at any level). S did not use varieties (except very exceptionally); many taxa recognized by S as species are here regarded as varieties, or not recognized at all. Overall and on average, substantially more taxa are recognized than are by RAB and H, slightly more than by C, G, GW, W, about the same

as K and SE, and substantially fewer than by F or S.

The *Flora* is being prepared as time allows. Drafts of family and genus treatments are being made available to interested botanists for use and field-testing. Some treatments must be considered tentative until further testing in the field and herbarium can be accomplished. All treatments should be considered as works in progress at this time, likely to change slightly or greatly before publication. For some species, determination of the distributions, habitats, and phenology requires additional herbarium and field work, not yet completed. I welcome suggestions on format and content.

## Progress (as of June 10, 2005)

Working drafts now completed of: 193 families, 1229 genera, 4561 species or infraspecific taxa.  
Estimated totals in 1° and 2° flora area: 234 families, 1343 genera, 6000 species or infraspecific taxa.  
Percentage complete: families (82.9 %), genera (93.6 %), species (79.6 %).

## Contents (as of June 10, 2005)

Genus name in ***bold italics*** = working draft completed  
Family name in **bold** = working draft completed  
Genus or family name in regular type = working draft not yet completed

[in brackets are the number of genera with completed drafts, and the number of species or infraspecific taxa]

### FERNS AND FERN ALLIES

Aspladiaceae: [see Dryopteridaceae, Thelypteridaceae]

**Aspleniaceae** [1: 17]: ***Asplenium*** [17].

**Azollaceae** [1: 2]: ***Azolla*** [2].

**Blechnaceae** [2: 3]: ***Blechnum*** [1], ***Woodwardia*** [2].

**Dennstaedtiaceae** [2: 3]: ***Dennstaedtia*** [1], ***Pteridium*** [2].

**Dryopteridaceae** [12: 30]: ***Arachniodes*** [1], ***Athyrium*** [2], ***Cyrtomium*** [2], ***Cystopteris*** [5], ***Deparia*** [2], ***Diplazium*** [1], ***Dryopteris*** [9], ***Gymnocarpium*** [2], ***Matteuccia*** [1], ***Onoclea*** [1], ***Polystichum*** [1], ***Woodsia*** [3].

**Equisetaceae** [1: 5]: ***Equisetum*** [5].

**Grammitidaceae** [1: 1]: ***Micropolypodium*** [1].

**Hymenophyllaceae** [2: 5]: ***Hymenophyllum*** [2], ***Trichomanes*** [3].

Isoetaceae: Isoetes (in progress).

**Lycopodiaceae** [8: 18]: ***Dendrolycopodium*** [3], ***Diphasiastrum*** [2], ***Huperzia*** [4], ***Lycopodiella*** [4], ***Lycopodium*** [2], ***Palhinhaea*** [1], ***Pseudolycopodiella*** [1], ***Spinulum*** [1].

**Lygodiaceae** [1: 2]: ***Lygodium*** [2].

**Marsileaceae** [2: 3]: ***Marsilea*** [2], ***Pilularia*** [1].

**Ophioglossaceae** [4: 17]: ***Botrychium*** [3], ***Botrypus*** [1], ***Ophioglossum*** [6], ***Sceptridium*** [7].

**Osmundaceae** [1: 4]: ***Osmunda*** [4].

**Polypodiaceae** [3: 5]: ***Phlebodium*** [1], ***Pleopeltis*** [1], ***Polypodium*** [3].

**Psilotaceae** [1: 1]: ***Psilotum*** [1].

**Pteridaceae** [7: 19]: ***Adiantum*** [4], ***Argyrochosma*** [1], ***Astrolepis*** [2], ***Cheilanthes*** [5], ***Cryptogramma*** [1], ***Pellaea*** [4], ***Pteris*** [2]. [and also see Dennstaedtiaceae]

**Salviniaceae** [1: 2]: ***Salvinia*** [2].

**Schizaeaceae** [1: 1]: ***Schizaea*** [1]. [and also see Lygodiaceae]

**Selaginellaceae** [1: 8]: ***Selaginella*** [8].

**Thelypteridaceae** [3: 10]: ***Macrothelypteris*** [1], ***Phegopteris*** [2], ***Thelypteris*** [7].

**Vittariaceae** [1: 2]: ***Vittaria*** [2].

### GYMNOSPERMS

Cephalotaxaceae [1: 1]: ***Cephalotaxus*** [1].

**Cupressaceae** [6: 9]: ***Chamaecyparis*** [1], ***Cunninghamia*** [1], ***Juniperus*** [3], ***Platycladus*** [1], ***Taxodium*** [2], ***Thuja*** [1].

**Ginkgoaceae** [1: 1]: ***Ginkgo*** [1].

**Pinaceae** [6: 24]: ***Abies*** [2], ***Cedrus*** [1], ***Larix*** [1], ***Picea*** [3], ***Pinus*** [15], ***Tsuga*** [2].

**Taxaceae** [2: 2]: ***Taxus*** [1], ***Torreya*** [1].

Taxodiaceae: [see Cupressaceae]

**Zamiaceae** [1: 1]: ***Zamia*** [1].

### DICOTYLEDONS

**Acanthaceae** [9: 22]: ***Dicliptera*** [1], ***Dyschoriste*** [2], ***Elytraria*** [1], ***Hygrophila*** [2], ***Justicia*** [5], ***Pseuderanthemum*** [1], ***Ruellia*** [8], ***Stenandrium*** [1], ***Yeatesia*** [1].

**Aceraceae**: [see Sapindaceae]

**Actinidiaceae**: Actinidia.

**Adoxaceae** [1: 4]: ***Sambucus*** [4], ***Viburnum*** (in progress).

**Aizoaceae** [3: 5]: ***Sesuvium*** [3], ***Tetragonia*** [1], ***Trianthema*** [1]. [also see Molluginaceae]

**Altingiaceae** [1: 1]: ***Liquidambar*** [1].

**Amaranthaceae** [7: 11]: ***Achyranthes*** [1], ***Alternanthera*** [3], ***Amaranthus*** (in progress), ***Celosia*** [2], ***Froelichia*** [2], ***Gomphrena*** [1], ***Guilleminea*** [1], ***Iresine*** [1].

**Anacardiaceae** [3: 13]: ***Cotinus*** [2], ***Rhus*** [6], ***Toxicodendron*** [5].

**Annonaceae** [1: 7]: ***Asimina*** [7].

**Apiaceae** [45: 101]: ***Aegopodium*** [1], ***Aethusa*** [1], ***Ammi*** [2], ***Ammoselinum*** [2], ***Anethum*** [1], ***Angelica*** [3], ***Anthriscus*** [3],

*Apium* [2], *Bupleurum* [2], *Carum* [1], *Centella* [1], *Chaerophyllum* [4], *Ciclospermum* [1], *Cicuta* [4], *Conioselinum* [1], *Conium* [1], *Coriandrum* [1], *Cryptotaenia* [1], *Daucus* [2], *Erigenia* [1], *Eryngium* [10], *Falcaria* [1], *Foeniculum* [1], *Heracleum* [1], *Hydrocotyle* [8], *Ligusticum* [1], *Lilaeopsis* [2], *Osmorhiza* [2], *Oxypolis* [4], *Pastinaca*, *Perideridia* [1], *Petroselinum* [1], *Peucedanum* [1], *Pimpinella* [1], *Polytaenia* [1], *Pseudotaenidia* [1], *Ptilimnium* [6], *Sanicula* [7], *Scandix* [1], *Sium* [1], *Spermolepis* [3], *Taenidia* [1], *Thaspium* [4], *Torilis* [3], *Trepocarpus* [1], *Zizia* [3].

Apocynaceae [11: 49]: *Amsonia* [6], *Angadenia* [1], *Apocynum*, *Asclepias* [25], *Catharanthus* [1], *Cynanchum* [3], *Gonolobus* [1], *Matelea* [7], *Nerium* [1], *Periploca* [1], *Trachelospermum* [1], *Vinca*, [2].

Aquifoliaceae [1: 18]: *Ilex* [18].

Araliaceae [4: 10]: *Aralia* [4], *Eleutherococcus* [1], *Hedera* [3], *Panax* [2].

Aristolochiaceae [5: 17]: *Aristolochia* [1], *Asarum* [3], *Endodeca* [1], *Hexastylis* [10], *Isotrema* [2].

Asclepiadaceae: [see Apocynaceae]

Asteraceae [123: 471]: *Acanthospermum* [3], *Achillea* (in progress), *Acmella* [2], *Ageratina* [5], *Ageratum* [2], *Ambrosia* (in progress), *Ampelaster* [1], *Amphiachyris* [1], *Anaphalis* [1], *Antennaria* [9], *Anthemis* [4], *Arctium* (in progress), *Arnica* [1], *Arnoglossum* [6], *Artemisia* [11], *Aster* (in progress), *Astranthium* [1], *Baccharis* [4], *Balduina* [3], *Balsamita* [1], *Bellis* [1], *Berlandiera* [1], *Bidens* (in progress), *Bigelovia* [2], *Boltonia* [4], *Borrchia* [1], *Brickellia* [2], *Brintonia* [1], *Calyptocarpus* [1], *Carduus* [3], *Carpophorus* [5], *Centaurea* [9], *Chamaemelum* [2], *Chaptalia* [1], *Chondrilla* [1], *Chrysanthemum* [1], *Chrysogonum* [3], *Chrysoma* [1], *Chrysopsis* [5], *Cichorium* [1], *Cirsium* [14], *Cnicus* [1], *Conyza* [4], *Coreopsis* [20], *Cosmos* [2], *Crepis* [4], *Croptilon* [1], *Dendranthema* [1], *Doellingeria* [3], *Dracopis* [1], *Echinacea* [5], *Echnops* [1], *Eclipta* [1], *Elephantopus* [4], *Emilia* [1], *Erechtites* [2], *Erigeron* [10], *Eupatorium* [29], *Eurybia* [16], *Euthamia* [5], *Eutrochium* [5], *Facelis* [1], *Filago* [3], *Fleischmannia* [1], *Gaillardia* [3], *Galinsoga* [2], *Gamochaeta* [8, in progress], *Gnaphalium* [1], *Grindelia* [2], *Guizotia* [1], *Gymnostyles* [1], *Hartwrightia* [1], *Hasteola* [1], *Helenium* [7], *Helianthus* [30], *Heliopsis* [3], *Heterotheca* [3], *Hieracium* [13], *Hymenopappus* [1], *Hypochaeris* [4], *Inula* [1], *Ionactis* [1], *Iva* [6], *Ixeris* [1], *Krigia* [5], *Lactuca* (in progress), *Lapsana* [1], *Leontodon* [2], *Leucanthemum* [2], *Liatris* (in progress), *Lygodesmia* [1], *Madia* [1], *Marshallia* [7], *Matricaria* [2], *Melanthera* [1], *Mikania* [1], *Oclemena* [2], *Oligoneuron* [3], *Onopordum* [1], *Packera* [10], *Palafoxia* [1], *Parthenium* [5], *Petasites* [1], *Picris* [2], *Pityopsis* [8], *Pluchea* [6], *Polymnia* [2], *Prenanthes* [10], *Pseudognaphalium* [5], *Pterocaulon* [1], *Pyrrhopappus* [1], *Ratibida* [2], *Rudbeckia* (in progress), *Rugelia* [1], *Santolina* [1], *Sclerolepis* [1], *Scolymus* [1], *Senecio* [1], *Sericocarpus* [3], *Silphium* (in progress), *Silybum* [1], *Smallanthus* [1], *Solidago* (in progress), *Soliva* [1], *Sonchus* (in progress), *Stokesia* [1], *Symphytotrichum* (in progress), *Tagetes* [3], *Tanacetum* [2], *Taraxacum* (in progress), *Tetragonotheca* [1], *Tragopogon* [3], *Tussilago* [1], *Verbesina* [7], *Vernonia* (in progress), *Xanthium* (in progress), *Youngia* [1], *Zinnia* [2].

Aucubaceae: [see Garryaceae]

Balsaminaceae [1: 3]: *Impatiens* [3].

Bataceae [1: 1]: *Batis* [1].

Begoniaceae [1: 1]: *Begonia* [1].

Berberidaceae [7: 11]: *Berberis* [3], *Caulophyllum* [2], *Diphylleia* [1], *Jeffersonia* [1], *Mahonia* [2], *Nandina* [1], *Podophyllum* [1].

Betulaceae [5: 19]: *Alnus* [6], *Betula* [8], *Carpinus* [2], *Corylus* [2], *Ostrya* [1].

Bignoniaceae [4: 5]: *Bignonia* [1], *Campsis* [1], *Catalpa* [2], *Macfadyena* [1].

Boraginaceae [14: 36]: *Amsinckia* [1], *Anchusa* [1], *Borago* [1], *Buglossoides* [1], *Cynoglossum* [3], *Echium* [2], *Hackelia* [1], *Heliotropium* [5], *Lithospermum* [4], *Mertensia* [1], *Myosotis* [8], *Onosmodium* [5], *Plagiobothrys* [1], *Symphytum* [2].

Brassicaceae [49: 123]: *Alliaria* [1], *Allysum* [1], *Arabidopsis* [2], *Arabis* [10], *Armoracia* [1], *Barbarea* [2], *Berteroa* [1], *Boechera* (in progress), *Brassica* [4], *Braya* [1], *Bunias* [2], *Cakile* [3], *Calepina* [1], *Camelina* [2], *Capsella* [1], *Cardamine* [18], *Chorispora* [1], *Cleome* [2], *Coicya* [1], *Conringia* [1], *Descurainia* [3], *Diplotaxis* [3], *Draba* [6], *Eruca* [1], *Erucastrum* [1], *Erysimum* [3], *Hesperis* [1], *Iberis* [1], *Isatis* [1], *Leavenworthia* [10], *Lepidium* (in progress), *Lobularia* [1], *Lunaria* [1], *Matthiola* [1], *Microthlaspi* [1], *Moricandia* [1], *Nasturtium* [3], *Neobeckia* [1], *Paysonia* [5], *Physaria* [2], *Polanisia* [3], *Raphanus* [2], *Rapistrum* [1], *Rorippa* [7], *Sinapis* [2], *Sibara* [1], *Sisymbrium* [2], *Teesdalia* [1], *Thlaspi* [2], *Turritis* [1], *Warea* [1].

Buddlejaceae: [see Scrophulariaceae].

Buxaceae [2: 3]: *Buxus* [1], *Pachysandra* [2].

Cabombaceae [2: 2]: *Brasenia* [1], *Cabomba* [1].

Cactaceae [1: 6]: *Opuntia* [6].

Caesalpiniaceae: [see Fabaceae].

Callitrichaceae: [see Plantaginaceae].

Calycanthaceae [1: 2]: *Calycanthus* [2].

Calyceraceae [1: 1]: *Acicarpa* [1].

Campanulaceae [5: 10]: *Campanula* [6], *Campanulastrum* [1], *Jasione* [1], *Lobelia* (in progress), *Platycodon* [1], *Triodanis* (in progress), *Wahlenbergia* [1].

Cannabaceae [3: 8]: *Cannabis* [1], *Celtis* [3], *Humulus* [4].

Capparaceae: [see Cleomaceae]

Caprifoliaceae [3: 23]: *Lonicera* [16], *Symphoricarpos* [3], *Triosteum* [4]. [also see Adoxaceae, Diervillaceae, Linnaeaceae]

Caryophyllaceae [24: 81]: *Agrostemma* [1], *Arenaria* [3], *Cerastium* [10], *Dianthus* [3], *Drymaria* [1], *Holosteum* [1], *Honckenya* [1], *Lychnis* [1], *Minuartia* [8], *Moehringia* [1], *Moenchia* [1], *Myosoton* [1], *Paronychia* [11], *Petrorhagia* [1], *Polycarpon* [1], *Sagina* [2], *Saponaria* [1], *Scleranthus* [1], *Silene* [16], *Spergula* [3], *Spergularia* [2], *Stellaria* [9], *Stipulicda* [1], *Vaccaria* [1].

Casuarinaceae [1: 1]: *Casuarina* [1].

Celastraceae [4: 13]: *Celastrus* [2], *Crossopetalum* [1], *Euonymus* [9], *Paxistima* [1].

Celtidaceae: [see Cannabaceae]

Ceratophyllaceae [1: 3]: *Ceratophyllum* [3].

Chenopodiaceae [9: 16]: *Atriplex* [4], *Bassia* [2], *Beta* [1], *Chenopodium* (in progress), *Cycloloma* [1], *Salicornia* [2], *Salsola*

[2], *Sarcocornia* [1], *Spinacia* [1], *Suaeda* [2].

**Chrysobalanaceae** [1: 1]: *Licania* [1].

**Cistaceae** [3: 21]: *Crocantemum* [8], *Hudsonia* [3], *Lechea* [10].

**Cleomaceae** [2: 5]: *Cleome* [2], *Polanisia* [3].

**Clethraceae** [1: 2]: *Clethra* [2].

**Clusiaceae**: [see Hypericaceae]

**Compositae**: [see Asteraceae]

**Convolvulaceae** [7: 28]: *Calystegia* (in progress), *Convolvulus* [1], *Cuscuta* (in progress), *Dichondra* [1], *Evolvulus* [2], *Ipomoea* [16], *Jacquemontia* [1], *Merremia* [1], *Stylisma* [6].

**Cornaceae**: *Cornus* (in progress).

**Crassulaceae** [5: 19]: *Crassula* [2], *Diamorpha* [1], *Hylotelephium* [3], *Rhodiola* [1], *Sedum* [12]. [and also see Penthoraceae]

**Cucurbitaceae** [9: 13]: *Cayaponia* [1], *Citrullus* [1], *Cucumis* [2], *Cucurbita* [3], *Echinocystis* [1], *Lagenaria* [1], *Luffa* [2], *Melothria* [1], *Sicyos* [1].

**Cuscutaceae**: [see Convolvulaceae]

**Cyrillaceae** [2: 3]: *Cliftonia* [1], *Cyrilla* [2].

**Diapensiaceae** [3: 5]: *Galax* [1], *Pyxidantha* [2], *Shortia* [2].

**Diervillaceae** [2, 4]: *Diervilla* [3], *Weigela* [1].

**Dionaeaceae** [1: 1]: [see Droseraceae].

**Dipsacaceae** [2: 4]: *Dipsacus* [3], *Knautia* [1].

**Droseraceae** [1: 6]: *Dionaea* [1], *Drosera* [6].

**Ebenaceae** [1: 1]: *Diospyros* [1].

**Elaeagnaceae** [1: 4]: *Elaeagnus* [4].

**Elatinaceae** [1: 4]: *Elatine* [4].

**Empetraceae**: [see Ericaceae]

**Ericaceae** [28: 96]: *Agarista* [1], *Andromeda* [1], *Arctostaphylos* [1], *Bejaria* [1], *Calluna* [1], *Ceratiola* [1], *Chamaedaphne* [1], *Chimaphila* [2], *Elliottia* [1], *Epigaea* [1], *Erica* [1], *Eubotrys* [2], *Gaultheria* [2], *Gaylussacia* [9], *Hypopitys* [1], *Kalmia* [6], *Leucothoe* [2], *Lyonia* [6], *Menziesia* [1], *Monotropa* [1], *Monotropsis* [1], *Orthilia* [1], *Oxydendrum* [1], *Pieris* [3], *Pyrola* [3], *Rhododendron* [18], *Vaccinium* [26], *Zenobia* [1].

**Euphorbiaceae** [12: 59]: *Acalypha* [6], *Chamaesyce* [13], *Cnidocolus* [1], *Croton* [9], *Ditrysinia* [1], *Euphorbia* [20], *Manihot* [1], *Ricinus* [1], *Stillingia* [2], *Tragia* [3], *Triadica* [1], *Vernicia* [1]. [and also see Phyllanthaceae]

**Fabaceae** [66: 261]: *Abrus* [1], *Acacia* [1], *Aeschynomene* [5], *Albizia* [1], *Alysicarpus* [1], *Amorpha* [8], *Amphicarpaea* [2], *Apios* [2], *Arachis* [1], *Astragalus* [8], *Baptisia* [11], *Centrosema* [1], *Cercis* [1], *Chamaecrista* [5], *Cladrastis* [1], *Clitoria* [2], *Crotalaria* [10], *Cytisus* [1], *Dalea* [11], *Desmanthus* [1], *Desmodium* [26], *Dioclea* [1], *Erythrina* [1], *Galactia* [7], *Genista* [1], *Gleditsia* [2], *Glottidium* [1], *Glycine* [1], *Glycyrrhiza* [1], *Gymnocladus* [1], *Indigofera* [4], *Kummerowia* [2], *Lablab* [1], *Lathyrus* [10], *Lespedeza* [14], *Leucaena* [1], *Lotus* [3], *Lupinus* [4], *Macroptilium* [1], *Medicago* [7], *Melilotus* [4], *Mimosa* [3], *Mucuna* [1], *Neptunia* [2], *Orbexilum* [6], *Parkinsonia* [1], *Pediomelum* [2], *Phaseolus* [5], *Pisum* [1], *Pueraria* [1], *Rhynchosia* [6], *Robinia* [8], *Securigera* [1], *Senna* [6], *Sesbania* [2], *Strophostyles* [3], *Stylosanthes* [1], *Styphnolobium* [1], *Tephrosia* [4], *Thermopsis* [3], *Trifolium* [23], *Trigonella* [1], *Ulex* [1], *Vicia* [20], *Vigna* [2], *Wisteria* [3], *Zornia* [1]. [and also see Krameriaceae]

**Fagaceae** [3: 45]: *Castanea* [4], *Fagus* [2], *Quercus* [39].

**Fumariaceae** [6: 11]: *Adlumia* [1], *Capnoides* [1], *Corydalis* [3], *Dicentra* [4], *Fumaria* [1], *Lamprocapnos* [1].

**Garryaceae** [1:1]: *Aucuba* [1].

**Gelsemiaceae** [1: 2]: *Gelsemium* [2].

**Gentianaceae** [8: 36]: *Bartonia* [3], *Centaurium* [3], *Frasera* [1], *Gentiana* [9], *Gentianella* [2], *Gentianopsis* [1], *Obolaria* [1], *Sabatia* [16]. [and also see Menyanthaceae]

**Geraniaceae** [2: 12]: *Erodium* [2], *Geranium* [10].

**Grossulariaceae** [1: 8]: *Ribes* [8].

**Guttiferae**: [see Hypericaceae]

**Haloragaceae** [2: 12]: *Myriophyllum* (in progress), *Proserpinaca* [4].

**Hamamelidaceae** [2: 3]: *Fothergilla* [2], *Hamamelis* [1]. [and also see Altingiaceae]

**Hippocastanaceae**: [see Sapindaceae]

**Hydrangeaceae** [4: 11]: *Decumaria* [1], *Deutzia* [1], *Hydrangea* [5], *Philadelphus* [4].

**Hydrastidaceae** [1: 1]: *Hydrastis* [1].

**Hydroleaceae** [1: 3]: *Hydrolea* [3].

**Hydrophyllaceae** [6: 19]: *Ellisia* [1], *Hydrophyllum* [5], *Nama* [1], *Nemophila* [1], *Phacelia* [8].

**Hypericaceae** [2: 42]: *Hypericum* [38], *Triadenum* [4].

**Illiciaceae** [1: 2]: *Illicium* [2].

**Iteaceae** [1: 1]: *Itea* [1].

**Juglandaceae** [2: 15]: *Carya* [13], *Juglans* [2].

**Krameriaceae** [1: 1]: *Krameria* [1].

**Labiatae**: [see Lamiaceae]

**Lamiaceae** [44: 138]: *Agastache* [3], *Ajuga* [3], *Blephilia* [3], *Callicarpa* [2], *Clerodendrum* [3], *Clinopodium* [9], *Collinsonia* [4], *Conradina* [1], *Cunila* [1], *Dicerandra* [5], *Dracocephalum* [1], *Elsholtzia* [1], *Galeopsis* [3], *Glechoma* [1], *Hedeoma* [2], *Hyptis* [2], *Hyssopus* [1], *Lamiastrum* [1], *Lamium* [5], *Leonotis* [1], *Leonurus* [3], *Lycopus* [8], *Macbridea* [1], *Marrubium* [1], *Meehania* [1], *Melissa* [1], *Mentha* [9], *Monarda* [11], *Mosla* [1], *Nepeta* [1], *Ocimum* [1], *Origanum* [1], *Perilla* [2], *Physostegia* [4], *Prunella* [3], *Pycnanthemum* [18], *Rosmarinus* [1], *Salvia* [8], *Satureja* [1], *Scutellaria* (in progress), *Sideritis* [1], *Stachys* (in progress), *Synandra* [1], *Teucrium* (in progress), *Thymus* [1], *Trichostema* [5], *Vitex* [1].

**Lardizabalaceae** [1: 1]: *Akebia* [1].

**Lauraceae** [6: 10]: *Cinnamomum* [1], *Laurus* [1], *Lindera* [4], *Litsea* [1], *Persea* [2], *Sassafras* [1].

**Leguminosae**: [see Fabaceae].

**Leitneriaceae**: [see Simaroubaceae].

**Lentibulariaceae** [2: 19]: *Pinguicula* [3], *Utricularia* [16].



Lepuropetalaceae: [see Parnassiaceae].  
**Limnathaceae** [1: 1]: *Floerkea* [1].  
**Linaceae** [1: 9]: *Linum* [9].  
**Linnaeaceae** [3: 3]: *Abelia* [1], *Kolkwitzia* [1], *Linnaea* [1].  
**Loganiaceae** [2: 5]: *Mitreola* [3], *Spigelia* [2]. [and also see Gelsemiaceae].  
Loranthaceae: [see Viscaceae].  
Lythraceae [9: 14]: *Ammania* [2], *Cuphea* [2], *Decodon* [1], *Didiplis* [1], *Lagerstroemia* [1], *Lythrum* [4], *Punica* [1], *Rotala* [1],  
*Trapa* [1].  
**Magnoliaceae** [2: 9]: *Liriodendron* [1], *Magnolia* [8].  
Malvaceae [21: 41]: *Abelmoschus* [1], *Abutilon* [1], *Alcea* [1], *Althaea* [1], *Anoda* [1], *Callirhoe* [3], *Firmiana* [1], *Gossypium*  
[1], *Hibiscus* [8], *Iliamna* [2], *Kosteletzkya* [2], *Malva* [4], *Malvastrum* [1], *Malvaviscus* [1], *Melochia* [1], *Modiola* [1],  
*Napaea* [1], *Pavonia* [1], *Sida* [5], *Tilia* [3], *Triumfetta* [1].  
**Martyniaceae** [1: 1]: *Proboscidea* [1].  
**Melastomataceae** [1: 10]: *Rhexia* [10].  
**Meliaceae** [1: 1]: *Melia* [1].  
**Menispermaceae** [3: 3]: *Calyocarpum* [1], *Cocculus* [1], *Menispermum* [1].  
**Menyanthaceae** [2: 4]: *Menyanthes* [1], *Nymphoides* [3].  
Mimosaceae: [see Fabaceae].  
**Molluginaceae** [1: 1]: *Mollugo* [1].  
**Moraceae** [6: 8]: *Broussonetia* [1], *Cudrania* [1], *Fatoua* [1], *Ficus* [2], *Maclura* [1], *Morus* [2].  
**Myricaceae** [3: 7]: *Comptonia* [1], *Morella* [5], *Myrica* [1].  
**Myrsinaceae** [4: 22]: *Anagallis* [4], *Glauca* [1], *Lysimachia* [16], *Trientalis* [1].  
**Nelumbonaceae** [1: 2]: *Nelumbo* [2].  
**Nyctaginaceae** [2: 5]: *Boerhavia* [2], *Mirabilis* [3].  
**Nymphaeaceae** [2: 8]: *Nuphar* [6], *Nymphaea* [2]. [and also see Nelumbonaceae].  
**Nyssaceae** [1: 4]: *Nyssa* [4].  
**Oleaceae** [7: 23]: *Chionanthus* [1], *Forestiera* [4], *Forsythia* [2], *Fraxinus* [6], *Ligustrum* [8], *Osmanthus* [1], *Syringa* [1].  
**Onagraceae** [6: 73]: *Chamerion* [1], *Circaea* [3], *Epilobium* [6], *Gaura* [5], *Ludwigia* [28], *Oenothera* [30].  
Orobanchaceae [13: 29]: *Agalinis* (in progress), *Aureolaria* [7], *Buchnera* [2], *Castilleja* [2], *Conopholis* [1], *Dasistoma* [1],  
*Epifagus* [1], *Macranthera* [1], *Melampyrum* [3], *Orobanche* [4], *Pedicularis* [3], *Schwalbea* [1], *Seymeria* [2], *Striga*  
[1].  
Oxalidaceae: *Oxalis* (in progress).  
**Paeoniaceae** [1: 1]: *Paeonia* [1].  
**Papaveraceae** [8: 14]: *Argemone* [2], *Chelidonium* [1], *Eschscholtzia* [1], *Glaucium* [1], *Macleaya* [1], *Papaver* [6],  
*Sanguinaria* [1], *Stylophorum* [1]. [and also see Fumariaceae].  
**Parnassiaceae** [2: 5]: *Lepuropetalon* [1], *Parnassia* [4].  
**Passifloraceae** [1: 3]: *Passiflora* [3].  
**Paulowniaceae** [1: 1]: *Paulownia* [1].  
**Pedaliaceae** [1: 1]: *Sesamum* [1].  
**Penthoraceae** [1: 1]: *Penthorum* [1].  
Phrymaceae [4: 12]: *Lindernia* [6], *Mazus* [2], *Mimulus* [3], *Phryma* [1].  
**Phyllanthaceae** [1: 1]: *Phyllanthus* [3].  
**Phytolaccaceae** [1: 2]: *Phytolacca* [2].  
**Piperaceae** [1]: *Peperomia* [1].  
**Pittosporaceae** [1: 1]: *Pittosporum* [1].  
Plantaginaceae [23: 67]: *Amphianthus* [1], *Antirrhinum* [2], *Bacopa* [5], *Callitriche* (in progress), *Chaenorrhinum* [1], *Chelone*  
[4], *Collinsia* [1], *Cymbalaria* [1], *Digitalis* [2], *Gratiola* [7], *Kickxia* [2], *Leucospora* [1], *Limnophila* [1], *Limosella*  
[1], *Linaria* [1], *Mecardonia* [1], *Micranthemum* [2], *Misopates* [1], *Nuttallanthus* [3], *Penstemon* [12], *Plantago* [13],  
*Scoparia* [2], *Sophranthe* [2], *Veronica* (in progress), *Veronicastrum* [1].  
**Platanaceae** [1: 1]: *Platanus* [1].  
**Plumbaginaceae** [1: 1]: *Limonium* [1].  
**Podostemaceae** [1: 1]: *Podostemum* [1].  
**Polemoniaceae** [3: 27]: *Ipomopsis* [1], *Phlox* [23], *Polemonium* [3].  
**Polygalaceae** [1: 23]: *Polygala* [23].  
Polygonaceae [7: 19]: *Brunnichia* [1], *Eriogonum* [3], *Fagopyrum* [1], *Fallopia* [5], *Persicaria* (in progress), *Polygonella* [6],  
*Polygonum* (in progress), *Reynoutria* [2], *Rheum* [1], *Rumex* (in progress).  
Portulacaceae [4: 18]: *Claytonia* [4], *Montia* (in progress), *Phemeranthus* [6], *Portulaca* [8], *Talinum* [1].  
**Primulaceae** [2: 3]: *Dodecatheon* [2], *Hottonia* [1].  
Punicaceae: [see Lythraceae].  
Ranunculaceae [20: 90]: *Aconitum* [3], *Actaea* [5], *Adonis* [1], *Anemonella* [1], *Anemone* [10], *Aquilegia* [2], *Caltha* [1],  
*Clematis* [17], *Consolida* [2], *Coptis* [1], *Delphinium* [5], *Enemion* [1], *Eranthis* [1], *Helleborus* [1], *Myosurus* [1],  
*Nigella* [1], *Ranunculus* [26], *Thalictrum* [9], *Trautvetteria* [1], *Xanthorrhiza* [1]. [and also see Hydrastidaceae].  
**Resedaceae** [1: 5]: *Reseda* [5].  
**Rhamnaceae** [6: 14]: *Berchemia* [1], *Ceanothus* [4], *Frangula* [2], *Hovenia* [1], *Rhamnus* [5], *Sageretia* [1].  
**Rhizophoraceae** [1: 1]: *Rhizophora* [1].  
Rosaceae [25: 91]: *Agrimonia* [7], *Amelanchier* (in progress), *Aphanes* [1], *Argentina* [1], *Aronia* [3], *Aruncus* [3],  
*Chaenomeles* [1], *Crataegus* (48 - in progress), *Dalibarda* [1], *Exochorda* [1], *Filipendula* [2], *Fragaria* (in progress),  
*Geum* [9], *Kerria* [1], *Malus* (in progress), *Neviusia* [1], *Physocarpus* [2], *Porteranthus* [2], *Potentilla* [11], *Prunus* (in  
progress), *Pyracantha* (in progress), *Pyrus* [2], *Rhodotypos* [1], *Rosa* (in progress), *Rubus* [20], *Sanguisorba* [3],  
*Sibbaldiopsis* [1], *Sorbaria* [1], *Sorbus* [2], *Spiraea* [11], *Stephanandra* [1], *Waldsteinia* [3]. [and also see  
Chrysobalanaceae].  
Rubiaceae [12: 49]: *Asperula* [1], *Cephalanthus* [1], *Cruciata* [1], *Diodia* (in progress), *Galium*, *Houstonia*, *Mitchella* [1],  
*Mitracarpus* [1], *Oldenlandia* [3], *Paederia* (in progress), *Pentodon* [1], *Pinckneya* [1], *Richardia* [2], *Sherardia* [1].

Spermacoce (in progress).

Rutaceae [4: 6]: *Citrus* [1], *Ptelea* [2], *Ruta* [1], *Zanthoxylum* [2].

Salicaceae [2: 24]: *Populus*, *Salix*.

Samolaceae [1: 1]: *Samolus* [1].

Santalaceae [4: 4]: *Buckleya* [1], *Comandra* [1], *Nestronia* [1], *Pyrularia* [1].

Sapindaceae [5:24]: *Acer* [13], *Aesculus* [6], *Cardiospermum* [1], *Koelreuteria* [3], *Sapindus* [1].

Sapotaceae [1: 5]: *Sideroxylon* [5].

Sarraceniaceae [1: 11]: *Sarracenia* [11].

Saururaceae [1: 1]: *Saururus* [1].

Saxifragaceae [8: 23]: *Astilbe* [2], *Boykinia* [1], *Chrysosplenium* [1], *Heuchera* [8], *Mitella* [1], *Saxifraga* [7], *Sullivantia* [1], *Tiarella* [2]. [and also see Grossulariaceae, Hydrangeaceae, Iteaceae, Parnassiaceae, and Penthoraceae]

Schisandraceae [1: 1]: *Schisandra* [1].

Scrophulariaceae [3: 10]: *Buddleja* [2], *Scrophularia* [2], *Verbascum* [6]. [and also see Orobanchaceae, Phrymaceae, and Plantaginaceae]

Simaroubaceae [2: 2]: *Ailanthus* [1], *Leitneria* [1].

Solanaceae [10: 26]: *Calibrachoa* [1], *Capsicum* [1], *Datura* [4], *Lycium* [3], *Nicandra* [1], *Nicotiana* [2], *Nierembergia* [1], *Petunia* [1], *Physalis* [11], *Salpichroa* [1], *Solanum* (in progress).

Sphenocleaceae [1: 1]: *Sphenoclea* [1].

Staphyleaceae [1: 1]: *Staphylea* [1].

Styracaceae [2: 8]: *Halesia* [5], *Styrax* [3].

Symplocaceae [1: 1]: *Symplocos* [1].

Tamaricaceae: *Tamarix* (in progress).

Tetrachondraceae [1: 1]: *Polypremum* [1].

Theaceae [4: 6]: *Camellia* [2], *Franklinia* [1], *Gordonia* [1], *Stewartia* [2].

Thymelaeaceae [1: 1]: *Dirca* [1].

Trapaceae: [see Lythraceae]

Tropaeolaceae [1: 1]: *Tropaeolum* [1].

Turneraceae [1: 1]: *Piriqueta* [1].

Ulmaceae [2: 10]: *Planera* [1], *Ulmus* [9]. [also see Celtidaceae].

Umbelliferae: [see Apiaceae].

Urticaceae [5: 14]: *Boehmeria* [2], *Laportea* [1], *Parietaria* [4], *Pilea* [3], *Urtica* [4].

Valerianaceae [2: 5]: *Valeriana* [2], *Valerianella* [3].

Verbenaceae [3: 6]: *Glandularia* [3], *Lantana* (in progress), *Phyla* [2], *Stylodon* [1], *Verbena* (in progress). [and also see Lamiaceae and Phrymaceae]

Violaceae [2: 39]: *Hybanthus* [2], *Viola* [40].

Viscaceae [1: 1]: *Phoradendron* [1].

Vitaceae [4: 17]: *Ampelopsis*, *Cissus*, *Parthenocissus*, *Vitis*.

Zygophyllaceae [2: 3]: *Kallstroemia* [1], *Tribulus* [2].

#### MONOCOTYLEDONS

Acoraceae [1: 2]: *Acorus* [2].

Agavaceae [4: 10]: *Camassia* [1], *Manfreda* [1], *Schoenolirion* [3], *Yucca* [5].

Alismataceae [3: 28]: *Alisma* [3], *Echinodorus* [4], *Sagittaria* [21].

Alliaceae [3: 18]: *Allium* [15], *Ipheion* [1], *Nothoscordum* [2].

Alstroemeriaceae [1: 1]: *Alstroemeria* [1].

Amaryllidaceae [8: 23]: *Crinum* [2], *Galanthus* [2], *Hymenocallis* [6], *Leucojum* [1], *Lycoris* [1], *Narcissus* [6], *Sternbergia* [1], *Zephyranthes* [4].

Araceae [15: 28]: *Arisaema* [5], *Arum* [1], *Calla* [1], *Colocasia* [1], *Landoltia* [1], *Lemna* [7], *Orontium* [1], *Peltandra* [2], *Pinellia* [1], *Pistia* [1], *Spirodela* [1], *Symplocarpus* [1], *Wolffia* [3], *Wolffiella* [1], *Xanthosoma* [1]. [and also see Acoraceae]

Arecaceae [4: 5]: *Butia* [1], *Rhapidophyllum* [1], *Sabal* [2], *Serenoa* [1].

Asparagaceae [1: 1]: *Asparagus* [1].

Bromeliaceae [1: 4]: *Tillandsia* [4].

Burmanniaceae [2: 3]: *Apteria* [1], *Burmannia* [2].

Cannaceae [1: 3]: *Canna* [3].

Colchicaceae [2: 7]: *Colchicum* [1], *Uvularia* [6].

Commelinaceae [4: 18]: *Commelina* [9], *Cuthbertia* [2], *Murdannia* [2], *Tradescantia* [5].

Convallariaceae: [see Ruscaceae].

Cymodoceaceae [2: 2]: *Halodule* [1], *Syringodium* [1].

Cyperaceae [17: 372]: *Bolboschoenus* [4], *Bulbostylis* [6], *Carex* (in progress), *Cladium* [2], *Cymophyllus* [1], *Cyperus* [59], *Dulichium* [1], *Eleocharis* (in progress), *Eriophorum* [4], *Fimbristylis* [13], *Fuirena* [4], *Isolepis* [2], *Kyllinga* [4], *Lipocarpus* [3], *Rhynchospora* [71], *Schoenoplectus* [12], *Scirpus* [11], *Scleria* [12], *Trichophorum* [2].

Dioscoreaceae [1: 5]: *Dioscorea* [5].

Eriocaulaceae [3: 12]: *Eriocaulon* (8), *Lachnocaulon* [3], *Syngonanthus* [1].

Gramineae: [see Poaceae]

Haemodoraceae [1: 1]: *Lachnanthes* [1].

Hemerocallidaceae [1: 2]: *Hemerocallis* [2].

Hostaceae [1: 3]: *Hosta* [3].

Hyacinthaceae [4: 8]: *Hyacinthoides* [2], *Hyacinthus* [1], *Muscari* [3], *Ornithogalum* [2].

Hydrocharitaceae [5: 7]: *Egeria* [1], *Elodea* [3], *Hydrilla* [1], *Limnobium* [1], *Vallisneria* [1].

Hypoxidaceae [1: 6]: *Hypoxis* [6].

Iridaceae [5: 15]: **Belamcanda [1], Calydorea [1]**, Crocus, **Crocasmia [1]**, Gladiolus (in progress), Herbertia (in progress), Iris (in progress), **Nemastylis [1], Sisyrinchium [11]**.

Juncaceae [2: 45]: **Juncus [38], Luzula [7]**.

Juncaginaceae [1: 1]: **Triglochin [1]**.

Lemnaceae: [see Araceae]

Liliaceae [8: 25]: **Clintonia [2], Erythronium [6], Lilium [10], Medeola [1], Prosartes [2], Streptopus [2], Tricyrtis [1], Tulipa [1]**. [and also see Agavaceae, Alliaceae, Amaryllidaceae, Asparagaceae, Colchicaceae, Hemerocallidaceae, Hostaceae, Hyacinthaceae, Hypoxidaceae, Melanthiaceae, Nartheciaceae, Ruscaceae, Smilacaceae, Themidaceae, Tofieldiaceae, Trilliaceae] – for disposition of genera in the formerly very broadly interpreted Liliaceae, see beginning of Liliaceae family treatment in the main text.

Marantaceae [1: 1]: **Thalia [1]**.

Mayacaceae [1: 1]: **Mayaca [1]**.

Melanthiaceae [9: 17]: **Amianthium [1], Anticlea [1], Chamaelirium [1], Helonias [1], Schoenocaulon [1], Stenanthium [5], Veratrum [5], Xerophyllum [1], Zigadenus [1]**.

Najadaceae [1: 5]: **Najas [5]**.

Nartheciaceae [3: 7]: **Aletris [4], Lophiola [1], Narthecium [2]**.

Nolinaceae: [see Ruscaceae]

Orchidaceae [26: 84]: **Aplectrum [1], Arethusa [1], Calopogon [5], Cleistes [2], Coeloglossum [1], Corallorrhiza [6], Cypripedium [7], Epidendrum [1], Epipactis [1], Galearis [1], Goodyera [2], Habenaria [2], Hexalectris [1], Isotria [2], Liparis [2], Listera [3], Malaxis [4], Platanthera [17], Platythelys [1], Pogonia [1], Ponthieva [1], Pteroglossaspis [1], Spiranthes [18], Tipularia [1], Triphora [1], Zeuxine [1]**.

Poaceae [122: 474]: **Aegilops [2], Agrostis [10], Aira [3], Alopecurus [4], Ammophila [1], Amphicarpum [2], Andropogon [19], Anthenantia [2], Anthoxanthum [2], Apera [1], Aristida [18], Arrhenatherum [2], Arthraxon [1], Arundinaria [2], Arundo [1], Avena [2], Axonopus [3], Bothriochloa [4], Bouteloua [4], Brachyelytrum [2], Brachypodium [1], Briza [1], Bromus [17], Calamagrostis [4], Calamovilla [1], Cenchrus [5], Chasmanthium [4], Chloris [2], Chrysopogon [1], Cinna [2], Coelorrhachis [4], Coix [1], Cortaderia [1], Ctenium [2], Cynodon [1], Cynosurus [2], Dactylis [1], Dactyloctenium [1], Danthonia [4], Deschampsia [2], Desmazeria [1], Diarrhena [2], Dichantherium [53], Digitaria [10], Dinebra [1], Distichlis [1], Echinochloa [7], Eleusine [2], Elymus (in progress), Elyonurus [1], Eragrostis [26], Eremochloa [1], Eriochloa [2], Eustachys [3], Festuca [5], Glyceria [10], Gymnopogon [3], Hackelochloa [1], Hainardia [1], Heteropogon [1], Hierochloa [1], Holcus [2], Hordeum [4], Imperata [1], Koeleria [1], Lagurus [1], Leersia [4], Leptochloa [6], Limnorea [1], Lolium [3], Luziola [1], Melica [2], Melinis [1], Microstegium [1], Miliium [1], Miscanthus [1], Muhlenbergia [15], Neeragrostis [1], Oplismenus [2], Oryza [1], Oryzopsis [1], Panicum [22], Parapholis [1], Pascopyrum [1], Paspalum (in progress), Pennisetum, Phalaris [5], Phanopyrum [1], Phleum [2], Phragmites [2], Phyllostachys [6], Piptatherum [2], Piptochaetium [1], Poa [17], Polypogon [3], Pseudosasa [1], Puccinellia [2], Rostraria [1], Rottboellia [1], Saccharum [6], Sacciolepis [2], Schedonorus [2], Schizachne [1], Schizachyrium [5], Sclerochloa [1], Secale [1], Setaria (in progress), Sorghastrum [4], Sorghum [3], Spartina [6], Sphenopholis [6], Sporobolus [15], Steinchisma [1], Stenotaphrum [1], Thinopyrum (in progress), Torreyochloa [2], Tragus [1], Tridens [5], Triplasis [2], Tripsacum [1], Trisetum [1], Triticum [1], Uniola [1], Urochloa [4], Vulpia [5], Zea [3], Zizania [1], Zizaniopsis [1], Zoysia (in progress)**.

Pontederiaceae [3: 7]: **Eichhornia [1], Heteranthera [4], Pontederia [2]**.

Potamogetonaceae [2: 31]: **Potamogeton [29], Stuckenia [2]**.

Ruppiaceae [1: 1]: **Ruppia [1]**.

Ruscaceae [4: 10]: **Convallaria [2]**, Liriope (in progress), **Maianthemum [4], Nolina [1], Polygonatum [3]**.

Scheuchzeriaceae [1:1]: **Scheuchzeria [1]**.

Smilacaceae [1: 16]: **Smilax [16]**.

Sparganiaceae: [see Typhaceae]

Stemonaceae [1: 1]: **Croomia [1]**.

Themidaceae [1: 1]: **Dichelostemma [1]**,

Tofieldiaceae [2: 4]: **Pleea [1], Tofieldia [3]**.

Trilliaceae: [1: 26]: **Trillium [26]**.

Typhaceae [2: 8]: **Sparganium [4], Typha [4]**.

Uvulariaceae: [see Calochortaceae, Colchicaceae, Liliaceae].

Xyridaceae [1: 19]: **Xyris [19]**.

Zannichelliaceae [1: 1]: **Zannichellia [1]**.

Zosteraceae [1: 1]: **Zostera [1]**. [also see Cymodoceaceae]

## Contributors

Richard J. LeBlond --  
 Cyperaceae: *Rhynchospora*, *Scleria*.  
 Melastomataceae.  
 Poaceae: *Dichantherium*, *Panicum*.

Zack Murrell --  
 Cornaceae.

John B. Nelson --  
 Lamiaceae: *Stachys*.

Robert K. Peet --  
 Juglandaceae: *Carya* (with A.S. Weakley).

Milo Pyne --  
 Solanaceae: *Physalis*.

Bruce A. Sorrie --  
 Asteraceae: *Pityopsis*.

Cistaceae: *Lechea*.

Cyperaceae: *Carex* (with T.F. Wieboldt and A.S. Weakley), *Eleocharis* (with A.S. Weakley).

Gentianaceae: *Sabatia*.

Haloragaceae: *Myriophyllum* (with A.S. Weakley).

Lamiaceae: *Lycopus*.

Violaceae: *Viola*.

Brian van Eerden --

Juncaceae: *Juncus*.

Thomas F. Wieboldt --

Cyperaceae: *Carex* (with A.S. Weakley and B.A. Sorrie).

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## FERNS AND FERN ALLIES

### ARTIFICIAL KEY TO THE GENERA OF FERNS AND FERN ALLIES

- 1 Plant a free-living gametophyte, consisting of filaments or thalli, generally a single cell thick, usually with abundant single-celled gemmae . . . . . **Key A**
- 1 Plant a sporophyte, consisting of a stem, rhizome, corm, or crown producing well-developed leaves, more than 1 cell thick (except in *Trichomanes* and *Hymenophyllum*), generally reproducing by spores.
  - 2 Plant aquatic, either floating and unattached, or rooting and largely submersed . . . . . **Key B**
  - 2 Plant of various habitats, including wetlands, where sometimes growing in soils saturated or intermittently flooded, but not aquatic.
    - 3 Leaves not "fern-like," unlobed, variously awl-shaped, scale-like, or terete . . . . . **Key C**
    - 3 Leaves "fern-like," variously lobed or divided, ranging from pinnatifid to 4-pinnate.
      - 4 Leaf blades (not including the petiole) small, less than 30 cm long or wide (some species will key either here or in the next lead).
        - 5 Epipetric or epiphytic, growing on rock, tree bark, walls, or over rock in thin soil mats or in small soil pockets . . . . . **Key D**
        - 5 Terrestrial, growing in soil, not associated with rock outcrops . . . . . **Key E**
      - 4 Leaf blades medium to large, more than 30 cm long or wide.
        - 6 Epipetric or epiphytic, growing on rock, walls, over rock in thin soil mats or in small soil pockets, or on tree trunks . . . . . **Key F**
        - 6 Terrestrial, growing in soil, not associated with rock outcrops . . . . . **Key G**

#### Key A -- Pteridophytes reduced to thalloid or filamentous, free-living gametophytes

- 1 Gametophytes filamentous . . . . . *Trichomanes* (HYMENOPHYLLACEAE)
- 1 Gametophytes thalloid, ribbon-like and branched.
  - 2 Gemmae absent or spathulate (more than 1 cell wide) . . . . . *Hymenophyllum* (HYMENOPHYLLACEAE)
  - 2 Gemmae uniseriate (1 cell wide) . . . . . *Vittaria* (VITTARIACEAE)

#### Key B -- Pteridophytes growing as floating or rooted aquatics

- 1 Plant a floating aquatic.
  - 2 Leaves less than 1 mm long, reddish or green, without hairs on the upper surface . . . . . *Azolla* (AZOLLACEAE)
  - 2 Leaves 5-50 mm long, bright green, with obvious hairs on the upper surface . . . . . *Salvinia* (SALVINIACEAE)
- 1 Plant a rooted aquatic.
  - 3 Plant cloverlike, with 4 leaf segments borne terminally . . . . . *Marsilea quadrifolia* (MARSILEACEAE)
  - 3 Leaves linear.
    - 4 Plants cormose, with numerous undivided leaves . . . . . *Isoetes* (ISOETACEAE)
    - 4 Plants rhizomatous, the leaves reduced to a winged petiole . . . . . *Pilularia americana* (MARSILEACEAE)

#### Key C -- Pteridophytes with leaves not "fern-like" (unlobed, variously awl-shaped, scale-like, or terete)

- 1 Stem obviously jointed; leaves scale-like, borne in a whorl at each of the distant joints; spores borne in a terminal strobilus with peltate scales . . . . . *Equisetum* (EQUISETACEAE)
- 1 Stem not jointed; leaves scale-like or larger, but if scale-like not borne in whorls at distant joints; spores borne variously, but if in a terminal strobilus the scales not peltate.
  - 2 Leaves linear, grass-like, 1-50 cm long, 20x or more as long as wide.
    - 3 Leaves solitary (though often the internodes very short from a thin, creeping rhizome); sporangia borne in a spherical (ca. 3 mm in diameter) sporocarp on a separate branch from the rhizome . . . . . *Pilularia* (MARSILEACEAE)
    - 3 Leaves numerous from a corm or short rhizome; sporangia either borne in the expanded leaf bases (*Isoetes*) or in 2 rows at the tip of the linear fertile leaves (*Schizaea*).
      - 4 Leaves straight, arching, or flaccid, from a 2-3-lobed corm; sporangia borne in the expanded, hyaline leaf bases . . . . . *Isoetes* (ISOETACEAE)
      - 4 Leaves notably spiral-curly, from a short rhizome; sporangia borne in 2 rows at the tip of the linear fertile leaves . . . . . *Schizaea* (SCHIZAEACEAE)
  - 2 Leaves various (scale-like, awl-like, moss-like, or flat), but not linear and grass-like, mostly 1-10x as long as wide.
    - 5 Leaves inconspicuous, reduced to a few nerveless scales (less than 1.5 mm long), the internodes much longer than the leaves; sporangia yellowish, 3-locular, 1-2 mm in diameter; stems upright, repeatedly branched dichotomously . . . . . *Psilotum* (PSILOACEAE)
    - 5 Leaves either larger or, if scale-like, with nerves and longer than the internodes (the leaves thus overlapping); sporangia yellowish to brownish, 1-locular, less than 1 mm in diameter; stems either subterranean or surficial rhizomes or erect or ascending (and sometimes dichotomously branched in whole or in part in *Huperzia*, *Diphasiastrum*, and *Dendrolycopodium*).
      - 6 Plant with leaves very numerous and overlapping along the creeping, ascending, or erect stems, the leaves

- usually scale-like or awl-like, 0.5-2 (-3) mm wide, typically acute, acuminate, or hair-tipped; sporangia either in terminal strobili (axillary to specialized, smaller leaves) or axillary to normal leaves.
- 7 Sporangia borne in flattened or quadrangular strobili sessile at the tips of leafy branches; spores and sporangia of two sizes, the megasporangia larger and borne basally in the strobili . . . . . ***Selaginella*** (SELAGINELLACEAE)
  - 7 Sporangia borne either in the axils of normal foliage leaves, or in strobili sessile at the tips of leafy branches or stalked on specialized branches with fewer and smaller leaves; spores and sporangia of one size.
    - 8 Leafy stems erect, simple or dichotomously branched, the ultimate branches vertically oriented; sporophylls like the sterile leaves or only slightly reduced, in annual bands along the stem; vegetative reproduction by leafy gemmae near stem apex . . . . . ***Huperzia*** (LYCOPODIACEAE)
    - 8 Leafy stems prostrate or erect, if erect then generally branched, the ultimate branches spreading (horizontal) or ascending; sporophylls differing from sterile leaves, either broader and shorter, or more spreading, aggregated into terminal cones; lacking vegetative reproduction by gemmae.
      - 9 Leaves herbaceous, pale or yellow-green, dull, deciduous; leafy stems creeping; rhizome dying back annually to an underground vegetative tuber at apex; [of wetlands, mostly on moist or wet sands or peats].
        - 10 Leaves of the prostrate stems 0.5-1.2 mm wide, ciliate-toothed or not toothed; leaves of the erect stem many, overlapping, spirally arranged; leaves of the strobilus resembling leaves of the prostrate and upright stems in size and shape; upright stems 1.5-15 mm in diameter (including the leaves) . . . . . ***Lycopodiella*** (LYCOPODIACEAE)
        - 10 Leaves of the prostrate stems 1.3-2.1 mm wide, not toothed; leaves of the erect stem few, not overlapping, whorled; leaves of the strobilus much reduced relative to leaves of the prostrate and upright stems; upright stems 1.5-3 mm in diameter (including the leaves) . . . . . ***Pseudolycopodiella*** (LYCOPODIACEAE)
      - 9 Leaves rigid, bright to dark green, shiny, evergreen; leafy stems mainly erect, treelike, fanlike, or creeping (if creeping, then the leaves with elongate, hyaline hair-tips); rhizome trailing, perennial; [of uplands, mostly in moist to dry soils].
        - 11 Branches 1-5 mm wide (including the leaves), compressed to quadrangular, with 4 ranks of leaves; branching of strobilus stalks dichotomous . . . ***Diphasiastrum*** (LYCOPODIACEAE)
        - 11 Branches 4-12 mm wide, terete (to somewhat compressed in *Dendrolycopodium obscurum*), with 6 or more ranks of leaves; branching of strobilus stalks (when present), pseudomonopodial (falsely appearing to have a main axis from which branches arise).
          - 12 Strobili borne on elongate, sparsely leafy peduncles borne at the tips of leafy, ascending branches; leaves with attenuate, hyaline hair-tips . . . . . ***Lycopodium*** (LYCOPODIACEAE)
          - 12 Strobili sessile, borne directly above densely leafy portions of upright branches; leaves acuminate to acute.
            - 13 Erect leafy stems 3-8 mm in diameter (including the leaves), treelike or fanlike, with a definite main axis; leaves acute at the apex; horizontal shoots subterranean, without winter bud constrictions . . . . . ***Dendrolycopodium*** (LYCOPODIACEAE)
            - 13 Erect leafy stems 10 mm or more in diameter (including the leaves), branched 1-4 times subdichotomously; leaves with a 0.4-1.0 mm long stiff spinule; horizontal shoots at or near the ground surface, with winter bud constrictions . . . . . ***Spinulum*** (LYCOPODIACEAE)
    - 6 Plant with leaves not as above (see below).
      - 14 Plant with 1 (-several) leaves, the sterile leaf blade 0.3-24 cm long, ovate to lanceolate, entire-margined, obtuse, the longer fertile portion with 2 rows of sporangia somewhat imbedded in it . . . . . ***Ophioglossum*** (OPHIOGLOSSACEAE)
      - 14 Plant with many leaves, generally 5 or more, not divided into separate sterile and fertile segments, the leaves either (a) small, 0.3-1.6 cm long, obovate, scattered along a very thin creeping rhizome, or (b) larger, (2-) 8-30 cm long, cordate at base, the tip long-attenuate (often proliferous, bearing a plantlet at the tip).
        - 15 Leaf blades (2-) 8-30 cm long, cordate at the base, the tip long-attenuate, often proliferous (bearing a plantlet at the tip); sporangia in indusiate sori on the undersurface; leaf texture moderately thick; rhizome erect or ascending, 1.0-1.5 mm in diameter, the leaves clustered from its tip . . . . . ***Asplenium rhizophyllum*** (ASPLENIACEAE)
        - 15 Leaf blades 0.3-1.6 cm long, cuneate at the base, rounded to obtuse at the tip, not proliferous; sporangia solitary in a marginal pocket on the leaf; leaf texture very thin; rhizome creeping on the surface of rock or bark, 0.1-0.3 mm in diameter, the leaves scattered along it . . . . . ***Trichomanes petersii*** (HYMENOPHYLLACEAE)

**Key D -- Small pteridophytes, epipetric or epiphytic, growing on rock, tree bark, walls, or over rock in thin soil mats or in small soil pockets**

- 1 Leaves pinnatifid or bipinnatifid, most of the pinnae not fully divided from one another (the rachis winged by leaf tissue most or all of its length). {key *Hymenophyllum* and *Trichomanes* under this lead}
- 2 Leaves bipinnatifid, at least the lowermost pinnae deeply lobed.
  - 3 Lowermost (and other) pinnae with numerous, rather even lobes . . . . . ***Phegopteris*** (THELYPTERIDACEAE)
  - 3 Lowermost pinnae with a few, irregular lobes (the upper pinnae unlobed) . . . . . ***Pteris multifida*** (PTERIDACEAE)

- 2 Leaves pinnatifid, the pinnae not lobed.
  - 4 Leaf blades with a long-attenuate apex, blade unlobed for 1/3 its length; sori elongate **Asplenium** (ASPLENIACEAE)
  - 4 Leaves without a long-attenuate apex, blade lobed for most of its length.
    - 5 Plants dwarf, the leaf blades less than 5 cm long; [occurring only in permanently moist habitats, as in grottoes behind waterfalls] ..... **Micropolypodium** (GRAMMITIDACEAE)
    - 5 Plants larger, the leaf blades 7-30 cm long; [occurring on moist to dry habitats].
      - 6 Leaf blade densely scaly on the lower surface; leaf segment margins entire; rhizome 1-2 mm in diameter ..... **Pleopeltis** (POLYPODIACEAE)
      - 6 Leaf blade scaleless on the lower surface; leaf segment margins denticulate; rhizome 3-6 mm in diameter ..... **Polypodium** (POLYPODIACEAE)
- 1 Leaves pinnate, pinnate-pinnatifid, 2-pinnate, or even more divided (the rachis naked for most of its length, often winged in the apical portion).
  - 7 Leaves pinnate or pinnate-pinnatifid.
    - 8 Leaves of a very delicate texture, 1 cell thick; sori borne in cups on the leaf margins; [of rock outcrops with high air humidity].
    - 9 Indusium ("involucre") bivalvate (deeply divided into 2 flaps); receptacle not exerted from between the 2 flaps of the indusium **Hymenophyllum** (HYMENOPHYLLACEAE)
    - 9 Indusium ("involucre") tubular or funnellform, sometimes slightly 2-lobed; receptacle long and whiplike, exerted from the mouth of the tubular indusium **Trichomanes** (HYMENOPHYLLACEAE)
    - 8 Leaves of an herbaceous, subcoriaceous, or coriaceous texture, more than 1 cell thick; sori otherwise; [of various habitats, not strictly of moist sites].
      - 10 Pinnae more than 1 cm wide; leaves subcoriaceous to coriaceous; veins anastomosing, rejoining to form a netlike pattern ..... **Cyrtomium** (DRYOPTERIDACEAE)
      - 10 Pinnae less than 1 cm wide; leaves herbaceous to subcoriaceous; veins free, not rejoining.
        - 11 Sori on the undersurface of the leaf, away from the margins ..... **Asplenium** (ASPLENIACEAE)
        - 11 Sori on the undersurface of the leaf, marginal and more-or-less hidden beneath either the unmodified revolute leaf margin or under a modified, reflexed false indusium.
          - 12 Leaf undersurface densely covered with stellate and ciliate scales ..... **Astrolepis sinuata** ssp. *sinuata* (PTERIDACEAE)
          - 12 Leaf undersurface glabrous or with non-stellate scales.
            - 13 Rachis dark-brown or purple; leaf margin unmodified, though often revolute ..... **Pellaea** (PTERIDACEAE)
            - 13 Rachis green or tan; leaf margin modified into a false indusium, reflexed to cover the sori ..... **Pteris vittata** (PTERIDACEAE)
  - 7 Leaves bipinnate or more divided.
    - 14 Leaf blade pentagonal or broadly triangular in outline, ca. 1x as long as wide.
      - 15 Leaf blade pentagonal in outline, the terminal pinna by far the largest; rhizome 5-8 mm in diameter; indusia present, thick, persistent, and reniform; [introduced species, naturalized in moist ravines in SC] ..... **Arachniodes** (DRYOPTERIDACEAE)
      - 15 Leaf blade broadly triangular in outline, the basal pinnae by far the largest; rhizome ca. 1 mm in diameter; indusia absent; [native species of mountain peaks of n. NC and VA] ..... **Gymnocarpium** (DRYOPTERIDACEAE)
    - 14 Leaf blade elongate, mostly lanceolate, generally 4x or more as long as wide (except in *Adiantum capillus-veneris*, with leaf blade often only 1.5 -3x as long as wide, but not notably triangular or pentagonal in outline).
      - 16 Sori not marginal, either naked, or slightly to strongly hidden by indusia.
        - 17 Leaf blades 3-12 cm long; sori elongate, covered by a flap-like, entire indusium ..... **Asplenium** (ASPLENIACEAE)
        - 17 Leaf blades 4-30 (-50) cm long; sori globular, surrounded or covered by an entire, ciliate, or divided indusium.
          - 18 Veins reaching the margin; indusium attached under one side of the sorus, hoodlike or pocketlike, arching over the sorus; petioles glabrous or sparsely beset with scales, the petiole bases not persistent ..... **Cystopteris** (DRYOPTERIDACEAE)
          - 18 Veins ending short of the margin; indusium attached under the sorus, cuplike (divided into 3-6 lanceolate to ovate lobes which surround the sorus from below) or of minute numerous septate hairs, which extend out from under the sorus on all sides; petioles often densely beset with scales, the petiole bases persistent ..... **Woodsia** (DRYOPTERIDACEAE)
      - 16 Sori marginal, usually more-or-less hidden under the revolute margin of the pinnule.
        - 19 Sori round or oblong, distinct and separate along the pinnule margins; leaves bright-green, glabrous, herbaceous, delicate, and flexible ..... **Adiantum** (PTERIDACEAE)
        - 19 Sori continuous along the pinnule margins; leaves mostly dark-green or glaucous, often pubescent, coriaceous, tough, and stiff.
          - 20 Leaves strongly dimorphic, the fertile leaves obviously longer than the sterile and with narrow elongate ultimate segments ..... **[Cryptogramma]** (PTERIDACEAE)
          - 20 Leaves essentially monomorphic.
            - 21 Lower leaf surfaces covered with whitish powder, otherwise glabrous or sparsely pubescent ..... **[Argyrochosma]** (PTERIDACEAE)
            - 21 Lower leaf surfaces pubescent (or glabrous in *Cheilanthes alabamensis*), never with conspicuous whitish powder ..... **Cheilanthes** (PTERIDACEAE)

- 1 Petiole branched once dichotomously, each branch bearing 3-7 pinnae in one direction only, the outline of the blade fan-shaped, often broader than long . . . . . ***Adiantum pedatum*** (PTERIDACEAE)
- 1 Petiole not branched dichotomously, the outline of the blade either longer than broad or triangular and about as wide as long.
  - 2 Leaves pinnatifid or bipinnatifid, most of the pinnae not fully divided from one another (the rachis winged by leaf tissue most or all of its length).
    - 3 Sporangia borne on an erect stalk that arises at or above ground level from the petiole of the sterile leaf blade (joining the petiole of the sterile leaf above the rhizome) . . . . . ***Botrychium*** (OPHIOGLOSSACEAE)
    - 3 Sporangia either borne on normal leaf blades or on specialized (fertile) leaves separate from the rhizome.
      - 4 Leaves monomorphic, the sori borne on normal leaf blades . . . . . ***Phegopteris*** (THELYPTERIDACEAE)
      - 4 Leaves dimorphic, the sori borne on leaves significantly different than normal leaves.
        - 5 Fertile leaf woody, brown, with bead-like segments; pinnae margins entire, often wavy or the lowermost even somewhat lobed; pinnae mostly with obtuse apices, tending to be borne opposite . . . . . ***Onoclea*** (DRYOPTERIDACEAE)
        - 5 Fertile leaf stiff but herbaceous, green, the pinnae linear, not at all bead-like; pinnae margins finely serrulate, otherwise slightly wavy or straight; pinnae mostly with acute apices, tending to be borne alternate . . . . . ***Woodwardia areolata*** (BLECHNACEAE)
  - 2 Leaves pinnate, pinnate-pinnatifid, 2-pinnate, or even more divided (the rachis naked for most of its length, often winged in the apical portion).
    - 6 Leaves broadly triangular in outline, about as broad as long; sporangia borne on an erect stalk that arises at or above ground level from the petiole of the sterile leaf blade (joining the petiole of the sterile leaf above the rhizome) . . . . . ***Sceptridium*** (OPHIOGLOSSACEAE)
    - 6 Leaves lanceolate in outline, much longer than broad; sporangia either borne on normal leaf blades, on slightly dimorphic blades, or on an erect stalk that arises at or above ground level from the petiole of the sterile leaf blade (joining the petiole of the sterile leaf above the rhizome).
      - 7 Leaf blades 1-8 cm long; sporangia borne on an erect stalk that arises at or above ground level from the petiole of the sterile leaf blade (joining the petiole of the sterile leaf above the rhizome) . . . . . ***Botrychium*** (OPHIOGLOSSACEAE)
      - 7 Leaf blades 10-30 (-100) cm long; sporangia either borne on normal leaf blades or on slightly dimorphic blades.
        - 8 Leaves dark green, subcoriaceous, evergreen . . . . . ***Polystichum*** (DRYOPTERIDACEAE)
        - 8 Leaves light to medium green, herbaceous, deciduous to semi-evergreen.
          - 9 Sori continuous along the midrib of the pinna . . . . . ***Blechnum*** (BLECHNACEAE)
          - 9 Sori distinct.
            - 10 Sori elongate; leaf blades somewhat dimorphic, the fertile larger and erect, the sterile smaller and prostrate, the larger leaf blades 2-4 (-6.5) cm wide . . . . . ***Asplenium platyneuron*** (ASPENIACEAE)
            - 10 Sori round; leaf blades monomorphic; the larger leaf blades 5-15 cm wide . . . . . ***Thelypteris*** (THELYPTERIDACEAE)

**Key F -- Medium to large pteridophytes, epipetric, growing on rock, walls, over rock in thin soil mats or in small soil pockets, or on tree trunks**

- 1 Leaves vine-like, 0.3-10 m long, the branching dichotomous, 1 branch of each dichotomy terminating in a pair of pinnae, the pinnae often widely spaced (more than 10 cm apart) . . . . . ***Lygodium*** (LYGODIACEAE)
- 1 Leaves not vine-like, 0.3-1 m long, the branching not as described above, the pinnae regularly and more-or-less closely spaced (mostly less than 10 cm apart).
  - 2 Leaves 1-pinnate-pinnatifid or less divided, the pinnae entire, toothed, lobed or pinnatifid.
    - 3 Sori marginal, continuous, covered by a reflexed false indusium along the leaf margin; pinnae usually opposite, linear, not toothed or lobed . . . . . ***Pteris vittata*** (PTERIDACEAE)
    - 3 Sori neither marginal nor continuous, slightly to entirely covered by an elongate or roundish indusium (sometimes ciliate, toothed, or divided into narrow segments); pinnae usually at least in part alternate, mostly lanceolate, toothed, lobed, or pinnatifid.
      - 4 Sori elongate, the indusium flap-like, attached along the side; leaf blades (if more than 30 cm long) less than 7 cm wide . . . . . ***Asplenium platyneuron*** (ASPENIACEAE)
      - 4 Sori circular or globular, the indusium peltate, reniform, or cuplike; leaf blades (if more than 30 cm long) more than 5 cm wide.
        - 5 Leaves pinnatifid . . . . . ***Phlebodium*** (POLYPODIACEAE)
        - 5 Leaves 1-pinnate or more divided.
          - 6 Leaves 1-pinnate, the pinnae toothed and each with a slight to prominent lobe near the base on the side towards the leaf tip, dark green, subcoriaceous to coriaceous; indusia peltate.
            - 7 Veins anastomosing, rejoining to form a netlike pattern; pinnae 4-25 pairs per leaf; [non-native, rarely naturalized] . . . . . ***Cyrtomium*** (DRYOPTERIDACEAE)
            - 7 Veins branching dichotomously, free, not rejoining to form a netlike pattern; pinnae 25-50 pairs on larger leaves; [native, common] . . . . . ***Polystichum*** (DRYOPTERIDACEAE)
          - 6 Leaves 1-pinnate-pinnatifid, the pinnae pinnatifid, generally lacking a prominent basal lobe, light green to dark green, herbaceous to subcoriaceous; indusium either reniform or cuplike.
            - 8 Vascular bundles in the petiole 3-7 . . . . . ***Dryopteris*** (DRYOPTERIDACEAE)
            - 8 Vascular bundles in the petiole 2, uniting above.
              - 9 Indusium reniform, arching over the sorus . . . . . ***Thelypteris*** (THELYPTERIDACEAE)
              - 9 Indusium cuplike, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments . . . . . ***Woodsia obtusa*** (DRYOPTERIDACEAE)



- 2 Leaves 2-pinnate or more divided, the pinnae divided to their midribs.
  - 9 Sori marginal and borne on the underside of the false indusium; petioles and rachis shiny black or reddish-black, glabrous except at the very base of the petiole; pinnules fan-shaped or obliquely elongate **Adiantum** (PTERIDACEAE)
  - 9 Sori not marginal, borne on the undersurface of the leaf blade (if marginal, as in *Pteridium* and *Dennstaedtia*, borne on the undersurface of the leaf); petioles darkened only basally (if at all), rachis green, tan, or reddish; pinnules not notably fan-shaped or obliquely elongate.
    - 10 Leaf blades pentagonal or broadly triangular in outline, ca. 1x as long as wide.
      - 11 Leaf blade pentagonal in outline, the terminal pinna the largest; sori submarginal, roundish, the indusium reniform . . . . . **Arachniodes** (DRYOPTERIDACEAE)
      - 11 Leaf blade broadly triangular in outline, the basal pinnae the largest; sori marginal, linear, indusium absent, protected by the revolute leaf margin and a minute false indusium . . . **Pteridium** (DENNSTAEDTIACEAE)
    - 10 Leaf blades elongate, mostly lanceolate, generally 4x or more as long as wide.
      - 12 Outline of leaf blade narrowed to base, the widest point more than 7 pinna pairs above the base, the lowermost pinnae 1/4 or less as long as the longest pinnae; rhizomes long-creeping, the leaves scattered, forming clonal patches . . . . . **Thelypteris noveboracensis** (THELYPTERIDACEAE)
      - 12 Outline of the leaf blade slightly if at all narrowed to the base, the widest point less than 5 pinna pairs from the base, the lowermost pinnae more than 1/2 as long as the longest pinnae; rhizomes short-creeping, the leaves clustered, not forming clonal patches (or with rhizomes long-creeping, leaves scattered, forming clonal patches in *Dennstaedtia*).
        - 13 Rhizomes long-creeping, leaves scattered, forming clonal patches; vascular bundles in the petiole 1, U-shaped (even in the lower petiole); sori very small, marginal in sinuses, the indusium cuplike, 2-parted, the outer part a modified tooth of the leaf blade; leaf blades conspicuously puberulent with septate hairs . . . . . **Dennstaedtia** (DENNSTAEDTIACEAE)
        - 13 Rhizomes short-creeping, the leaves clustered, not forming clonal patches; vascular bundles in the petiole 2-7 (sometimes uniting to 1 in the upper petiole); sori mostly larger, mostly not marginal, the indusium not as above (though cuplike in *Woodsia obtusa*); leaf blades either glabrous, glabrescent, with flattened scales, or puberulent with glandular trichomes.
          - 14 Vascular bundles (3-) 5 (-7) in the petiole . . . . . **Dryopteris** (DRYOPTERIDACEAE)
          - 14 Vascular bundles 2 in the petiole (or uniting near the leaf blade into 1).
            - 15 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy, presently known in our area only from the Coastal Plain of SC] . . . . . **Macrothelypteris** (THELYPTERIDACEAE)
            - 15 Leaves 5-25 (-30) cm wide, with scales and minute glands (sometimes also with septate hairs); [native species, widespread].
              - 16 Leaves 1-pinnate-pinnatifid; indusium cuplike, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments . . . . . **Woodsia obtusa** (DRYOPTERIDACEAE)
              - 16 Leaves 2-pinnate-pinnatifid; indusium flaplike or pocketlike, attached at one side of the sorus and arching over it.
                - 17 Leaves 10-30 cm wide, the tip acute to acuminate; indusium flaplike . . . . . **Athyrium** (DRYOPTERIDACEAE)
                - 17 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocketlike or hoodlike . . . . . **Cystopteris bulbifera** (DRYOPTERIDACEAE)

**Key G -- Medium to large pteridophytes, terrestrial,  
growing in soil, not associated with rock outcrops**

- 1 Leaves vine-like, 0.3-10 m long, the branching dichotomous, 1 branch of each dichotomy terminating in a pair of pinnae, the pinnae often widely spaced (more than 10 cm apart) . . . . . **Lygodium** (LYGODIACEAE)
- 1 Leaves not vine-like, 0.3-3 m long, the branching not as described above, the pinnae regularly and more-or-less closely spaced (mostly less than 10 cm apart).
  - 2 Leaf blades broadly (about equilaterally) triangular, pentagonal, or flabellate in outline, 0.7-1.3x as long as wide.
    - 3 Leaf blades flabellate or fan-shaped in outline, the petiole branched once dichotomously, each branch bearing 3-7 pinnae in one direction only . . . . . **Adiantum pedatum** (PTERIDACEAE)
    - 3 Leaf blades pentagonal or broadly triangular in outline, the petiole not branched dichotomously.
      - 4 Leaf blade pentagonal in outline, the terminal pinna the largest; sori submarginal, roundish, the indusium reniform . . . . . **Arachniodes simplicior** (DRYOPTERIDACEAE)
      - 4 Leaf blade broadly triangular in outline, the basal pinnae the largest; sori marginal, linear, indusium absent, protected by the revolute leaf margin and a minute false indusium (*Pteridium*), or sporangia borne in a stalked, specialized, fertile portion of the blade (*Botrychium*).
        - 5 Sporangia borne in marginal, linear sori, indusium absent, protected by the revolute leaf margin and a minute false indusium; texture of mature blades somewhat fleshy; plants solitary from a short underground rhizome with thick, mycorrhizal roots; [primarily of moist forests] . . . . . **Botrypus** (OPHIOGLOSSACEAE)
        - 5 Sporangia borne in a stalked, specialized, fertile portion of the blade; texture of mature leaf blades hard and stiff; plants colonial from deep-seated rhizomes; [primarily of moist to dry woodlands and savannas] . . . . . **Pteridium** (DENNSTAEDTIACEAE)
  - 2 Leaves elongate in outline, mostly ovate, lanceolate, oblanceolate, or narrowly triangular, 1.5-10x or more as long as wide.
    - 6 Leaves 2-pinnate or more divided, the pinnae divided to their midribs.
      - 7 Leaf blade divided into sterile and fertile portions, the fertile pinnae basal, the sterile pinnules 30-70 mm long and 8-23 mm wide, serrulate, rounded basally, rounded to somewhat acute apically, the fertile pinnae terminal

- and greatly reduced in size, the fertile pinnules 7-11 mm long and 2-3 mm wide . . . . .
- 7 Leaf blade not divided into sterile and fertile portions (though often not all pinnules on a leaf bearing sporangia), the pinnules bearing sporangia only slightly if at all reduced in size, both fertile and sterile pinnules usually 4-20 mm long and 2-10 mm wide.
- 8 Rhizomes long-creeping, leaves scattered, forming clonal patches; vascular bundles in the petiole 1, U-shaped (even in the lower petiole); sori very small, marginal in sinuses, the indusium cuplike, 2-parted, the outer part a modified tooth of the leaf blade; leaf blades conspicuously puberulent with septate hairs . . . . . **Dennstaedtia** (DENNSTAEDTIACEAE)
- 8 Rhizomes short-creeping, the leaves clustered, not forming clonal patches; vascular bundles in the petiole 2-7 (sometimes uniting to 1 in the upper petiole); sori mostly larger, mostly not marginal, the indusium not as above (though cuplike in *Woodsia obtusa*); leaf blades either glabrous, glabrescent, with flattened scales, or puberulent with glandular trichomes.
- 9 Vascular bundles (3-) 5 (-7) in the petiole . . . . . **Dryopteris** (DRYOPTERIDACEAE)
- 9 Vascular bundles 2 in the petiole (or uniting near the leaf blade into 1).
- 10 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy, presently known in our area only from the Coastal Plain of SC] . . . . . **Macrothelypteris** (THELYPTERIDACEAE)
- 10 Leaves 5-25 (-30) cm wide, with scales and minute glands (sometimes also with septate hairs); [native species, widespread].
- 11 Leaves 1-pinnate-pinnatifid; indusium cuplike, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments . . . . . **Woodsia obtusa** (DRYOPTERIDACEAE)
- 11 Leaves 2-pinnate-pinnatifid; indusium flaplike or pocketlike, attached at one side of the sorus and arching over it.
- 12 Leaves 10-30 cm wide, the tip acute to acuminate; indusium flaplike . . . . . **Athyrium** (DRYOPTERIDACEAE)
- 12 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocketlike or hoodlike . . . . . **Cystopteris bulbifera** (DRYOPTERIDACEAE)
- 6 Leaves 1-pinnate-pinnatifid or less divided, the pinnae entire, toothed, lobed or pinnatifid.
- 13 Leaves 1-pinnatifid, most of the pinnae not fully divided from one another (the rachis winged by leaf tissue most or all of its length); leaves dimorphic, the fertile much modified, stiff and/or woody.
- 14 Fertile leaf woody, brown, with bead-like segments; pinnae margins entire, often wavy or the lowermost even somewhat lobed; pinnae mostly with obtuse apices, tending to be borne opposite . . . . . **Onoclea sensibilis var. sensibilis** (DRYOPTERIDACEAE)
- 14 Fertile leaf stiff but herbaceous, green, the pinnae linear, not at all bead-like; pinnae margins finely serrulate, otherwise slightly wavy or straight; pinnae mostly with acute apices, tending to be borne alternate . . . . . **Woodwardia areolata** (BLECHNACEAE)
- 13 Leaves 1-pinnate or 1-pinnate-pinnatifid, the pinnae fully divided from one another (the rachis naked for most of its length, often winged in the terminal portion); leaves dimorphic or not.
- 15 Rhizomes long-creeping, leaves scattered, forming clonal patches.
- 16 Sori roundish, borne away from the main veins; pinna lobes of sterile leaves with the lateral veins free and pinnately arranged (the lowermost lateral vein sometimes joining that of the adjacent pinna lobe just below the sinus, but the remainder of the lateral veins all free) . . . . . **Thelypteris** (THELYPTERIDACEAE)
- 16 Sori elongate, borne end to end along either side of the main veins; pinna lobes of sterile leaves with reticulate, chain-like venation along the central vein . . . . . **Woodwardia virginica** (BLECHNACEAE)
- 15 Rhizomes short-creeping, the leaves clustered, not forming clonal patches (or rhizomes of both types, but leaves borne only in clusters on the short erect ones, in *Matteucia*)
- 17 Plants moderately to very robust, the leaves typically 6-30 dm tall; leaves either strongly dimorphic, the fertile leaves very unlike the sterile, brown at maturity (*Matteucia* and *Osmunda cinnamomea*) or the fertile pinnae very unlike the sterile, brown at maturity, borne as an interruption in the blade, with normal green pinnae above and below (*Osmunda claytoniana*); rachises scaleless, petioles scaleless (except at the base in *Matteucia*).
- 18 Leaves strongly tapering to the base from the broadest point (well beyond the midpoint of the blade), the basalmost pinnae much less than 1/2 as long as the largest pinnae . . . . . **Matteucia struthiopteris** (DRYOPTERIDACEAE)
- 18 Leaves slightly if at all tapering to the base, about equally broad through much of their length, the basalmost pinnae much more than 1/2 as long as the largest pinnae . . . . . **Osmunda** (OSMUNDACEAE)
- 17 Plants mostly less robust, the leaves 3-10 dm tall (except *Dryopteris ludoviciana*, *D. celsa*, and *D. goldiana* to 15 dm); leaves not at all or only slightly dimorphic, the fertile differing in various ways, such as having narrower pinnae (as in *Dryopteris ludoviciana*, *Polystichum acrostichoides*, *Diplazium*, and *Thelypteris palustris*) or the fertile leaves taller and more deciduous (as in *Asplenium platyneuron* and *Dryopteris cristata*), but not as described in the first lead; rachises and petioles variously scaly or scaleless, but at least the petiole and often also the rachis scaly if the plants over 1 m tall.
- 18 Sori elongate, the indusium elongate, attached along one side as a flap.
- 19 Petiole and rachis lustrous brownish-black; fertile leaves 2-8 (-12) cm wide . . . . . **Asplenium platyneuron** (ASPENIACEAE)
- 19 Petiole and rachis green; fertile leaves 10-20 (-30) cm wide.
- 20 Leaves 1-pinnate-pinnatifid (the pinnae pinnatifid) . . . . . **Deparia** (DRYOPTERIDACEAE)
- 20 Leaves 1-pinnate (the pinnae entire) . . . . . **Diplazium** (DRYOPTERIDACEAE)
- 18 Sori roundish, the indusium kidney-shaped or roundish, attached by a central stalk.

- 21 Leaves 1-pinnate, the pinnae toothed and each with a slight to prominent lobe near the base on the side towards the leaf tip, dark green, subcoriaceous to coriaceous; indusia peltate ..... **Polystichum** (DRYOPTERIDACEAE)
- 21 Leaves 1-pinnate-pinnatifid, the pinnae pinnatifid, generally lacking a prominent basal lobe, light green to dark green, herbaceous to subcoriaceous; indusium reniform.
  - 22 Vascular bundles in the petiole 4-7 ..... **Dryopteris** (DRYOPTERIDACEAE)
  - 22 Vascular bundles in the petiole 2, uniting above ..... **Thelypteris** (THELYPTERIDACEAE)

**ASPENIACEAE** Frank 1877 (Spleenwort Family)

A family of a single genus and more than 720 species, of nearly cosmopolitan distribution. Murakami et al. (1999) conducted a molecular phylogenetic analysis of the Aspleniaceae, which confirmed that *Camptosorus* should be included in *Asplenium*, but suggested that *Phyllitis* is better separated from *Asplenium*. A later and more comprehensive study shows *Phyllitis* and *Camptosorus* to be deeply embedded in *Asplenium* (Schneider et al. 2004), a conclusion followed here. References: Kramer & Viane in Kramer & Green (1993); Schneider et al. (2004).

**Asplenium** Linnaeus 1753 (Spleenwort)

*Asplenium* is a large, nearly cosmopolitan genus of more than 720 species, with centers of diversity in the Appalachians, Central America mountains, Andes, and Himalayas. References: Wagner, Moran, & Werth in FNA (1993b); Moran (1982); Taylor, Mohlenbrock, & Burton (1976); Murakami et al. (1999); Kramer & Viane in Kramer & Green (1993).

**Identification notes:** Several of the more frequently encountered sterile hybrids are included in the key and treated fully below.

- 1 Leaves simple, unlobed (or sometimes with a few, irregular forkings); veins free or anastomosing-areolate.
  - 2 Leaf blades 0-3 mm wide, linear, forking or with a few toothlike projections ..... [**A. septentrionale**]
  - 2 Leaf blades 10-40 mm wide, lanceolate, lance-attenuate, or oblong.
    - 3 Leaf apex long-attenuate and characteristically producing plantlets at the tip; veins anastomosing . **A. rhizophyllum**
    - 3 Leaf apex acute or obtuse, not attenuate, not producing plantlets at the tip; veins free.
      - 4 Longer indusia of each frond avg. 1.2 cm long; leaves (1-) avg. 2.3 (-3.4) dm long; [native in TN, AL, and elsewhere, in natural limestone sinkholes] ..... [**A. scolopendrium** var. **americanum**]
      - 4 Longer indusia of each frond avg. 1.7 cm long; leaves (1-) avg. 3 (-6) dm long; [rarely introduced in North America, typically in artificial settings, such as wells] ..... [**A. scolopendrium** var. **scolopendrium**]
- 1 Leaves pinnatifid (at least in the lower half of the leaf), pinnate, pinnate-pinnatifid, bipinnate, or tripinnate, the apex obtuse, acute, acuminate, or attenuate; veins free.
  - 5 Rachis dull green throughout its length, or at least towards the tip; leaves pinnatifid to tripinnate, the outline of the leaf blade narrowly to broadly triangular, widest at the base.
    - 6 Petiole dark throughout its length (from base to first leaflet).
      - 7 Leaves bipinnate at the base, pinnate-pinnatifid above; spores normal ..... **A. bradleyi**
      - 7 Leaves pinnate at the base, pinnatifid above; spores abortive (very rarely normal, outside of our area) ..... **A. xebenoides**
    - 6 Petiole partially or entirely green (darkened or not at its base).
      - 8 Leaves pinnatifid or pinnate through most or all of their lengths.
        - 9 Leaves pinnatifid, sometimes fully pinnate at the base; spores normal ..... **A. pinnatifidum**
        - 9 Leaves pinnate, sometimes pinnate-pinnatifid at the base; spores abortive ..... **A. xtrudellii**
      - 8 Leaves bipinnate to tripinnate.
        - 10 Petiole darkened towards the base; pinnules toothed, lacerate, pinnatifid, or pinnate; leaves bipinnate to tripinnate, the leaf blades lanceolate-ovate to lanceolate-oblong; ultimate leaf segments sessile or nearly so; [of acidic rocks] ..... **A. montanum**
        - 10 Petiole entirely green; pinnules toothed; leaves bipinnate, the leaf blades ovate-triangular; ultimate leaf segments mostly stalked; [of calcareous rocks] ..... **A. ruta-muraria** var. **cryptolepis**
    - 5 Rachis shiny black or dark brown throughout its length; leaves pinnate, the outline of the leaf blade linear, lanceolate, or oblanceolate, with more-or-less parallel sides for much of its length.
      - 11 Pinnae orbicular to obovate-oblong, 1-2x as long as wide, the base more-or-less symmetrical (if auriculate, only slightly so and on the side of the pinna towards the base of the leaf); old leaf rachises often with persistent projections left from the disarticulation of the pinnae.
        - 12 Sori 4-6 (-9) per pinna, up to 2 mm long; rhizome scales up to 3 mm long; petiole relatively thin, shiny, coppery or bronze; pinnae mostly alternate, suborbicular, spaced more distantly, thinner in texture, set at a fairly oblique angle to the rachis, often slightly auriculate on the side of the pinna towards the leaf base; spores mostly 29-36 μ long; stomate guard cells mostly 38-43 μ long; [mostly of noncalcareous rocks] ..... **A. trichomanes** ssp. **trichomanes**
        - 12 Sori 4-9 (-12) per pinna, up to 3 mm long; rhizome scales up to 5 mm long; petiole relatively thicker, blackish-brown; pinnae mostly opposite, oblong, spaced more closely, thicker in texture, set at a nearly right angle to the rachis, rarely at all auriculate; spores mostly 34-43 μ long; stomate guard cells mostly 41-49 μ long; [of calcareous rocks] ..... **A. trichomanes** ssp. **quadrivalens**
      - 11 Pinnae oblong-rectangular, 2x or more as long as wide, the base asymmetrical or auricled (more prominently auricled on the side of the pinna towards the tip of the leaf); old leaf rachises lacking persistent projections left from the disarticulation of the pinnae.
        - 13 Leaves slightly dimorphic, the fertile upright and larger, the sterile spreading and smaller; pinna auricles

- prominent, often overlapping the rachis; [terrestrial, often not associated with rock outcrops] . . . **A. platyneuron**
- 13 Leaves not dimorphic; pinna auricles less prominent, usually not overlapping the rachis; [epipetric, always growing in crevices of rock outcrops or in thin soil immediately adjacent to exposed rock].
- 14 Main vein of the pinna running along the basal edge; sori 1 (-3) per pinna, 1.5-3 mm long, borne along the basal edge, the indusium translucent, whitish, opening towards the leaf tip . . . . . **A. monanthes**
- 14 Main vein of the pinna running more-or-less medially; sori 4-10 per pinna (on well-developed pinnae), 1.0-1.5 mm long, borne on both sides of the main vein, the indusium opaque, greenish, opening towards the pinna tip.
- 15 Pinnae margins subentire; pinnae blue-green, coriaceous, borne at right angles to the rachis or slightly reflexed, usually strictly opposite throughout the entire length of the leaf blade . . . **A. resiliens**
- 15 Pinnae margins shallowly crenate or crenate-serrate; pinnae bright-green, subcoriaceous, borne at right angles to the rachis or ascending, opposite below but usually becoming alternate in the apical 1/3-1/2 of the leaf blade
- 16 Pinna margins crenate to serrate; pinna base lacking an auricle, or the auricle rudimentary; veins evident; spores 64 per sporangium . . . . . **A. heterochroum**
- 16 Pinna margins shallowly crenate; pinna base with auricle; veins obscure; spores 32 per sporangium . . . . . **A. heteroresiliens**

**Asplenium bradleyi** D.C. Eaton, Bradley's Spleenwort. Pd (GA, NC, SC, VA), Mt (GA, NC, VA), Cp (GA, SC): dry outcrops of felsic sedimentary or metasedimentary rocks, such as sandstone, quartzite, or metaquartzite, at low to moderate elevations; rare (NC Rare, SC Rare, VA Watch List). April-October. PA, MD, OH, KY, s. IL, and MO south to c. NC, c. GA, AL, TN, and AR, reaching its greatest abundance in the Ozarkian highlands. This species is a fertile allotetraploid derived from hybridization between *A. montanum* and *A. platyneuron*. Its chromosome complement can be symbolized MMPP. The sterile hybrid has also been found in NC; its chromosome complement is MP. [= RAB, C, F, FNA, G, K, S, W; = *A. xbradleyi*]

**Asplenium xebenoides** R.R. Scott (pro species) [*A. platyneuron* x *rhizophyllum*], Scott's Spleenwort. Mt (GA, NC, VA), Pd, Cp (VA): moist outcrops of calcareous sedimentary rocks, such as limestone, dolostone, and on coquina limestone (shell marl), at low elevations; rare. May-October. VT, NJ, c. PA, OH, s. IL, and MO south to e. VA, w. NC, nw. GA, c. AL, TN, and AR. So far as is known, *A. xebenoides* is a sterile hybrid throughout our range (chromosome complement symbolized PR). In AL, however, one population in Hale County has undergone chromosome doubling and is a fertile allotetraploid (PPRR). Populations of this taxon, especially if consisting of many individuals, should be checked for fertile spores. [= K; = *xAsplenosorus ebenoides* (R.R. Scott) Wherry -- F; = *Asplenosorus ebenoides* (R.R. Scott) Wherry -- G; = *Asplenium ebenoides* R.R. Scott -- FNA, S]

**Asplenium heterochroum** Kunze, Bicolored Spleenwort. Cp (GA, SC): fairly moist outcrops of calcareous sedimentary rocks, such as coquina limestone ("marl"); rare (GA Special Concern). Se. and sc. GA (Jones & Coile 1988) south to n. FL; West Indies; Belize. [= FNA, K; < *A. heterochroum* Kunze -- S, in part]

**Asplenium heteroresiliens** W.H. Wagner, Marl Spleenwort, Carolina Spleenwort, Wagner's Spleenwort, Morzenti's Spleenwort. Cp (GA, NC, SC): fairly moist outcrops of calcareous sedimentary rocks, such as coquina limestone ("marl"), along small blackwater streams or larger rivers, at low elevations, and rarely also on old ruins made of tabby (a cement made from lime, sand and oyster shells); rare (US Species of Concern, GA Threatened, NC Endangered, SC Rare). April-October. Rare and scattered from se. NC to se. GA, sw. GA, and n. FL, on the Coastal Plain. This species is an apogamous (producing viable spores asexually) allopentaploid derived from hybridization of the sexual tetraploid *H. heterochroum* Kunze (of Florida and the West Indies) and the apogamous triploid *A. resiliens*. Its chromosome complement can be symbolized EEEHH. [= RAB; = *A. xheteroresiliens* -- FNA, K; < *A. heterochroum* Kunze -- S, in part]

**Asplenium monanthes** Linnaeus, Single-sorus Spleenwort. Mt (NC, SC): moist outcrops of calcareous to semi-calcareous metamorphic rocks, such as mylonite or marble, near waterfalls in humid escarpment gorges with high rainfall, at low elevations; rare (NC Endangered, SC Rare). April-October. Scattered in highly humid (montane or maritime) parts of the tropics, subtropics, and warm temperate areas, known from se. and sw. North America, the West Indies (Hispaniola and Jamaica), n. South America, Central America, Mexico, South Africa, Hawaii, and Sandwich Islands, the Azores, Madeira Islands, Madagascar, and the Philippines. In the continental United States, it is known from widely scattered sites with humid and calcareous microhabitats: humid escarpment gorges in Transylvania County, NC and Oconee County, SC; moist limestone outcrops in n. peninsular and Panhandle FL (Nelson 2000); sinkholes limestone talus in the collapsed mouth of a sinkhole in Jackson County, AL; and the Huachuca Mountains, Cochise County, AZ. [= RAB, FNA, K, W]

**Asplenium montanum** Willdenow, Mountain Spleenwort. Mt, Pd (GA, NC, SC, VA): moist to dry outcrops of metamorphic, sedimentary, or igneous rocks, such as gneiss, schist, amphibolite, quartzite, rhyolite, sandstone, mostly at moderate to high elevations (up to over 2000m), but in the Piedmont to as low as 150 m; common. May-October. Primarily Appalachian: s. VT, MA, NY, OH, and KY south to c. NC, n. GA and AL; absent from the Ozarkian highlands. *A. montanum* is one of the diploid progenitors of the reticulately evolved Appalachian *Asplenium* complex; its chromosome complement is symbolized MM. It is one parent of *A. bradleyi*, *A. pinnatifidum*, and *A. xtrudellii* (and of other sterile hybrids). [= RAB, C, F, FNA, G, K, S, W]

**Asplenium pinnatifidum** Nuttall, Lobed Spleenwort. Pd, Mt (GA, NC, SC, VA): fairly moist to very dry outcrops of felsic sedimentary or (mostly low-grade) metamorphic rocks, such as sandstone, phyllite, and schist, at low to moderate elevations; uncommon (NC Watch List, SC Rare). May-October. NJ, se. PA, wc. PA, s. OH, IN, IL, and MO south to w. NC, c. GA (Jones & Coile 1988), AL, n. MS, AR, and e. OK. This species is a fertile allotetraploid derived from hybridization of *A. montanum* and *A. rhizophyllum*; its chromosome complement is symbolized MMRR. [= RAB, C, F, FNA, S, W; = *A. pinnatifidum* var. *pinnatifidum* -- G; = *A. xpinnatifidum* -- K]

**Asplenium platyneuron** (Linnaeus) Britton, Sterns, & Poggenburg, Ebony Spleenwort. Mt, Pd, Cp (GA, NC, SC, VA): moist to dry soils of forests, woodlands, old fields; also on outcrops, especially of calcareous rocks, at low to moderate elevations; common. April-October. Québec, Ontario, se. MN, IA, and se. CO south to FL, TX, NM, and AZ (and varieties or relatives reported from Central and South America). This species is one of the diploid progenitors involved in the reticulately evolved Appalachian *Asplenium* complex. It is one parent of *A. bradleyi* and *A. xebenoides* (as well as other sterile hybrids). *A. platyneuron* in general, and var. *platyneuron* specifically, is by far the most common of our *Asplenium*, and the only one found characteristically away from rock. *A. platyneuron* var. *incisum* does not seem to warrant taxonomic recognition. Strikingly large plants of the outer Atlantic Coastal Plain and Gulf Coastal Plain have been named var. *bacculum-rubrum* (Featherman) Fernald; they are probably not worthy of taxonomic recognition. They can be distinguished as follows: var. *bacculum-rubrum* has the longest pinnae more than 3.5-6 cm

long, the pinnae often coarsely serrate-incised to pinnatifid and the larger leaves to (30-) 40-70 (-100) cm tall, with 45-70 pairs of pinnae (vs. longest pinnae less than 3.5 cm long, pinnae subentire to pinnatifid, larger leaves to 20-45 (-50) cm tall, with 25-50 pairs of pinnae). [= RAB, C, FNA, S, W; > *A. platyneuron* var. *bacculum-rubrum* (Featherman) Fernald – F, G, K; > *A. platyneuron* var. *incisum* (Howe ex Peck) B.L. Robinson -- F]

***Asplenium resiliens*** Kunze, Blackstem Spleenwort. Mt (GA, NC, SC, VA), Pd (GA, NC, VA), Cp (GA): moist to dry outcrops of calcareous sedimentary or metamorphic rocks, such as limestone, dolostone, or marble, sometimes on narrow seams of calcareous materials in otherwise acidic rocks, mostly at low to moderate elevations, but remarkably on Grandfather Mountain at over 1800m; common in VA, rare in VA Piedmont, NC, and SC (NC Watch List, SC Rare). April-October. Sc. PA, KY, s. IL, MO, se. KS, OK, TX, CO, and s. NV south to FL, TX, AZ, and Mexico; also in the West Indies, Central America, and South America. This species is a triploid (EEE), unable to produce viable spores by sexual means, but producing spores apogamously. It is a parent species of the rare *A. heteroresiliens*. [= RAB, C, F, FNA, G, K, S, W]

***Asplenium rhizophyllum*** Linnaeus, Walking Fern. Mt (GA, NC, SC, VA), Pd (GA, NC, VA), Cp (NC, VA): moist outcrops of calcareous sedimentary, calcareous metamorphic, or mafic metamorphic rocks, such as limestone, dolostone, calcareous siltstone, amphibolite, mostly at low to moderate elevations, rarely to 1500 m or higher; common (but local) in VA Mountains, uncommon in VA Piedmont, rare in VA Coastal Plain, uncommon in NC Mountains, rare in NC Piedmont and Coastal Plain (SC Rare). May-October. S. Québec, Ontario and se. MN south to c. GA, AL, MS, AR, OK, and IA. This species, sometimes placed in the genus *Camptosorus* because of its strikingly different morphology from (most) other *Asplenium*, is one of the diploid progenitors of the reticulately evolved Appalachian *Asplenium* complex. It is a parent of *A. pinnatifidum* and *A. xebenooides* (as well as other sterile hybrids), both of which have inherited a limited ability to produce plantlets at the attenuate leaf-tip. It is closely related to *Asplenium sibiricum* of e. Asia. [= RAB, C, FNA, K, W; = *Camptosorus rhizophyllum* (Linnaeus) Link -- F, G, S]

***Asplenium ruta-muraria*** Linnaeus var. ***cryptolepis*** (Fernald) Wherry, American Wall-rue. Mt (GA, NC, VA), Pd (VA): moist to dry outcrops of calcareous sedimentary or metamorphic rocks, such as limestone, dolostone, or marble, at low to moderate elevations; uncommon in VA (rare in Piedmont, rare in NC) (GA Special Concern). May-October. *A. ruta-muraria* is a circumboreal species of Europe, Asia, and North America; in North America it ranges as var. *cryptolepis* from VT, s. Ontario and n. MI south to n. NJ, w. NC, nw. GA (Jones & Coile 1988), n. AL, TN, and AR. Var. *ohionis* is very likely only a form. The relationship of North American *A. ruta-muraria* (here distinguished as var. *cryptolepis*), a tetraploid, to the diploid and tetraploid subspecies of *A. ruta-muraria* present in Europe and e. Asia is uncertain. Given the prevalence of allopolyploidy in *Asplenium* and slight morphologic differences between American and European material, I prefer not to assume its identity to the European plants. In Europe *A. ruta-muraria* is an abundant plant of masonry, such as the defensive walls of towns and cities; it is very rarely seen on walls in North America, presumably because they are not old enough. [< *A. ruta-muraria* -- RAB, C, FNA, W; > *A. cryptolepis* Fernald var. *cryptolepis* -- F, S; > *A. cryptolepis* Fernald var. *ohionis* Fernald -- F, S; > *A. ruta-muraria* var. *ohionis* (Fernald) Wherry -- G; > *A. ruta-muraria* var. *cryptolepis* – G; > *A. ruta-muraria* var. *lanceolum* Christ -- K; > *A. ruta-muraria* var. *cryptolepis* – K, in a narrower sense]

***Asplenium trichomanes*** Linnaeus ssp. ***quadrivalens*** D.E. Meyer emend. Lovis, Maidenhair Spleenwort. Mt (VA): moist outcrops of calcareous sedimentary rocks, such as limestone or dolostone; rare (VA Watch List). May-October. Ssp. *quadrivalens* is known from North America and Europe (at least); in North America it is substantially rarer than ssp. *trichomanes* and more limited in range, occurring from New England and s. Ontario south to w. VA, OH, and s. IL, and in British Columbia, WA, and OR. Ssp. *quadrivalens* is a tetraploid of uncertain origin, presumably autotetraploid, but perhaps the result of the hybridization of 2 ecologically differentiated diploid races of *A. trichomanes*. [= FNA, K, W; < *A. trichomanes* -- RAB, C, F, G, S]

***Asplenium trichomanes*** Linnaeus ssp. ***trichomanes***, Maidenhair Spleenwort. Mt, Pd (GA, NC, SC, VA): moist outcrops of slightly to strongly calcareous sedimentary or metamorphic rocks and moderately to strongly mafic metamorphic and igneous rocks, such as limestone, dolostone, mafic and intermediate gneisses and schists, amphibolite, most typically in strong shade, as under overhangs; common (SC Rare). May-October. *A. trichomanes* as a whole is a complex species, with diploid, tetraploid, and hexaploid elements, occurring in North America, Europe, Australia, New Zealand, and Asia. Ssp. *trichomanes* is known to occur in Europe and North America (at least); in North America, it ranges from Newfoundland to AK, south to NC, c. GA (Jones & Coile 1988), c. AL, AR, OK, w. TX, se. AZ, and w. OR. Ssp. *trichomanes* is a diploid, probably involved in the origin of ssp. *quadrivalens*. [= FNA, K, W; < *A. trichomanes* -- RAB, C, F, G, S]

***Asplenium xtrudellii*** Wherry (pro species) [*montanum* x *pinnatifidum*], Trudell's Spleenwort. Pd (GA, VA), Mt (GA, NC, VA): moist outcrops of felsic sedimentary or metamorphic rocks, such as sandstone, phyllite, schist, at low elevations; rare. May-October. This taxon is a sterile triploid hybrid (MMR) of *A. montanum* and *A. pinnatifidum*. It is considerably more common than most other sterile *Asplenium* hybrids, sometimes occurring without one or either parents. There are some reports that it can sometimes produce fertile spores. [= F, FNA, K; = *Asplenium pinnatifidum* Nuttall var. *trudellii* (Wherry) Clute -- G; = *Asplenium trudellii* Wherry -- S; = x*Asplenosorus trudellii* (Wherry) Mickel]

***Asplenium scolopendrium*** Linnaeus var. ***americanum*** (Fernald) Kartesz & Gandhi, American Hart's-tongue Fern, is a very rare taxon, occurring in humid sinkholes in e. TN and n. AL, and other habitats, farther north in c. NY, n. MI, and Ontario; it is also reported as naturalized in MD by Reed (1953). [= FNA, K; = *Phyllitis scolopendrium* (Linnaeus) Newman var. *americana* Fernald -- C, F, G]

\* ***Asplenium scolopendrium*** Linnaeus var. ***scolopendrium*** is reported as naturalized in a well in MD by Reed (1953). [= FNA, K; = *Phyllitis scolopendrium* (Linnaeus) Newman var. *scolopendrium* -- C, F, G]

***Asplenium septentrionale*** (Linnaeus) Hoffmann, Forked Spleenwort, occurs in WV (Hardy and Monroe counties), close to the VA line. It occurs on acidic rocks and may well be found in our area, as it is so inconspicuous. Its chromosome formula is SSSS. [= C, FNA, K]

The following additional hybrids (with both parents occurring in our area) are known; not all have been reported from our area, but all could plausibly occur here. They can usually be fairly readily recognized by observers experienced with both of their parents; their morphology is intermediate between the two parents, and they are usually (though not always) found in close proximity to both parents.

***Asplenium xalternifolium*** Wulfen (pro sp.) [*A. septentrionale* x *trichomanes*]. Chromosome formula = SSTT. Known from Hardy County, WV (Wagner et al. 1991). [= FNA, K]

***Asplenium xboydstoniae*** (Walter) Short [*A. ebenoides* x *platyneuron*]. Chromosome formula = PPPR. Known from Hale County,

AL. This hybrid can only occur in association with fertile (autotetraploid) *A. ebenoides*, which is so far known only from Hale County, AL. [= FNA, K]

***Asplenium xclermontiae*** Syme [*A. ruta-muraria* x *trichomanes*]. Chromosome formula = TTUU. Known from OH. [= K; = *A. xclermontae* -- FNA, orthographic variant]

***Asplenium xgravesii*** Maxon [*A. bradleyi* x *pinnatifidum*]. Chromosome formula = MMPR. Known from GA, VA, TN, KY, and other states. [= FNA, K]

***Asplenium xherb-wagneri*** W.C. Taylor & Mohlenbrock [*A. pinnatifidum* x *trichomanes*]. Chromosome formula = MRT. [= FNA, K]

***Asplenium xinexpectatum*** (E.L. Braun ex Friesner) Morton [*A. rhizophyllum* x *ruta-muraria*]. Chromosome formula = RUU. [= FNA, K]

***Asplenium xkentuckiense*** T.N. McCoy [*A. pinnatifidum* x *platyneuron*]. Chromosome formula = MPR. Known from several localities in the VA Mountains and Piedmont. [= FNA, K]

***Asplenium xmorganii*** W.H. Wagner [*A. platyneuron* x *ruta-muraria*]. Chromosome formula = PUU. Known from MD. [= K]

***Asplenium xshawneense*** (R.C. Moran) H.E. Ballard [*A. rhizophyllum* x *trichomanes*]. Chromosome formula = RT. [= FNA, K]

***Asplenium xvirginicum*** Maxon [*A. platyneuron* x *trichomanes*]. Chromosome formula = PT. [= FNA, K]

***Asplenium xwherryi*** D.M. Smith [*A. bradleyi* x *montanum*]. Chromosome formula = MMP. Known from Murray Co. GA. [= FNA, K]

***Camptosorus***

[see *Asplenium*]

***Phyllitis***

[see *Asplenium*]

**AZOLLACEAE** Wettst. 1903 (Mosquito Fern Family)

Azollaceae consists of the single genus *Azolla*, with about 6 species. References: Lumpkin in FNA (1993b).

***Azolla*** Lamarck 1783 (Mosquito Fern)

A small genus of about 6 species, floating aquatics, in tropical and warm temperate regions. Very un-fernlike, this floating aquatic looks superficially more like an aquatic liverwort. In some years and some places it occurs in great abundance, covering the surface of the water with a green or red mass of vegetation. *Azolla* has a symbiotic, nitrogen-fixing cyanobacterium, *Anabaena azollae* Strasburger. The nitrogen-fixing capabilities of *Azolla* have resulted in its use as a fertilizer, green manure, and livestock feed, much promoted in recent years, but used historically in Asian rice paddies for centuries (Lumpkin in FNA 1993b). References: Lumpkin in FNA (1993b).

- 1 Largest hairs on upper leaf lobe with 2 or more cells; megaspores densely covered with tangled filaments . . . . . ***A. caroliniana***
- 1 Largest hairs on upper leaf lobe with 1 cell; megaspores with raised angular bumps, visible through a sparse layer of filaments . . . . . ***A. filiculoides***

***Azolla caroliniana*** Willdenow, Eastern Mosquito Fern, Water fern. Cp (GA, NC, SC, VA), Mt, Pd (NC, SC, VA): stagnant waters of interdune ponds, limesink ponds, old millponds, beaver ponds, floodplain sloughs; uncommon (though often locally abundant, rare in Mountains and Piedmont of Virginia only). June-September. Widespread in the se. United States, extending irregularly north (partly from introductions) into s. New England and MN, and south into the tropics. [= RAB, C, F, FNA, G, K, S]

\* ***Azolla filiculoides*** Lamarck. Cp (GA): freshwater lake; rare, introduced from w. North America. This species is reported for e. GA from a freshwater lake on Sapelo Island, McIntosh Co. (Bates & Browne 1981), presumably as an accidental introduction. [= FNA, K]

**BLECHNACEAE** (C. Presl) Copeland 1947 (Deer Fern Family)

A family of about 9 genera and 250 species, cosmopolitan in distribution. References: Lellinger (1985); Cranfill in FNA (1993b); Kramer, Chambers, & Hennipman in Kramer & Green (1993).

- 1 Veins of sterile leaves free; sori continuous . . . . . ***Blechnum***
- 1 Veins of sterile leaves anastomosing; sori distinct from one another, in rows . . . . . ***Woodwardia***

***Blechnum*** Linnaeus 1753 (Deer Fern)

A genus of about 220 species, of nearly cosmopolitan distribution (mostly tropical and especially Southern Hemisphere). References: Kramer, Chambers, & Hennipman in Kramer & Green (1993).

***Blechnum occidentale*** Linnaeus var. *minor* Hooker, Hammock Fern. Cp (GA): moist forests; rare. S. GA south to FL, the West Indies, Central America, and South America. [= FNA; < *B. occidentale* -- K, S]

***Woodwardia*** J.E. Smith 1793 (Chain Fern)

A genus of about 13 species of temperate and tropical portions of the Northern Hemisphere. References: Kramer, Chambers, & Hennisman in Kramer & Green (1993).

- 1 Sterile leaves pinnatifid, the pinnae 7-10 pairs per leaf, basally not distinct from one another, the rachis therefore winged by leaf tissue throughout its length, the pinnae merely finely serrulate . . . . . **W. areolata**
- 1 Sterile leaves pinnate-pinnatifid, the pinnae 15-20 pairs per leaf, fully distinct, the rachis therefore not winged by leaf tissue, the pinnae themselves pinnatifid . . . . . **W. virginica**

**Woodwardia areolata** (Linnaeus) T. Moore, Netted Chain Fern. Cp, Pd, Mt (GA, NC, SC, VA): moist to wet, acid, organic soils, such as bogs, blackwater bottomlands, pocosins; common (rare in VA Mountains). May-September. Ranging from Nova Scotia west to MI and MO, south to FL and e. TX, primarily on the Coastal Plain. When fruiting structures are not present, sometimes confused with *Onoclea*, but *W. areolata* has the pinnae tending to be alternate (vs. tending to be opposite), the pinnae tending to be acute or acuminate (vs. obtuse), and the pinna margin finely serrulate (vs. entire). See Cranfill (1983) for a discussion of the geography and ecology of *W. areolata*. [= RAB, C, F, FNA, G, K, W; = *Lorinseria areolata* (Linnaeus) K. Presl -- S]

**Woodwardia virginica** (Linnaeus) J.E. Smith, Virginia Chain Fern. Cp, Mt, Pd (GA, NC, SC, VA): moist to wet, acid, organic soils, such as bogs, blackwater bottomlands, pocosins, sometimes in standing water, as in periodically flooded coastal plain depression ponds; common (rare in VA Mountains and VA Piedmont). June-September. Ranging from Nova Scotia west to MI and IL, south to FL and TX, and in Bermuda, primarily on the Coastal Plain. Sometimes confused when sterile with *Osmunda cinnamomea* (which see for discussion). [= RAB, C, F, FNA, G, K, W; = *Anchistea virginica* (Linnaeus) K. Presl -- S]

**DENNSTAEDTIACEAE** Pichi Sermolli 1970 (Bracken Family)

A family of about 16 genera and 370 species, of cosmopolitan distribution; the circumscription is very uncertain and controversial, however. References: Lellinger (1985); Cranfill in FNA (1993b); Kramer in Kramer & Green (1993).

- 1 Leaf blades elongate in outline, at least 4x as long as broad, membranaceous; sori globular, separate . . . . . **Dennstaedtia**
- 1 Leaf blades broadly triangular in outline, about as broad as long, subcoriaceous; sori linear, confluent . . . . . **Pteridium**

**Dennstaedtia** Bernhardt 1801 (Cuplet Fern)

A genus of about 45 species, of tropical to temperate distribution; *Dennstaedtia* is poorly known and of uncertain circumscription. References: Nauman & Evans in FNA (1993b); Kramer in Kramer & Green (1993).

**Dennstaedtia punctilobula** (Michaux) T. Moore, Hay-scented Fern, Pasture Fern, Boulder Fern. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): rocky or dry woodlands and forests, rock outcrops, pastures, clearings, roadbanks; common (uncommon in Piedmont, rare in Coastal Plain). June-September. Nova Scotia and Québec west to MI, south to NC, n. GA, n. AL, and AR, progressively more montane southwards. This common species can be distinguished from other woodland ferns with deciduous fronds of similar size and shape (such as *Athyrium*, *Dryopteris*, and *Thelypteris*) by the following characteristics: leaves yellow-green or pale-green in color, with whitish-gray glandular trichomes, petioles silvery-pilose, leaves borne scattered (as clonal patches), sori tiny (less than 0.5 mm in diameter). *Dennstaedtia* is a large, pantropical genus; only *D. punctilobula* is temperate in distribution. Anatomical evidence indicates that it is not closely related to tropical *Dennstaedtia*, and its separation from that genus may be warranted. [= RAB, C, F, FNA, G, K, S, W]

\* *Dennstaedtia cicutaria* (Sw.) T. Moore. AL. {investigate status} [= K]

**Pteridium** Gleditsch ex Scopoli 1760 (Bracken)

A genus of 2-11 species, cosmopolitan in distribution. *Pteridium* is a notorious and nearly worldwide weed (though less consequential in our area than in many parts of the world), nearly impossible to eradicate because of its deeply subterranean rhizomes. Bracken fiddleheads are sometimes eaten, but they are poisonous and highly carcinogenic. Bracken is not favored by grazing animals, and increases its abundance under grazing pressure. In overgrazed pastures, however, cattle will graze on bracken, the carcinogenic compound (shikimic acid) then transmittable to humans through milk. References: Jacobs & Peck in FNA (1993b).

- 1 Terminal segments of well-developed pinnules 2-4x as long as broad, about 3-7 mm wide, the margins usually pubescent; lower surface of rachis and costae shaggy pubescent . . . . . **P. aquilinum** var. **latiusculum**
- 1 Terminal segments of well-developed pinnules 6-15x as long as broad, about 2-5 mm wide, the margins usually glabrous or sparsely pilose; lower surface of rachis and costae glabrous or sparsely pilose . . . . . **P. aquilinum** var. **pseudocaudatum**

**Pteridium aquilinum** (Linnaeus) Kuhn var. **latiusculum** (Desvaux) Underwood ex Heller, Eastern Bracken. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): mainly in dry woodlands, forests, and heath balds, up to 1600m in elevation; common (rare in Coastal Plain). July-September. The species is nearly worldwide in distribution; var. *latiusculum* is itself very widely distributed, occurring in most of North America (largely replaced by var. *pseudocaudatum* in the Southeast), in Mexico, and in Eurasia. The relationship of these two varieties is discussed in detail by Speer & Hilu (1999) and Speer, Werth, & Hilu (1999). [= RAB, C, F, FNA, G, K, W; = *P. latiusculum* (Desvaux) Hieronymus var. *latiusculum* -- S]

**Pteridium aquilinum** (Linnaeus) Kuhn var. **pseudocaudatum** (Clute) Heller, Tailed Bracken, Southern Bracken. Cp, Pd (GA, NC, SC, VA), Mt (GA, NC, SC): mainly in dry sandy woodlands, often locally abundant in sandhills and flatwoods; common (uncommon in Piedmont). July-September. Var. *pseudocaudatum* is primarily a variety of the Southeastern Coastal Plain (where it is ubiquitous and abundant), but is reported north to MA, OH, IN, s. MI, and MO. [= RAB, C, F, FNA, G, K, W; = *P. latiusculum*

(Desvaux) Hieronymus var. *pseudocaudatum* (Clute) Maxon -- S]

**DRYOPTERIDACEAE** Ching 1965 (Wood-fern Family)

A family of about 47 genera and 1700 species, cosmopolitan in distribution, but concentrated in temperate and montane areas. References: Smith in FNA (1993b); Lellinger (1985); Kramer et al. in Kramer & Green (1993).

- 1 Leaves dimorphic, the pinnae or pinnules of the fertile leaves contracted, brown, and more-or-less beadlike; [subfamily *Athyrioideae*, tribe *Onocleaeae*].
  - 2 Sterile leaves pinnate-pinnatifid, 6-25 dm tall, broadest towards the tip; fertile leaves 1-pinnate; veins free; rhizomes of 2 types, the slender, creeping rhizomes leafless, giving rise at intervals to extremely stout, vertical rhizomes which bear a cluster of many leaves . . . . . **Matteucia**
  - 2 Sterile leaves pinnatifid, 2-10 dm tall, broadest near the base; fertile leaves 2-pinnate; veins netted; rhizomes all slender and creeping, the leaves borne scattered along the rhizome . . . . . **Onoclea**
- 1 Leaves monomorphic (the fertile like the sterile), or slightly dimorphic (the fertile differing from the sterile only in size, shape, or orientation).
  - 3 Sori elongate, indusia present and flaplike, attached along a long side; vascular bundles in the petiole 2; [subfamily *Athyrioideae*, tribe *Physematieae*].
    - 4 Leaves 2-pinnate to 3-pinnate (the pinnae at least 1-pinnate); sori elongate, 2-3x as long as wide, the larger sori generally curved and extending across the veins . . . . . **Athyrium**
    - 4 Leaves 1-pinnate to 1-pinnate-pinnatifid (the pinnae entire or pinnatifid); sori elongate, 2.5-6x as long as wide, even the larger sori generally straight and not extending across the veins.
      - 5 Leaves 1-pinnate-pinnatifid, the pinnae pinnatifid . . . . . **Deparia**
      - 5 Leaves 1-pinnate, the pinnae entire . . . . . **Diplazium**
  - 3 Sori round, indusia present or absent, if present reniform, peltate, cuplike, or lateral (but not attached along a long side); vascular bundles in the petiole either 2 or 4-7.
    - 6 Leaf blades pentagonal or broadly triangular in outline, ca. 1x as long as wide.
      - 7 Leaf blade pentagonal in outline, the terminal pinna by far the largest; rhizome 5-8 mm in diameter; indusia present, thick, persistent, and reniform; vascular bundles in the lower petiole 4-7; [introduced species, naturalized in moist ravines in SC]; [subfamily *Dryopteridoideae*, tribe *Dryopterideae*] . . . . . **Arachniodes**
      - 7 Leaf blade broadly triangular in outline, the basal pinnae by far the largest; rhizome ca. 1 mm in diameter; indusia absent; vascular bundles in the lower petiole 2; [native species of mountain peaks of n. NC and VA]; [subfamily *Athyrioideae*, tribe *Physematieae*] . . . . . **Gymnocarpium**
    - 6 Leaf blades lanceolate, oblong, or ovate in outline, 2x or more as long as wide.
      - 8 Leaves 1-pinnate, the pinnae toothed and each with a slight to prominent lobe near the base on the side towards the leaf tip, dark green, subcoriaceous to coriaceous; indusia peltate; [subfamily *Dryopteridoideae*, tribe *Dryopterideae*].
        - 9 Veins anastomosing, rejoining to form a netlike pattern; pinnae 4-25 pairs per leaf; [non-native, rarely naturalized] . . . . . **Cyrtomium**
        - 9 Veins branching dichotomously, free, not rejoining to form a netlike pattern; pinnae 25-50 pairs on larger leaves; [plant a common native species] . . . . . **Polystichum**
      - 8 Leaves 1-pinnate-pinnatifid to more divided, the pinnae pinnatifid or themselves fully divided, generally lacking a prominent basal lobe, light green to dark green, herbaceous to subcoriaceous; indusia reniform, cuplike, or lateral.
        - 10 Indusia reniform; vascular bundles in the lower petiole 4-7; plants medium to large, the larger leaf blades 23-100 cm long, (8-) 10-40 cm wide; [subfamily *Dryopteridoideae*, tribe *Dryopterideae*] . . . . . **Dryopteris**
        - 10 Indusia hoodlike, pocketlike, cuplike, or consisting of numerous hairs attached below the sorus; vascular bundles in the lower petiole 2; plants small to medium, the larger leaf blades 5-65 cm long, 1.5-12 cm wide (sometimes longer or wider in *Cystopteris bulbifera*, distinguishable by its long-attenuate leaf tip and bulblets); [subfamily *Athyrioideae*, tribe *Physematieae*].
          - 11 Indusium attached under one side of the sorus, hoodlike or pocketlike, arching over the sorus; petioles glabrous or sparsely beset with scales, the petiole bases not persistent . . . . . **Cystopteris**
          - 11 Indusium attached under the sorus, cuplike (divided into 3-6 lanceolate to ovate lobes which surround the sorus from below) or of minute numerous septate hairs, which extend out from under the sorus on all sides; petioles often densely beset with scales, the petiole bases persistent . . . . . **Woodsia**

**Arachniodes** Blume 1828 (East Indian Holly Fern)

A genus of about 50-60 species, of tropical and warm temperate regions, and especially of Asia and America. References: Smith in FNA (1993b); Kramer et al. in Kramer & Green (1993).

\* **Arachniodes simplicior** (Makino) Ohwi, Simpler East Indian Holly Fern. Pd (SC): moist banks in forested creek ravine; rare, introduced from Japan and China. Gordon (1981) discusses this interesting introduced population, apparently established for several decades at the time of its discovery, and likely originating from spores. [= FNA, K]

**Athyrium** Roth 1799 (Lady Fern)

A genus of about 180 species, cosmopolitan in distribution, but concentrated in e. and se. Asia. Kelloff et al. (2002) and Kelloff & Werth (1998) support recognition of two taxa at either specific or infraspecific levels, based on morphology, allozymes, and spores.



References: Kato in FNA (1993b); Kramer et al. in Kramer & Green (1993); Kelloff et al. (2002).

**Identification notes:** *Athyrium* and *Deparia* superficially resemble *Dryopteris*, and they often grow together. *Athyrium* and *Deparia* have linear, flap-like sori (vs. rounded, reniform sori). Sterile individuals can be distinguished by the number of vascular bundles in the petiole (easily determined by breaking off a leaf and counting the vascular bundles, which will appear as thread-like strands); *Athyrium* and *Deparia* have 2, *Dryopteris* has 4-7.

- 1 Leaf blade widest near middle (the fourth or fifth pair of pinnae from the base the largest); margins of indusium toothed or ciliate (not glandular); rachis glandular; spores yellow or brown, finely papillose; petiole scales persistent, up to 1 cm long and 1.5 mm wide ..... **A. angustum**
- 1 Leaf blade widest near base (the second or third pair of pinnae from the base the largest); margins of indusium ciliate and glandular-ciliate; rachis eglandular; spores brown or dark brown, reticulate-wrinkled; petiole scales early deciduous, up to 5 mm long and 1 mm wide ..... **A. asplenioides**

***Athyrium angustum*** (Willdenow) K. Presl, Northern Lady Fern. Mt (NC, VA?): rock outcrops on grassy balds at high elevations; rare (NC Watch List). June-September. The occurrence of this northern species is not fully documented in NC or VA; it was found in the 1980's by Murray Evans on Hump Mountain, on or near the TN-NC border. Newfoundland and n. Québec west to Saskatchewan, south to w. NC, e. TN, OH, MO, and NE. Reported for VA by Kartesz (1999). [= S; = *A. filix-femina* (Linnaeus) Roth ex Mertens var. *michauxii* (Sprengel) Farwell -- C, F, G; = *A. filix-femina* var. *angustum* (Willdenow) G. Lawson -- FNA; = *A. filix-femina* ssp. *angustum* (Willdenow) Clausen -- K, W]

***Athyrium asplenioides*** (Michaux) A.A. Eaton, Southern Lady Fern. Mt, Pd, Cp (GA, NC, SC, VA): moist forests; common. May-September. MA, WV, IL, and KS south to n. FL and e. TX. [= RAB, S; = *A. filix-femina* (Linnaeus) Roth ex Mertens var. *asplenioides* (Michaux) Farwell -- C, F, FNA, G; = *A. filix-femina* ssp. *asplenioides* (Michaux) Hultén -- K, W]

***Cyrtomium* K. Presl 1836 (Net-veined Holly Fern)**

A genus of about 15 species, of temperate regions of Africa, Asia, and the Pacific Islands. Perhaps better treated as a portion of *Polystichum*; at the least, *Cyrtomium* is closely related to *Polystichum*. Both species in our area are apogamous triploids. References: Yatskievych in FNA (1993b); MacDougal (1976); Kramer et al. in Kramer & Green (1993).

- 1 Leaf coriaceous, the upper surface dark green and shiny; pinnae 4-10 (-12) pairs per leaf, 1.5-3 cm wide, the margins coarsely toothed or undulate ..... **C. falcatum**
- 1 Leaf less coriaceous, the upper surface pale green and dull; pinnae (8-) 10-25 pairs per leaf, 1-2 cm wide, the margins finely denticulate ..... **C. fortunei** var. *fortunei*

\* ***Cyrtomium falcatum*** (Linnaeus f.) K. Presl, Asian Net-veined Holly Fern. Cp (GA, NC, SC), Mt (GA?, VA): ditches, old mortar of brick walls; rare, native of e. Asia. [= FNA, K, S; = *Polystichum falcatum* Linnaeus f.]

\* ***Cyrtomium fortunei*** J. Smith var. *fortunei*, Fortune's Net-veined Holly Fern. Cp (GA, SC), Pd? (GA?): old mortar of brick walls; rare, native of se. China. Two other varieties are known; neither appears to be naturalized in North America. [= FNA; < C. *fortunei* -- K]

***Cystopteris* Bernhardt 1806 (Bladder Fern, Brittle Fern)**

A genus of about 20 species, semicosmopolitan in distribution, primarily of temperate regions but also in montane to alpine settings in tropical regions. References: Haufler, Moran, & Windham in FNA (1993b); Haufler, Windham, & Ranker (1990); Kramer et al. in Kramer & Green (1993).

**Identification notes:** See *Woodsia* for suggestions on distinguishing between *Cystopteris* and *Woodsia*, similar ferns often confused.

- 1 Lowest pair of pinnae the longest, thus the leaf widest at the base; bulblets often present on the rachis; indusia, rachises, and veins with stalked glands (these sometimes sparse in *C. tennesseensis*).
  - 2 Leaf blade 10-55 cm long, usually 2-3x as long as the reddish to tan petiole; bulblets usually present, smooth, green, 2-3 mm in diameter, usually on the rachis and the costa; spores 20-27 µ long ..... **C. bulbifera**
  - 2 Leaf blade 6-25 cm long, usually about 1x as long as the dark brown petiole; bulblets present or absent, deformed and scaly, dark, less than 1.5 mm in diameter, on the rachis only; spores 25-35 µ long ..... **C. tennesseensis**
- 1 Lowest pair of pinnae shorter than the second or third pair, thus the leaf widest above the base; bulblets never present; indusia, rachises, and veins eglandular.
  - 3 Leaf blade (2.5-) 3-4x as long as wide; pinnae usually perpendicular to the rachis (or even reflexed); margins of pinnae serrulate, the teeth sharp; basal pinnules sessile, truncate to rounded at the base; indusium up to 1 mm long, lanceolate; pinnae usually perpendicular to rachis; [on rock outcrops] ..... **C. fragilis**
  - 3 Leaf blade 2-2.5 (-3)x as long as wide; pinnae usually at an acute angle to the rachis, curving toward the blade apex; margins of pinnae crenulate, the teeth rounded; basal pinnules short-stalked or sessile, rounded to cuneate at the base; indusium about 0.5 mm long, ovate to round; pinnae usually at an acute angle to the rachis; [on rock outcrops or forest floor].
    - 4 Rhizome long-creeping, the apex extending 10-60 mm beyond the last of the widely-spaced petioles (especially as seen from late spring to summer); rhizome covered with scales and tan to golden hairs; spores 20-32 µ long; leaves membranaceous in texture; basal pinnules conspicuously stalked; petiole green to tan, darkened at base; lowermost pinnules of each pinna deeply cut; [typically on forest floor, less commonly on rocks] ..... **C. prostrusa**
    - 4 Rhizome short-creeping, the apex extending only 1-5 mm beyond the last of the closely-spaced petioles; rhizome

covered with scales, lacking hairs; spores 32-42  $\mu$  long; leaves thicker in texture; basal pinnules slightly stalked or merely cuneate to the base; petiole dark brown; lowermost pinnules of each pinna slightly lobed; [often on rocks, less commonly on forest floor] . . . . . **C. tenuis**

**Cystopteris bulbifera** (Linnaeus) Bernhardt, Bulblet Fern, Bulblet Bladder Fern. Mt (GA, NC, VA), Pd (NC, VA): moist outcrops and talus of calcareous rocks, rarely up to 1500m elevation; uncommon, rare in Piedmont (SC Rare). May-August. Newfoundland west to MN, south to NC, AL, and AR; also disjunct in UT, AZ, NM, and TX. This species is a diploid involved in the reticulate evolution of *Cystopteris* in e. North America. It is one parent of *C. tennesseensis*. Its genome can be symbolized BB. [= RAB, C, F, FNA, G, K, S, W]

**Cystopteris fragilis** (Linnaeus) Bernhardt, Fragile Fern, Brittle Fern. Mt (NC, VA): cliffs, ascending in our area to 1650m; rare (VA Rare). June-September. Circumboreal, in North America ranging from Newfoundland west to AK, south to MA, CT, NJ, montane NC, VA, KY, MO, OK, TX, NM, and AZ. This species is a fertile allotetraploid, presumed to be derived from hybridization between *C. reevesiana* Lellinger and an extinct or currently undiscovered second parent (*C. "hemifragilis"*); its genome can be symbolized HHRR (Paler & Barrington 1995). *C. fragilis* appears to be a complex needing further study; additional entities may be found to warrant taxonomic recognition (see FNA for discussion). [= FNA, K, W; = *C. fragilis* var. *fragilis* -- C, F, G, S]

**Cystopteris protrusa** (Weatherby) Blasdell, Lowland Bladder Fern. Mt, Pd (GA, NC, SC, VA): rich woods or on moss- and soil-covered talus in boulderfields, occasionally on ledges of rock outcrops; common (SC Rare). April-June. NY and Ontario west to MN, south to GA, AL, MS, LA, AR, e. KS, and IA. This species is a diploid involved in the reticulate evolution of *Cystopteris* in e. North America. It is one parent of *C. tennesseensis* and *C. tenuis*. Its genome can be symbolized PP. [= RAB, C, FNA, K, W; = *C. fragilis* var. *protrusa* Weatherby -- F, G, S]

**Cystopteris tennesseensis** Shaver, Tennessee Bladder Fern. Mt (GA, NC, VA), Cp (NC): moist to dry outcrops of calcareous rocks, including coquina limestone ("marl") in the outer Coastal Plain; rare (GA Special Concern, NC Rare, VA Rare). April-June. PA, KY, IL, WI, and IA south to NC, n. AL, AR, and OK. This species is a fertile allotetraploid derived from hybridization between *C. bulbifera* and *C. protrusa*. Its genome can be symbolized BBPP. Haufler, Windham, & Ranker (1990) consider this a "successfully fledged and vigorous young species," adapted to a hybrid niche not successfully utilized by either parent [= RAB, C, FNA, K, W]

**Cystopteris tenuis** (Michaux) Desvaux, Mackay's Bladder Fern. Mt (GA, NC, VA), Pd (VA): moist outcrops and cliffs of metamorphic and sedimentary rocks, occasionally in moist soils near rock outcrops; uncommon (NC Rare). May-August. Newfoundland west to MN and NE, south to VA, IL, and MO, and in the mountains to NC, TN, and n. GA. This species is a fertile allotetraploid derived from hybridization between *C. protrusa* and an extinct or currently undiscovered second parent (*C. "hemifragilis"*); its genome can be symbolized HHPP (Paler & Barrington 1995). [= FNA, K, W; = *C. fragilis* var. *mackayi* Lawson -- C, F, G]

Hybrids frequently occur where two or more species of *Cystopteris* grow in proximity. The following hybrids may be anticipated in our area:

- Cystopteris bulbifera* × *tenesseensis*.**
- Cystopteris bulbifera* × *tenuis* [*C. xillinoensis* R.C. Moran].**
- Cystopteris fragilis* × *tenuis*.**
- Cystopteris protrusa* × *tenesseensis*.**
- Cystopteris protrusa* × *tenuis*.**
- Cystopteris tennesseensis* × *tenuis* [*C. xwagneri* R.C. Moran].**

***Deparia* Hooker & Greville 1829**

A genus of about 40-50 species, primarily in tropical to warm temperate Asia and Africa. Our species is the only species native to the New World; it has several very closely related species in e. Asia (in section *Lunathyrium*). References: Kato in FNA (1993b); Kramer et al. in Kramer & Green (1993).

- 1 Leaf blade narrowed to base; petiole bases swollen, with 2 rows of teeth; [plant a common native species of moist forests]; [section *Lunathyrium*] . . . . . ***D. acrostichooides***
- 1 Leaves widest at the base; petiole bases not markedly swollen, lacking teeth; [plant an exotic species, rarely introduced and naturalized]; [section *Athyriopsis*] . . . . . ***D. petersenii***

***Deparia acrostichooides*** (Swartz) M. Kato, Silvery Spleenwort. Mt, Pd (GA, NC, SC, VA), Cp (NC, VA): moist forests, cove forests; common (uncommon in Piedmont, rare in Coastal Plain). June-September. Nova Scotia west to MN, south to NC, SC, n. GA, n. AL, and AR. Unlike *Athyrium*, *Deparia* has the costal groove not continuous with the rachis groove. In addition, *Deparia* has multicellular hairs on the leaf blades. It stores starch in the swollen, persistent petiole bases. [= FNA, K, W; = *Athyrium thelypteroides* (Michaux) Desvaux -- RAB, C, F, G; = *Diplazium acrostichooides* (Swartz) Butters -- S]

\* ***Deparia petersenii*** (Kunze) M. Kato. Cp (GA): disturbed areas; rare, native to se. Asia. Introduced and naturalized in the Southeast, including in c. and s. GA, AL, and FL. [= FNA; = *Deparia petersonii* – K, orthographic variant; = *Deparia japonica* (Thunberg) M. Kato, misapplied; = *Diplazium japonicum* (Thunberg) Beddome, misapplied]

***Diplazium* Swartz 1800 (Twin-sorus Fern, Glade Fern)**

A genus of about 400 species, primarily tropical and north temperate in distribution. References: Kato in FNA (1993b); Kramer et al. in Kramer & Green (1993).

***Diplazium pycnocarpon*** (Sprengel) M. Broun, Glade Fern. Mt (GA, NC, SC, VA), Pd (NC, VA), Cp (VA): very nutrient-rich, loamy or seepy forests, over calcareous sedimentary (such as limestone or dolostone) or mafic metamorphic or igneous rocks (such

as greenstone or amphibolite); uncommon (rare in Coastal Plain and south of VA) (NC Watch List, SC Rare). July-September. Widespread in e. North America, much more common in limestone areas of the Ridge and Valley than in the primarily acid-soil Blue Ridge and Piedmont. [= FNA, K; = *Athyrium pycnocarpon* Sprengel -- RAB, C, F, G; = *Homalosorus pycnocarpus* (Sprengel) Pichi-Sermolli -- S, W]

***Dryopteris*** Adanson 1763 (Wood-fern, Shield-fern)

A genus of about 250 species, nearly cosmopolitan, but concentrated in temperate Asia. References: Montgomery & Wagner in FNA (1993b); Montgomery & Paulton (1981); Montgomery (1982); Kramer et al. in Kramer & Green (1993); Hoshizaki & Wilson (1999).

**Identification notes:** *Dryopteris* and *Athyrium* are often confused when not fertile; they can be easily distinguished by breaking off a leaf and counting vascular bundles (which will appear as thread-like strands). *Dryopteris* has 5 and *Athyrium* has 2.

Many *Dryopteris* species will hybridize with one another to form sterile hybrids. Whenever two or more *Dryopteris* species are found growing together, there is a good chance that hybrids are present. Hybrids generally show intermediacy between the two parents, and have abortive sporangia or spores. For further information on hybrids, see the discussion of hybrids following the species accounts.

- 1 Leaves bipinnate-pinnatifid to tripinnate-pinnatifid (or to quadripinnate in the lower pinnae).
  - 2 Leaves evergreen, minutely glandular-pubescent, especially on the indusium, rachis, and pinnae midribs; first basal-pointed pinnule of the basal pinna shorter than or equal to the next outermost basal-pointed pinnule; first basal-pointed pinnule of the basal pinna usually less than 2x as long as the first tip-pointed pinnule of the basal pinna . . . . . ***D. intermedia***
  - 2 Leaves deciduous, lacking gland-tipped hairs (except occasionally on the indusium); first basal-pointed pinnule of the basal pinna longer than the next outermost basal-pointed pinnule; first basal-pointed pinnule of the basal pinna more than 2x as long as the first tip-pointed pinnule of the basal pinna.
    - 3 Leaf blade ca. 1x as long as the petiole; indusium occasionally glandular; first basal-pointed pinnule of the basal pinna 2.5-5x as long as the first tip-pointed pinnule of the basal pinna . . . . . ***D. campyloptera***
    - 3 Leaf blade 2x as long as the petiole; indusium glabrous; first basal-pointed pinnule of the basal pinna ca. 2x as long as the first tip-pointed pinnule of the basal pinna . . . . . ***D. carthusiana***
- 1 Leaves pinnate-pinnatifid to bipinnate (or to bipinnate-pinnatifid in the lower pinnae).
  - 4 Sori marginal; leaves evergreen, gray-green, leathery in texture . . . . . ***D. marginalis***
  - 4 Sori medial or submedial; leaves evergreen or deciduous, dark- to bright-green, thin to stiff in texture.
    - 5 Leaves dimorphic, the deciduous, fertile leaves erect, 2-3x as long as the spreading, evergreen, sterile leaves, which form a winter "rosette"; fertile leaves linear-lanceolate in outline, generally 4-8x as long as wide; pinnae mostly 1.5-3x as long as wide, triangular; scales at base of petiole tan.
      - 6 Fertile pinnae nearly in plane of the blade (like a closed Venetian blind); fertile leaves 12-20 cm wide . . . . . ***D. clintoniana***
      - 6 Fertile pinnae usually twisted out of the plane of the leaf axes, often nearly to 90 degrees (like an open Venetian blind); fertile leaves 8-12 cm wide . . . . . ***D. cristata***
    - 5 Leaves not dimorphic, or only slightly so, deciduous (*D. celsa* and *D. goldiana*) or evergreen (*D. ludoviciana*); fertile leaves lanceolate to ovate in outline, generally 1.5-4x as long as wide; pinnae mostly 3-4x as long as wide; scales at base of petiole dark brown with tan margins.
      - 7 Leaves evergreen, fertile only towards the tip, the fertile pinnae and segments narrower than the sterile and more widely spaced; scales at the petiole base light brown, not shiny . . . . . ***D. ludoviciana***
      - 7 Leaves deciduous, fertile throughout or nearly so, the fertile pinnae and segments not differentiated from sterile ones; scales at petiole base medium to dark brown, shiny or not.
        - 8 Sori submedial, not touching the costule at maturity; leaf blade lanceolate, usually 2-4x as long as wide, gradually tapering at the apex; scales at the petiole base medium to dark brown, with a narrow black central band . . . . . ***D. celsa***
        - 8 Sori medial, touching the costule at maturity; leaf blade ovate to narrowly ovate, usually 1.5-3x as long as wide; abruptly tapering at the apex; scales at the petiole base dark brown, nearly black, with a narrow pale margin . . . . . ***D. goldiana***

***Dryopteris campyloptera*** Clarkson, Mountain Wood-fern. Mt (NC, VA): spruce-fir forests, northern hardwood forests; common (VA Watch List). July-September. Newfoundland and n. Québec south to extreme n. PA, and from extreme s. PA south through e. WV and w. VA to e. TN and w. NC. This species is a fertile allotetraploid derived from hybridization of *D. intermedia* and the northern and western *D. expansa* (K. Presl) Fraser-Jenkins & Jermy, which does not (now) reach our area. The chromosome complement is symbolized EEII. [= RAB, C, K, S, W; = *D. spinulosa* (O.F. Mueller) Watt var. *americana* (Fischer ex Kunze) Fernald -- F; = *D. austriaca* (Jacquin) Woynar ex Schinz & Thellung var. *austriaca* -- G]

***Dryopteris carthusiana*** (Villars) H.P. Fuchs, Spinulose Wood-fern, Toothed Wood-fern. Mt (GA, NC, SC, VA), Pd, Cp (NC, SC, VA): acidic, organic-rich bogs, swamps, less frequently in moist rocky ravines, rich forests, and sloping rock outcrops; common, uncommon to rare south and east of VA Mountains (GA Special Concern, SC Rare). June-September. Irregularly circumboreal, in North America ranging from n. Québec west to Yukon, south to NC, SC, TN, AR, NE, w. MT, and WA. This species is a fertile allotetraploid derived from hybridization of *D. intermedia* and "*D. semicristata*," a hypothetical species which may now be extinct. Its chromosome complement is symbolized IISS. [= C, FNA, K, W; = *D. spinulosa* (O.F. Mueller) Watt -- RAB, S; = *D. spinulosa* var. *spinulosa* -- F; = *D. austriaca* (Jacquin) Woynar ex Schinz & Thellung var. *spinulosa* (O.F. Mueller) Fiori -- G]

***Dryopteris celsa*** (W. Palmer) Knowlton, W. Palmer, & Pollard ex Small, Log Fern. Mt (GA, NC, SC, VA), Cp, Pd (NC, SC, VA): swamps, seepage bogs; uncommon (GA Special Concern). June-September. Ranging (scattered) from ne. NJ and ne. NY west to s. IL, e. MO, and AR, south to SC, nw. GA, n. AL, TN, and n. LA; disjunct in w. NY and w. MI. This species is a fertile allotetraploid derived from hybridization of *D. goldiana* and *D. ludoviciana*; its chromosome complement is symbolized GGLL (Werth 1991). [= RAB, C, F, FNA, K, S, W; = *D. goldiana* (Hooker ex Goldie) ssp. *celsa* W. Palmer -- G]

***Dryopteris clintoniana*** (D.C. Eaton) Dowell, Clinton's Wood-fern, Broad Swamp Fern. Pd? (VA?): moist to wet forests; rare. This species is fertile allohexaploid derived from hybridization of *D. cristata* and *D. goldiana*; its chromosome complement is symbolized GGLLSS. This species has a disputed southern distribution; it is sometimes attributed to our area (as by Shetler & Orli 2000). It is definitely known as far south as se. PA, sc. PA, and OH. It is provisionally accepted for our area; additional study is needed. [= FNA, C, G, K; = *D. cristata* (Linnaeus) A. Gray var. *clintoniana* (D.C. Eaton) Underwood – F]

***Dryopteris cristata*** (Linnaeus) A. Gray, Crested Wood-fern. Mt (NC, VA), Pd (\*GA, NC, VA), Cp (NC, VA): bogs, swamp forests; uncommon (GA Special Concern). July-September. Circumboreal, in North America from Newfoundland to s. Saskatchewan and se. British Columbia, south to NC, TN, OH, IN, n. IL, IA, NE, and ID; disjunct in AL. This species is a fertile allotetraploid derived from hybridization of *D. ludoviciana* and "*D. semicristata*," a hypothetical species which may be extinct. Its chromosome complement is symbolized LLSS. It has also served as a "parent species" of *D. clintoniana*, a fertile allohexaploid derived from *D. cristata* × *goldiana*. Thus, its genome constitutes two thirds of the genome of *D. clintoniana*. [= RAB, C, FNA, G, K, S, W; = *D. cristata* var. *cristata* -- F]

***Dryopteris goldiana*** (Hooker ex Goldie) A. Gray, Goldie's Wood-fern. Mt (GA, NC, SC, VA), Pd (VA): boulderfield forests, rich cove forests, seepage swamps, especially over calcareous sedimentary or mafic metamorphic or igneous rocks; uncommon (NC Watch List, SC Rare). June-September. New Brunswick west to s. Ontario and MN, south to nw. SC, n. GA, n. AL, TN, KY, IL, and IA. This species is one of the diploid "parent species" of the e. North American reticulately-evolved *Dryopteris* complex. Its genome (symbolized GG) forms half of the genome of the tetraploid *D. celsa*, and one third of the hexaploid *D. clintoniana*, which does not occur as far south as our area. [= RAB, C, F, FNA, K, S, W; = *D. goldiana* ssp. *goldiana* -- G]

***Dryopteris intermedia*** (Muhlenberg ex Willdenow) A. Gray, Fancy Fern, Evergreen Wood-fern. Mt (GA, NC, SC, VA), Pd, Cp (NC, VA): cove forests, other moist, rocky forests, over a variety of substrates; common (uncommon in Piedmont, rare in Coastal Plain) (SC Rare). June-September. Newfoundland west to MN, south to n. GA and AR. This species is one of the diploid "parent species" of the e. North American reticulately-evolved *Dryopteris* complex. Its genome (symbolized II) forms half of the genome of the tetraploids *D. campyloptera* and *D. carthusiana*. [= RAB, C, FNA, K, S, W; = *D. spinulosa* (O.F. Mueller) Watt var. *intermedia* (Muhlenberg ex Willdenow) Underwood -- F; = *D. austriaca* (Jacquin) Woyнар ex Schinz & Thellung var. *intermedia* (Muhlenberg ex Willdenow) Morton -- G]

***Dryopteris ludoviciana*** (Kunze) Small, Southern Wood-fern. Cp (GA, NC, SC): blackwater swamp forests; rare (NC Watch List). June-September. A Southeastern Coastal Plain species: e. NC south to s. FL, west to s. AL and s. MS (Sorrie & Leonard 1999); disjunct in the West Gulf Coastal Plain of LA and AR. This species is one of the diploid "parent species" of the e. North American reticulately-evolved *Dryopteris* complex. Its genome (symbolized LL) forms half of the genome of the tetraploids *D. cristata* and *D. celsa*, as well as contributing one third of the genome of *D. clintoniana* indirectly (via its daughter species *D. cristata*). [= RAB, FNA, K, S]

***Dryopteris marginalis*** (Linnaeus) A. Gray, Marginal Wood-fern. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): rock outcrops, boulderfield forests, other rocky forests; common (less common in Piedmont, rare in Coastal Plain). June-September. Newfoundland west to s. Ontario and MI, south to SC, c. GA, AL, TN, AR, and e. OK. *D. marginalis* has not participated in the reticulate evolution of *Dryopteris* in e. North America; it does, however, form sterile hybrids with some other species. [= RAB, C, F, FNA, G, K, S, W]

The following hybrids are known between species which occur in our area. If the hybrid has been reported from our area, it is so indicated. In addition, the chromosome formulae are indicated, using the conventions listed at the end. These hybrids all have unbalanced chromosome complements which do not allow pairing. Thus, all produce aborted spores (if they produce spores at all), which can be recognized (at 30-40x) by their irregular size, shape, and color. For further information on these hybrids and a key to them, see Montgomery (1982).

***D. campyloptera* × *intermedia***. Known from NC. Chromosome formula = EII.

***D. campyloptera* × *marginalis***. Known from VA. Chromosome formula = EIM.

***D. carthusiana* × *cristata* [*D. xuliginosa* (A. Braun ex Dowell) Druce]**. Known from VA. Chromosome formula = ILSS.

***D. carthusiana* × *intermedia* [*D. xtriploidea* Wherry]**. Known from NC and VA. Chromosome formula = IIS. This is one of the commonest *Dryopteris* hybrids.

***D. carthusiana* × *marginalis* [*D. xpittsfordensis* Slosson]**. Chromosome formula = IMS.

***D. celsa* × *cristata***. Known from NC. Chromosome formula = GLLS.

***D. celsa* × *goldiana***. Chromosome formula = GGL.

***D. celsa* × *intermedia* [*D. xseparabilis* (Wm. Palmer) Small]**. Known from NC and VA. Chromosome formula = GIL.

***D. celsa* × *ludoviciana* [*D. xaustralis* (Wherry) Small]**. Known from GA, NC, SC, and VA. Chromosome formula = GLL.

***D. celsa* × *marginalis* [*D. xleedsii* Wherry]**. Chromosome formula = GLM.

***D. clintoniana* × *marginalis* [*D. xburgessii* Boivin]**. Chromosome formula = GLMS.

***D. cristata* × *intermedia* [*D. xboottii* (Tuckerman) Underwood]**. Known from VA. Chromosome formula = ILS. This is one of the commonest *Dryopteris* hybrids.

***D. cristata* × *marginalis* [*D. xslossoniae* Wherry ex Lellinger]**. Known from VA. Chromosome formula = LMS.

***D. goldiana* × *intermedia***. Known from NC. Chromosome formula = GI

***D. goldiana* × *marginalis* [*D. xneowherryi* W.H. Wagner]**. Known from NC and VA. Chromosome formula = GM.

***D. intermedia* × *marginalis***. Known from VA. Chromosome formula = IM.

E = *D. expansa*

G = *D. goldiana*

I = *D. intermedia*

L = *D. ludoviciana*

S = *D. "semicristata"* (hypothetical taxon, perhaps extinct)

***Gymnocarpium* Newman 1851 (Oak Fern)**

A genus of about 8 species, north temperate in distribution. References: Pryer in FNA (1993b); Pryer & Haufler (1993)=Z; Pryer (1992); Kramer et al. in Kramer & Green (1990). Key based on FNA.

- 1 Sessile basal basicopic pinnule of the proximal pinnae with basal basicopic pinnulet shorter than the adjacent pinnulet; pinnae of second pair sessile, with basal pinnules shorter than the adjacent pinnule (or second basal pinule rarely stalked); spores 27-31 µm in diameter ..... **G. *appalachianum***
- 1 Sessile basal basicopic pinnule of the proximal pinnae with basal basicopic pinnulet more or less equal in length to the adjacent pinnulet; pinnae of second pair usually sessile, with basal pinnules more or less equal in length to the adjacent pinnule; spores 34-39 µm in diameter ..... [**G. *dryopteris***]

***Gymnocarpium appalachianum*** Pryer & Haufler, Appalachian Oak Fern. Mt (NC, VA): moist, rocky forests, at medium to high elevations; uncommon (US Species of Concern, NC Rare, VA Watch List). June-September. Endemic to the c. and s. Appalachians (known from ne. WV, nw. VA, sc. PA, and disjunct in nw. NC and OH). Electrophoretic and morphologic analyses show that it is one of the diploid parents of the widespread allotetraploid *G. dryopteris*. In NC, it is limited to a single site, below the north-facing summit cliffs on Bluff Mountain, Ashe County, where seepage results in extensive ice formations which frequently persist until June. [= FNA, K, Z; < *G. dryopteris* (Linnaeus) Newman – C, G, W; < *Dryopteris disjuncta* (Ledeb.) C.V. Morton – F]

*Gymnocarpium dryopteris* (Linnaeus) Newman is circumboreal, occurring throughout northern and central Eurasia, Greenland, south in North America to MD (?), s. PA, OH, MI, WI, IA, w. SD, CO, n. NM, and c. AZ. Since it approaches our area from the north and closely resembles *G. appalachianum*, it should be carefully sought in our area, especially in the mountains of VA. See Pryer & Haufler (1993) for a detailed analysis of the distinguishing features between *G. appalachianum* and *G. dryopteris*. *Gymnocarpium robertianum* (Hoffmann) Newman of n. North America, south to MI, MN, and WI. [= FNA, K, Z; *Dryopteris disjuncta* (Ledeb.) C.V. Morton – F, misapplied; < *G. dryopteris* – C, G (also see *G. appalachianum*)]

Triploids are known from the mountains of VA. Their identity is uncertain; based on geography they are presumably *G. appalachianum* × *dryopteris*, but could be *G. xbrittonii* (Sarvela) Pryer & Haufler [= *G. disjunctum* × *dryopteris*]. Triploids can be distinguished from *G. appalachianum* by the presence of malformed spores, irregular in shape and size, often intermixed with large round spores (vs. all spores reniform and relatively uniform in size and shape). [*G. xbrittonii* (Sarvela) Pryer & Haufler – K]

***Matteuccia*** Todaro 1866 (Ostrich Fern)

A genus of 1 species, north temperate in distribution. Two other species formerly included in *Matteuccia* (or sometimes in *Onoclea*) are better treated in the genus *Pentarrhizidium* Hayata (Gastony & Ungerer 1997). References: Johnson in FNA (1993b); Kramer et al. in Kramer & Green (1990).

***Matteuccia struthiopteris*** (Linnaeus) Todaro var. ***pensylvanica*** (Willdenow) C.V. Morton, Ostrich Fern. Mt, Pd (VA): alluvial forests and calcareous wetlands; rare (VA Rare). The species is circumboreal; the North American var. *pensylvanica* ranges from Newfoundland west to AK, south to VA, MO, SD, and British Columbia. The North American var. *pensylvanica* is separated from the Eurasian var. *struthiopteris* on the basis of its concolorous rhizome scales (vs. bicolorous scales) and less truncate pinna lobes. *Matteuccia* stores starch in its persistent petiole bases. [= FNA, G; < *M. struthiopteris* -- C, K; = *Pteritis pensylvanica* (Willdenow) Fernald -- F]

***Onoclea*** Linnaeus 1753 (Sensitive Fern)

A genus of 1 species, of temperate e. North America and e. Asia. References: Johnson in FNA (1993b); Kramer et al. in Kramer & Green (1990).

***Onoclea sensibilis*** Linnaeus var. ***sensibilis***, Sensitive Fern, Bead Fern. Mt, Pd, Cp (GA, NC, SC, VA): marshes, swamps, wet disturbed places; common. May-June. The species ranges from Newfoundland west to MN and CO, south to FL, TX, and CO; also in e. Asia. Var. *sensibilis* is North American; var. *interrupta* is Asian. The recognition of two varieties is supported by molecular evidence. The genus is monotypic. The specific epithet and common name refer to the fact that the fronds wither at the first touch of frost, not that they respond to touch. The peculiar fertile leaves (with their brown, beadlike, fertile pinnules) are collected for use in dried arrangements. The expanded, persistent petiole bases store starch. [< *O. sensibilis* -- RAB, C, F, FNA, G, K, S, W]

***Polystichum*** Roth 1799 (Holly Fern)

A genus of about 180 species, nearly cosmopolitan in distribution. References: D.H. Wagner in FNA (1993b); Kramer et al. in Kramer & Green (1990).

***Polystichum acrostichoides*** (Michaux) Schott, Christmas Fern. Mt, Pd, Cp (GA, NC, SC, VA): moist to dry forests and woodlands; common. June-September. Nova Scotia west to MN, south to s. FL and e. TX; also in Mexico. One of the most familiar ferns in e. North America. Var. *lonchitoides* Brooks, allegedly endemic to WV, is of uncertain taxonomic value. [= RAB, C, F, FNA, G, S, W; > *P. acrostichoides* var. *acrostichoides* -- K; > *P. acrostichoides* var. *lonchitoides* Brook – K]

***Woodsia*** R. Brown 1810 (*Woodsia*, Cliff Fern)

A genus of about 30 species, of temperate and cool-temperate regions, widespread in the Northern Hemisphere, in montane tropical South America, and south temperate in Africa and South America. References: Windham in FNA (1993b); Kramer et al. in Kramer

& Green (1990).

**Identification notes:** *Woodsia* species and *Cystopteris* species are all small ferns with thin-textured leaves, occurring primarily on or near rock outcrops; they frequently occur together or in proximity to one another and are often confused. *Woodsia* has the indusium divided into a series of scale-like or hair-like structures, attached below the sorus; *Cystopteris* has an undivided indusium, pocket-like or hood-like, attached around one side of the sorus. *Woodsia* has persistent dark petiole bases; in *Cystopteris* the petiole bases are deciduous. *Woodsia* has the final veinlets not reaching the margin; *Cystopteris* veins do reach the margin.

- 1 Petioles with a distinct joint about 1-3 cm above the base, the petiole bases of former leaves forming a fairly even stubble; leaf blade lacking glands (though bearing both long septate hairs and pale linear scales); indusium of numerous filamentous segments ..... *W. ilvensis*
- 1 Petioles lacking a distinct joint, the petiole bases of former leaves disintegrating irregularly and forming an uneven stubble; leaf blade with stalked glands, at least below on the costae, costules, and veins (and also bearing nonglandular hairs and/or linear scales); indusium of 3-6 lanceolate segments.
  - 2 Rachis with flattened, septate, white hairs and elongate stipitate glands ..... *W. appalachiana*
  - 2 Rachis with scattered scales; leaf blade with sparse to dense stipitate glands ..... *W. obtusa* ssp. *obtusa*

***Woodsia appalachiana*** T.M.C. Taylor, Appalachian Woodsia, Appalachian Cliff Fern, Mountain Woodsia. Mt (GA, NC, VA), Pd (NC, VA): on cliffs of sandstone, shale, granite, granitic gneiss, and hornblende gneiss; uncommon, rare in North Carolina (NC Rare). June-September. Endemic to the Southern and Central Appalachians of VA, WV, NC, and TN and the Ozarks of AR. This species is similar to *W. scopulina* of the western mountains of AK south to CO and CA. The eastern plants have been variously treated as a full species, a subspecies or variety of *W. scopulina*, or as indistinguishable from *W. scopulina* (see synonymy). It now appears that *W. appalachiana* may be a rather cryptic but distinct element of a reticulate complex also involving *W. scopulina* ssp. *scopulina* (of the Rocky Mountains) and *W. scopulina* ssp. *laurentiana* Windham (primarily of the Rocky Mountains but also disjunct eastwards in Ontario and Québec). Windham in FNA (1993b) treats these three entities as subspecies, and suggests that ssp. *laurentiana* is the allotetraploid derivative of hybridization of the eastern and western diploids. If this is indeed so, each of the 3 entities should be recognized at the species level. [= F, K; < *W. scopulina* D.C. Eaton -- RAB, C, S, W; = *W. scopulina* ssp. *appalachiana* (T.M.C. Taylor) Windham -- FNA; = *W. scopulina* var. *appalachiana* (T.M.C. Taylor) Morton -- G]

***Woodsia ilvensis*** (Linnaeus) R. Brown, Rusty Woodsia, Rusty Cliff Fern. Mt (NC, VA): cliffs of amphibolite, greenstone, other rocks; uncommon, rare in NC and apparently only in the northernmost few counties of that state (NC Rare). June-September. Circumboreal, ranging in North America from Newfoundland and AK south to VA, nw. NC, OH, n. IL, nw. IA, Saskatchewan, and British Columbia. [= RAB, C, F, FNA, G, K, S, W]

***Woodsia obtusa*** (Sprengel) Torrey ssp. *obtusa*, Common Woodsia, Blunt-lobed Cliff Fern. Mt, Pd, Cp (GA, NC, SC, VA): rock outcrops of various sorts, moist talus, terrestrial near rock outcrops; common. June-September. ME, Québec, MN, and e. NE, south to FL and TX. [= FNA, K; < *W. obtusa* -- RAB, C, F, G, S, W]

**EQUISETACEAE** L.C. Richard ex de Candolle 1805 (Horsetail Family)

A family with a single genus and about 15 species. References: Hauke in FNA (1993b); Lellinger (1985); Mickel (1979); Hauke in Kramer & Green (1990); Des Marais et al. (2003).

***Equisetum*** Linnaeus 1753 (Horsetail, Scouring Rush)

A genus of about 15 species, nearly cosmopolitan in distribution. References: Hauke in FNA (1993b); Lellinger (1985); Mickel (1979); Hauke in Kramer & Green (1990); Des Marais et al. (2003); Guillon (2004).

- 1 Stems perennial, evergreen, stiff; sterile and fertile stems monomorphic and either unbranched or with 2-3 short and unequal branches per node; [subgenus *Hippochaete*].
  - 2 Main erect stems unbranched (rarely branched as a result of injury); stems 3-18 mm in diameter; stomatal lines 1 on each slope of the stem ridges ..... *E. hyemale* ssp. *affine*
  - 2 Main erect stems usually with 2-3 branches at the nodes; stems 1.5-7 mm in diameter; stomatal lines 1-2 on each slope of the stem ridges ..... *E. ramosissimum* ssp. *ramosissimum*
- 1 Stems annual, deciduous, the sterile stems flexible; sterile and fertile stems dimorphic or monomorphic, usually branched (often copiously so) but sometimes unbranched or sparsely and irregularly so; [subgenus *Equisetum*].
  - 3 Sterile and fertile stems monomorphic; sterile and fertile stems sparsely and irregularly branched; stem ridges 12-24, indistinct; diameter of the central cavity of the stem about 4/5's of the stem diameter ..... *E. fluviatile*
  - 3 Sterile and fertile stems dimorphic; sterile stems copiously branched and green, fertile stems unbranched or branched, green, tan, brown, or purplish; stem ridges 4-18, distinct; diameter of the central cavity of the stem usually less than 3/4's of the stem diameter.
    - 4 Sheaths of the sterile stems 3-10 mm long, the teeth dark brown with white margins; sterile stems regularly whorled with simple branches (rarely rebranching) ..... *E. arvense*
    - 4 Sheaths of the sterile stems 10-30 mm long, the teeth reddish-brown with brown margins; sterile stems regularly whorled with branches which regularly rebranch ..... *E. sylvaticum*

***Equisetum arvense*** Linnaeus, Field Horsetail. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): moist streambanks, bottomlands, moist disturbed sites; common. March-April. A circumboreal species, occurring throughout North America. [= RAB, C, FNA, G, K, S, W; *E. arvense* var. *arvense* -- F]

***Equisetum fluviatile*** Linnaeus, Water Horsetail, Pipes. Mt (VA): open calcareous wetlands; rare (VA Rare). June-August. Circumboreal, south in North America to n. VA, PA, IL, IA, and WA. [= C, F, FNA, G, K, W]

**Equisetum hyemale** Linnaeus ssp. **affine** (Engelmann) Calder & R.L. Taylor, Tall Scouring Rush. Mt, Pd, Cp (GA, NC, SC, VA): riverbanks, alluvial floodplains; common (uncommon in NC and SC). May-September. Ssp. *affine* occurs nearly throughout North America and in Mexico and Guatemala; ssp. *hyemale* is Eurasian. [= FNA; *E. hyemale* var. *affine* (Engelmann) A.A. Eaton -- RAB, C, K, W; > *E. hyemale* var. *affine* – F, in a narrower sense; > *E. hyemale* var. *robustum* (A. Braun) A.A. Eaton -- F; > *E. hyemale* var. *pseudohyemale* (Farwell) Morton -- G; > *E. hyemale* var. *elatum* (Engelmann) Morton -- G; *E. praealtum* Rafinesque -- S; = **Hippochaete hyemalis** (Linnaeus) Bruhin ssp. **affinis** (Engelmann) W.A. Weber]

\* **Equisetum ramosissimum** Desfontaines ssp. **ramosissimum**, Branched Scouring Rush. Cp (NC): disturbed areas; rare, introduced from the Old World, where it is widespread in Europe, Asia, and Africa. This species was apparently introduced long ago on ship's ballast to Wilmington (New Hanover Co. NC), and other southeastern ports, such as Pensacola, FL and New Orleans, LA. It is naturalized on the Wilmington waterfront, persisting in disturbed areas, such as in gravel along railroad tracks. Hauke (1979, 1984, 1992) discusses the occurrence of this species in North America. Ssp. *debile* (Roxburgh) Hauke occurs in se. Asia and southern Pacific Islands; it is not known to be naturalized in North America. [= FNA; < *E. ramosissimum* -- K; = **Hippochaete ramosissima** (Desfontaines) Farwell ssp. **ramosissima**]

**Equisetum sylvaticum** Linnaeus, Woodland Horsetail. Mt (VA): seepage swamps; rare (VA Rare). Circumboreal, south in North America to MD, n. VA, WV, OH, MI, WI, IA, WY, MT, and WA. [= C, FNA, K; > *E. sylvaticum* var. *sylvaticum* – F, G; > *E. sylvaticum* var. *pauciramosum* Milde -- F, G]

**Equisetum x ferrissii** Clute (pro sp.) [= *E. hyemale* x *laevigatum*]. There are old reports, repeated in RAB, S, and FNA, of the occurrence of *E. x ferrissii* Clute (pro sp.) [= *E. hyemale* x *laevigatum*] in our area; documentation of these reports is not known; it is reported for Prince George's County, MD ((Shetler & Orli 2000). *E. x ferrissii* may be distinguished from *E. hyemale* var. *affine* (to which it will key above) by the failure of its cones to produce spores at all or the production of aborted spores (vs. production of normal spores) and most stem sheaths lacking a blackish band well below the teeth (vs. most stem sheaths with a narrow to broad blackish band well below the teeth). [= FNA, K; = **Hippochaete x ferrissii** (Clute) Škoda & Holub] {add synonymy}

**Equisetum laevigatum** A. Braun. Widespread in n. North America, south to CT, NY, PA, KY, AR, and TX. There are old reports, repeated in RAB, and S, of this species in our area; documentation of these reports is not known. It will key to *E. hyemale* ssp. *affine* in the above key, but has the strobilus apex rounded (vs. pointed), and aerial stems annual (vs. perennial). [= FNA, K; = **Hippochaete laevigata** (A. Braun) Farwell] {add synonymy}

**Equisetum x litorale** Kühlewein ex Ruprecht (pro sp.) [*arvense* x *fluvatile*] is reported by FNA for VA. It can be distinguished from *E. arvense* by its white, mis-shapen spores. [= FNA, K] {add synonymy}

#### **GRAMMITIDACEAE** (C. Presl) Ching 1940 (Dwarf Polypody Family)

A family of 5-10 genera and about 500-600 species, tropical to subtropical. References: Smith in FNA (1993b); Parris in Kramer & Green (1990).

#### **Micropolypodium** Hayata (Dwarf Polypody)

A genus of about 30 species, mainly of tropical America and e. and se. Asia. *Micropolypodium* has traditionally been considered a part of a broadly circumscribed *Grammitis*, but has been recircumscribed at the generic level by Smith (1992). Smith in FNA (1993b) states that our species "probably warrants generic status under the name *Micropolypodium* Hayata, a primarily neotropical genus with representatives in eastern Asia (Malaysia, China, Sikkim, Taiwan, and Japan)." References: Smith in FNA (1993b); Massey *et al.* (1983); Smith (1992)=Z.

**Micropolypodium nimbatum** (Jenman) A.R. Smith, Dwarf Polypody. Mt (NC): on ceiling of grotto in spray cliff of waterfall in humid gorge; rare (US Species of Concern, NC Endangered). Sporophytes (juvenile only) have been found at only a single site in North America, in Macon County, NC. Gametophytes (and/or sporophytes) may be present at other spray cliffs in the escarpment gorges of sw. NC or adjacent SC and GA. Other than this disjunct temperate-zone occurrence, the species is known from Cuba, Jamaica, and Hispaniola. See Moran (1998) for an interesting discussion and overview of independent fern gametophytes in e. North America. [= Z; = *Grammitis nimbata* (Jenman) Proctor -- RAB, FNA, K]

#### **HYMENOPHYLLACEAE** Link 1833 (Filmy Fern Family)

A family of 6-10 (or many more) genera and 600-650 species. See Moran (1998) for an interesting discussion and overview of independent fern gametophytes in e. North America. References: Farrar in FNA (1993b); Iwatsuki in Kramer & Green (1990); Morton (1968).

- 1 Sporophytes present.
  - 2 Indusium ("involucre") bivalvate (deeply divided into 2 flaps); receptacle not exerted from between the 2 flaps of the indusium ..... **Hymenophyllum**
  - 2 Indusium ("involucre") tubular or funnellform, sometimes slightly 2-lobed; receptacle long and whiplike, exerted from the mouth of the tubular indusium ..... **Trichomanes**
- 1 Gametophytes only present.
  - 3 Gametophytes thalloid, flattened ..... **Hymenophyllum**
  - 3 Gametophytes filamentous, no portion flattened and planar ..... **Trichomanes**

#### **Hymenophyllum** J.E. Smith 1793 (Filmy Fern)

As here very broadly circumscribed, a genus of about 330 species, almost strictly tropical in distribution. *Sphaerocionium* C. Presl

and other segregates are often recognized; these segregates may well be warranted. Iwatsuki in Kramer & Green (1990) takes a broad view of the genus, recognizing only *Sphaerocionium* among the potential segregates. If this distinction is recognized, *H. tunbrigense* is in *Hymenophyllum* and *H. tayloriae* in *Sphaerocionium* (the combination has not been made). References: Raine, Farrar, & Sheffield (1991); Iwatsuki in Kramer & Green (1990); Morton (1968).

- 1 Sporophytes present.
  - 2 Leaf blade with stellate hairs . . . . . ***H. tayloriae***
  - 2 Leaf blade glabrous . . . . . ***H. tunbrigense***
- 1 Gametophytes only present.
  - 3 Gemmae present; margin crenate, composed predominantly of cells with concave outer walls; archegonia and antheridia rare; plant forming sprawling, ribbon-like forms; branches filamentous to broad; proliferations abundant, arising marginally and centrally . . . . . ***H. tayloriae***
  - 3 Gemmae absent; margin entire, composed predominantly of straight-sided cells; archegonia and antheridia common, often present on the same gametophyte; plant typically forming rosettes; branches always broad; proliferations few, always marginal . . . . . ***H. tunbrigense***

***Hymenophyllum tayloriae*** Farrar & Raine, Gorge Filmy Fern. Mt (GA, NC, SC): spray cliffs near waterfalls, permanently moist ceilings of grottoes in escarpment gorges with high rainfall; rare (GA Special Concern, NC Watch List). This species is endemic to the southern end of the Southern Appalachians (Transylvania, Jackson, and Macon counties, NC, Pickens and Oconee counties, SC, Rabun County, GA (Davison 1997) and sites in e. TN and n. AL. It was recently named (in honor of the first collector), following the demonstration that it represented a gametophyte distinct from the gametophytes of any (sporophytically) known species (Raine, Farrar, & Sheffield 1991), including *H. tunbrigense*, present in the close vicinity. Raine, Farrar, & Sheffield (1991) point out that "*H. tayloriae* is distinguished from the independent gametophytes of *Vittaria appalachiana* Farrar & Mickel by its 2-dimensional spatulate gemmae (those of *V. appalachiana* are uniseriate), rhizoid attachment only to marginal cells, yellow-green color, and glossy texture. Thalloid liverworts of similar size are generally more than one cell thick or have a distinct midrib, have notched apical meristems, and do not produce spatulate gemmae." An immature sporophyte, collected by Taylor in 1936, has stalked stellate hairs on the margins and midrib of the leaf and was the only sporophytic collection of the species until the recent discovery of additional juvenile sporophytes in AL (FNA 1993b). [= FNA, K; = "a branching ribbon-like gametophyte with marginal rhizoids and small, ovate, plate-like gemmae several cells wide, of the genus *Hymenophyllum*" -- RAB; = ***Sphaerocionium* sp. 1]**

***Hymenophyllum tunbrigense*** (Linnaeus) J.E. Smith, Tunbridge Filmy Fern. Mt (SC): moist rock faces in an escarpment gorge with high rainfall; rare (SC Rare). June-September. The occurrence of this filmy fern in the escarpment gorge of Eastatoe Creek (and its tributaries) is remarkable. Overall, *H. tunbrigense* is a "Gulf Stream plant," found in highly humid, climates in the West Indies, and the maritime west coast of the British Isles. *H. tunbrigense* somewhat resembles *Trichomanes boschianum*. This species may yet be found in NC in similarly rugged and humid escarpment gorges. It differs from *T. boschianum* in having the sporangia not extending beyond the deeply 2-lobed involucre (as opposed to having the sporangia exerted beyond the slightly bilobed, funnellform involucre). [= RAB, FNA, K, W]

***Trichomanes*** Linnaeus 1753 (Filmy Fern)

Depending on circumscription, a genus of 80-300 species, primarily tropical. Dubuisson et al. (2003) and other molecular phylogenetic studies of *Trichomanes* suggest that some of the segregates may warrant recognition at the generic level. References: Iwatsuki in Kramer & Green (1990); Morton (1968); Dubuisson et al. (2003).

- 1 Plant a sporophyte (thus with simple, lobed, or pinnate-pinnatifid leaves).
  - 2 Leaves pinnate-pinnatifid, more than 5 cm long; [subgenus *Trichomanes*, section *Lacosteopsis*] . . . . . ***T. boschianum***
  - 2 Leaves simple to slightly lobed, less than 2 cm long; [subgenus *Didymoglossum*, section *Didymoglossum*] . . . . . ***T. petersii***
- 1 Plant a gametophyte (thus filamentous, forming felt-like mats).
  - 3 Gametophytes free-living, distant from sporophytes of *T. boschianum* or *T. petersii* . . . . . ***T. intricatum*** (see discussion under *T. intricatum*)
  - 3 Gametophytes growing in association with or in proximity to sporophytes of *T. boschianum* or *T. petersii* . . . . . ***T. boschianum* or *T. petersii*** (see discussion under *T. intricatum*)

***Trichomanes boschianum*** Sturm, Appalachian Filmy Fern. Mt (GA, NC, SC, VA): on rock outcrops, usually vertical or overhanging, usually in deeply shaded grottoes receiving seepage or spray from waterfalls; rare (GA Rare, NC Threatened, SC Rare). June-September. W. NC and w. SC west to ne. GA, AL, MS (Menapace, Davison, & Webb 1998), and AR, and north to s. OH, KY, and s. IL; also disjunct in Chihuahua, Mexico. See Belden et al. (2004) for more details on the first documented Virginia occurrence. [= RAB, C, F, FNA, G, K, S, W]

***Trichomanes intricatum*** Farrar, Grotto-felt, Appalachian Trichomanes, Weft Fern. Mt, Pd (GA, NC, SC, VA): on ceilings or back walls of grottoes, especially in humid gorges or near or behind waterfalls; rare (NC Watch List, VA Watch List). This species is rather widespread in e. North America, from VT, MA, CT, IN, and IL south to NC, SC, GA, AL, TN, and KY. *T. intricatum* cannot be morphologically distinguished from gametophytes of *T. boschianum* or *T. petersii*; the electrophoretic and phytogeographic evidence of Farrar (1992) leave little question, however, that it should be considered a distinct species. Although Farrar (1992) found that 30 of 30 populations of *Trichomanes* gametophytes "east of the Mississippi River that were not within or adjacent to sporophyte populations of *T. boschianum* or *T. petersii*" were *T. intricatum*, the key above (based on proximity to sporophytes) should be considered to provide only a presumptive or likely identification of gametophytes. Farrar (1992) also showed that independent gametophytes in AR were those of *T. boschianum* and *T. petersii*. Farrar (1992) points out the "intriguing possibility that somewhere in the Appalachian Mountains sporophytes of this species may yet exist." Probably the most likely area in which to search for the sporophyte generation of *T. intricatum* is the escarpment gorge region of NC, SC, and GA near Highlands, NC, where topography, waterfalls, and the highest rainfall east of the Cascade Mountains combine to create microclimatic conditions that have favored the relict survival of numerous species of mosses, liverworts, and ferns. Any filmy-fern sporophyte which differs from *T. boschianum*, *T. petersii*, or *Hymenophyllum tunbrigense* should be investigated carefully. *Vittaria appalachiana* and *Hymenophyllum tayloriae*



gametophytes differ from *Trichomanes intricatum* in being thallose rather than filamentous. [= FNA, K; = "a filamentous gametophyte, with spindle-shaped gemmae one cell wide but with the cells decreasing in size toward the apices, of the genus *Trichomanes*" -- RAB]

***Trichomanes petersii*** A. Gray, Dwarf Filmy Fern. Mt (NC, SC), Cp (GA): on vertical faces of acidic rock outcrops in humid gorges, primarily of the Savannah River drainage, in the context of the very humid escarpment gorges on relatively dry rocks, not on rocks receiving substantial seepage or spray from waterfalls, also on outcrops of Altamaha Grit in the Coastal Plain; rare (GA Rare, NC Threatened, SC Rare). June-August. W. NC and w. SC southwest to FL, AL, MS, and LA, and north to AR and s. IL; also in Mexico and Guatemala. This diminutive species is often overlooked, except by bryologists and hepaticologists; it does superficially resemble a moss or liverwort more than a fern. It occurs on tree bark in some parts of its range. [= RAB, FNA, K, S, W; = *Didymoglossum petersii* (A. Gray) Copeland]

**ISOETACEAE** Dumortier 1829 (Quillwort, Merlin's-grass)

A family of a single genus and about 300 species. Isoetaceae, along with Selaginellaceae and Lycopodiaceae, now appear to be only distantly related to other extant pteridophytes and seed plants (Pryer et al. 2001). References: Jermy in Kramer & Green (1990).

***Isoetes*** Linnaeus 1753 (Quillwort, Merlin's-grass)

A genus of about 300 species, cosmopolitan in distribution. References: Taylor et al. in FNA (1993b); Hoot, Napier, & Taylor (2004); Boom (1982); Kott & Britton (1983); Brunton & Britton (1996a, 1996b, 1997, 1998, 1999); Caplen & Werth (2000a, 2000b); Musselman & Knepper (1994); Musselman, Bray, & Knepper (1996, 1997); Musselman et al. (1995); Musselman, Taylor, & Bray (2001); Musselman (2001)=Z; Jermy in Kramer & Green (1990).

***Isoetes acadensis*** L. Kott, Acadian Quillwort. Cp (VA): freshwater tidal marshes; rare. A tetraploid species (2n=44). [= FNA, K; < *I. tuckermanii* A. Braun – C, F, G]

***Isoetes appalachiana*** Brunton & Britton, Appalachian Quillwort. Cp (NC, SC, VA), Pd (SC), Mt (VA): seepages, small woodland streams, ephemeral wetlands, backwaters; uncommon (GA Special Concern). A tetraploid species (2n=44), apparently derived from a southern *I. engelmannii* entity and *I. valida* (Hoot, Napier, & Turner 2004), genotype=SSVV. See Brunton & Britton (1997) for additional information. [= K, Z; < *I. engelmannii* -- RAB, C, FNA, W; < *I. engelmannii* var. *engelmannii* – F, S; > *I. engelmannii* var. *georgiana* Engelm.]

***Isoetes boomii*** N. Luebke, Boom's Quillwort. Cp (GA): shallow water of slow-moving streams; rare (GA Special Concern). Known from Laurens County, GA and AL. A hexaploid species (2n=66). [= FNA, K; < *I. boomii* – Z (also see *I. georgiana*)]

***Isoetes butleri*** Engelm., Butler's Quillwort. Mt (GA): seepage areas on calcareous glades; rare (GA Special Concern). Occurs in calcareous areas of the midwest, extending east to c. TN, nw. GA (Jones & Coile 1988), and n. AL. A diploid species (2n=22), genotype=BB. [= C, F, FNA, G, K, S, Z]

***Isoetes engelmannii*** A. Braun. Cp, Pd, Mt (NC, SC, VA): usually in permanent water bodies with active current; common. A diploid species (2n=22). Apparently there are 2 cryptic taxa currently called *I. engelmannii* (Hoot, Napier, & Taylor 2004), genotype NN and genotype SS. [= K, Z; < *I. engelmannii* -- RAB, C, G, FNA, W (also see *I. appalachiana*, *I. hyemalis*, and *I. valida*); < *I. engelmannii* var. *engelmannii* – F, S]

***Isoetes flaccida*** A. Braun var. *alata* Pfeiffer, Winged Florida Quillwort. Cp (GA): springs, streambottoms, riverbottoms, ditches; rare. S. GA and FL. A diploid species (2n=22). [= FNA, K, S; < *I. flaccida* – Z]

***Isoetes georgiana*** N. Luebke, Georgia Quillwort. Cp (GA): {}. Known only from GA (Colquitt, Dodge, Irwin, Tift, Tucker, Turner, and Worth counties). A hexaploid species (2n=66). See Brunton & Britton (1996b) for additional information. Musselman (2001) indicates that this may be conspecific with *I. boomii*. [= FNA, K; < *I. boomii* – Z]

***Isoetes hyemalis*** Brunton, Wintergreen Quillwort. Cp (GA, NC, SC, VA), Pd (GA?, NC, VA): blackwater streams and sandy streambanks; rare (GA Special Concern, VA Rare). Sc. VA south through e. and c. NC to GA, AL, and FL Panhandle (Nelson 2000), in the Coastal Plain and lower Piedmont. A tetraploid species (2n=44), apparently derived from 2 unknown or extinct species, X and Y (Hoot, Napier, & Taylor 2004). See Brunton, Britton, & Taylor (1994) and Brunton & Britton (1996a) for additional information on this species. [= K, Z; < *I. engelmannii* -- RAB, C, G; < *I. engelmannii* var. *engelmannii* – F, S]

***Isoetes junciformis*** Brunton & Britton, Rush Quillwort. Cp (GA): ephemeral wetland swales in bottomland hardwood swamps; rare (GA Special Concern). In sw. GA Coastal Plain (Tift and probably Calhoun counties, GA). A tetraploid species (2n=44). See Brunton & Britton (1999) for additional information. [= Z]

***Isoetes lacustris*** Linnaeus, Lake Quillwort. Mt (VA): (VA Rare). July-September. A decaploid species (2n=110). [= FNA, C, K; > *I. macrospora* Durieu – F, G, W]

***Isoetes mattaponica*** L.J. Musselman & W.C. Taylor, Mattaponi River Quillwort. Cp (VA): tidal rivers; uncommon? Rivers flowing into Chesapeake Bay. A diploid relative of *I. acadensis*. A diploid species (2n=22). See Musselman, Taylor, & Bray (2001) for additional information on this species.

***Isoetes melanopoda*** Gay & Durieu ex Durieu, Blackfoot Quillwort. Pd (NC, SC, VA), Cp (SC): clay soils in low woods, seeps on sandstone or granitic rocks; rare (GA Special Concern, VA Rare). In MS (Sorrie & Leonard 1999). A diploid species (2n=22), genotype=PP. [= FNA, K, C, G, Z; < *I. melanopoda* -- RAB (also see *I. melanospora*, *I. virginica*, *I. piedmontana*)]

***Isoetes melanospora*** Engelm., Black-spored Quillwort. Pd (GA, SC): in pools on granite flatrocks; rare (US Endangered, GA Endangered). A diploid species (2n=22). [= Z, S; < *I. melanospora* -- FNA, K; < *I. melanopoda* -- RAB]

***Isoetes microvela*** Brunton. Cp (NC): banks of rivers in the outer Coastal Plain; rare. May-July (-September). See Brunton & Britton (1998) for additional information. [= K]

***Isoetes piedmontana*** (N.E. Pfeiffer) C.F. Reed, Piedmont Quillwort. Pd (GA, NC, SC, VA), Cp (GA): in seepage on granitic flatrocks; uncommon (VA Rare). [= K, Z; < *I. melanopoda* -- RAB; < *I. virginica* -- C, F, FNA, G]

***Isoetes riparia*** Engelm. ex A. Braun, Shore Quillwort. (VA Watch List). A tetraploid species (2n=44), apparently derived from the southern *I. engelmannii* entity and *I. echinospora* (Hoot, Napier, & Taylor 2004). [< *I. riparia* – RAB, C, FNA (also see *I. saccharata*); > *I. riparia* var. *riparia* -- G, K; > *I. riparia* var. *amesii* (A.A. Eaton) Proctor – G, K; > *I. riparia* var. *robbinsii* (A.A. Eaton)

Proctor – G; > *I. riparia* var. *reticulata* (A.A. Eaton) Proctor – G]

***Isoetes saccharata*** Engelm. Cp (VA): {disentangle from *I. riparia*} [= K; < *I. riparia* – C, FNA; = *I. riparia* var. *palmeri* (A.A. Eaton) Proctor – G]

***Isoetes* sp. 1.** Pd (SC): pools on granite flatrocks; rare. Forty Acre Rock, Lancaster County, SC. Being worked on by W.C. Taylor.

***Isoetes* sp. 3.** Cp (VA): tidal marshes. A diploid relative of *I. melanopoda*. Being worked on by C. Caplen. A diploid species (2n=22).

***Isoetes tegetiformans*** Rury, Mat-forming Merlin's-grass. Pd (GA): in shallow pools on granite flatrocks; rare (US Endangered, GA Endangered). Endemic to a few granite flatrocks in ne. GA, near the SC line. A diploid species (2n=22), genotype=TT. [= FNA, K, Z]

***Isoetes valida*** (Engelmann) Clute, Mountain Quillwort, Carolina Quillwort. Mt (NC, SC, VA): bogs (growing in *Sphagnum*), pools, ponds; common (GA Special Concern). A diploid species (2n=22). Genotype=VV. [= K, Z; = *I. caroliniana* (A.A. Eaton) N. Luecke -- FNA; < *I. engelmannii* -- RAB, C, W; = *I. engelmannii* A. Braun var. *caroliniana* A.A. Eaton – F, S]

***Isoetes virginica*** N.E. Pfeiffer, Virginia Quillwort. Mt (VA), Pd (NC, SC?, VA): in woodland streams; rare (US Species of Concern, VA Rare). July-September. See Brunton, Britton, & Wieboldt (1996) for additional information. [= C, K; < *I. melanopoda* Gay & Durieu ex Durieu -- RAB; < *I. virginica* -- C, F, FNA, G, W (also see *I. piedmontana*)]

*Isoetes louisianensis* Thieret, Louisiana Quillwort. S. AL, MS, and LA. [= FNA, K] {add to synonymy}

*Isoetes tenella* Léman, Spiny-spore Quillwort. South to PA and NJ (Kartesz 1999). [= K; = *I. echinospora* Durieu – FNA; > *I. echinospora* var. *echinospora* – F, G; > *I. echinospora* var. *muricata* (Durieu) Engelmann – C, F, G; > *I. echinospora* var. *braunii* (Durieu) Engelmann – G; > *I. muricata* Durieu] {add synonymy}

*Isoetes tennesseensis* N.T. Luecke & J.M. Budke. Endemic to Polk County, TN, near the North Carolina-Georgia state line, in the Hiwassee River. An octoploid species. See Luecke & Budke (2003) for additional information. [< *I. lacustris* – FNA, K, formerly misidentified as a southern disjunct population of *I. lacustris*]

*Isoetes tuckermanii* A. Braun, Tuckerman's Quillwort. South to MD (Kartesz 1999). A tetraploid species (2n=44), apparently derived from hybridization of a northern *I. engelmannii* entity and an unknown or extinct species, Z (Hoot, Napier, & Taylor 2004), genotype=NNZZ. [= FNA, K; < *I. tuckermanii* – C, F, G]

The following hybrids are known from our area, or nearby:

*Isoetes xaltonharvillii* Musselman & Bray [*I. engelmannii* x *valida*]. Known from Mountains, Piedmont, and Coastal Plain of VA. [= K]

*Isoetes xbruntonii* Knepper & Musselman [*I. engelmannii* x *hyemalis*]. Known from Coastal Plain of VA. [= K]

*Isoetes xfairbrothersii* Montgomery & Taylor [*I. engelmannii* x *macrospora*]. Known from s. NJ. [= K]

*Isoetes xcartaylorii* Musselman [*I. engelmannii*? x *riparia*]. Known from Coastal Plain of VA.

#### **LYCOPODIACEAE** Mirbel 1802 (Clubmoss Family)

A family of 10-15 genera and about 400 species. Lycopodiaceae, along with Selaginellaceae and Isoetaceae, now appear to be only distantly related to other extant pteridophytes and seed plants (Pryer et al. 2001). The division of North American *Lycopodium* into three or more genera has been strongly advocated by Wagner & Beitel (1992), Wagner & Beitel in FNA (1993), Haines (2003a), and nearly all other recent authors. The traditionally broad *Lycopodium* appears to include a number of natural groups which are strikingly different from one another and have constituted separate lineages for tens to hundreds of millions of years. These natural groups are separable by numerous morphological, developmental, and anatomical characters, karyotype, and inability to hybridize. Wagner & Beitel divide *Lycopodium* of our area into six genera in three subfamilies, as follows: *Huperzia* in Subfamily Huperzioidae, *Lycopodium* and *Diphasiastrum* in Subfamily Lycopodioidae, and *Lycopodiella*, *Palhinhaea*, and *Pseudolycopodiella* in Subfamily Lycopodielloideae. Haines (2003a) further divides *Lycopodium* into 3 genera: *Dendrolycopodium*, *Spinulum*, and *Lycopodium* s.s. The reasoning behind this division is very strong, and it is here followed. Profound differences in anatomy, morphology, reproduction, gametophyte morphology, and karyotype support this separation. The chromosome numbers of our genera: *Dendrolycopodium* (x=34), *Diphasiastrum* (x=23), *Huperzia* (x=67, 68), *Lycopodiella* (x=78), *Lycopodium* (x=34), *Palhinhaea* (x=55), *Pseudolycopodiella* (x=35), and *Spinulum* (x=34). Øllgaard in Kramer & Green (1990) and Wikström & Kenrick (2000) follow a somewhat broader coarse, recognizing 3 genera for our species (corresponding to the subfamilies of Wagner & Beitel 1992), and recognizing as sections the genera of Wagner & Beitel (1992). Øllgaard states that the "genera are very distinct, and also the sections within *Lycopodiella* and *Lycopodium* seem to represent ancient, independent evolutionary lines." Wikström & Kenrick (2000, 2001) suggest that the phylogenetic separation of *Lycopodium* (including *Diphasiastrum*) and *Lycopodiella* (including *Pseudolycopodiella* and *Palhinhaea*) occurred at least as long ago as the early Jurassic (208 million years before present), and the divergence of *Huperzia* from *Lycopodium* and *Lycopodiella* still longer ago. References: Lellinger (1985); Mickel (1979); Wagner & Beitel (1992); Beitel (1979); Snyder & Bruce (1986); Wagner & Beitel in FNA (1993b); Øllgaard in Kramer & Green (1990); Wikström & Kenrick (2000, 2001); Øllgaard (1987); Haines (2003a). Key based in part on Haines (2003a).

- 1 Leafy stems erect, simple or dichotomously branched, the ultimate branches vertically oriented; sporophylls like the sterile leaves or only slightly reduced, in annual bands along the stem; vegetative reproduction by leafy gemmae near the stem apex; [subfamily *Huperzioidae*] ..... ***Huperzia***
- 1 Leafy stems prostrate or erect, if erect then generally branched, the ultimate branches spreading (horizontal) or ascending; sporophylls differing from sterile leaves, either broader and shorter, or more spreading, aggregated into terminal cones; lacking vegetative reproduction by gemmae; [subfamily *Lycopodioidae*].
  - 2 Leaves herbaceous, pale or yellow-green, dull, deciduous; principal leafy stems creeping (except erect and repeatedly branched in *Palhinhaea*); rhizome dying back annually to an underground vegetative tuber at apex; spores rugulate; [of wetlands, mostly on moist or wet sands or peats]; [subfamily *Lycopodielloideae*].
  - 3 Upright shoots repeatedly branched; strobili nodding at the ends of the branches; [known to occur from se. SC southwards] ..... ***Palhinhaea***

- 3 Upright shoots not branched; strobili erect on upright shoots; [widespread in our area].
  - 4 Leaves of the prostrate stems 0.5-1.2 mm wide, ciliate-toothed or not toothed; leaves of the erect stem many, overlapping, spiral; leaves of the strobilus (sporophylls) resembling leaves of the prostrate and upright stems in size and shape; upright stems 1.5-15 mm in diameter (including the leaves) . . . . . **Lycopodiella**
  - 4 Leaves of the prostrate stems 1.3-2.1 mm wide, not toothed; leaves of the erect stem few, not overlapping, whorled; leaves of the strobilus (sporophylls) much reduced relative to leaves of the prostrate and upright stems; upright stems 1.5-3 mm in diameter (including the leaves) . . . . . **Pseudolycopodiella**
- 2 Leaves rigid, bright to dark green, shiny, evergreen; principal leafy stems mainly erect, treelike, fanlike, or creeping (if creeping, then the leaves with elongate, hyaline hair-tips); rhizome trailing, perennial; spores reticulate; [of uplands, mostly in moist to dry soils].
  - 5 Branches 1-5 mm wide (including the leaves), compressed to quadrangular, with 4 ranks of leaves; branching of strobilus stalks dichotomous . . . . . **Diphasiastrum**
  - 5 Branches 4-12 mm wide, terete (to somewhat compressed in *Dendrolycopodium obscurum*), with 6 or more ranks of leaves; branching of strobilus stalks (when present), pseudomonopodial (falsely appearing to have a main axis from which branches arise).
    - 6 Strobili borne on elongate, sparsely leafy peduncles borne at the tips of leafy, ascending branches; leaves with attenuate, hyaline hair-tips . . . . . **Lycopodium**
    - 6 Strobili sessile, borne directly above densely leafy portions of upright branches; leaves acuminate to acute.
      - 7 Erect leafy stems 3-8 mm in diameter (including the leaves), treelike or fanlike, with a definite main axis; leaves acute at the apex; horizontal shoots subterranean, without winter bud constrictions . . . . . **Dendrolycopodium**
      - 7 Erect leafy stems 10 mm or more in diameter (including the leaves), branched 1-4 times subdichotomously; leaves with a 0.4-1.0 mm long stiff spinule; horizontal shoots at or near the ground surface, with winter bud constrictions . . . . . **Spinulum**

**Dendrolycopodium** A. Haines 2003 (Tree-clubmoss)

A genus of 4 species, temperate and subarctic. Haines (2003a) makes the case for this genus as distinct from *Lycopodium* s.s. and other relatives. References: Wagner & Beitel in FNA (1993b); Wagner, Beitel, & Moran (1989); Hickey (1977); Øllgaard in Kramer & Green (1990); Haines (2003a)=Z.

- 1 Leaves of the main vertical axis spreading (30-90 degree angle to stem) in the vicinity of the lower lateral branches, prickly to the touch; branchlets round in cross-section, the 6 ranks of leaves (2 lateral ranks, 2 adaxial ranks, and 2 abaxial ranks) equal in length and spreading to ascending . . . . . **D. dendroideum**
- 1 Leaves of the main vertical axis appressed (15-30 degree angle to stem) in the vicinity of the lower lateral branches, soft to the touch; branchlets slightly to strongly dorsiventrally flattened in cross-section, the 6 ranks of leaves (4 lateral ranks, 1 adaxial rank, 1 abaxial rank) round or slightly to very unequal, the abaxial leaves more appressed and mostly shorter than (to equal to) the spreading lateral leaves.
  - 2 Abaxial leaves of the horizontal branchlets about one half to two thirds as long as the lateral leaves; leaves of the abaxial and adaxial ranks generally appressed to the branchlet, the lateral 4 ranks spreading at a (27-) ca. 40 (-59) degree angle from the branchlet, thus the branchlet and leaves together ca. 6-9 mm wide . . . . . **D. obscurum**
  - 2 Abaxial leaves of the horizontal branchlets about the same length as the lateral leaves; leaves of all the ranks spreading at a (21-) ca. 27 (-36) degree angle from the branchlet, thus the branchlet and leaves together 3.5-6 (-7) mm wide . . . . . **D. hickeyi**

**Dendrolycopodium dendroideum** (Michaux) A. Haines, Tree Ground-pine, Round-branch Clubmoss, Prickly Tree-clubmoss. Mt (NC, VA): openings, grassy balds, high elevation spruce-fir and northern hardwood forests; rare (NC Watch List, VA Watch List). July-September. The northernmost of the *L. obscurum* complex, ranging from n. Québec and Newfoundland west to AK, south to w. NC, MO, MN, SD, CO, MT, ID, and WA; also in Asia. [= Z; < *Lycopodium obscurum* var. *dendroideum* (Michaux) D.C. Eaton -- RAB, F, G; = *Lycopodium dendroideum* Michaux -- FNA, K, W; < *L. obscurum* -- C]

**Dendrolycopodium hickeyi** (W.H. Wagner, Beitel, & R.C. Moran) A. Haines, Pennsylvania Ground-pine, Hickey's Tree-clubmoss. Mt (NC, VA): grassy balds, bog margins, forest openings; rare (NC Watch List, VA Watch List). July-September. N. Québec and Newfoundland west to MN, south to NJ, w. NC, and n. IN. [= Z; < *Lycopodium obscurum* var. *dendroideum* (Michaux) D.C. Eaton -- RAB, F, G; = *Lycopodium hickeyi* W.H. Wagner, Beitel, & R.C. Moran -- FNA, K; = *Lycopodium obscurum* var. *isophyllum* Hickey -- W; < *L. obscurum* -- C]

**Dendrolycopodium obscurum** (Linnaeus) A. Haines, Common Ground-pine, Flat-branched Tree-clubmoss. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): acidic forests; common (uncommon in Piedmont and Coastal Plain). July-September. The southernmost of the *L. obscurum* complex, ranging from Nova Scotia and New Brunswick west to MI and WI, south to n. GA, n. AL, and IN. [= Z; = *Lycopodium obscurum* Linnaeus -- FNA, K; = *Lycopodium obscurum* var. *obscurum* -- RAB, F, G, W; < *L. obscurum* -- C, S]

**Diphasiastrum** Holub 1975 (Flat-branched Clubmoss, Running Cedar)

A genus of about 15-20 species, mostly north temperate and subarctic. This group is sometimes treated as *Lycopodium* section *Complanata* (Øllgaard in Kramer & Green 1990, Øllgaard 1987, Wikström & Kenrick 2000). References: Wagner & Beitel in FNA (1993b); Haines (2003a)=Z; Øllgaard in Kramer & Green (1990); Wikström & Kenrick (2000).

- 1 Foliage dark green, not glaucous; horizontal branchlets 2-4 mm wide (including the leaves); branchlets without conspicuous annual constrictions; rhizomes 0-1 cm deep (which can be determined by pulling up a single upright shoot -- the depth to rhizome is approximately the length of the white portion of the vertical stem); abaxial rank of leaves shorter than lateral ranks

- (thus the branchlets flat in cross-section) . . . . . ***D. digitatum***  
 1 Foliage blue-green, glaucous; horizontal branchlets 1-2 mm wide (including the leaves); branchlets with conspicuous annual constrictions; rhizomes (1-) 5-12 cm deep; abaxial rank of leaves as long as lateral ranks (thus the branchlets more-or-less square in cross-section) . . . . . ***D. tristachyum***

***Diphasiastrum digitatum*** (Dillenius ex A. Braun) Holub, Common Running-cedar, Fan Ground-pine. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): dry to mesic forests and openings, especially common in disturbed sites, such as successional pine forests; common. July-September. Widespread in e. North America. Hickey & Beitel (1979) and Holub (1975a & 1975b) explain the nomenclatural decision to accept the epithet '*digitatum*' over the more familiar '*flabelliforme*.' [= FNA, Z; = *Lycopodium flabelliforme* (Fernald) Blanch -- RAB, S; = *Lycopodium digitatum* Dillenius ex A. Braun -- C, K, W; = *Lycopodium complanatum* Linnaeus var. *flabelliforme* Fernald -- F, G]

***Diphasiastrum tristachyum*** (Pursh) Holub, Blue Running-cedar, Ground-cedar. Mt (GA, NC, SC, VA), Pd (NC, VA), Cp (VA): dry forests, glades, balds, barrens, forest openings; uncommon, rare in Piedmont and Coastal Plain (GA Special Concern, SC Rare). July-September. Widespread in ne. North America, south in the mountains to nw. SC, ne. GA, and AL. [= FNA, Z; = *Lycopodium tristachyum* Pursh -- RAB, C, F, G, K, S, W]

*Diphasiastrum xhabereri* (House) Holub [*D. digitatum* x *tristachyum*; is known from widely scattered localities in our area. [= FNA, Z; = *Lycopodium* x *habereri* House – K]

***Huperzia* Bernhardtii (Firmoss, Clubmoss)**

A genus of about 10-15 species, north temperate and arctic (and tropical mountains of Asia). Within the Lycopodiaceae, *Huperzia* has "an isolated position", basal to the remainder of the family, and is sometimes separated in a separate family, the Huperziaceae (Haines 2003a). References: Wagner & Beitel in FNA (1993b); Haines (2003a)=Z; Øllgaard in Kramer & Green (1990); Wikström & Kenrick (2000).

**Identification notes:** Several hybrids are known from our area; they usually occur in intermediate habitats (such as in thin soil at the base of cliffs) and generally are found in proximity to both parents, but sometimes occur in the absence of one or both parents. Hybrids can be recognized by their intermediate morphology.

- 1 Leaves oblanceolate, the apical portion toothed with 1-8 large, irregular teeth; leaves 6-15 mm long, 1.0-2.5 mm wide; stomates on lower leaf surface only (visible at 10x or preferably 20-40x); spores 23-29 µm in diameter; [mainly of forest soils] . . . . . ***H. lucidula***  
 1 Leaves lanceolate (awl-shaped), margins not toothed, or minutely toothed in the apical portion only with 1-3 low teeth; leaves 3-9 mm long, 0.6-1.3 mm wide; stomates on both leaf surfaces (visible at 10x or preferably 20-40x); spores 29-38 µm in diameter; [mainly of rock outcrops].  
 2 Leaves spreading, (3-) 5-9 mm long, ca. 1 mm wide, usually sparsely toothed; stomates relatively few on the upper leaf surface (1-25 on each side of midrib); [of outcrops at low to medium elevations] . . . . . ***H. porophila***  
 2 Leaves ascending to spreading, 2-7.5 mm long, 0.6-0.8 (-1.0) mm wide, untoothed (though sometimes with minute, single cell bumps); stomates relatively many on the upper leaf surface (30-90 on each side of midrib); [of high to medium elevations].  
 3 Leaves dimorphic, those at the base longer and spreading wider from the shoot axis than those from the apical portion of the plant; gemmiferous branches borne throughout the apical portion of mature shoots; lateral leaves of gemmae 0.5-1.1 mm wide . . . . . ***H. appressa***  
 3 Leaves relatively monomorphic; gemmiferous branches, if present at all, borne in 1 pseudowhorl at the apex of seasonal growth; lateral leaves of gemmae 1.3-2.5 mm wide . . . . . [***H. selago***]

***Huperzia appressa*** (Desvaux) A. Löve & D. Löve, Appalachian Firmoss. Mt (GA, NC, VA): rock outcrops at high elevations (very rarely at middle elevations), rarely also in seepage or along banks of small streams at high elevations, and in fens (on hummocks); rare (NC Rare, VA Rare). June-August. N. Québec and Newfoundland west to Ontario, MI, and MN and south along the Appalachians to w. NC, e. TN, and ne. GA. This species was named in 1992 as *H. appalachiana* (Beitel & Mickel 1992), but *H. appressa* (Desvaux) A. Löve & D. Löve is an older combination that applies to the same species (Haines 2003a). Though morphologically only subtly differentiated from the circumboreal *H. selago* (for distinctions see Beitel & Mickel 1992; Brunton, Wagner, & Beitel 1992; Haines 2003a), the case for the distinctness of *H. appressa* is confirmed by the production of sterile (abortive-spored) hybrids where it co-occurs with *H. selago*. [= Z; = *H. appalachiana* Beitel & Mickel -- FNA, K; < *Lycopodium selago* Linnaeus -- RAB, S, W; >> *Lycopodium selago* Linnaeus var. *appressum* (Desvaux) Petrovic -- C, F; >> *Lycopodium selago* var. *selago* -- C, G]

***Huperzia lucidula*** (Michaux) Trevisan, Shining Firmoss, Shining Clubmoss. Mt (GA, NC, SC, VA), Pd (NC, VA), Cp (VA): moist forests and ravines; common (uncommon in Piedmont and Coastal Plain). June-August. Widespread in ne. North America, south to SC, TN, IN, IL, and MO. [= FNA, K, Z; = *Lycopodium lucidulum* Michaux -- RAB, C, F, G, S, W]

***Huperzia porophila*** (Lloyd & Underwood) Holub, Rock Clubmoss. Mt (GA, NC, SC, VA): rock outcrops and cliffs, especially in the spray of waterfalls, at low to medium elevations; rare (GA Special Concern, NC Rare, SC Rare, VA Rare). June-August. Centered in the sedimentary Central Appalachians, *H. porophila* ranges from ne. PA, WV, OH, and WI south to NC, TN, nw. AL, and e. MO. Waterway (1986) clarified the distinctions between *H. porophila* and *H. lucidula*. [= FNA, K; = *Lycopodium porophilum* Lloyd & Underwood -- RAB, C, F, S, W; < *Lycopodium selago* var. *patens* (Beauvois) Desvaux -- G, misapplied]

*Huperzia selago* (Linnaeus) Bernhardtii ex Martius & Schrank, Northern Firmoss, is circumboreal, ranging south in North America to NY, New England, and the Great Lakes region, and disjunct to OH. It could easily occur as a disjunct in our area, and should be sought in the high mountains. [= FNA, Z; >> *Lycopodium selago* Linnaeus var. *appressum* (Desvaux) Petrovic -- C, F; >> *Lycopodium selago* var. *selago* -- C, G; > *Huperzia selago* (Linnaeus) Bernhardtii ex Martius & Schrank var. *selago* -- K]

*Huperzia xbartleyi* (Cusick) Kartesz & Gandhi [*H. lucidula* x *porophila*] is reported for NC by Waterway (1986). This hybrid can

be told from its parents by the presence of stomates on both surfaces of the leaf (unlike *H. lucidula*), but their marked lower density on the upper surface (unlike *H. porophila*). [= K, Z]

*Huperzia xprotoporophila* A. Haines [*H. appressa* x *lucidula*] may be expected at cliff bases on high elevation rocky summits. It is known from Chimney Rock Park, Rutherford County (the lowest elevation occurrence of *H. appressa* in NC) and from Roan Mountain, Mitchell County, and Grandfather Mountain, Avery County. This hybrid can be told from its parents by the presence of stomates on both surfaces of the leaf (unlike *H. lucidula*), but their marked lower density on the upper surface (unlike *H. appressa*). An additional useful character is the distribution of gemmiphores (i.e., gemmiferous branches): those of *Huperzia appressa* are abundantly distributed throughout the apical portion of mature plants, while those of the hybrid are confined to 1 or 2 pseudowhorls at the apex of annual growth (i.e., there are large gaps between the pseudowhorls of gemmiferous branches). [= Z]

***Lycopodiella*** Holub 1964 (Bog Clubmoss)  
(also see *Pseudolycopodiella*)

A genus of about 15-20 species, temperate and tropical. Additional research on this genus in our area is needed. Two fertile tetraploid species were recently named from MI (Bruce, Wagner, & Beitel 1991), and additional cryptic or semicryptic species may be found in the Southeastern Coastal Plain. This group is variously treated as genus *Lycopodiella*, or as *Lycopodiella* section *Lycopodiella* (Øllgaard in Kramer & Green 1990, Wikström & Kenrick 2000). References: Wagner & Beitel in FNA (1993b); Øllgaard in Kramer & Green (1990); Wikström & Kenrick (2000); Haines (2002, 2003a, 2003b)=Z.

**Identification notes:** Species of this genus are difficult to identify. They often grow together; it is not uncommon to find two or more species at a single site in the Coastal Plain. Hybrids occur. Juvenile plants, resprouting in spring or after fire are especially difficult. In contrast to the other species, *Pseudolycopodiella caroliniana* and, to a lesser degree, *L. prostrata*, are dorsiventrally flattened (or apparently distichous), but it seems that juvenile sprouts of all species are somewhat flattened.

- 1 Leaves of the horizontal shoots entire (rarely those toward the shoot apex with a few teeth); horizontal shoots, excluding the leaves, 0.5-0.9 (-1.0) mm in diameter; each horizontal shoot segment commonly producing a single upright shoot; [in our area, a plant of the Mountains] ..... ***L. inundata***
- 1 Leaves of the horizontal shoots toothed (except when inundated); horizontal shoots, excluding the leaves, 1.5-5.0 mm in diameter; each horizontal shoot segment producing 2-6 upright shoots; [collectively primarily of the Coastal Plain, with some disjunctions inland into the Piedmont and Mountains].
  - 2 Fertile leaves (sporophylls) 2.9-5.0 (-5.2) mm long, appressed at maturity, entire or with short teeth less than 0.3 mm long; strobili 3-6 mm in diameter at maturity ..... ***L. appressa***
  - 2 Fertile leaves (sporophylls) 5.5-9 mm long, spreading, with 1-8 teeth per margin, some or all of the teeth exceeding 0.3 mm in length; strobili 10-20 mm in diameter at maturity.
    - 3 Prostrate stems arching, not in contact with the ground (and rooting) all along their length, 8-11 mm wide (including leaves), the stem (stripped of leaves) 2-4 mm in diameter; leaves of the prostrate stem of one size and shape, spreading to ascending, 5-7 mm long, 0.5-0.7 mm wide; erect stems many, equally spaced along the prostrate stems, progressively shorter and sterile towards the apex of the prostrate stems ..... ***L. alopecuroides***
    - 3 Prostrate stems creeping, in contact with the ground (and rooting) all along their length, 12-19 mm wide (including leaves), the stem (stripped of leaves) 1-2.2 mm in diameter; leaves of the prostrate stems dimorphic, spreading to reflexed, the upper leaves smaller (4-5 mm long, 0.4-0.6 mm wide) than the lateral leaves (7-8 mm long, 0.7-1.8 mm wide); erect stems few, clustered well behind the apex of the prostrate stems, mostly fertile and subequal in length ..... ***L. prostrata***

***Lycopodiella alopecuroides*** (Linnaeus) Cranfill, Foxtail Clubmoss. Cp, Pd, Mt (GA, NC, SC, VA): savannas, seepages, and other wet, sandy sites; common (rare in Mountains and Piedmont). July-September. Primarily Southeastern Coastal Plain: se. MA south to FL and west to se. TX, and disjunct in the Cumberland Plateau of KY, TN, and VA, the Allegheny Mountains of WV (Morton et al. 2004), the e. Highland Rim of TN, and in ME (Haynes 2001). [= FNA, K, Z; < *Lycopodium alopecuroides* Linnaeus -- RAB (also see *L. prostrata*); = *Lycopodium alopecuroides* Linnaeus -- C, G, S, W]

***Lycopodiella appressa*** (Chapman) Cranfill, Southern Bog Clubmoss. Cp, Pd (GA, NC, SC, VA), Mt (GA, NC, SC): savannas, seepages, bogs; common (rare in Mountains and Piedmont). July-September. Primarily Southeastern Coastal Plain: se. Newfoundland and MA, south to FL, west to OK, AR, and TX, and disjunct in the mountains of KY, TN, NC, and in sw. MI. [= FNA, K, Z; = *Lycopodium appressum* (Chapman) Lloyd & Underwood -- RAB, C, S, W; = *Lycopodium inundatum* Linnaeus var. *bigelovii* Tuckerman -- F, G]

***Lycopodiella inundata*** (Linnaeus) Holub, Northern Bog Clubmoss. Mt (NC, VA): gravelly or sandy seepage areas in bogs at middle to high elevations; rare (NC Rare, VA Rare). July-September. A circumboreal species, ranging south in the Appalachians to NC, where it was first found in 1986 (Weakley, *in prep.*). [= FNA, K, Z; = *Lycopodium inundatum* Linnaeus -- C, W; = *Lycopodium inundatum* var. *inundatum* -- F, G]

***Lycopodiella prostrata*** (Harper) Cranfill, Featherstem Clubmoss, Prostrate Bog Clubmoss. Cp (GA, NC, SC); Pd (GA): savannas, seepages; uncommon. July-September. A Southeastern Coastal plain endemic, ranging from se. NC south to FL and west to TX. [= FNA, K; < *Lycopodium alopecuroides* -- RAB; = *Lycopodium prostratum* Harper -- C, S]

All pairwise combinations of sympatric species form fertile hybrids (only *L. inundata* and *L. prostrata* are entirely allopatric and not known to hybridize). The following hybrids should be expected where the parents grow together. Which occur in our area is uncertain at present.

*Lycopodiella alopecuroides* x *appressa*. [= *Lycopodiella xcopelandii* (Eiger) Cranfill -- K, Z; *Lycopodium xcopelandii* Eiger]

*Lycopodiella alopecuroides* x *inundata*. [= *Lycopodiella xrobusta* (R.J. Eaton) A. Haines -- Z]. See Haynes (2002) for additional information.

*Lycopodiella alopecuroides* x *prostrata*. [= *Lycopodiella xbrucei* Cranfill -- K; = *Lycopodium xbrucei* (Cranfill) Lellinger]

*Lycopodiella appressa* x *inundata*. [*Lycopodiella xgilmanii* A. Haines -- Z]. Earlier tentative reports of *Lycopodiella margueritae* J.G. Bruce, W.H. Wagner, & Beitel for the Mountains of Virginia are apparently based on this hybrid. See Haynes (2003a, 2003b)

for additional information. [= *Lycopodiella margaritiae* J.G. Bruce, W.H. Wagner, & Beitel – K, misapplied; = *Lycopodiella xgilmanii* A. Haines – Z]

*Lycopodiella appressa* x *prostrata*.

***Lycopodium*** Linnaeus 1753 (Running Clubmoss)

(see also *Dendrolycopodium*, *Diphasiastrum*, *Huperzia*, *Lycopodiella*, *Palhinhaea*, *Pseudolycopodiella*, and *Spinulum*)

A genus of 5-10 species, mainly temperate and subarctic. The prospective fractionation of *Lycopodium* has resulted in the creation of more natural genera, more comparable to those in other groups of plants. References: Wagner & Beitel in FNA (1993b); Wagner, Beitel, & Moran (1989); Hickey (1977); Øllgaard in Kramer & Green (1990); Haines (2003a)=Z.

- 1 Strobili 2-5, borne on alternate "pedicels" branching from the central "peduncle"; leaves 4-6 mm, spreading to loosely ascending . . . . . ***L. clavatum***
- 1 Strobili 1 (rarely 2, if then, the 2 strobili not on separate "pedicels," but sessile at the top of the "peduncle"; leaves 3-5 mm long, ascending to appressed . . . . . [***L. lagopus***]

***Lycopodium clavatum*** Linnaeus, Running Clubmoss. Mt (GA, NC, SC, VA), Pd, Cp (VA): openings, balds, roadbanks, open forests; uncommon (rare in Piedmont and Coastal Plain) (GA Special Concern). July-September. Circumboreal, south in e. North America along the Appalachians to NC and n. GA. [= RAB, FNA, K, W, Z; < *L. clavatum* -- C (see also *L. lagopus*); = *L. clavatum* var. *clavatum* -- F, G, S]

*Lycopodium lagopus* (C. Hartman) G. Zinserling ex Kuzeneva-Prochorova ranges south to c. PA (Rhoads & Klein 1993) and Tucker County, in e. WV (Gottlieb 2002). [= FNA, K, Z; < *L. clavatum* -- C; > *L. clavatum* Linnaeus var. *monostachyon* Greville & Hooker -- F, G; > *L. clavatum* var. *megastachyon* Fernald & Bissel -- F, G; > *L. clavatum* var. *brevispicatum* Peck -- F]

***Palhinhaea*** Vasconcellos & Franco 1967 (Nodding Clubmoss)

A genus of 10-15 species, tropical and subtropical. This group is variously treated as the genus *Palhinhaea* or as *Lycopodiella* section *Campylostachys* (Øllgaard in Kramer & Green 1990, Wikström & Kenrick (2000). References: Wagner & Beitel in FNA (1993b); Øllgaard in Kramer & Green (1990); Wikström & Kenrick (2000).

***Palhinhaea cernua*** (Linnaeus) Vasconcellos & Franco, Nodding Clubmoss, Staghorn Clubmoss. Cp (GA, SC): wet savannas, disturbed moist areas; uncommon (rare in SC). This species is pantropical, occurring in the both the Neotropics and the Paleotropics. Its occurrence in our area may be adventive. [= FNA; =? *Lycopodiella cernua* (Linnaeus) Pichi Sermolli var. *cernua* -- K; = *Lycopodium cernuum* Linnaeus -- S]

***Pseudolycopodiella*** Holub 1983 (Carolina Bog Clubmoss)

A genus of about 12 species, subcosmopolitan. This group has often been treated as section of *Lycopodium* (or of *Lycopodiella*); it appears to warrant status as a genus separate from *Lycopodiella*. In addition to the morphologic distinctions, this species has considerable anatomical differences, a different base chromosome number than the four species of *Lycopodiella* ( $x = 35$  vs.  $x = 78$ ), and does not hybridize with *Lycopodiella* (Wagner & Beitel 1992). Øllgaard in Kramer & Green (1990) and Wikström & Kenrick (2000) retain it as *Lycopodiella* section *Caroliniana*. References: Wagner & Beitel in FNA (1993b); Haines (2003a)=Z; Øllgaard in Kramer & Green (1990); Wikström & Kenrick (2000).

***Pseudolycopodiella caroliniana*** (Linnaeus) Holub, Carolina Bog Clubmoss, Slender Clubmoss. Cp (GA, NC, SC, VA): savannas, seepages; uncommon, rare in VA (VA Rare). July-September. This species occurs in se. North America, the West Indies, and is widespread in the Southern Hemisphere; in North America, it ranges from MA south to FL and west to e. TX. [= FNA, Z; = *Lycopodium carolinianum* Linnaeus -- RAB, C, F, G, S; =? *Lycopodiella caroliniana* (Linnaeus) Pichi Sermolli var. *caroliniana* -- K]

***Spinulum*** A. Haines (Bristly Clubmoss)

A genus of 3 species, north temperate and subarctic. References: Wagner & Beitel in FNA (1993b); Wagner, Beitel, & Moran (1989); Hickey (1977); Øllgaard in Kramer & Green (1990); Haines (2003a)=Z.

***Spinulum annotinum*** (Linnaeus) A. Haines, Stiff Clubmoss, Bristly Clubmoss. Mt (VA): high elevation hardwood or coniferous forests; uncommon (NC Watch List). August-October. A circumboreal species, south in North America to NJ and MN, and in the Appalachians to WV, sw. VA, and e. TN (Blount County). Two varieties have been considered to reach our area in VA: var. *acrifolium* Fernald and var. *annotinum*. They are doubtfully distinct but need further study. This species was reported for NC by Lellinger (1985) and FNA, and is apparently indicated as occurring in NC on the range map in Mickel (1979); there is apparently no documentation for these reports, though the species occurs in Grayson County, VA, a county adjacent to NC. There is also an old collection from the Great Smoky Mountains of TN. Its occurrence in NC is certainly plausible, and it should be sought. [= Z; *Lycopodium annotinum* Linnaeus -- C, FNA, K, W; > *L. annotinum* var. *acrifolium* Fernald -- F, G; > *L. annotinum* var. *annotinum* -- F, G]

**LYGODIACEAE** C. Presl 1845 (Climbing Fern Family)

A family with a single genus and about 40 species, of tropical and temperate regions, particularly equatorial and south temperate. Sometimes included in the Schizaeaceae, but the relationship is remote and unclear. References: Nauman in FNA (1993b).

***Lygodium* Swartz 1800 (Climbing Fern)**

A genus of about 40 species, mostly tropical, with a few temperate species.

- 1 Sterile pinnae palmately lobed into 4-8 smooth to undulate lobes . . . . . ***L. palmatum***
- 1 Sterile pinnae pinnately divided into numerous serrate pinnules . . . . . ***L. japonicum***

\* ***Lygodium japonicum*** (Thunberg) Swartz, Japanese Climbing Fern. Cp, Pd (GA, NC, SC): disturbed areas; rare, introduced from Asia. June-September. Rare in our area, but common and weedy in FL, the leaves (up to 30 m in length!) climbing into the canopy of trees in swamp forests and other wet habitats. [= RAB, FNA, K, S]

***Lygodium palmatum*** (Bernhardi) Swartz, American Climbing Fern, Hartford Fern. Mt (GA, NC, SC, VA), Pd, Cp (NC, SC, VA): bogs, moist thickets, swamp forests, in strongly acid soils; uncommon (GA Special Concern, SC Rare, VA Watch List). July-September. Widespread in e. North America, but uncommon or rare in most of its range. The species is perhaps most common in the Cumberland Plateau of KY and TN. Garrison (1992) discusses two forms of the species, "one with long appressed hairs scattered over the lower (abaxial) side of the sterile leaflets and the other relatively hair-free." The two forms appear to be geographically differentiated, the pubescent form predominating south and west of Maryland, the glabrous form occurring primarily in the Northeast. Both forms are present in our area. Further research is needed to determine the taxonomic significance of this variation in pubescence. [= RAB, C, F, FNA, G, K, S, W]

**MARSILEACEAE** Mirbel 1802 (Water-clover Family)

A family of 3 genera and about 55-75 species, nearly cosmopolitan. References: Johnson in FNA (1993b); Kramer in Kramer & Green (1990).

- 1 Leaves cloverlike, the 4 cuneate, obovate or wedge-shaped leaflets borne at the summit of the petiole; sporocarps ovoid . . . . . ***Marsilea***
- 1 Leaves grasslike, linear, the leaf blade absent, the petiole narrowly winged; sporocarps spherical . . . . . ***Pilularia***

***Marsilea* Linnaeus 1753 (Water-clover)**

A genus of 50-70 species, nearly cosmopolitan. References: Johnson in FNA (1993b); Kramer in Kramer & Green (1990); Knepper, Johnson, & Musselman (2002).

- 1 Leaves strongly bicolored . . . . . ***M. mutica***
- 1 Leaves unicolored . . . . . ***M. quadrifolia***

\* ***Marsilea mutica*** Mettenius. Cp (VA), Pd (GA): ditches, ponds; rare, introduced from Australasia.

\* ***Marsilea quadrifolia*** Linnaeus, European Water-clover. Pd (NC): shallow water of artificial impoundment; rare; native of Europe. Not seen fertile in NC. First reported for our area in 1992; sold in garden stores as an aquatic to be grown in water gardens, and likely to be encountered more widely in the future. [= C, F, FNA, G, K]

***Pilularia* Linnaeus 1753 (Pillwort)**

A genus of 3-6 species, nearly cosmopolitan. References: Dennis & Webb (1981); Kramer in Kramer & Green (1990).

***Pilularia americana*** A. Braun, American Pillwort. Pd (GA, SC): vernal pools and seepage areas on granitic flatrocks; rare (GA Special Concern). This peculiar plant has a puzzling distribution, being known from several disjunct regions: OR to s. CA; NE to TX; AR; TN; and GA to SC. The fragmented distribution may be at least partly explainable by the inconspicuous nature of the plant. It lacks a leaf-blade, the 1-8 cm long petiole being narrowly winged, appearing rather like an *Isoetes* or *Juncus* leaf. In vegetative condition, it may be recognized as a "fern" by the typical coiled ("fiddlehead") development of young leaves. The primary rhizome produces individual "fronds" at nodes, a short rhizome branch at each node also produces "fronds." First reported for SC in 1993 (J. Allison, pers. comm.). [= FNA, K, S]

**OPHIOGLOSSACEAE** (R. Brown) Agardh 1822 (Adder's-tongue Family)

A family of 7-8 genera and about 75-115 species. The Ophioglossaceae is only distantly related to the leptosporangiate ferns; Pryer et al. (2004) indicate that it is most closely related to Psilotaceae. References: Wagner & Wagner in FNA (1993b); Wagner in Kramer & Green (1990).

- 1 Sterile portion of the leaf simple, unlobed; fertile stalks unbranched, the sporangia embedded in a linear spike ***Ophioglossum***
- 1 Sterile portion of the leaf blade pinnate, pinnatifid, or more divided; fertile stalks branched, the sporangia sessile or stalked.

- 2 Fertile stalk joined to stalk of sterile leaf blade near the rhizome, far below the base of the leaf blade, and usually at or below the surface of the ground; leaves evergreen . . . . . **Sceptridium**
- 2 Fertile stalk joined to stalk of sterile leaf blade near the base of the leaf blade, far above the rhizome, and usually well above the surface of the ground; leaves deciduous.
  - 3 Sterile portion of the leaf blade 1-2-pinnate; plants usually less than 20 cm tall; sterile blade fleshy in texture, 1-8 cm long . . . . . **Botrychium**
  - 3 Sterile portion of the leaf blade 3-pinnate or even more finely divided; plants (9-) 30-50 cm tall; sterile blade herbaceous in texture, 10-40 cm long . . . . . **Botrypus**

**Botrychium** Swartz 1801 (Moonwort)

A genus of 25-30 species, nearly cosmopolitan, but primarily temperate and concentrated in North America and e. Asia. *Botrychium* as traditionally circumscribed to include *Botrypus* and *Sceptridium* is very heterogeneous (Hauk, Parks, & Chase 2003); I have here accepted the arguments of Hauk (1996), Hauk, Parks, & Chase (2003), and others recommending recognition of the anciently divergent and molecularly and morphologically distinctive segregates as genera. References: Wagner in Kramer & Green (1990); Hauk, Parks, & Chase (2003).

- 1 Sterile pinnae contracted at the base, thus cuneate or wedge-shaped; leaf blades pinnate to nearly simple, 1-6 cm long, 0.3-2 cm wide; pinna margins entire, the apices round; [section *Simplex*] . . . . . **B. simplex** var. **simplex**
- 1 Sterile pinnae (or pinnules of 2-pinnate blades) not contracted at the base, thus oblong or elongate; leaf blades pinnate, pinnate-pinnatifid, or 2-pinnate, 1-8 cm long, 0.8-6 cm wide; pinna or pinnule margins entire, lobed, or incised, the pinna apices round, obtuse, or acute; [section *Lanceolatum*].
  - 2 Sterile pinnae apices obtuse to round at the apex, their segments (and undivided pinnae) about as long as wide, round, obtuse, or truncate at the apex; leaf blade mostly short-petioled (rarely sessile), the petiole (0-) 1-3 cm long; leaf blade pinnate to pinnate-pinnatifid . . . . . **B. matricariifolium**
  - 2 Sterile pinnae acute at the apex, their segments (and undivided pinnae) at least twice as long as wide, mostly lanceolate, acute at the apex; leaf blade sessile, leaf blade pinnate-pinnatifid to 2-pinnate . . . . . **B. lanceolatum** var. **angustisegmentum**

**Botrychium lanceolatum** (S.G. Gmelin) Angström var. **angustisegmentum** Pease & A.H. Moore, Lanceleaf Moonwort, Narrow Triangle Moonwort. Mt (NC, VA): forests and grassy balds; rare (NC Rare, VA Rare). July-August. Var. **angustisegmentum** ranges from Newfoundland and Ontario south to VA, WV, NC, OH, MI, and MN, and in the Rocky Mountains of Canada and MT. Var. **lanceolatum** is widespread in w. North America. The two varieties are genetically distinct (Farrar & Wendel 1996). [= C, F, G, K, W; = *B. lanceolatum* ssp. *angustisegmentum* (Pease & A.H. Moore) R.T. Clausen -- FNA]

**Botrychium matricariifolium** (A. Braun ex Duwell) A. Braun ex W.D.J. Koch, Daisyleaf Moonwort. Mt (NC, VA): forests (often successional) and old fields; uncommon (NC Rare). June-August. Newfoundland and Alberta south to NC, TN, KY, WV, OH, IL, WI, MN, and ND. [= FNA, K, W; = *B. matricariaefolium* -- F, G (orthographic variant); > *B. matricariaefolium* var. *matricariaefolium* -- C]

**Botrychium simplex** E. Hitchcock var. **simplex**, Least Moonwort. Mt (NC, VA): forests; rare (NC Rare, VA Rare). May-June. Widespread in n. North America, from Newfoundland and British Columbia south to NJ, VA, NC, MI, IN, WI, IA, SD, WY, CO, NM, UT, NV, and CA. Wagner & Wagner in FNA (1993b) discuss variation within *B. simplex*. Farrar & Wendel (1996) indicate that 3 varieties of *B. simplex* have strong genetic divergence, comparable to that usually distinguishing species. [= C, F, G; < *B. simplex* -- FNA, K, W]

**Botrypus** Richard 1801 (Rattlesnake Fern)

A genus of 1-2 species, of North America (and depending on circumscription) Asia. References: Hauk, Parks, & Chase (2003)

**Botrypus virginianus** (Linnaeus) Holub, Rattlesnake Fern, Sang-find. Mt, Pd, Cp (GA, NC, SC, VA): in a wide range of fairly dry, mesic, and wet forests, cove forests; common. April-June. Newfoundland and British Columbia south to FL and CA. [= *Botrychium virginianum* (Linnaeus) Swartz -- RAB, C, FNA, G, K, W; = *B. virginianum* var. *virginianum* -- F; = *Osmundopteris virginiana* (Linnaeus) Small -- S]

**Ophioglossum** Linnaeus 1753 (Adder's-tongue)

A genus of about 25-30 species, nearly cosmopolitan, primarily tropical. References: Lellinger (1985); Wagner in Kramer & Green (1990).

- 1 Underground stem globose, nearly spherical, 3-11 mm in diameter; fertile spikes commonly with a conspicuous, acute or attenuate sterile portion (apiculum) at its apex; sterile blade 1-4 cm long, 0.5-2.5 cm wide, borne horizontally near the ground . . . . . **O. crotalophoroides**
- 1 Underground stem narrowly cylindrical or irregularly elongate, 2-4 mm in diameter; fertile spikes without a sterile portion at the apex or the sterile portion inconspicuous; sterile blade 0.5-10 cm long, 0.2-5.5 cm wide, borne horizontally, ascending, or vertically.
  - 2 Sterile blade 0.2-1 cm wide, the polygonal venation areoles usually lacking both smaller areoles and free included veinlets **O. nudicaule**
  - 2 Sterile blade (0.5-) 1.2-5 cm wide, the polygonal venation areoles either with smaller areoles or with free included veinlets.
    - 3 Large areoles of the of the sterile blade subdivided into smaller areoles, further subdivided into smaller areoles and free veinlets; sterile blade apiculate . . . . . **O. engelmannii**
    - 3 Large areoles of the sterile blade subdivided into smaller areoles, which lack free veinlets; sterile blade obtuse or



acute.

- 4 Sterile blade ovate-lanceolate, the base obtuse to nearly truncate, broadest less than a quarter of the way from the base to the apex; primary areoles mostly more than 2 mm wide, without included veinlets . . . **O. petiolatum**
- 4 Sterile blade ovate to elliptic, the base cuneate to obtuse, broadest between one quarter and one half of the way from the base to the tip; primary areoles mostly less than 2 mm wide, with included veinlets.
- 5 Sterile blade elliptic, broadest near the middle, acute to attenuate at the base, pale green, dull, herbaceous in texture; basal frond sheath membranaceous and ephemeral; spores 50-60  $\mu$  in diameter . . . **O. pusillum**
- 5 Sterile blade ovate, broadest below the middle, obtuse at the base, dark green, shiny, firm in texture; basal frond sheath leathery and tending to persist; spores 35-45  $\mu$  in diameter . . . . . **O. pycnostichum**

**Ophioglossum crotalophoroides** Walter, Bulbous Adder's-tongue. Cp (GA, NC, SC), Pd (GA): moist ditchbanks and grassy roadside flats; rare (or overlooked) north of GA. March-September. A Southeastern Coastal Plain species, ranging from e. NC (Dare County) south to FL and west to TX; also in Mexico, the West Indies, Central America, and South America. [= RAB, FNA, S; > *O. crotalophoroides* var. *crotalophoroides* -- K; > *O. crotalophoroides* var. *nanum* Osten ex de Lichtenstein -- K]

**Ophioglossum engelmannii** Prantl, Engelmann's Adder's-tongue, Limestone Adder's-tongue. Mt (GA, NC?, VA), Pd (GA): dry barrens and glades over calcareous rocks, very rarely on granite; uncommon (GA Special Concern, VA Watch List). March-June. W. VA, IN, IL, KS, and AZ south to FL and TX; also in Mexico and Central America. Ascribed to NC by Wagner & Wagner in FNA (1993b), the documentation unknown. [= C, F, FNA, G, K, S, W]

**Ophioglossum nudicaule** Linnaeus f., Slender Adder's-tongue. Cp (GA, NC, SC), Pd (GA): lawns and other moist, grassy areas; rare or overlooked. E. NC south to s. FL, west to TX; also in Mexico, the West Indies, Central and South America, Asia, and Africa. First reported from NC by Thomas & Marx (1979). [= RAB, FNA, K; > *O. dendroneuron* E.P. St. John -- S; > *O. mononeuron* E.P. St. John -- S; *O. tenerum* Mettenius -- S]

**Ophioglossum petiolatum** Hooker, Long-stem Adder's-tongue. Cp (GA, NC, SC, VA): maritime wet grasslands, moist ditchbanks, and grassy roadside flats; rare or overlooked north of GA (NC Watch List, SC Rare, VA Rare). March-November. Widespread in se. United States, from se. VA south to FL and west to TX and OK; also in the West Indies, Mexico, n. South America, and Asia. First reported for NC by Thomas & Marx (1979). Wagner & Wagner in FNA (1993b) suggest that this species is likely introduced in North America. [= RAB, FNA, K; *O. floridanum* E. St. John -- S] {add synonymy}

**Ophioglossum pusillum** Rafinesque, Northern Adder's-tongue. Mt (NC?, VA): moist streamside meadow; rare (VA Rare). March-July. Nova Scotia west to ND, south to VA, possibly NC, IN, and NE; and in the Pacific Northwest. [= FNA, K; = *O. vulgatum* Linnaeus var. *pseudopodium* (Blake) Farwell -- F]

**Ophioglossum pycnostichum** (Fernald) A. & D. Löve, Southern Adder's-tongue. Pd, Mt (GA, NC, SC, VA), Cp (NC, SC, VA): bottomland forests, moist loamy soils of successional forests and old fields; uncommon (or overlooked) (SC Rare). March-July. Fairly widespread in e. North America, mostly south of the Wisconsinan glaciation, from s. NJ, IN, IL, and s. MI south to FL, MS, and e. TX. *O. vulgatum* (defined narrowly) is Eurasian. The best treatment of this complex is uncertain. [= W; = *O. vulgatum* Linnaeus var. *pycnostichum* Fernald -- RAB, C, F; < *O. vulgatum* Linnaeus -- FNA, G, K, S]

**Sceptridium** Lyon 1905 (Grape Fern)

A genus of ca. 14 species, nearly cosmopolitan. References: Hauk, Parks, & Chase (2003); Hauk (1996).

- 1 Sterile leaf 4-pinnate-pinnatifid, finely divided, the ultimate segments lacerate and linear, less than 3 mm wide . . . **S. dissectum**
- 1 Sterile leaf 2-pinnate to 4-pinnate, not finely divided, the ultimate segments ovate or oblong, more than 8 mm wide.
- 2 Sterile pinnae entirely divided into short, round or acute pinnules; lateral pinnules with an inconspicuous and poorly-developed central vein; plant producing 1 or 2 leaves per season.
  - 3 Sterile pinna and pinnule apices obtuse to acute (rarely round); ultimate segments mostly rounded at the base, not fan-shaped, ovate or oblong; ultimate segments often crowded and overlapping . . . . . **S. multifidum**
  - 3 Sterile pinna and pinnule apices round to obtuse; ultimate segments cuneate, rounded, or truncate at the base; ultimate segments remote or overlapping.
    - 4 Stalk of the basal sterile pinnae (10-) 15-70 mm long; roots irregularly ribbed, blackish; ultimate leaf segments fan-shaped, obovate, longer than wide, pinnately veined, the midrib weakly developed; sporulating August-October . . . . . **S. jenmanii**
    - 4 Stalk of the basal sterile pinnae 4-15 (-20) mm long; roots smooth, yellowish; ultimate leaf segments about as long as wide, subflabellately veined, lacking a midrib; sporulating January-April . . . . . **S. lunarioides**
- 2 Sterile pinnae (or their terminal portion) elongate (the sides often nearly parallel), entire to shallowly lobed, not divided into pinnules; lateral pinnules with a conspicuous and well-developed central vein; plant producing 1 leaf per season.
  - 5 Sterile pinna and pinnule apices obtuse to rounded (to somewhat acute); ultimate segments mostly ovate, narrowly ovate, or oblong, mostly about 2x as long as broad or less; overwintering leaves green, not bronze . . . **S. oneidense**
  - 5 Sterile pinna and pinnule apices acute; ultimate segments mostly oblong or lanceolate-oblong, often more than 2x as long as broad; overwintering leaves bronze (or green if covered by leaves).
    - 6 Sterile blade mostly 2-pinnate, the segments sharply serrulate . . . . . **S. biternatum**
    - 6 Sterile blade mostly 3-pinnate (or more divided, those forms keyed above), the segments entire to obscurely serrulate or crenulate . . . . . **S. dissectum**

**Sceptridium biternatum** (Savigny) Lyon, Southern Grapefern. Mt, Pd, Cp (GA, NC, SC, VA): moist forests, clearings, old fields; common. August-October. Widespread in se. United States, from MD, PA, s. IN, s. IL, and se. MO south to FL and e. TX. [= *Botrychium biternatum* (Savigny) Underwood -- RAB, C, FNA, K, S, W; *B. dissectum* var. *tenuifolium* (Underwood) Farwell -- F, G]

**Sceptridium dissectum** (Sprengel) Lyon, Cut-leaf Grape Fern, Dissected Grapefern. Mt, Pd, Cp (GA, NC, SC, VA): moist forests, clearings, old fields; common (rare in Coastal Plain of NC, SC, and GA). August-October. Widespread in ne. North America, from Nova Scotia and Québec west to Ontario and MI, south to FL and TX; also in the West Indies. The two forms have caused much confusion. In our area, forma *obliquum* is much more common and widely distributed, often confused with *B. biternatum*. Forma *dissectum* is fairly common in our area only in VA (rare in NC and SC), occurring primarily in the Mountains. The

different distributions of the 2 forms suggest that further research is needed. [= *Botrychium dissectum* Sprengel -- RAB, C, F, FNA, K, W; < *B. dissectum* var. *obliquum* (Muhlenberg ex Willdenow) Clute -- G; < *B. dissectum* var. *dissectum* -- G; < *B. dissectum* -- S, in a narrower sense; < *B. obliquum* Muhlenberg ex Willdenow -- S; =]

***Sceptridium jenmanii*** (Underwood) Lyon, Alabama Grapefern. Mt (GA, NC, SC, VA), Pd (GA, NC, SC), Cp (GA): moist to dryish forests and disturbed areas; rare (NC Rare, VA Rare). August-October. VA and TN south to FL, AL, and e. LA; also in the West Indies. This species probably arose as a hybrid between *B. biternatum* and *B. lunarioides* (Michaux) Swartz, followed by polyploidization, resulting in a fertile taxon functioning as a species. [= *Botrychium jenmanii* Underwood -- C, FNA, K, W; = *B. alabamense* Maxon -- RAB, S]

***Sceptridium lunarioides*** (Michaux) Holub, Winter Grapefern. Cp (GA, SC), Pd (GA, NC): old fields, pastures, young forests; rare (NC Rare, SC Rare). January-April. W. NC and s. SC south to n. FL, and west to e. TX and se. OK. Wagner (1992) proposes that *B. lunarioides* be treated in a new monotypic section, *Hiemobotrychium*, of *Botrychium*, subgenus *Sceptridium*. The species is hard to spot, and all the more difficult to find because of its phenology; the leaves appear in late fall and die by early spring. [= *Botrychium lunarioides* (Michaux) Swartz -- RAB, FNA, K; = *Holubiella lunarioides* (Michaux) Škoda]

***Sceptridium multifidum*** (S.G. Gmelin) M. Nishida, Leather Grapefern. Mt (NC, VA): grassy balds and high elevation meadows; rare (NC Rare, VA Rare). August-September. Widespread in n. North America, from Labrador and Alaska south PA, OH (and in the mountains to VA and NC), IN, IL, IA, NE, CO, NM, and CA. [= *Botrychium multifidum* (S.G. Gmelin) Treviranus -- C, FNA, K, W; > *B. multifidum* var. *multifidum* -- F, G; > *B. multifidum* var. *intermedium* (D.C. Eaton) Farwell -- F, G]

***Sceptridium oneidense*** (Gilbert) Holub, Bluntlobe Grapefern. Mt (NC, VA), Pd (VA): moist or boggy forests, bogs; rare (NC Rare, VA Watch List). July-October. Northeastern in distribution and local in its occurrence, from New Brunswick, Québec, and Ontario south to NC, TN, KY, IN, and WI. Recent studies by Warren Hauk suggest that *B. oneidense* may not be distinct from *B. dissectum*. [= *Botrychium oneidense* (Gilbert) House -- RAB, C, FNA, K, W; = *B. dissectum* forma *oneidense* (Gilbert) Clute -- F ("embarrassingly transitional"); = *B. multifidum* var. *oneidense* (Gilbert) Farwell -- G]

**OSMUNDACEAE** Bercht. & J.C. Presl 1820 (Royal Fern Family)

A family of 1-3 genera and about 15-25 species. References: Lellinger (1985); Whetstone & Atkinson in FNA (1993b); Kramer in Kramer & Green (1990); Yatabe, Nishida, & Murakami (1999).

***Osmunda*** Linnaeus (Royal Fern, Cinnamon Fern, Interrupted Fern)

A genus of about 10 species (or if circumscribed more broadly as suggested by molecular phylogenetics to include *Todea* and *Leptopteris*, of 15-25 species), tropical and temperate (most diverse in e. and se. Asia and e. North America). References: Lellinger (1985); Whetstone & Atkinson in FNA (1993b); Kramer in Kramer & Green (1990); Yatabe, Nishida, & Murakami (1999).

**Identification notes:** Sterile plants of *Osmunda cinnamomea* are sometimes confused with *Woodwardia virginica*, which also has rather coarse, pinnate-pinnatifid leaves and grows in similar wet, acid places. *Osmunda* is much coarser, has cinnamon tufts of tomentum present in the axils of the pinnae (vs. absent), has the rachis greenish and rather fleshy in texture (vs. brown and wiry), and bears fronds clumped or tufted from a massive, woody, ascending rhizome covered with old petiole bases (vs. fronds borne scattered along a thick, horizontal, creeping rhizome).

- 1 Leaves bipinnate, each pinna fully divided into distinct pinnules, the larger pinnules 3-7 cm long and 0.7-2.0 cm wide; spores borne on modified pinnae in the terminal portion of the leaf blade; veins mostly 2-forked; [subgenus *Osmunda*] . . . . . ***O. regalis* var. *spectabilis***
- 1 Leaves pinnate-pinnatifid, each pinna pinnatifid but not divided into distinct pinnules; spores borne either on separate, modified, fertile leaves, or on modified pinnae in the middle of the leaf blade; veins mostly 1-forked.
  - 2 Spores borne on modified pinnae in the middle of the leaf blade, pinnae above and below the fertile portion green and leafy; sterile pinnae lacking a tuft of brown tomentum at the base; [subgenus *Osmunda*] ***O. claytoniana* var. *claytoniana***
  - 2 Spores borne on separate, modified fertile leaves which (normally) lack green leafy portions; sterile pinnae with a prominent tuft of brown tomentum at the base; [subgenus *Osmundastrum*].
    - 3 Leaf surfaces and upper portion of the rachis not glandular . . . . . ***O. cinnamomea* var. *cinnamomea***
    - 3 Leaf surfaces and upper portion of the rachis densely glandular pubescent . . . . . ***O. cinnamomea* var. *glandulosa***

***Osmunda cinnamomea*** Linnaeus var. ***cinnamomea***, Cinnamon Fern. Cp, Pd, Mt (GA, NC, SC, VA): bogs, peatlands, pocosins, wet savannas, floodplains, blackwater stream swamps; common. March-May. Labrador west to MN, south to FL, TX, NM, Central America, and South America. The species also occurs in e. Asia, where generally treated as a separate variety. "When the *rbcl* trees, the fossil and morphological evidences are all taken into account, it can be concluded that the extant *Osmunda cinnamomea* has no closely related living species in Osmundaceae, and it has evolutionarily very static morphology with no significant modification for more than 200 million years. Thus we can call extant *Osmunda cinnamomea* a 'living fossil' (Yatabe, Kishima, & Murakami 1999). [= C, F, K; < *O. cinnamomea* -- RAB, FNA, G, S, W]

***Osmunda cinnamomea*** Linnaeus var. ***glandulosa*** Waters, Glandular Cinnamon Fern. Cp (SC, VA), Mt (VA): acidic seepage swamps, sphagnum seeps; rare (VA Rare). March-May. This taxon is poorly understood, but appears to be worthy of taxonomic recognition. It is known from scattered locations in e. North America. [= F, K; < *O. cinnamomea* -- FNA]

***Osmunda claytoniana*** Linnaeus var. ***claytoniana***, Interrupted Fern. Mt (GA, NC, SC, VA), Pd (VA), Cp (VA): upland forests, woodlands, and balds, moist to rather dry; common (uncommon in Piedmont, rare in Coastal Plain). March-June. Newfoundland west to MN, south to n. GA, TN, and AR; another variety occurs in e. and sc. Asia. [= C, F; < *O. claytoniana* -- RAB, FNA, G, K, S, W]

***Osmunda regalis*** Linnaeus var. ***spectabilis*** (Willdenow) A. Gray, Royal Fern. Cp, Mt, Pd (GA, NC, SC, VA): bogs, marshes (including tidal), moist forests, floodplains, swamp forests; common. March-June. Newfoundland west to Saskatchewan, south to FL, TX, and Mexico; var. *regalis* is widespread in Eurasia, var. *japonica* is Japanese. [= RAB, C, F, FNA, G, K, W; < *O. regalis* -- S]

The hybrid *Osmunda x ruggii* R. Tryon [*O. claytoniana* var. *claytoniana* x *regalis* var. *spectabilis*] is known from Giles County, VA and one other historic population in CT. It has 2-pinnate sterile leaves, with the pinnules sessile. [= K]

**POLYPODIACEAE** (Polypody Family)

A family of about 35-40 genera and 500-700 species, cosmopolitan, especially tropical. References: Smith in FNA (1993b); Hennipman, Veldhoen, & Kramer in Kramer & Green (1990).

- 1 Leaf blade densely scaly on the lower surface; rhizome 1-2 mm in diameter; leaf segment margins entire . . . . . ***Pleopeltis***
- 1 Leaf blade scaleless on the lower surface; rhizome 3-15 (-30) mm in diameter; leaf segment margins denticulate (*Polypodium*) or entire (*Phlebodium*).
  - 2 Venation highly reticulate, with 3-4 rows of areoles between the midvein and the margin; rhizome 8-15 (-30) mm in diameter; leaf blade 10-50 cm wide . . . . . ***Phlebodium***
  - 2 Venation free or with a row of areoles between the midvein and the margin; rhizome 3-6 mm in diameter; leaf blade <9 cm wide . . . . . ***Polypodium***

***Phlebodium*** (R. Brown) J. Smith 1841 (Golden Polypody)

A genus of 2-4 species, of tropical and subtropical regions of the Western Hemisphere. References: Hennipman, Veldhoen, & Kramer in Kramer & Green (1990).

***Phlebodium aureum*** (Linnaeus) J. Smith, Goldfoot Fern, Golden Polypody. Cp (GA): epiphytic on the old leaf bases of *Sabal palmetto*, and rarely terrestrial on calcareous soils; rare (GA Special Concern). E. GA (Chatham County), a county adjacent to the SC line) south to FL. [= FNA, K, S; = *Polypodium aureum* Linnaeus]

***Pleopeltis*** Humboldt & Bonpland ex Willdenow 1810 (Shielded-Sorus Polypody)

A genus of about 50 species, primarily tropical. Windham (1993) makes a compelling case, based on morphological, chemical, and molecular data, that the "scaly polypodies" (including the above taxon) are more closely related to *Pleopeltis* and should be placed there, rather than in *Polypodium*. References: Windham (1993); Andrews & Windham in FNA (1993b); Hennipman, Veldhoen, & Kramer in Kramer & Green (1990).

***Pleopeltis polypodioides*** (Linnaeus) E.G. Andrews & Windham ssp. ***michauxiana*** (Weatherby) E.G. Andrews & Windham, Resurrection Fern, Scaly Polypody. Cp, Pd, Mt (GA, NC, SC, VA): on tree limbs and trunks (especially when leaning) and on rocks; common (rare in n. VA). June-October. Ssp. *michauxiana* ranges from se. MD, IL, MO, and se. KS, south to s. FL and TX; also in Mexico and Guatemala. Ssp. *polypodioides* ranges in the West Indies, Central America and South America. Four additional varieties are tropical in Central America, South America, and Africa. [= FNA, K; < *Polypodium polypodioides* (Linnaeus) Watt -- RAB; = *Polypodium polypodioides* (Linnaeus) Watt var. *michauxianum* Weatherby -- C, F, G, W; <? *Marginaria polypodioides* (Linnaeus) Tidestrom -- S]

***Polypodium*** Linnaeus 1753 (Polypody)  
(also see *Phlebodium* and *Pleopeltis*)

A genus of about 100 species, cosmopolitan. References: Haufler et al. in FNA (1993b); Haufler, Windham, & Rabe (1995)=Z; Haufler & Windham (1991); Bryan & Soltis (1987); Kott & Britton (1982); Hennipman, Veldhoen, & Kramer in Kramer & Green (1990); Cusick (2002).

[Note: three leads]

- 1 Leaf blade averaging 5.8 cm wide (range of 3.2-8.2 cm), widest at the base, thus the blade elongate-deltoid in outline; rhizome scales averaging 1.1 mm wide, mostly golden brown throughout; paraphyses (sporangia) usually more than 40 per sorus (range of 25-120); leaves mostly lobed to apex, without an attenuate, unlobed tip . . . . . ***P. appalachianum***
- 1 Leaf blade averaging 4.5 cm wide (range of 3.0-5.8 cm); blade widest near the middle, thus the blade oblong to narrowly lanceolate in outline; rhizome scales averaging 1.5 mm wide, mostly brown, with a dark central stripe; paraphyses (sporangia) usually fewer than 40 per sorus (range of 7-69); leaves mostly with an attenuate, unlobed tip . . . ***P. virginianum***
- 1 Characters intermediate; spores abortive . . . . . ***P. xincognitum***

***Polypodium appalachianum*** Haufler & Windham [*P. virginianum* complex], Appalachian Rockcap Fern. Mt (GA, NC, SC, VA): moist rocks at low to high elevations, especially in ravines, on north-facing outcrops, and in other moist sites; uncommon. June-October. Newfoundland west to e. Ontario, south to n. GA and n. AL; nearly restricted to the Appalachian Mountains. Its chromosome complement can be symbolized as AA. It is one parent of *P. virginianum*. [= FNA, K, Z; < *P. virginianum* -- RAB, C, F, S, W, in part; < *P. vulgare* Linnaeus var. *virginianum* (Linnaeus) Eaton -- G, in part]

***Polypodium virginianum*** Linnaeus [*P. virginianum* complex], Common Rockcap Fern. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): moist rocks; common (rare in Coastal Plain). June-October. Haufler and Windham (1991) indicate that the tetraploid cytotype (*P. virginianum*) of the *P. virginianum* complex is an allotetraploid derivative of the sterile hybrid of the diploid occurring in our area (*P. appalachianum*) and another diploid with a boreal distribution (*P. sibiricum* Siplivinsky). Electrophoretic evidence supports this finding (Bryan & Soltis 1987, Haufler, Windham, & Rabe 1995). Thus, *Polypodium* in our area is another classic example of the reticulate evolution of pteridophytes, and the cytotypes must be treated as species and given names. Unfortunately, the two species

are somewhat cryptic, and the relatively frequent triploid backcross makes field identification still more problematic. Individuals not identified to species may be referred to as "*Polypodium virginianum* complex." The chromosome complement of *P. virginianum* can be symbolized as AASS. [= FNA, K, Z; < *P. virginianum* -- RAB, C, F, S, W (see also *P. appalachianum*); < *P. vulgare* Linnaeus var. *virginianum* (Linnaeus) Eaton -- G (see also *P. appalachianum*)]

*Polypodium xincognitum* Cusick is the triploid hybrid [*P. appalachianum* x *virginianum*]. It is rather frequent; there is some evidence that it may reproduce successfully via apogamous spores. It is best recognized by the spores, which are irregular in size and shape. Morphologically, it tends to intermediacy between the two parents, but can closely resemble either. Its chromosome complement can be symbolized AAS.

**PSILOTACEAE** Kanitz 1887 (Whiskfern Family)

A family of 2 genera and 4-12 species, pantropical and warm temperate. References: Lellinger (1985); Thieret in FNA (1993b); Kramer in Kramer & Green (1990).

***Psilotum*** Swartz 1800 (Whiskfern)

A genus of 2-3 species, tropical and warm temperate. *Psilotum* lacks roots and true leaves. Other than the Australasian genus *Tmesipteris*, *Psilotum* has no close living relatives, and the 2 genera are usually considered to comprise a distinct class (Wagner 1977). The stem is chlorophyllose. Fungal cells interspersed in the outer layers of the rhizome aid in the absorption of nutrients. References: Lellinger (1985); Thieret in FNA (1993b); Kramer in Kramer & Green (1990).

**Identification notes:** The stiff, dichotomously-branched habit of *Psilotum* is unmistakable.

***Psilotum nudum*** (Linnaeus) Palisot de Beauvois, Whiskfern. Cp (GA, NC, SC), Pd\* (NC): in moist bottomland forests, on soil, stumps, and tree bases, along building foundations (where introduced); rare (GA Special Concern, NC Rare, SC Rare). April-September. S. SC south to s. FL, west to e. TX, disjunct (and apparently native) in ne. NC (Perry & Musselman 1994), rarely naturalized around buildings in c. NC; also in sw. United States and in the tropics of Central and South America, Africa, and Asia. [= RAB, FNA, K, S]

**PTERIDACEAE** (Maidenhair Fern Family)

A family of about 40 genera and about 1000 species. This family may be further subdivided, into families Adiantaceae (*Adiantum*), Cheilantheaceae (*Cheilanthes*, *Notholaena*, *Astrolepis*, *Pellaea*, *Cryptogramma*), and Pteridaceae (*Pteris*). References: Lellinger (1985); Windham in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990).

- 1 Sori round or oblong, distinct and separate along the pinnule margins; leaves bright-green, glabrous, herbaceous, delicate, and flexible; [subfamily *Adiantoideae*] . . . . . ***Adiantum***
- 1 Sori continuous along the pinnule margins; leaves mostly dark-green or glaucous, often pubescent, coriaceous, tough, and stiff.
  - 2 Leaves strongly dimorphic, the fertile leaves obviously longer than the sterile and with narrow elongate ultimate segments; [subfamily *Cheilantheoideae*] . . . . . [***Cryptogramma***]
  - 2 Leaves essentially monomorphic.
    - 3 Leaves 2-5-pinnate, the ultimate leaf-segments 1-4 (-8) mm long, more-or-less densely hairy (glabrous in *Cheilanthes alabamensis*) or covered on the undersurface with a whitish powder; [subfamily *Cheilantheoideae*].
      - 4 Lower leaf surfaces covered with whitish powder, otherwise glabrous or sparsely pubescent . . . [***Argyrochosma***]
      - 4 Lower leaf surfaces pubescent (or glabrous in *Cheilanthes alabamensis*), never with conspicuous whitish powder . . . . . ***Cheilanthes***
    - 3 Leaves 1-2-pinnate, the ultimate leaf-segments 8-100 mm long, glabrous or sparsely and inconspicuously hairy.
      - 5 Leaf undersurface densely covered with stellate and ciliate scales; [subfamily *Cheilantheoideae*] . . . ***Astrolepis***
      - 5 Leaf undersurface glabrous or with non-stellate scales.
        - 6 Rachis dark-brown or purple; [subfamily *Cheilantheoideae*] . . . . . ***Pellaea***
        - 6 Rachis green or tan; [subfamily *Pteridoideae*] . . . . . ***Pteris***

***Adiantum*** Linnaeus 1753 (Maidenhair Fern)

A genus of 150-200 species, nearly cosmopolitan. References: Paris in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990).

- 1 Petiole and rachises roughly pubescent; [rare introduction] . . . . . ***A. hispidulum***
- 1 Petiole and rachises glabrous; [collectively common natives].
  - 2 Leaves longer than broad, pinnately divided, with a main central axis, not fanlike; ultimate segments rhombic, about as long as broad to slightly longer than broad . . . . . ***A. capillus-veneris***
  - 2 Leaves broader than long, dichotomously divided at the summit of the petiole, the two main branches pedately branched, fanlike; ultimate segments oblong, more than 2x as long as broad.
    - 3 Ultimate segments at middle of penultimate divisions usually more than 3.2x as long as broad, the apices with sharply denticulate, angular lobes, these lobes separated by deep sinuses 0.6-4 mm deep; segment stalks 0.2-0.9 (-1.3) mm long; [disjunct in se. PA on serpentine from a generally more northern and western distribution] . . . . .

- ..... [A. **aleuticum**]  
 3 Ultimate segments at middle of penultimate divisions usually less than 3.2x as long as broad, the apices with rounded, crenulate, or crenate-denticulate lobes, these lobes separated by shallow sinuses 0.1-2.0 (-3.7) mm deep; segment stalks 0.5-1.5 (-1.7) mm long ..... **A. pedatum**

**Adiantum capillus-veneris** Linnaeus, Venus'-hair Fern, Southern Maidenhair. Cp (GA, NC, SC), Mt (GA, VA): moist calcareous rocks, in the Coastal Plain of NC and SC on "marl" (coquina limestone), in the mountains of VA (formerly) on limestone: rare (NC Rare, VA Rare). June-July. Widespread on several continents, in e. North America largely southern in distribution, from e, NC, w. VA, MO, CO, UT, and CO south; also disjunct in SD and British Columbia, and in Mexico, the West Indies, tropical and warm temperate portions of Central and South America, Eurasia, and Africa. There is some question whether North American plants are conspecific with those in the Old World (Paris in FNA 1993b). [= RAB, C, F, FNA, G, K, S, W]

\* **Adiantum hispidulum** Sw., Rough Maidenhair, Garden Maidenhair. Cp (GA): stone walls; rare, introduced from Asia. Reported for GA (FNA, Kartesz 1999). [= FNA, K, S]

**Adiantum pedatum** Linnaeus, Northern Maidenhair. Mt, Pd (GA, NC, SC, VA), Cp (GA, NC, VA): moist forests and cliffs, especially in seepage; common (uncommon in Piedmont, rare in Coastal Plain). June-August. Widespread in e. United States, from Nova Scotia and New Brunswick west to Ontario and MN, south to GA, AL, MS, LA, and OK. [= RAB, FNA, G, K, S, W; = A. *pedatum* ssp. *pedatum* -- C; = A. *pedatum* var. *pedatum* -- F]

*Adiantum aleuticum* (Ruprecht) Paris is disjunct on serpentine in se. PA and MD (FNA). It occurs as well at scattered locations in ne. and w. North America, from s. AK south to s. CA, AZ, and Mexico (Chihuahua). [= FNA, K; = A. *pedatum* Linnaeus ssp. *calderi* Cody -- C; = A. *pedatum* Linnaeus var. *aleuticum* Ruprecht -- F]

**Argyroschisma** (J. Smith) Windham 1987 (Powdery Cloak Fern)

A genus of about 20 species, of s. North America, Central America, South America, and the West Indies. Traditionally treated as a component of *Notholaena* (or sometimes *Pellaea*) (Tryon, Tryon, & Kramer in Kramer & Green 1990), but best recognized as a separate genus (Windham in FNA 1993b, Windham 1987, Gastony & Rollo 1998). Molecular studies show that this group is more closely related to *Pellaea* and *Astrolepis* than to *Notholaena*. References: Windham in FNA (1993b); Windham (1987); Tryon, Tryon, & Kramer in Kramer & Green (1990); Gastony & Rollo (1998).

*Argyroschisma dealbata* (Pursh) Windham occurs on calcareous rocks east to AR and KY. It has leaves 3-5-pinnate, the small ultimate segments covered below with a whitish powder. [= FNA, K; = *Notholaena dealbata* (Pursh) Kunze -- C, F, G; = *Cheilanthes dealbata* Pursh; = *Pellaea dealbata* (Pursh) Prantl]

**Astrolepis** D.M. Benham & Windham 1992 (Star-scaled Cloak Fern)

A genus of about 8 species, of s. North America, Central America, South America, and the West Indies. This group of species has traditionally been placed either in *Notholaena* or *Cheilanthes*, but is best recognized as a separate genus, more closely related to *Argyroschisma*, *Pellaea*, and *Cheilanthes* than to *Notholaena* (Gastony & Rollo 1998). References: Benham & Windham in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990); Gastony & Rollo (1998).

- 1 Scales of the upper leaf surface dense and usually persistent; largest pinnae asymmetrically lobed or entire; [rare eastern disjunct known from AL] ..... [A. **integerrima**]  
 1 Scales of the upper leaf surface sparse and usually deciduous; largest pinnae usually symmetrically lobed; [rare eastern disjunct known from GA] ..... **A. sinuata** ssp. **sinuata**

**Astrolepis sinuata** (Lagasca ex Swartz) D.M. Benham & Windham ssp. **sinuata**, Wavy Cloak-fern. Pd (GA): granitic outcrops and boulders; rare (GA Special Concern). TX west to AZ, south into Central and South America; disjunct in GA. Its leaves are pinnate-pinnatifid, with 30-60 pairs of pinnae. [= FNA, K; *Cheilanthes sinuata* (Lagasca ex Swartz) Domin; *Notholaena sinuata* (Lagasca ex Swartz) Kaulfuss]

*Astrolepis integerrima* (Hooker) D.M. Benham & Windham occurs as a disjunct on Ketona dolomite in c. AL (Bibb County). Its primary distribution is in sw. United States and Mexico. This taxon is apparently an apogamous triploid derived from *Astrolepis cochisensis* (Goodding) D.M. Benham & Windham and an unknown taxon. [= FNA; = *Astrolepis xintegerrima* -- K; = *Cheilanthes integerrima* (Hooker) Mickel; = *Notholaena integerrima* (Hooker) Hevly]

**Cheilanthes** Swartz 1806 (Lip-fern)  
 (also see *Argyroschisma*, *Astrolepis*)

A genus of about 150 species, primarily in the Western Hemisphere. References: Lellinger (1985)=Z; Windham & Rabe in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990); Gastony & Rollo (1998).

- 1 Leaf surfaces glabrescent; ["*Cheilanthes alabamensis* group"] ..... **Ch. alabamensis**  
 1 Leaf surfaces pubescent (tomentose, villous, or lanose).  
 2 Petiole and rachis with a mixture of flattened scales (in *C. tomentosa* these very narrow and superficially mistakable for hairs) and jointed hairs (as seen at 10x); plants tufted, without creeping rhizomes; margins of leaf segments strongly under-rolled, modified into a scarios flap (false indusium) that covers the sori; [subgenus *Physapteris*].  
 3 Leaf blade nearly glabrous above, appearing dark green; scales 0.2-1.0 mm wide, lanceolate; tomentum on the leaf under-surface chestnut-brown (at maturity, whitish when young) ..... **Ch. castanea**

- 3 Leaf blade villous above, appearing whitish or gray-green; scales ca. 0.1 mm wide, linear, nearly hair-like; tomentum on the leaf under-surface white, tan, or silver-gray ..... **Ch. tomentosa**
- 2 Petiole and rachis with hairs only (as seen at 10x); plants mat-forming (with leaves scattered along creeping rhizomes) or tufted (without creeping rhizomes); margins of leaf segments under-rolled but not modified into a scarios flap, the sori more-or-less exposed at maturity; [subgenus *Cheilanthes*].
  - 4 Petiole and rachis glabrous to sparsely pubescent with rather straight hairs; leaves 3-pinnate, with 7-12 (-15) pairs of pinnae, the lower surface lanose (the hairs curly); leaf blades 2.5-10 (-15) cm long; ultimate segments 1-3 mm long, beadlike ..... **Ch. feei**
  - 4 Petiole and rachis rather densely pubescent with long jointed hairs; leaves 2-pinnate-pinnatifid (rarely to 3-pinnate), with 12-20 pairs of pinnae, the lower surface tomentose (the hairs straight or bent); leaf blades (4-) 8-24 cm long; ultimate segments 3-5 mm long, elongate ..... **Ch. lanosa**

***Cheilanthes alabamensis*** (Buckley) Kunze, Alabama Lip-fern. Mt (GA, NC, VA): dry outcrops of limestone; rare (GA Special Concern, NC Rare, VA Rare). June-September. VA, w. NC, s. MO, and OK south and west to n. GA, AL, TX, NM, se. AZ, and Mexico. Considering morphology and chromosome number (sharing  $x = 29$  with *Pellaea*, in contrast to  $x = 30$  in the rest of *Cheilanthes*), it has been suggested that *Ch. alabamensis* and close relatives could be placed equally well in *Pellaea*, as *P. alabamensis* (Buckley) Baker ex Hooker, as done by Cranfill (1980). Windham & Rabe in FNA (1993b) suggest that *Ch. alabamensis* is uncomfortably placed in either *Cheilanthes* and *Pellaea* and that "it may constitute a natural group worthy of consideration as a distinct genus." A molecular analysis suggests that *Ch. alabamensis* and close relatives form a monophyletic group sister to the rest of *Cheilanthes*; this could be the basis for status as a separate genus or for inclusion in *Cheilanthes* (but not for inclusion in *Pellaea*) (Gastony & Rollo 1998). Our plants are apparently apogamous triploids. [= RAB, C, F, FNA, G, K, S, W, Z]

***Cheilanthes castanea*** Maxon, Chestnut Lip-fern. Mt, Pd (VA): dry outcrops of sedimentary or metamorphic rocks (including calcareous shales and siltstones); rare (VA Rare). June-September. Sw. TX to s. AZ, with scattered disjunct occurrences in c. OK, n. AR, e. WV, and c. and w. VA (to be expected elsewhere in our area). The ultimate segments of the pinnules tend to be roundish and closely spaced, so that they overlap the adjacent segments of the pinnule and the segments of the adjacent pinnule. These characters do not match some descriptions (such as in Z). Whether or not *Ch. castanea* is distinct from or merely a form of *Ch. eatonii* is controversial. The complex of the 2 taxa includes apogamous triploids and sexual tetraploids. [= W, Z; < *Ch. eatonii* Baker -- C, FNA, K]

***Cheilanthes feei*** T. Moore, Slender Lip-fern. Mt (VA): dry outcrops of calcareous sedimentary rocks (dolostone); rare (VA Rare). June-September. WI, MN SD, MT, Alberta, and British Columbia south to AR, TX, NM, AZ, s. CA, and n. Mexico; disjunct eastwards in KY and w. VA. The only known site in our area is on a dolostone cliff in Pulaski County, VA, where disjunct about 450 km east of a population in Bullitt County, KY, and an additional 200 km from other populations in IL (Wieboldt & Bentley 1982, Porter & Wieboldt 1991). The species is an apogamous triploid of unknown parentage. [= C, FNA, G, K, W, Z]

***Cheilanthes lanosa*** (Michaux) D.C. Eaton, Hairy Lip-fern. Mt, Pd (GA, NC, SC, VA); Cp (GA): dry outcrops of felsic or intermediate metamorphic and igneous rocks; uncommon. June-September. CT, NY, PA, s. IL, MO, and KS south to FL, AL, MS, LA, and e. TX, and disjunct in WI and MN. Much the commonest lip-fern in our area, a sexual diploid, and the most "eastern" of a predominantly western genus. [= RAB, C, FNA, G, K, W, S, Z; = *Ch. vestita* (Sprengel) Swartz -- F]

***Cheilanthes tomentosa*** Link, Woolly Lip-fern. Mt, Pd (GA, NC, SC, VA), Cp (GA, SC): dry outcrops of intermediate or calcareous metamorphic, igneous, or sedimentary rocks (including sandstone outcrops in the Coastal Plain of GA and SC); uncommon (rare in Coastal Plain). June-September. Primarily Appalachian, from PA south to KY, GA, and AL, also at scattered localities from AR, OK, and KS south and west to NM, AZ, and Mexico. The species is an apogamous triploid. [= RAB, C, FNA, G, K, W, S, Z; = *Ch. lanosa* -- F, misapplied]

***Cryptogramma*** R. Brown 1823 (Parsley Fern)

A genus of about 10 species, of temperate Eurasia, North America, and South America. References: Alverson in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990).

*Cryptogramma stelleri* (S.G. Gmelin) Prantl in Engler, Slender Rock-brake, ranges south to c. PA and WV (Randolph County). It is a small fern of calcareous rocks, with dimorphic pinnate-pinnatifid to 2-pinnate leaves to 20 cm long. [= FNA, C, F, G, K]

***Pellaea*** Link 1841 (Cliff-brake)

(also see *Argyroschisma*, *Astrolepis*, *Cheilanthes*)

A genus of about 40 species, mostly in the Western Hemisphere. References: Gastony (1988); Gastony, Yatskievych, & Dixon (1992); Windham in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990); Gastony & Rollo (1998); Heafner (2001). Key based in part on Heafner (2001).

- 1 Petioles terete, glabrous or pubescent; rhizome scales uniformly orangish-brown, entire.
  - 2 Petioles and rachises sparsely to densely pubescent, dull; pinnae long-stalked, those towards the base of the leaf on stalks 5-15 mm long; [of a variety of substrates, including non-calcareous] ..... ***P. atropurpurea***
  - 2 Petioles and rachises glabrous to very sparsely pubescent, shiny; pinnae sessile or short-stalked, those towards the base of the leaf on stalks 0-4 (-6) mm long; [strictly of calcareous substrates] ..... ***P. glabella* ssp. *glabella***
- 1 Petioles slightly grooved or flattened, glabrous; rhizome scales with a blackish median stripe and pale brown margins, obscurely toothed.
  - 3 Ultimate segments thin in texture, not strongly rolled, acute to acuminate at the apex, but lacking a mucr or cusp ..... ***P. viridis***
  - 3 Ultimate segments leathery, strongly rolled, mucronate at the apex.
    - 4 Leaves oblong to elliptic in outline; pinnae either ternate towards the base of the leaf and simple towards the tip of the leaf, or all simple; [known from outcrops in the upper Piedmont of SC] ..... ***P. ternifolia* ssp. *arizonica***

- 4 Leaves usually narrowly triangular in outline; pinnae usually pinnate towards the base, becoming ternate to simple towards the tip; [known from outcrops in Piedmont of NC] ..... ***P. wrightiana***

***Pellaea atropurpurea*** (Linnaeus) Link, Purple Cliff-brake. Mt, Pd, Cp (GA, NC, SC, VA): outcrops of limestone and other rocks (usually either calcareous or mafic), rarely on masonry walls (Wieboldt 1995); common only in the Ridge and Valley of VA, otherwise uncommon to rare (SC Rare). May-September. This species is an apogamously-reproducing triploid, either an allopolyploid derived from the hybridization of a sexually-reproducing diploid species and sexually-reproducing tetraploid, or an autopolyploid of an undiscovered or extinct species. Gastony, Yatskievych, & Dixon (1992) provide convincing evidence that modern *P. glabella* is not one of the parental taxa, as indicated by Lellinger (1985). *P. atropurpurea* is widespread in e. North America, from VT, NY, MN, SD, Saskatchewan, and Alberta south to FL, AL, TN, AR, TX, NM, AZ, and Mexico; also in Guatemala. [= RAB, C, F, FNA, K, S, W; = *P. atropurpurea* var. *atropurpurea* -- G; = *P. xatropurpurea*]

***Pellaea glabella*** Mettenius ex Kuhn ssp. ***glabella***, Smooth Cliff-brake. Mt (VA): dry, exposed outcrops of calcareous rocks (limestone, dolostone), rarely on masonry walls (Wieboldt 1995); rare (VA Watch List). May-September. The diploid, sexually-reproducing *P. glabella* ssp. *missouriensis* (Gastony) Windham is (so far as is known) restricted to MO; the apogamously-reproducing autotetraploid derivative, ssp. *glabella*, is more widespread, ranging from VT, ONT, and MN, south to VA, TN, KY, AR, OK, and n. TX. Two additional taxa (both western) have been variously treated as additional subspecies of *P. glabella* or as two subspecies of *P. occidentalis* (E.E. Nelson) Rydberg. [= FNA, K; = *P. glabella* var. *glabella* -- C; = *P. atropurpurea* var. *bushii* Mackenzie -- G; < *P. glabella* -- F, S, W]

***Pellaea ternifolia*** (Cavanilles) Link ssp. ***arizonica*** Windham, Arizona Cliff-brake. Pd (SC): on granitic outcrops; rare. A remarkable disjunct from sw. United States and Mexico to w. SC; see Heafner (2001) for additional information. When discovered, it was believed that this was a SC record for *P. wrightiana* (Platt & Townsend 1996), but Heafner (2001) has demonstrated that this actually represents *P. ternifolia* ssp. *arizonica*. [= FNA, K]

\* ***Pellaea viridis*** (Forsskål) Prantl, Green Cliffbrake. Cp (GA): outcrop of Altamaha Grit; rare, introduced from Africa. This species is naturalized on an Altamaha Grit outcrop in Coffee County, GA (J. Allison, pers. comm.). Various infraspecific taxa have been recognized in the native range. [= K; = *Cheilanthes viridis* (Forsskål) Swartz]

***Pellaea wrightiana*** Hooker, Wright's Cliff-brake. Pd (NC): south-facing outcrops of Carolina slate or granitic rock with infrequent nutrient-rich seepage; rare (NC Endangered). May-September. OK west to se. CO and sw. UT, south to TX, AZ, and Mexico, with a few, remarkable disjunct occurrences in c. NC. *P. wrightiana* is apparently a sexually-reproducing allotetraploid derivative of hybridization between *P. ternata* (Cavanilles) Link and *P. truncata* Goodding. [= RAB, FNA, K]

***Pteris*** Linnaeus 1753 (Brake)

A genus of about 250-300 species, warm temperate and tropical. References: Nauman in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990).

- 1 Rachis winged; pinnae (at least the basal ones) with 1-several lobes or pinnules; outline of leaf blade ovate to orbicular, typically nearly as wide as long ..... ***P. multifida***  
 1 Rachis not winged; pinnae strictly simple, without lobes or pinnules; outline of leaf blade lanceolate, typically 3x or more as long as wide ..... ***P. vittata***

\* ***Pteris multifida*** Poiret, Spider Brake. Cp, Pd (GA, NC, SC), Mt (GA): old walls with lime mortar; rare, introduced from the Tropics. [= RAB, FNA, K; = *Pycnodoria multifida* (Poiret) Small -- S]

\* ***Pteris vittata*** Linnaeus, Ladder Brake. Cp (GA, SC): old walls with lime mortar; rare, introduced from China. [= RAB, FNA, K; = *Pycnodoria vittata* (Linnaeus) Small -- S]

**SALVINIACEAE** Dumortier 1829 (Floating Fern Family)

A family of a single genus and about 10 species. References: Nauman in FNA (1993b); Schneller in Kramer & Green (1990).

***Salvinia*** Séguier 1754 (Water Spangles)

A genus of about 10 species, mostly tropical. References: Nauman in FNA (1993b); Lellinger (1985)=Z; Jacono (1999); Schneller in Kramer & Green (1990).

- 1 Leaves 5-15 mm long; multicellular hairs of the upper leaf surface with 4 free, spreading branches (use 10x magnification) ..... ***S. minima***  
 1 Leaves to 50 mm long; multicellular hairs of the upper leaf surface with 4 branches joined at their tips, forming a cage-like structure (use 10x magnification) ..... ***S. molesta***

\* ***Salvinia minima*** Baker, Water Spangles. Cp (GA, SC): quiet waters; rare, probably introduced in our area from further south. [= FNA, K, Z; *S. auriculata* -- S, misapplied]

\* ***Salvinia molesta*** D.S. Mitchell. Cp (NC, SC), Pd (NC), Mt (VA): still waters of farm ponds, calcareous seepage ponds, and other situations; rare, introduced (potentially a serious weed in our area). *S. molesta* has been found at scattered sites in NC (Brunswick, Carteret, Craven, Cumberland, Duplin, Durham, Johnston, Jones, Lenoir, Mecklenburg, New Hanover, Onslow, Orange, Person, Pitt, Sampson, and Wake counties), SC (Colleton County), and VA (Shenandoah County), where it has been subjected to extermination efforts; it will likely be reintroduced (Anonymous 1999, D. Patterson, pers. comm.). This species is considered a noxious aquatic weed and has been reported from other southeastern states, such as TX and LA (Jacono 1999). Moran & Smith (1999) support the continued use of the name *S. molesta* for this species, as opposed to the ambiguous name *S. adnata* Desvaux. [= FNA, K, Z]

**SCHIZAEACEAE** Kaulf. 1827 (Curly-grass Family)

A family of 3-4 genera and about 30 species (depending on circumscription). The Lygodiaceae is often combined with the Schizaeaceae. References: Wagner in FNA (1993b); Kramer in Kramer & Green (1990).

**Schizaea** J.E. Smith 1793 (Curly-grass Fern)

A genus of about 10 species (excluding *Actinostachys*), mostly tropical. References: Wagner in FNA (1993b); Kramer in Kramer & Green (1990).

\* ***Schizaea pusilla*** Pursh, Curly-grass Fern. Cp (NC): moist, peaty soil under *Chamaecyparis thyoides*; rare, apparently introduced. May-July. In acid, boggy sites in DE, NJ, NY, Newfoundland, Nova Scotia, and New Brunswick; a similar or possibly identical plant is known from Peru. The leaves are filiform, 1-12 cm long. Spores of *Schizaea* have been identified in Pleistocene organic sediment from Singletary Lake (Bladen County, NC) and Rockyhock Bay (Chowan County, NC) (Whitehead 1963). Its native occurrence in our area as an extant species is plausible. See LeBlond & Weakley (2002) for further information on this species' occurrence in North Carolina. [= FNA, C, F, G, K]

**SELAGINELLACEAE** Willk. 1861 (Spikemoss Family)

A family of a single genus (as currently broadly conceived) and about 700-750 species. References: Valdespino in FNA (1993b); Tryon (1955); Lellinger (1985); Buck (1977); Somers & Buck (1975); Jermy in Kramer & Green (1990). Key adapted in part from Valdespino in FNA (1993b).

**Selaginella** Palisot de Beauvois 1804 (Spikemoss)

As currently conceived broadly, a genus of about 700-750 species, cosmopolitan, but mostly tropical. It appears likely that *Selaginella* will likely be subdivided, based on morphology and molecular phylogenetic analyses (Soják 1992; Škoda 1997; Korall, Kenrick, & Therrien 1999). Selaginellaceae, along with Lycopodiaceae and Isoetaceae, now appear to be only distantly related to other extant pteridophytes and seed plants (Pryer et al. 2001). References: Valdespino in FNA (1993b); Tryon (1955); Lellinger (1985); Buck (1977); Somers & Buck (1975); Jermy in Kramer & Green (1990). Key adapted in part from Valdespino in FNA (1993b).

- 1 Sterile leaves dimorphic, in 4 ranks, the ventral pair spreading laterally, the dorsal pair ascending; leaves acute, mucronate, lacking a white or translucent apical hair-tip; fertile branch tips strongly differentiated (into strobili) from the sterile portions of the stem; [subgenus *Stachygynandrum* or genus *Lycopodioides*].
  - 2 Main stems erect, the plants to 5 dm tall . . . . . ***S. braunii***
  - 2 Main stems creeping or ascending.
    - 3 Lateral leaves of the main stems 2.5-4 mm long, elliptic; lateral stems ascending or erect, 2-6 cm long; rhizophores (modified, leafless, root-producing shoots) borne on the upper side of the stem . . . . . ***S. kraussiana***
    - 3 Lateral leaves of the main stem 1-2.5 (or to 3.6 in *S. uncinata*) mm long, ovate; lateral stems creeping (or the tips sometimes slightly ascending), 0.2-1 cm long; rhizophores axillary.
      - 4 Margins of lateral leaves entire; lateral branches of the stems further branching 2-3 times . . . . . ***S. uncinata***
      - 4 Margins of lateral leaves dentate-serrate; lateral branches of the stems further branching 1-2 times
        - 5 Leaves with margins undifferentiated or with 1-2 rows of slightly paler cells stomates distributed over entire upper surface . . . . . ***S. apoda***
        - 5 Leaves with margins of 3-5 rows of transparent (hyaline) cells; stomates of lateral leaves confined to near the midrib on the upper surface . . . . . ***S. ludoviciana***
  - 1 Sterile leaves monomorphic, spirally arranged around the stems; leaves acuminate and with a white or translucent apical hair-tip (the hair-tip rarely lost); fertile branch tip only slightly differentiated from the sterile portions of the stems; [subgenus *Tetragonostachys* or genus *Bryodesma*].
    - 6 Apical hair-tip of the leaves twisted-contorted, 1.2-1.7 mm long (sometimes deciduous); strobili 3-6 mm long, 1.5-2 mm wide; leaves 0.15-0.3 mm wide, the marginal cilia absent, toothlike, or as much as 1/6 as wide as the leaf blade; budlike arrested branches present . . . . . ***S. tortipila***
    - 6 Apical hair-tip of the leaves straight, 0.3-1.4 mm long (sometimes deciduous); strobili (5-) 10-35 mm long, 1-1.5 mm wide; leaves 0.2-0.45 mm wide, the marginal cilia 1/4-1/3 as wide as the leaf blade; budlike arrested branches present or absent.
      - 7 Stems mostly creeping or turned up at the apex, forming mats 1.5-4 cm high; rhizome or rhizomatous stem absent; aerial roots present all along the stems; budlike arrested branches absent . . . . . ***S. rupestris***
      - 7 Stems mostly erect or ascending, forming compact clumps usually more than 4 cm high; rhizome or rhizomatous stem present; aerial roots present only at or near the base of the erect stems; budlike arrested branches present.
        - 8 Leaves of the underground (rhizomatous) stems not scalelike; rhizophores mostly aerial; sporophyll base pubescent; leaf and sporophyll apices often pubescent . . . . . ***S. acanthonota***
        - 8 Leaves of the underground (rhizomatous) stems scalelike; rhizophores mostly subterranean; sporophyll base glabrous; leaf and sporophyll apices glabrous.
          - 9 Leaves mostly tightly appressed; base conspicuously pubescent; strobili distinctly larger in diameter than the subtending stem; sporophyll apex often recurved . . . . . ***S. arenicola* ssp. *arenicola***
          - 9 Leaves mostly loosely appressed; base usually glabrescent; strobili not distinctly larger in diameter than the subtending stem; sporophyll apex usually straight . . . . . ***S. arenicola* ssp. *riddellii***



***Selaginella acanthonota*** Underwood, Spiny Spikemoss, Sand Spikemoss. Cp (GA, NC, SC): sandhills, Altamaha Grit glades; uncommon. June-August. *S. acanthonota* ranges from se. NC south to s. FL, west to panhandle FL. The complex comprising *S. acanthonota*, *S. arenicola*, and *S. riddellii* has been controversial. The complex ranges from se. NC south to s. FL and west to c. TX. *S. arenicola* Underwood ssp. *arenicola* is more southern, from n. GA south to s. FL and west to e. panhandle FL. *S. arenicola* ssp. *riddellii* (Van Eseltine) R. Tryon occurs in TX, OK, AR, LA, AL, and GA. See Tryon (1955) and Valdespino in FNA (1993b) for additional information on the complex. [= FNA, K; < *S. arenicola* -- RAB; = *S. arenicola* Underwood ssp. *acanthonota* (Underwood) R. Tryon; = ***Bryodesma acanthonota*** (Underwood) Škoda]

***Selaginella apoda*** (Linnaeus) Spring, Meadow Spikemoss. Cp, Pd, Mt (GA, NC, SC, VA): seepages, bogs, spray cliffs, stream margins, other moist habitats; common. June-October. S. ME, NY, OH, s. IN, AR, and e. OK south to FL, GA, AL, MS, LA, and e. TX. Often overlooked by vascular plant botanists as a moss or liverwort. *S. ludoviciana* of the Gulf Coast east to GA, and *S. eclipses*, more northern, are superficially very similar. [= RAB, C, F, FNA, G, K, W; = *Diplostachyum apodum* (Linnaeus) Beauvois -- S; = ***Lycopodioides apodum*** (Linnaeus) Kuntze]

***Selaginella arenicola*** Underwood ssp. *arenicola*, Sand Spikemoss. Cp (GA): dry sands. E. GA south to s. FL, se. GA, and Panhandle FL. [= FNA, K; = *S. arenicola* -- S, in the narrow sense; = ***Bryodesma arenicola*** (Underwood) Soják]

***Selaginella arenicola*** Underwood ssp. *riddellii* (Van Eseltine) R.M. Tryon, Riddell Spikemoss. Pd, Cp (GA): dry sands, granite outcrops; uncommon? E. and c. GA west to TX and OK. [= FNA, K; = ***Bryodesma arenicola*** (Underwood) Soják ssp. *riddellii* (Van Eseltine) Škoda]

\* ***Selaginella braunii*** Baker, Treelet Spikemoss, Braun's Spikemoss. Cp (NC): naturalized around graveyards or gardens; rare, introduced, native of China. [= FNA, K; ***Lycopodioides***]

\* ***Selaginella kraussiana*** (Kunze) A. Braun, Krauss's Spikemoss, Mat Spikemoss. Cp (GA, NC, SC, VA?): naturalized around gardens or lawns; rare, introduced. [= FNA, K; ***Lycopodioides***]

***Selaginella ludoviciana*** (A. Braun) A. Braun, Gulf Spikemoss, Louisiana Spikemoss. Cp (GA): swamp margins, wet meadows; rare (GA Special Concern). Gulf Coastal Plain from n. FL and sw. GA west to e. LA. [= FNA, K; = *Diplostachyon ludovicianum* (A. Braun) Small -- S; = ***Lycopodioides ludovicianum*** (A. Braun) Kuntze]

***Selaginella rupestris*** (Linnaeus) Spring, Rock Spikemoss. Pd, Mt (GA, NC, SC, VA): granite flatrocks, other, mostly acidic, rock outcrops, occasionally on greenstone or calcareous shales; common. June-September. S. Greenland and Nova Scotia west to Alberta, south to GA, AL, AR, OK, and NE. Valdespino in FNA (1993b) suggests that two or more cryptic or semicryptic species are present within what is currently called *S. rupestris*. Additional study is needed. [= RAB, C, F, FNA, G, K, S, W; = ***Bryodesma rupestre*** (Linnaeus) J. Soják]

***Selaginella tortipila*** A. Braun, Twisted-hair Spikemoss. Mt, Pd (GA, NC, SC): rock outcrops, mostly at high elevations; common. July-September. Endemic to the Southern Appalachians (rarely into the Piedmont) of NC, TN, SC, and GA. Occurring close to the VA border; it should be sought there. [= RAB, FNA, K, S, W; = ***Bryodesma tortipila*** (A. Braun) J. Soják]

\* ***Selaginella uncinata*** (Desv. ex Poir.) Baker, Blue Spikemoss. Cp, Mt (GA): moist forests; rare, introduced from China. Introduced in sw. GA and other places in the Southeastern United States. [= FNA, K; ***Lycopodioides***] {not yet keyed}

*Selaginella eclipses* W.R. Buck, Hidden Meadow Spikemoss, from Québec and Ontario south to NY, OH, KY, AR, and OK, differs from *S. apoda* in having the dorsal leaves with long attenuate apices with a well-developed midrib (vs. with acute apices, or if attenuate, then usually keeled and without a well-developed midrib), and the mature megaspores shiny, the reticulation lax (observed at 40x) (vs. dull and closely reticulate). Given its semi-cryptic separation from *S. apoda*, it could easily be present in our area. {not keyed} [= FNA, K; = *S. apoda* (Linnaeus) Spring ssp. *eclipses* (W.R. Buck) Škoda; ***Lycopodioides***]

#### **THELYPTERIDACEAE** Pichi Sermolli 1970 (Marsh Fern Family)

A family of 6-30 genera (generic circumscription especially controversial and problematic) and about 900 species. References: Smith in FNA (1993b); Smith & Cranfill (2002); Lellinger (1985); Mickel (1979); Smith in Kramer & Green (1990).

- 1 Leaf blades 7-25 (-30) cm long, triangular, not more than 2x as long as wide; rachis with adnate wings between the pinnae; sori without indusia; midribs of pinnae lacking an adaxial groove . . . . . ***Phegopteris***
- 1 Leaf blades (15-) 20-100 cm long, lanceolate, oblong-lanceolate, or triangular, more than 2x as long as wide; rachis without adnate wings between the pinnae; sori with reniform indusia; midribs of pinnae with an adaxial groove (adaxial groove lacking in *Macrothelypteris*).
  - 2 Midribs of the pinnae lacking an adaxial groove; leaf bipinnate to tripinnate . . . . . ***Macrothelypteris***
  - 2 Midribs of the pinnae with an adaxial groove; leaf pinnate to pinnate-pinnatifid . . . . . ***Thelypteris***

#### ***Macrothelypteris*** (H. Itô) Ching 1963 (Maiden Fern)

A genus of about 10 species, tropical and subtropical. References: Smith in Kramer & Green (1990).

\* ***Macrothelypteris torresiana*** (Gaudichaud-Beaupré) Ching, Mariana Maiden Fern. Cp, Pd (GA, SC): disturbed areas; uncommon (rare in SC), introduced from the Asian and African tropics. Leonard (1972) discusses the history of this species in the southeastern United States. [= FNA, K; = *Dryopteris setigera* Blume -- S, misapplied; = *Thelypteris torresiana* (Gaudichaud-Beaupré) Alston]

#### ***Phegopteris*** (C. Presl) Fée 1852 (Beech Fern)

A genus of 3 species, north temperate and boreal. References: Smith in Kramer & Green (1990).

- 1 Rachis wings absent between the two basal pinna pairs; rachis bearing on its lower surface numerous tan to brown, lanceolate scales (these mostly 6-12 cells wide at the base) and acicular hairs 0.3-1.0 mm long . . . . . **Ph. connectilis**
- 1 Rachis wings present between the two basal pinna pairs; rachis bearing on its lower surface relatively few, white to pale tan, narrowly lanceolate scales (these mostly 3-5 cells wide at the base) and hairs 0.1-0.25 mm long . . . . . **Ph. hexagonoptera**

**Phegopteris connectilis** (Michaux) Watt, Northern Beech Fern. Mt (NC): moist cliffs where wet by spray from waterfalls (at medium elevations), also on high elevation cliffs wet by seepage and in spruce-fir forests; rare (NC Rare). April-August. A circumboreal species, at its southern limit in North America in NC, TN, IA, MT, and OR. Most of the occurrences in NC are at waterfalls in the escarpment gorges of Transylvania, Macon, and Jackson counties, near Highlands. The Southern Appalachian occurrences are disjunct; the species ranges south to WV, and is apparently absent from VA, n. NC, and n. TN. The species is a triploid, reproducing apogamously. [= FNA, K; = *Thelypteris phegopteris* (Linnaeus) Slosson -- RAB, C, G, W; = *Dryopteris phegopteris* (Linnaeus) C. Christensen -- F; = *Phegopteris phegopteris* (Linnaeus) Keyserling -- S]

**Phegopteris hexagonoptera** (Michaux) Fée, Broad Beech Fern. Mt, Pd, Cp (GA, NC, SC, VA): mesic to submesic forests; common (uncommon in the Coastal Plain). April-August. Widespread in eastern North America, from Québec west to Ontario, WI, and MN, south to FL and e. TX. [= FNA, K, S; = *Thelypteris hexagonoptera* (Michaux) Weatherby -- RAB, C, G, W; = *Dryopteris hexagonoptera* (Michaux) C. Christensen -- F]

***Thelypteris*** Schmidel 1763 (Maiden Fern, Shield Fern, Marsh Fern)

A genus of about 875 species, cosmopolitan, perhaps warranting separation into various segregates. *Thelypteris* is a large and rather heterogeneous group, even with the removal of *Phegopteris* and *Macrothelypteris*. Our species fall into several subgenera, sometimes treated as genera: subgenus or genus *Thelypteris* (*Th. palustris* var. *pubescens*), subgenus or genus *Parathelypteris* (*Th. noveboracensis*, *Th. simulata*), subgenus *Cyclosorus* or genus *Christella* (*Th. dentata*, *Th. hispidula* var. *versicolor*, *Th. kunthii*, *Th. ovata* var. *ovata*), and subgenus or genus *Stegnogramma* (*Th. pilosa* var. *alabamensis*). The appropriate names, should the segregate genera be adopted, are listed in synonymy. References: Smith (1981); Smith in Kramer & Green (1990).

- 1 Leaves 5-15 (-20) cm wide; rhizome scales 1-4 mm long, lanceolate to ovate, glabrous, pale brown to golden brown, flexible and very thin.
  - 2 Leaf blade broadest near the middle, gradually reduced to the base, the petiole less than 1/3 the length of the blade; [of upland and wetland habitats]; [subgenus or genus *Parathelypteris*] . . . . . ***Th. noveboracensis***
  - 2 Leaf blade broadest near the base, the pinnae stopping abruptly, the petiole 2/3 to fully as long as the blade; [of wetland habitats].
    - 3 Undersurface of blades without glands; lateral veins of sterile lobes forked once between the pinnule midvein and the margin; lower surface of costae with tan, ovate scales; lobes of fertile leaves revolute; indusia ciliate (rarely glabrous); [subgenus or genus *Thelypteris*] . . . . . ***Th. palustris* var. *pubescens***
    - 3 Undersurface of blades with minute, sessile, globular, golden to reddish glands; lateral veins of sterile lobes simple, not forked between the pinnule midvein and the margin; lower surface of costae lacking scales; lobes of fertile leaves plane to slightly revolute; indusia with minute glands along the margins; [subgenus or genus *Parathelypteris*] . . . . . ***Th. simulata***
- 1 Leaves (6-) 10-35 cm wide; rhizome scales 2-6 mm long, linear-lanceolate, usually minutely pilose, yellowish-brown to brown, stiff and rather thick; [subgenus *Cyclosorus* or genus *Christella*].
  - 4 Basal veins from adjacent lobes of the pinna uniting below the sinus (between the sinus and the costa), with a united vein continuing to the sinus.
    - 5 Rachises and petioles usually purplish; costae densely short-hairy on the lower surface, the hairs 0-0.1 (-0.2) mm long (about half as long as the costa width); widest point of the leaf usually 3-5 pairs of pinnae up from the base . . . . . ***Th. dentata***
    - 5 Rachises and petioles usually tan; costae sparsely hairy on the lower surface, the hairs variable in length, most of them more than 0.3 mm long and at least some more than 0.5 mm long (the longer as long as or longer than the costa width); widest point of the leaf usually 1-3 pairs of pinnae up from the base . . . . . ***Th. hispidula* var. *versicolor***
  - 4 Basal veins from adjacent lobes of the pinna not meeting at all, or reaching the sinus at the same point, thus without a united vein to the sinus.
    - 6 Upper surface of the costae and costules glabrous above (rarely minutely hairy, the hairs never exceeding 0.2 mm in length), eglandular . . . . . ***Th. ovata* var. *ovata***
    - 6 Upper surface of the costae and costules with at least a few stout hairs more than 0.3 mm long; upper leaf surface pubescent to nearly glabrous, also glandular with stipitate glands.
      - 7 Lowermost 1-2 pairs of pinnae distinctly shorter than the pair above (ca. 3/4's as long); basal veins from adjacent lobes of the pinna always meeting . . . . . ***Th. hispidula* var. *versicolor***
      - 7 Lowermost pair of pinnae equal to or very slightly shorter than the next pair above; basal veins from adjacent lobes of the pinna not meeting at all, or reaching the sinus at the same point . . . . . ***Th. kunthii***

\* ***Thelypteris dentata*** (Forsskål) E. P. St. John, Downy Maiden Fern. Cp (GA, SC), Pd (GA): disturbed areas; rare, native to tropical and subtropical Asia and Africa. [= FNA, K, S; = ***Christella dentata* (Forsskål) Brownsey & Jermy**]

\* ***Thelypteris hispidula*** (Decaisne) C.F. Reed var. ***versicolor*** (R. St. John) Lellinger, Hairy Maiden Fern. Cp (GA, SC): on soil in disturbed areas; rare. In our area, probably only adventive from further south. [= FNA, K; = *Th. versicolor* R. St. John -- S; < ***Christella hispidula* (Decaisne) Holttum**; = *Th. quadrangularis* (Fee) Schelpe var. *versicolor* (R. St. John) A.R. Smith]

***Thelypteris kunthii*** (Desvaux) C.V. Morton, Kunth's Maiden Fern, Southern Shield Fern. Cp (GA, NC, SC), Pd (GA): coquina limestone ("marl") outcrops, calcareous bluffs and sinkhole slopes, also adventive on and around coquina limestone (marl) riprap around small bridges and ditches; rare (in NC, perhaps only recently adventive from further south). May-August. In North America, ranging from se. NC south to FL and west to TX. [= RAB, FNA, K; < *Th. normalis* (C. Christensen) Moxley -- S; < ***Christella normalis* (C. Christensen) Holttum**]

***Thelypteris noveboracensis*** (Linnaeus) Nieuwland, New York Fern. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): mesic forests, bottomland forests, bogs, submesic forests; common. May-August. Newfoundland and WI south to GA, AL, and AR. Distinctive in the leaves tapering about equally both to tip and base. [= RAB, C, FNA, G, K, S, W; = *Dryopteris noveboracensis* (Linnaeus) A. Gray -- F; = ***Parathelypteris noveboracensis* (Linnaeus) Ching**]

***Thelypteris ovata*** R. P. St. John var. ***ovata***, Ovate Maiden Fern. Cp (GA, SC): on coquina limestone ("marl") or in disturbed, calcareous areas; rare (GA Rare). S. SC south to s. FL, west to s. AL; and in the Bahamas. In our area, perhaps only adventive from further south. Var. *lindheimeri* (C. Christensen) A.R. Smith occurs in TX, Mexico, Belize, Guatemala, and Jamaica. [= FNA, K; > *Th. ovata* var. *ovata* – S, in a narrower sense; > *Th. ovata* var. *harperi* (C. Christensen) R. P. St. John -- S; = ***Christella ovata* (R.P. St. John) Löve & Löve**]

***Thelypteris palustris*** Schott var. ***pubescens*** (Lawson) Fernald, Marsh Fern. Cp, Pd, Mt (GA, NC, SC, VA): bogs, marshes (including freshwater tidal marshes), and bottomland forests; common. June-September. The species is circumboreal, occurring in n. Europe, n. Asia, and n. North America. Var. *pubescens* is the American variety, ranging from Newfoundland and Manitoba south to FL and TX. [= C, FNA, G, K, W; < *Th. palustris* -- RAB; = *Dryopteris thelypteris* (Linnaeus) Swartz var. *pubescens* (Lawson) A.R. Prince ex Weatherby -- F; < *Th. thelypteris* (Linnaeus) Nieuwland -- S]

***Thelypteris simulata*** (Davenport) Nieuwland, Bog Fern, Massachusetts Fern. Mt (NC), Cp (VA): in NC in acid peat bogs at about 1000 meters in elevation, in VA in acid seepage swamps in the Coastal Plain; rare (NC Threatened, VA Rare). July-September. Northeastern, ranging from Nova Scotia south to ne. VA (Accomack, New Kent, Northampton and Westmoreland counties) and n. WV (Tucker and Preston counties), and disjunct in NC (Alleghany and Avery counties) and WI. Discovered in NC in the 1980's. Presently known in NC only from two sites. [= C, FNA, G, S, W; = *Dryopteris simulata* Davenport -- F; = ***Parathelypteris simulata* (Davenport) Holttum**]

*Thelypteris burksiorum* J.E. Watkins & D.R. Farrar is a narrow endemic of moist sandstone rocks in nc. AL. Watkins & Farrar (2002) present evidence for its recognition as a species distinct from *Thelypteris pilosa*. It differs from all our species in having elongate sori (vs. round to slightly oblong), sporangia with minute puberulence (vs. glabrous), and small (less than 20 cm long) evergreen leaf blades. It is in a fourth group (see discussion above), subgenus or genus *Stegnogramma*. The appropriate combination for its recognition at the species level in *Stegnogramma* has not been made. [= *Thelypteris pilosa* (M. Martens & Galeotti) Crawford var. *alabamensis* Crawford -- FNA; = ***Stegnogramma pilosa* (M. Martens & Galeotti) K. Iwatsuki** var. ***alabamensis* (Crawford) K. Iwatsuki**] {add to key}

#### **VITTARIACEAE** (C. Presl) Ching 1940 (Shoestring Fern Family)

A family of about 9 genera and 100 species. References: Crane (1997); Kramer in Kramer & Green (1990).

#### **Vittaria** J.E. Smith 1793 (Shoestring Fern)

A genus of about 50 species, tropics and subtropics. References: Farrar in FNA (1993b); Farrar & Mickel (1991); Kramer in Kramer & Green (1990). Key adapted from Farrar in FNA.

- 1 Sporophytes present, the leaves linear, 10-60 cm long and 1-3 mm wide . . . . . ***V. lineata***
- 1 Gametophytes only present.
  - 2 Gemmae with 2-12 body cells (with at least some present with 2-3 body cells); end cells of gemmae often swollen and larger than the medial cells; rhizoid primordia often absent on 1 or both end cells, seldom present on medial cells; sporophytes apparently not produced . . . . . ***V. appalachiana***
  - 2 Gemmae with 4-16 body cells; end cells of gemmae equal to or smaller than the medial cells; rhizoid primordia regularly present on the end cells, as well as on some medial cells; sporophytes frequently produced (and small sporophytes often present in largely gametophytic colonies) . . . . . ***V. lineata***

***Vittaria appalachiana*** Farrar & Mickel, Appalachian Shoestring Fern, "Appalachian Gametophyte." Mt (GA, NC, SC, VA), Pd (NC, VA): shaded grottoes, undersides of overhanging rock outcrops, especially in moist gorges or on spray cliffs in the vicinity of waterfalls, usually on felsic metamorphic rocks, such as mica schist, mica gneiss, granite gneiss, or metaquartzite; rare (NC Watch List, VA Watch List). This reduced species consists of "a branched, ribbon-like thallus one cell in thickness, usually differentiated into basal and upright branches; basal branches attached to the substrate by numerous short, brown rhizoids emanating from marginal and interior cells; upright branches terminating in the production of gemmae" (Farrar & Mickel 1991). The species is often overlooked or mistaken for a liverwort; it is most often collected by bryologists and hepaticologists, and was first noted in 1824 by von Schweinitz, who considered it a *Jungermannia*. Southern and Central Appalachians, south of the glacial boundary, from se. PA, sw. NY, and ne. OH south through c. TN and c. KY to n. GA, n. AL, and n. MS (Menapace, Davison, & Webb 1998). Although this species has been known for some time (often referred to as the "Appalachian Gametophyte"), it was only recently named formally (Farrar & Mickel 1991). A range of evidence (morphologic, electrophoretic, and developmental) indicates that it is not the gametophyte of any known *Vittaria* sporophyte; instead, it is a distinct taxon, reproducing vegetatively by gemmae, having lost the capability of producing sporophytes. For additional information, see Farrar (1974), Farrar (1978), Gastony (1977), Farrar, Parks, & McAlpin (1983), and Pittillo *et al.* (1975). [= FNA; = "a branching, ribbon-like gametophyte, with diffuse rhizoids and linear-shaped gemmae only one cell wide, of the genus *Vittaria*" -- RAB; = "thalloid, irregularly shaped gametophytes of a species of *Vittaria*" -- C]

***Vittaria lineata*** (Linnaeus) Smith, Shoestring Fern. Cp, Pd (GA): epiphyte on the bark of *Sabal palmetto*, but the northernmost site (in Lincoln County, GA, adjacent to SC) was on rock; rare. Se. GA and formerly ec. GA south through FL. Sporophytic plants have pendant linear leaves, 1-3 mm wide and up to 60 cm long. [= FNA, K, S]

## **GYMNOSPERMS**

The gymnosperms are a likely artificial grouping of about 16 families, about 86 genera, and about 850 species. References: Kramer & Green (1990).

**Standard Key to Families**

- 1 Leaves pinnately compound ..... **ZAMIACEAE**
  - 1 Leaves simple.
    - 2 Leaves fan-shaped, dichotomously-veined, deciduous ..... **GINKGOACEAE**
    - 2 Leaves needle-like or scale-like, not dichotomously veined, evergreen (rarely deciduous).
      - 3 Seeds borne singly in a soft fleshy to leathery aril ..... **TAXACEAE**
      - 3 Seeds 2-many, borne in a woody or fleshy cone (sometimes resembling a rather hard berry).
        - 4 Foliage leaves needle-like or scale-like, alternate, opposite, or whorled; cone scales valvate or imbricate (if imbricate, the leaves scale-like and opposite) ..... **CUPRESSACEAE**
        - 4 Foliage leaves needle-like, alternate or fascicled; cone scales imbricate ..... **PINACEAE**
- {add Cephalotaxaceae}

**Key to Genera, Emphasizing Vegetative Characters**

- 1 Leaves pinnately compound ..... **Zamia** (ZAMIACEAE)
- 1 Leaves simple.
  - 2 Leaves fan-shaped, dichotomously-veined, deciduous ..... **Ginkgo** (GINKGOACEAE)
  - 2 Leaves needle-like or scale-like, not dichotomously veined, evergreen (deciduous in *Taxodium* and *Larix*).
    - 3 Leaves either borne on short spur-shoots or in fascicles of 2-5; leaves rounded to somewhat flattened in cross-section, but not 4-sided.
      - 4 Leaves evergreen, more than 3 cm long, borne in fascicles of 2-5 ..... **Pinus** (PINACEAE)
      - 4 Leaves deciduous or evergreen, less than 3 cm long, borne on short spur-shoots.
        - 5 Leaves evergreen; cones 6-12 cm long ..... **Cedrus** (PINACEAE)
        - 5 Leaves deciduous; cones 1-2 cm long ..... **Larix** (PINACEAE)
    - 3 Leaves borne singly, alternate, opposite, or whorled; leaves flattened, scale-like, or 4-sided in cross-section.
      - 6 Leaves opposite or whorled, generally scale-like.
        - 7 Branchlets not disposed in one plane, thus bushy and not fan-like; plants dioecious, male and female cones on separate plants; mature female cones fleshy and berry-like, with smooth surfaces, indehiscent ..... **Juniperus** (CUPRESSACEAE)
        - 7 Branchlets disposed in one plane, thus flattened and fan-like; plants monoecious, male and female cones on the same plant; mature female cones woody or leathery, with irregular surfaces, dehiscent.
          - 8 Female cones globose and woody, the hard scales peltate, not imbricate; ultimate branchlets (including the scale leaves) about 1 mm broad ..... **Chamaecyparis** (CUPRESSACEAE)
          - 8 Female cones ellipsoid and leathery, the pliable scales basally attached, imbricate; ultimate branchlets (including the scale leaves) about 1.5 mm broad
            - 9 Branchlets flattened in vertical planes; seeds wingless; [planted tree, sometimes persistent] ..... **Platycladus** (CUPRESSACEAE)
            - 9 Branchlets flattened in horizontal planes; seeds winged; [native tree, but also sometimes planted] ..... **Thuja** (CUPRESSACEAE)
      - 6 Leaves alternate, needle-like or flattened.
        - 10 Leaves 4-sided in cross-section ..... **Picea** (PINACEAE)
        - 10 Leaves flattened in cross-section.
          - 11 Leaves rounded, blunt, or minutely notched at the tip (at 10x), prominently whitened beneath (with stomatal stripes); cone scales imbricate.
            - 12 Leaves attached directly to twig; cones 4-5 cm long, erect ..... **Abies** (PINACEAE)
            - 12 Leaves jointed, on short, persistent base; cones 1-3.8 cm long, pendant ..... **Tsuga** (PINACEAE)
          - 11 Leaves acute to acuminate (distinctly pointed at the tip), green beneath; seeds borne in a fleshy aril or cone scales valvate.
            - 13 Leaves deciduous, soft-textured ..... **Taxodium** (CUPRESSACEAE)
            - 13 Leaves evergreen, firm-textured.
              - 14 Leaves tapering from near the base to a long-acuminate apex; seeds borne in a woody cone with valvate scales ..... **Cunninghamia** (CUPRESSACEAE)
              - 14 Leaves parallel-sided for most of their length, the apex acute; seeds borne singly in a soft fleshy to leathery aril.
                - 15 Leaves 2.0-7.5 cm long (at least the larger on a branch > 4 cm long) ..... **Cephalotaxus** (CEPHALOTAXACEAE)
                - 15 Leaves 1.0-3.8 cm long.
                  - 16 Leaves flexible, the tips pointed but not piercing to the touch; fleshy "cone" ca. 5 mm long, ca. 5 mm in diameter, red when ripe, the seed exposed at the top by a gap in the aril ..... **Taxus** (TAXACEAE)
                  - 16 Leaves stiff, the tips piercing to the touch; fleshy "cone" 2.5-3 cm long, ca. 2 cm in diameter, dark green to purple when ripe, seed entirely surrounded by fleshy tissue ..... **Torreya** (TAXACEAE)

**CEPHALOTAXACEAE** (Plum-yew Family)

A family of 1 genus and ca. 10 species, trees and shrubs, of e. Asia. References: Farjon (1998); Tripp (1995)=Z; Page in Kramer & Green (1990).

***Cephalotaxus*** Siebold and Zuccarini ex Endlicher 1842 (Plum-yew)

\* ***Cephalotaxus ? harringtonia*** (Knight ex J. Forbes) K. Koch, Plum-yew. Pd (NC): suburban woodlands; rarely grown horticulturally, rarely naturalizing in the vicinity of plantings (as in Chapel Hill, Orange County, NC), introduced from Asia. [? *Cephalotaxus harringtonia* (Knight ex J. Forbes) K. Koch]

**CUPRESSACEAE** (Cypress Family)  
(including **TAXODIACEAE**)

A family of about 25-30 genera and about 120 species. Recent studies indicate that the separation of the Taxodiaceae from the Cupressaceae is not warranted, and they are here combined (Gadek et al. 2000; Brunsfeld et al. 1994). The subfamilial classification used here follows Gadek et al. (2000). References: Hart & Price (1990); Hardin (1971); Watson & Eckenwalder in FNA (1993b); Page in Kramer & Green (1990).

- 1 Leaves alternate.
  - 2 Leaves evergreen, rigid, more than 2 cm long, tapering from near the base to a long-acuminate apex; [subfamily *Cunninghamioideae*] . . . . . ***Cunninghamia***
  - 2 Leaves deciduous, flexible, less than 2 cm long, parallel-sided, the apex short-acute; [subfamily *Taxodioideae*] ***Taxodium***
- 1 Leaves opposite or whorled; [subfamily *Cupressoideae*].
  - 3 Branchlets not disposed in one plane, thus bushy and not fan-like; plants dioecious, male and female cones on separate plants; mature female cones fleshy and berry-like, with smooth surfaces, indehiscent . . . . . ***Juniperus***
  - 3 Branchlets disposed in one plane, thus flattened and fan-like; plants monoecious, male and female cones on the same plant; mature female cones woody or leathery, with irregular surfaces, dehiscent.
    - 4 Female cones globose and woody, the hard scales peltate, not imbricate; ultimate branchlets (including the scale leaves) about 1 mm broad . . . . . ***Chamaecyparis***
    - 4 Female cones ellipsoid and leathery, the pliable scales basally attached, imbricate; ultimate branchlets (including the scale leaves) about 1.5 mm broad
      - 5 Branchlets flattened in vertical planes; seeds wingless; [planted tree, sometimes persistent] . . . . . ***Platyclusus***
      - 5 Branchlets flattened in horizontal planes; seeds winged; [native tree, but also sometimes planted] . . . . . ***Thuja***

***Chamaecyparis*** Spach 1841 (White Cedar)

A genus of about 5-8 species, trees, of warm temperate to cool temperate North America and Asia. References: Michener in FNA (1993b); Farjon (1998)=Z; Page in Kramer & Green (1990).

***Chamaecyparis thuyoides*** (Linnaeus) Britton, Sterns, & Poggenburg, Atlantic White Cedar, Juniper. Cp (GA, NC, SC, VA): peat dome and streamhead pocosins, blackwater stream swamps, hillside seepages, in highly acidic, peaty or sandy soils; uncommon (GA Rare, VA Rare). March-April; October-November. S. ME south to n. FL and west to s. MS. From NJ south it is strictly a tree of the Coastal Plain; northwards it is often found in kettle-hole bogs. In SC and GA, *Ch. thuyoides* is absent in the outer Coastal Plain, occurring primarily in the fall-line Sandhills. A prized timber tree, now much reduced in abundance, formerly used for cabinetry, boat-building, shingles, and other uses. The wood is valuable enough (and resistant enough to rot) to have been mined from bogs in NJ. NC has some of the largest remaining stands of Atlantic White Cedar, in areas of very difficult access, such as the interiors of major peat-domes and large peat-filled Carolina bays. The species is generally known as "juniper" in our area. The genus consists of 6 species -- ours, 2 in w. North America, and 3 in Japan & Taiwan. [= RAB, C, F, FNA, G, K, S; *Ch. thuyoides* var. *thuyoides* – Z; = *Cupressus thuyoides* Linnaeus]

***Cunninghamia*** R. Brown 1826 (China-fir)

A genus of 2 species, trees, of e. Asia (China and Taiwan). References: Farjon (1998)=Z; Page in Kramer & Green (1990).

\* ***Cunninghamia lanceolata*** (Lambert) Hooker, China-fir. Pd (NC): planted horticulturally; rare, perhaps only persistent, introduced from China. A variety of forms are seen, some with dark-green, others with glaucous-blue foliage. [= K, Z; *C. sinensis* R. Brown]

***Cupressus*** Linnaeus (Cypress)

The circumscription of *Cupressus* may require modification, as it appears that Old World and New World members do not form a monophyletic group; New World members would be placed in a new genus. References: Little et al. (2004).

\* ***Cupressus xleylandii*** A.B. Jackson & Dallimore, Leyland Cypress, is commonly planted as an ornamental tree in our area. It is a hybrid between *Cupressus nootkatensis* D. Don in Lambert [*Chamaecyparis nootkatensis* (D. Don in Lambert) Spach; *Callitropsis nootkatensis* (D. Don in Lambert) Örest.] and *Cupressus macrocarpa* Hartweg. [= x*Cupressocyparis leylandii* (A.B. Jackson & Dallimore) Dallimore & A.B. Jackson] {not yet keyed}

**Juniperus** Linnaeus 1753 (Red Cedar, Juniper, Savin)

A genus of about 60 species, trees and shrubs, of temperate, boreal, and subtropical regions of the Northern Hemisphere. Various species of *Juniperus*, especially creeping species, are frequently used in landscaping. Molecular studies suggest that section *Juniperus* (*J. communis* var. *depressa* in our area) and section *Sabina* (*J. virginiana* in our area) are quite divergent (Adams & Demeke 1993). Small's (1933) recognition of the genus *Sabina* may prove to be warranted; some modern authors accept it (especially Europeans) and recent molecular evidence provides some support. References: Adams in FNA (1993b); Adams (1986); Adams & Demeke (1993); Adams (1995); Page in Kramer & Green (1990).

- 1 Leaves flat-acicular, 5-20 mm long, never scale-like, with a white line on the upper surface; leaves borne in whorls of 3, spreading at 45-90 degrees from the twig; female cone ("berry") axillary, maturing in 2-3 years; [section *Juniperus*] . . . . . ***J. communis* var. *depressa***
- 1 Leaves primarily scale-like, ca. 1-2 mm long, though acicular and 2-10 mm long on young trees and some lower branches of larger trees, without a white line on the upper surface (though generally somewhat glaucous); leaves of mature twigs borne in opposite pairs of 2, decussate (thus 4-ranked), appressed to the twig (leaves of immature twigs sometimes in whorls of 3, spreading at 10-45 degrees from the twig); female cones ("berries") terminal on short branches, maturing the first year; [section *Sabina*].
  - 2 Female cones ("berries") 3-4 mm long; terminal twigs 0.75-0.90 mm wide (including the scale-like leaves); scale leaves 1.20-1.45 mm long, obtuse to acute; trees generally with rounded crowns, the lower branches often drooping . . . . . ***J. virginiana* var. *silicicola***
  - 2 Female cones ("berries") 4-7 mm long; terminal twigs 0.85-1.00 mm wide (including the scale-like leaves); scale leaves 1.40-1.65 mm long, acute; trees generally with sharply tapered crowns, the lower branches generally ascending . . . . . ***J. virginiana* var. *virginiana***

***Juniperus communis* Linnaeus var. *depressa*** Pursh, Ground Juniper, Mountain Juniper, Common Juniper. Mt (NC, SC, VA), Pd (GA, NC, VA), Cp (SC, VA): in thin soil around rock outcrops on mountain summits and Piedmont monadnocks and rocky bluffs (in GA and NC), high elevation old fields (in VA), xeric Coastal plain sandhills (in SC and VA); rare (GA Special Concern, NC Rare, SC Rare, VA Rare). March-April; fleshy cone maturing in second or third year. This species is circumpolar, widespread in n. North America, n. Europe, and n. Asia. In North America it is primarily northern and montane, occurring nearly throughout Canada and AK, south in the Appalachians to n. GA, south in the Rocky Mountains to NM, AZ, and CA. Its berry is the juniper berry used as a spice, as well as the main flavoring of gin. It is sometimes planted as a landscaping plant. In e. North America, it is rare and scattered south of PA, MI, and WI, ranging south to a few disjunct sites in VA, NC, SC, GA, and s. IN. As a native species, it is very rare in the Southeast; in NC known only from a few sites, notably Mount Satulah (Macon County) and King's Pinnacle (Gaston County). In SC, a notable population occurs in sandy soils in Aiken County (Hitchcock Woods). Definitely in our area is var. *depressa*, a decumbent shrub, up to about 1 meter high, forming large clonal patches. Harvill et al. (1992) report scattered sites for var. *communis* in montane VA; these are based on columnar trees. Adams in FNA (1993b) considers var. *depressa* to be the only variety occurring in e. United States, and states that var. *depressa* sometimes forms columnar trees to 10 m tall; such individuals may be the basis of reports of var. *communis* from our area. Additional problems about the status of *Juniperus communis* in our area remain unresolved; variation in growth form, morphologic characters, and habitat suggest the possibility of the presence of several native taxa. See Coker & Totten (1945) for additional discussion. [= RAB, C, F, FNA, G, K, W; *J. sibirica* Burgsdorff -- S]

***Juniperus virginiana* Linnaeus var. *silicicola*** (Small) E. Murray, Southern Red Cedar, Coastal Red Cedar. Cp (GA, NC, SC, VA?): maritime forests and scrub, hammocks, coastal shell middens and natural shell deposits, brackish marshes, and other sandy or peaty, circumneutral situations; common. January-February; October-November. Var. *silicicola* ranges from e. NC south to s. FL, and possibly west to MS. Many recent authors have treated this taxon as a species, but Adams (1986) and Adams in FNA (1993b) consider varietal status more appropriate; Adams (1995) suggests that the two may have diverged as recently as the Pleistocene. The two varieties are said to intergrade in GA. Large individuals can be as much as a meter in diameter. [= FNA, K; = *Juniperus silicicola* (Small) Bailey -- RAB; = *Sabina silicicola* Small -- S; = *Juniperus virginiana* ssp. *silicicola* (Small) J. Silba]

***Juniperus virginiana* Linnaeus var. *virginiana***, Eastern Red Cedar. Pd, Mt, Cp (GA, NC, SC, VA): in a wide variety of forests, pastures, old fields, roadsides, and fencerows, primarily upland, occurring most abundantly on circumneutral soils (including shrink-swell clays), derived from mafic or calcareous rocks; common (especially in the Piedmont). January-March; October-November. Var. *virginiana* ranges throughout e. United States. The wood is much used for fenceposts and the traditional southern cedar chest (which takes advantage of the moth-deterrent properties of cedar wood). [= C, F, FNA, G, K; = *Juniperus virginiana* -- RAB, W; = *Sabina virginiana* (Linnaeus) Antoine -- S]

**Platycladus** Spach 1842 (Chinese Arborvitae)

A monotypic genus, a tree, of e. Asia (n. China and Manchuria). *Platycladus* is distinct from *Thuja*. References: Watson & Eckenwalder in FNA (1993); Page in Kramer & Green (1990).

\* ***Platycladus orientalis*** (Linnaeus) Franco, Oriental Arborvitae, Tree-of-life. Cp, Mt (NC): commonly planted, especially in graveyards, and rarely persisting and spreading to pastures, fields, and roadsides; rare, introduced from Asia. [= FNA, K; = *Biota orientalis* (Linnaeus) Endlicher -- S; = *Thuja orientalis* Linnaeus]

**Taxodium** L.C. Richard 1810 (Bald-cypress)

A genus of 3 species, trees, of e. North America and Mexico. There has been much debate over whether the two taxa of *Taxodium* in our area should be treated as species or varieties, and if as varieties, the proper nomenclature. I agree with Godfrey (1988), in his preference "to recognize two species ... because it is my perception that the vast majority of trees (populations) are thus distinguishable." At least in our area, true intermediates appear to be non-existent, though the "mimicry" of the two species creates

"pseudo-intermediates" that can cause difficulties in identification. Occasionally, the two species can be seen growing together, in "hybrid habitats," as at the junction of Lake Waccamaw and the Waccamaw River (Columbus County, NC); there are no intermediates, and with both species present for comparison, even juvenile trees are readily identifiable. Neufeld (1986) discusses the different architecture and ecophysiology of the two species. The only other species in the genus is *T. mucronatum* Tenore, ranging from s. TX south to Mexico and Guatemala. West of the Mississippi River, the architecture of *T. distichum* comes to resemble that of *T. mucronatum*, suggesting the possibility of introgression. For this and other reasons, Watson in FNA (1993b) and other authors prefer to treat *T. mucronatum* as a third variety of *T. distichum*, *T. distichum* var. *mexicanum* Gordon. *Taxodium* is most closely related to *Glyptostrobus* and *Cryptomeris*. References: Godfrey (1988)=Z; Duncan and Duncan (1988); Watson in FNA (1993b); Page in Kramer & Green (1990). Key adapted from Z.

- 1 Larger knees short, rarely more than 4 dm tall, usually columnar or broad and mound-like, with thick, compact bark on top; leafy branchlets ascending from the twigs, secundly erect (the base often curving, the apical portion of the branchlet borne in a vertical plane), except on juvenile trees (which mimic *T. distichum*); leaves subulate, spirally arranged, not spreading laterally and featherlike (except on juvenile trees), ascending or appressed; leaves mostly 3-10 mm long (to 15 mm long on juvenile trees); bark thick (1-2.5 cm thick), furrowed, dark-brown, not exfoliating; [trees of isolated depressions (clay-based Carolina bays, depression ponds), wet savannas, pocosins and other wet peaty habitats, and, less commonly, blackwater swamps and natural lakes] ..... ***T. ascendens***
- 1 Larger knees often tall, often over 4 dm tall, usually narrowly conical, with thin, shreddy bark on top; leafy branchlets spreading laterally from the twigs, except in the crowns of mature trees (which mimic *T. ascendens*); leaves linear, flat, spirally arranged but by twisting of their basal portions spreading laterally and featherlike (pseudodistichous), appressed only on drooping branches of the crown, if at all; leaves mostly 8-20 mm long (sometimes less on crown branches); bark thin (less than 1 cm thick), exfoliating in shreddy, orange-brown strips; [trees of brownwater swamp forests, blackwater swamp forests, natural lakes, and millponds] ..... ***T. distichum***

***Taxodium ascendens*** Brongniart, Pond-cypress. Cp (GA, NC, SC, VA?): limesink ponds (dolines), clay-based Carolina bays, wet savannas, pocosins and other wet, peaty habitats, shores of natural blackwater lakes, swamps of blackwater streams; common. March-April; October. E. NC (or se. VA) south to s. FL, west to e. LA; it is surely one of the most scenic trees of eastern North America. Material resembling *T. ascendens* occurs in se. VA; its taxonomic status is uncertain. [= RAB, G, K, S, Z; < *T. distichum* -- F; = *T. distichum* var. *imbricarium* (Nuttall) Croom -- FNA; = *T. distichum* var. *nutans* (Aiton) Sweet]

***Taxodium distichum*** (Linnaeus) L.C. Richard, Bald-cypress. Cp (GA, NC, SC, VA), Pd\* (NC): brownwater and blackwater swamps, usually in riverine situations; common. March-April; October. DE and e. MD south to FL and west to e. TX and se. OK, north along the Mississippi River and its tributaries to s. IN and s. IL. This species is sometimes planted as an ornamental in upland sites. [= RAB, G, K, S, Z; = *T. distichum* var. *distichum* -- C, FNA; < *T. distichum* -- F (see also *T. ascendens*)]

***Thuja* Linnaeus 1753 (Arborvitae)**

A genus of 5 species, trees, of e. North America, w. North America, and e. Asia. References: Chambers in FNA (1993b); Page in Kramer & Green (1990).

***Thuja occidentalis*** Linnaeus, American Arborvitae, Northern White Cedar, Flat Cedar. Mt (NC?, VA), Pd (VA): dry limestone, dolostone, and calcareous sandstone cliffs, talus, and boulderfields, rarely in our area in calcareous swamps, also planted and persisting around old homesites and cemeteries (mainly in the Mountains); uncommon (rare in VA Piedmont, rare in NC, where perhaps only introduced). March-April. Nova Scotia, Hudson Bay, and Manitoba south to PA (where considered strictly introduced by Rhoads & Klein 1993), OH, n. IN, n. IL, and in the mountains to WV, w. VA, and e. TN. This species is alleged by various authors to have occurred as a native species in nw. NC on limestone bluffs in Alleghany, Ashe, and/or Burke counties, but it has not been relocated in this century, and little apparently suitable habitat occurs in NC. [= RAB, C, F, FNA, G, K, S, W]

**GINKGOACEAE** Engler in Engler & Prantl 1897 (Ginkgo Family)

A family of a single genus and single species, a tree, native of China. *Ginkgo* has no close living relatives. References: Whetstone in FNA (1993b); Page in Kramer & Green (1990).

***Ginkgo* Linnaeus 1771 (Ginkgo, Maidenhair Tree)**

A monotypic genus, a tree, native of China. *Ginkgo* is famous as a "living fossil," known from fossils nearly 200 million years old which are nearly identical to modern plants; it may be extinct as a native plant. References: Whetstone in FNA (1993b); Page in Kramer & Green (1990).

\* ***Ginkgo biloba*** Linnaeus, Ginkgo, Maidenhair Tree. Pd, Mt (NC): frequently planted, rarely escaped to suburban woodlands and yards; rare, native to se. China. As pointed out by Whetstone in FNA (1993b), *Ginkgo* is only weakly naturalized. [= C, FNA, K]

**PINACEAE** (Pine Family)

A family of about 12 genera and about 220 species, trees and shrubs, almost exclusively in the Northern Hemisphere. References: Thieret in FNA (1993b); Price (1989)=Z; Page in Kramer & Green (1990).

- 1 Leaves flat and linear; [subfamily *Abietoideae*].

- 2 Leaves attached directly to twig; cones 4-5 cm long, erect ..... **Abies**
- 2 Leaves jointed, on short, persistent base; cones 1-3.8 cm long, pendant ..... **Tsuga**
- 1 Leaves needle-like, angular rather than flat in cross-section.
  - 3 Leaves borne singly, 4-sided; [subfamily *Abietoideae*] ..... **Picea**
  - 3 Leaves either borne on short spur-shoots or in fascicles of 2-5, rounded to somewhat flattened in cross-section, but not 4-sided.
    - 4 Leaves evergreen, more than 3 cm long, borne in fascicles of 2-5; [subfamily *Pinoideae*] ..... **Pinus**
    - 4 Leaves deciduous or evergreen, less than 3 cm long, borne on short spur-shoots; [subfamily *Laricoideae*].
      - 5 Leaves evergreen; cones 6-12 cm long ..... **Cedrus**
      - 5 Leaves deciduous; cones 1-2 cm long ..... **Larix**

**Abies** P. Miller 1754 (Fir)

A genus of about 40-50 species, trees, of temperate regions of the Northern Hemisphere, south to Central America. Our 2 native species and other non-natives are grown as ornamentals, especially in the mountains. References: Hunt in FNA (1993b); Liu (1971)=Y; Page in Kramer & Green (1990).

- 1 Cones 10-15 cm long; [section *Abies*] ..... **A. alba**
- 1 Cones 3.5-8 cm long; [section *Balsameae*].
  - 2 Bracts of the mature cones shorter than the scales or slightly exerted beyond the scales; stomatal rows (4-) 7 (-8) on each side of the midvein on the lower leaf surface (visible at 10x); [plant of the Central Appalachians and north, from Page and Madison counties, VA, northwards] ..... **A. balsamea**
  - 2 Bracts of the mature cones longer than the scales and reflexed; stomatal rows (8-) 10 (-12) on each side of the midvein on the lower leaf surface (visible at 10x); [plant of the Southern Appalachians, from Grayson and Smyth counties, VA, southwards] ..... **A. fraseri**

\* **Abies alba** P. Miller, European Fir, Silver Fir. Mt (NC): naturalized in Highlands, NC (Macon Co.), from plantings made by Harbison in the late 1800's (J.D. Pittillo, pers. comm.); rare. May; October. [= Y]

**Abies balsamea** (Linnaeus) P. Miller, Balsam Fir, Northern Balsam. Mt (VA): high elevation forests and cliffs; rare (VA Rare). April-May. Newfoundland and Labrador west to n. Alberta, south to NY, PA, MI, WI, and IA, and (disjunct) in the mountains to n. VA (known in our area as a native only from Page and Madison counties, VA). There has been considerable debate over the taxonomic status of some, especially southern, populations of *A. balsamea*, which show some transition in characters towards *A. fraseri*, and have been variously treated as *A. intermedia* Fulling, *A. balsamea* var. *phanerolepis* Fernald, or *A. xphanerolepis* (Fernald) Liu. Variation in e. North American *Abies* is somewhat clinal, with the greatest geographical and morphological discontinuity between n. VA and s. VA. It seems best, therefore, to recognize *A. fraseri* as a species and *A. balsamea* as a species including the clinal var. *phanerolepis*. The balsam woolly adelgid is afflicting this species in Shenandoah National Park. [= C, FNA, K, W, Y, Z; < *A. balsamea* var. *balsamea* – F, G; < *A. balsamea* var. *phanerolepis* Fernald -- F, G; < *A. xphanerolepis* (Fernald) Liu – Y; < *A. intermedia* Fulling]

**Abies fraseri** (Pursh) Poiret, Fraser Fir, She Balsam, Southern Balsam. Mt (\*GA, NC, VA): high elevation forests, from about 1500-2037m; uncommon (US Species of Concern, NC Rare, VA Rare). May-June; September-November. Southern Appalachian endemic, from Grayson and Smyth counties, VA (notably, Mount Rogers) south to e. TN and sw. NC. This species is threatened as a native species by a virulent alien pest, the balsam woolly adelgid, and environmental damage caused by pollution. Populations on Mt. Rogers and, to a lesser extent, Roan and Grandfather mountains, appear to be relatively healthy. *A. fraseri* is closely related to the northern Balsam Fir, *A. balsamea*, and may be a relatively recent derivative of it. During the 1970's and 1980's, the cultivation of Fraser Fir Christmas trees became an important part of the economy of the North Carolina mountains. Most Christmas tree plantations are at 1000-1500m in elevation; below 1000m, Fraser Fir is very susceptible to a fungal root rot (*Phytophthora*), above 1500m it grows too slowly to be profitable and is often "flagged" by winds, ruining its shape for commercial purposes. [= RAB, C, F, FNA, G, K, S, W, Y, Z]

**Cedrus** Trew 1757 (Cedar)

A genus of 2-4 species, trees, native to n. Africa to Asia. References: Page in Kramer & Green (1990).

\* **Cedrus deodara** (Roxburgh ex D. Don) G. Don, Deodar Cedar. Pd, Cp (NC, SC): frequently planted, rarely escaped to suburban woodlands; rare. [= K]

**Larix** P. Miller 1754 (Larch)

A genus of about 10 species, trees, of cold temperate and boreal regions of the Northern Hemisphere. References: Parker in FNA (1993b); Page in Kramer & Green (1990).

- 1 Leaves 2.5-3 cm long; cones 2-3.5 cm long; [alien species rarely planted] ..... **L. decidua**
- 1 Leaves 1-2.5 cm long; cones 1.2-2 cm long; [native species south to MD and WV] ..... [**L. laricina**]

\* **Larix decidua** P. Miller, European Larch. Mt (NC): forests; rare, introduced from Europe. Planted as an ornamental and experimentally as a forest tree, persisting and sometimes escaping in the high mountains of NC. [= F, K]

**Larix laricina** (Du Roi) K. Koch, Eastern Larch or Tamarack, ranges south in bogs and swamps to Garrett County, MD and Preston County, WV. [= FNA, C, F, G, K]



***Picea* A. Dietrich 1824 (Spruce)**

A genus of about 40 species, trees, of cool temperate and boreal parts of the Northern Hemisphere. References: Taylor in FNA (1993b); Page in Kramer & Green (1990).

- 1 Cones 10-16 cm long; upper branches spreading to ascending, the lower drooping; outer bud scales without hairlike projections; [plant an alien, but widely planted as an ornamental and sometimes as an experimental timber plantation tree] . . . . . ***P. abies***
- 1 Cones 1.5-4.5 cm long; upper branches ascending, the lower spreading; outer bud scales prolonged into minute hairlike projections; [plant native].
  - 2 Cones 1.5-2.5 cm long, gray at maturity, long-persistent . . . . . [***P. mariana***]
  - 2 Cones 2.5-4.5 cm long, red-brown at maturity, short-persistent . . . . . ***P. rubens***

\* ***Picea abies*** (Linnaeus) H. Karsten, Norway Spruce. Mt (NC, VA): persisting and escaping from forestry plantations at moderate or high elevations, notably in Great Smoky Mountains National Park (Kephart Prong), Mount Mitchell State Park, and the Biltmore Estate; rare, introduced from n. Europe. [= FNA, K]

***Picea rubens*** Sargent, Red Spruce, He Balsam. Mt (NC, VA): common to dominant in spruce and spruce-fir forests at high elevations, scattered in northern hardwood forests, heath balds, boulderfield forests, ridges, and rarely coves, also in bogs or swampy forests at lower elevations (down to about 1000m), ranging in moisture tolerance from dry ridges (though these are often fog-bathed) to saturated peats; uncommon. May-June; October. Nova Scotia and New Brunswick south (interruptedly) to w. NC and e. TN. Hardin (1971) discusses the existence of southern populations of *P. rubens* growing in bogs (notably Long Hope Valley, Ashe and Watauga counties, NC and Pineola Bog, Avery County, NC) with shorter than normal leaves (8-10 mm long vs. 12-15 mm long). He suggests that "this may be ecotypic, but one wonders whether the short leaves and bog habitat might reflect a few Black Spruce genes that have persisted since the Pleistocene." Further study with modern electrophoretic and molecular techniques seems warranted. [= RAB, C, F, FNA, G, K, S, W, Z; > *P. australis* Small -- S]

\* ***Picea mariana*** (P. Miller) Britton, Sterns, & Poggenburg, Black Spruce, ranges south to s. PA. It has also been reported from bogs in our area: for NC (Small 1933) and for VA (Fernald 1950). These reports are apparently based on misidentifications of short-leaved, bog-inhabiting populations of *P. rubens* (see discussion under *P. rubens*). [= C, F, FNA, G; > *P. mariana* var. *mariana* – K]

***Pinus* Linnaeus 1753 (Pine)**

A genus of about 110 species, trees, of the Northern Hemisphere, south to Central America. References: Kral in FNA (1993b); Duncan & Duncan (1988); Gernandt et al. (2005); Price, Liston, & Strauss (1998); Richardson (1998); Page in Kramer & Green (1990).

**Identification notes:** Young saplings generally have shorter needles than larger saplings and mature trees; measurements in the key are those of mature trees.

**Main Key**

- 1 Needles 5 in each bundle; each needle with 1 vascular bundle; [subgenus *Strobus*, section *Strobus*] . . . . . ***P. strobus***
- 1 Needles 2-3 (-4) in each bundle; each needle with 2 vascular bundles; [subgenus *Pinus*].
  - 2 Bracts and bud scales fimbriate; sheath more than 1.3 cm long; needles 20-50 cm long, in bundles of 3 (-4); twigs about 1 cm in diameter; [subgenus *Pinus*, section *Trifoliae*, subsection *Austerales*] . . . . . ***P. palustris***
  - 2 Bracts and bud scales entire or edged with hairs, but not fimbriate; sheath less than 1.5 cm long; needles (2-) 3-30 cm long, in bundles of 2-4; twigs less than 1 cm in diameter.
    - 3 Needles in bundles of 3, or 2 and 3, or 3 and 4 (predominantly or at least substantially in 3's); [subgenus *Pinus*, section *Trifoliae*, subsection *Austerales*].
      - 4 Needles in bundles of 2 and 3.
        - 5 Needles 3-7 cm long; prickles on cones 3-8 mm long, stout (more than 1 mm wide at base of prickle) . . . . . ***P. pungens***
        - 5 Needles 5-30 cm long; prickles on cones 1-3 mm long, slender (less than 1 mm wide at base of prickle).
          - 6 Needles 17-30 cm long; cones (6) 12-15 cm long . . . . . ***P. elliotii* var. *elliotii***
          - 6 Needles 5-12 cm long; cones 4-7 cm long . . . . . ***P. echinata***
      - 4 Needles in bundles of 3 (rarely with a few 2's), or 3 and 4.
        - 7 Cones distinctly longer than broad when open or closed, 5-13 cm long; needles mostly (10-) 12-23 (-28) cm long, 0.7-1.5 mm wide; buds not resinous (or only slightly so); trunks not producing adventitious sprouts (epicormic sprouting) . . . . . ***P. taeda***
        - 7 Cones about as broad as long, 3-6 cm long; needles (4-) 7-16 (-20) cm long, 1.5-2.0 mm wide; buds resinous; trunks commonly producing adventitious sprouts (epicormic sprouting), especially in response to fire.
          - 8 Needles (10-) 16-20 (-21) cm long, persisting 3-4 years; cones serotinous; [trees of pocosins, savannas, and other wetlands of the Coastal Plain] . . . . . ***P. serotina***
          - 8 Needles (4-) 7-10 (-15) cm long, persisting only 2 years; cones opening at maturity, not serotinous; [trees of ridges, slopes, bottomlands, and bogs of the Mountains and Piedmont] . . . . . ***P. rigida***
  - 3 Needles in bundles of 2 only.
    - 9 Needles stout, 1.3-2 mm wide.
      - 10 Leaves 7-15 cm long; cones 4-6 cm long, each scale bearing a small depressed mucro; [introduced tree,

- usually planted only on Coastal Plain barrier islands]; [subgenus *Pinus*, section *Pinus*, subsection *Pinus*] .  
 ..... ***P. thunbergiana***
- 10 Leaves 3-6 (-8) cm long; cones **either** 6-9 cm long with each scale bearing a stout, woody spine, or 3-6 cm long, unarmed; [native tree of the Mountains and upper Piedmont **or** introduced tree south to MD and WV].
- 11 Cones 6-9 cm long with each scale bearing a stout, woody spine; [native tree of the Mountains and upper Piedmont; [subgenus *Pinus*, section *Trifoliae*, subsection *Austerales*] ..... ***P. pungens***
- 11 Cones 3-6 cm long, unarmed; [introduced tree south to MD and WV][subgenus *Pinus*, section *Pinus*, subsection *Pinus*] ..... [***P. sylvestris***]
- 9 Needles slender to somewhat stout, 0.5-1.2 mm wide.
- 12 Needles 15-25 cm long; [trees naturalized on barrier islands]; [subgenus *Pinus*, section *Pinus*, subsection *Pinaster*] ..... ***P. pinaster***
- 12 Needles 2-17 cm long; [trees generally elsewhere].
- 13 Needles 10-17 cm long; branches brittle; spring shoots with a single node, with 1 whorl of branches; [trees of the north, sometimes planted in our mountains]; [subgenus *Pinus*, section *Pinus*, subsection *Pinus*] ..... ***P. resinosa***
- 13 Needles 2-13 cm long; branches flexible; spring shoots usually with several nodes (several whorls of branches); [trees of various habitats].
- 14 Needles 2-8 cm long, generally twisted; cones opening at maturity, not serotinous, the scales bearing prominent, slender prickles 2-5 mm long; [subgenus *Pinus*, section *Trifoliae*, subsection *Contortae*] ..... ***P. virginiana***
- 14 Needles 5-13 cm long, twisted or not; cones opening at maturity or serotinous, the scales bearing prominent, short, stout prickles or minute, deciduous prickles, and also with a faint to conspicuous horizontal ridge.
- 15 Anthers yellow; bark tight, closely ridged, not sloughing off, reminiscent of a hardwood; [native trees of mesic to fairly wet, fertile soils]; [subgenus *Pinus*, section *Trifoliae*, subsection *Austerales*] ..... ***P. glabra***
- 15 Anthers dark orange; bark flaky, the laminated layers sloughing off in a manner typical of a pine; [non-native (in our immediate area) trees of xeric sands]; [subgenus *Pinus*, section *Trifoliae*, subsection *Contortae*] ..... ***P. clausa***

**Auxiliary Key to common pines of the Piedmont**

- 1 Needles 12-25 cm long, predominantly in bundles of 3; winter buds more than 1 cm long; cones 6-15 cm long, falling soon after releasing seed; bark plates thick, without crater-like blisters ..... ***P. taeda***
- 1 Needles 2-13 cm long, predominantly in bundles of 2; winter buds less than 1 cm long; cones 3-7 cm long, persisting on trees for several years after releasing seed; bark plates thin, with or without crater-like blisters.
- 2 Needles 7-13 cm long, not twisted, or slightly so, in bundles of 2 (usually with some in bundles of 3), rather slender, less than 1.0 mm wide; bark plates mostly more than 4 cm wide, with crater-like blisters ca. 1 mm in diameter; winter buds not very resinous; 3-4 year-old twigs rough and flaking ..... ***P. echinata***
- 2 Needles 2-8 cm long, typically twisted, in bundles of 2, rather stout, often 1.0-1.2 mm wide; bark plates mostly about 2 cm wide, without crater-like blisters; winter buds very resinous; 3-4 year-old twigs smoothish to rough, but not flaking ..... ***P. virginiana***

***Pinus clausa*** (Chapman ex Engelm.) Vasey ex Sargent, Sand Pine. Cp (GA, \*NC): persisting after experimental planting in plantations; rare, native to Florida. *P. clausa* is closely related to *P. virginiana*, the northeastern North American *P. banksiana*, and the northwestern North American *P. contorta* complex. [= FNA, K, S, Z]

***Pinus echinata*** P. Miller, Shortleaf Pine, Rosemary Pine, Yellow Pine. Pd, Mt, Cp (GA, NC, SC, VA): dry rocky ridges and slopes, sandhills, old fields, forests, generally in rather xeric sites, but also occurring in mesic to even wet sites; common. March-April; September-October. Widespread in se. North America, north to s. NY, NJ, s. PA, s. OH, s. IL, s. MO, and e. OK, perhaps reaching its greatest importance in dry, sandstone landscapes, such as the Cumberland Plateau of WV, KY, TN, and AL, and the Ozarks and Ouachitas of AR, MO, and OK. [= RAB, C, F, FNA, G, K, S, W, Z]

***Pinus elliotii*** Engelm. var. ***elliotii***, Slash Pine. Cp (GA, NC\*, SC): native in wet pine flatwoods and maritime forests in SC, extensively planted in SC and NC in silvicultural plantations on a wide variety of soils, many of them unsuitable for its successful growth; common. January-February; October-November. *P. elliotii* var. *elliotii* ranges from e. SC south to c. peninsular FL, west to e. LA; var. *densa* Little & Dorman is restricted to c. and s. peninsular FL. *P. elliotii* var. *densa* is perhaps better treated as a full species, *Pinus densa* (Little & Dorman) de Laubenfels & Silba. *P. elliotii* var. *elliotii* has been extensively planted throughout the Coastal Plain of NC and SC, where it now occupies tens of thousands of hectares. Superficially, *P. elliotii* resembles both *P. palustris* and *P. taeda*, with cone size and needle length intermediate. *P. elliotii* var. *elliotii* is sometimes difficult to tell from *P. taeda*; additional helpful characteristics are the seed cones on 1.5-3 cm long stalks (vs. essentially sessile), seed cones reddish-brown and glossy, appearing varnished (vs. brown and dull), needles thicker and a dark glossy green (vs. thinner and a yellowish green); bark prominently flaking off and revealing reddish patches (vs. not notably flaking off and revealing reddish patches). [= FNA, K, Z; < *P. elliotii* -- RAB; *P. caribaea* Morelet -- S in part, misapplied; *P. palustris* P. Miller -- S in part, misapplied; *P. heterophylla* -- S]

***Pinus glabra*** Walter, Spruce Pine, Walter's Pine. Cp (GA, SC): bottomland forests, rich, moist soils; common, uncommon in SC. March-April; September-October. SC south to n. FL and west to se. LA. This pine is unusual in growing in moist (even infrequently flooded), fertile habitats, usually mixed with bottomland hardwoods, and apparently rather shade tolerant, sometimes growing as an understory tree. [= RAB, FNA, K, S, Z]

***Pinus palustris*** P. Miller, Longleaf Pine, Southern Pine. Cp, Pd (GA, NC, SC, VA), Mt (GA): formerly throughout the Coastal Plain, Sandhills, and lower Piedmont, on a wide variety of soils (sandy, loamy, clayey, or peaty), from very dry to very wet conditions, in savannas, woodlands, and forests affected by relatively frequent natural (lightning caused) fires (likely augmented by native Americans), now reduced to less than a tenth of its former abundance by a variety of forces, including turpentine, timbering,

free-range hogs, fire suppression, and "site conversion" by foresters to other trees, now extremely rare in VA and north of the Neuse River in NC, still occurring in some abundance in the outer Coastal Plain from Carteret County, NC south into GA, in the Bladen Lakes area of Bladen and Cumberland counties, and in the Sandhills of Harnett, Hoke, Scotland, Richmond, Moore, Anson, and Montgomery counties, NC and south into GA; common (locally) (VA Rare). March-April; September-October. A Southeastern Coastal Plain endemic: se. VA south to FL and west to se. TX; it extends slightly into the Piedmont in most states where it occurs, and further into the Piedmont and low mountains in GA and AL. "The species has been heavily exploited for timber and turpentine production, and it has been estimated that by 1930 only ten percent of its original volume of timber remained" (Price 1989); certainly much less now remains. Longleaf Pine is the state tree of NC. A hybrid with *P. taeda*, *P. xsonderegeri* H.H. Chapman, occurs. [= RAB, C, FNA, K; = *P. australis* Michaux f. -- F, G, S]

\* ***Pinus pinaster*** Aiton, Maritime Pine, Cluster Pine. Cp (NC): planted and naturalized on barrier islands; rare, introduced from Mediterranean Europe. *P. pinaster* is reported by Brown (1959) to be "introduced from Mediterranean region and planted on sandflats in vicinity of Corolla, Currituck Banks, Bodie and Hatteras Island 1936-1940.... Now producing seeds and becoming naturalized near Cape Hatteras Lighthouse. More resistant to salt spray than native pines" (Brown 1959). Graetz (1973) discusses its use on the Outer Banks and concludes that it is "not as well adapted to inclement beach conditions as Japanese black pine." *P. pinaster* is conspicuous just south of Nags Head on NC 12 (Dare County, NC), further south at Bodie Island Lighthouse (Dare County, NC), on Ocracoke Island (Hyde County, NC), and elsewhere. It has needles in 2's, (10-) 15-20 (-25) cm long. [= K]

***Pinus pungens*** Lambert, Table Mountain Pine, Burr Pine, Hickory Pine. Mt (GA, NC, SC, VA), Pd (NC, SC, VA): dry ridges, cliffs, shale barrens, usually requiring fire for its reproduction, occurring at least up to 5000 feet in elevation; common (rare in Coastal Plain). May; September-October. A Central and Southern Appalachian endemic: n. NJ, through se. PA, w. MD, WV, w. VA, w. NC, and e. TN to nw. SC and ne. GA. [= RAB, F, FNA, G, K, S, W, Z]

\* ***Pinus resinosa*** Aiton, Red Pine. Mt (NC, VA): in pine plantations, and persisting after silvicultural planting; rare. This species is native as far south as WV (Pendleton and Hardy counties) and PA (Luzerne, Wyoming, Tioga, and Centre counties). [= C, F, FNA, G, K]

***Pinus rigida*** P. Miller, Pitch Pine. Mt (GA, NC, SC, VA), Pd (NC, SC, VA), Cp (VA): primarily on dry ridges, more or less requiring fire for its reproduction, less commonly in peat soils of mountain bogs (and then often at elevations of 800-1000 m) and also scattered through a variety of forest types; uncommon (rare in Coastal Plain of VA). May; September-October. S. Canada and s. ME south to n. GA. It is abundant near sea level in the Pine Barrens of NJ, but in NC is limited to the mountains and upper Piedmont; it is replaced in Coastal Plain fire-maintained wetland communities by the related *Pinus serotina*. [= RAB, C, F, FNA, G, K, S, W, Z; = *P. rigida* ssp. *rigida*]

***Pinus serotina*** Michaux, Pocosin Pine, Pond Pine, Marsh Pine. Cp (GA, NC, SC, VA), Pd (NC, SC, VA): peaty soils of pocosins, swamps of small blackwater streams; common, rare in Piedmont. April; August (or at any time of year in response to fire). A Southeastern Coastal Plain endemic: s. NJ south to n. FL and se. AL, restricted to the Coastal Plain. A remarkable tree, well-adapted to fire by its serotinous cones and its ability to resprout needles from the branches, trunk ("epicormic sprouting"), or roots following fire. Extensive areas of peatland in the outer Coastal Plain are dominated by *P. serotina*, sometimes codominant with *Gordonia lasianthus*. Following fires which destroy all branches but do not kill the trees, epicormic sprouting results in entire forests of odd-looking cylindrical pond pines, the trunk thickly beset with needles, the outline of the tree a narrow cylinder 10-20 meters tall and less than 1 meter in diameter from base to summit. *P. serotina* is clearly a southern relative of *P. rigida*. It normally occurs in fire-maintained wetlands associated with ("downhill" from) *P. palustris*. On deep peats, *P. serotina* is stunted and of very irregular form; on mineral or shallower organic soils it can reach large size. Even when well-developed, the trunk is typically twisted and gnarled, helping to distinguish it from *P. taeda*. [= RAB, C, F, FNA, K, S, Z; = *P. rigida* P. Miller ssp. *serotina* (Michaux) Clausen]

***Pinus strobus*** Linnaeus, Eastern White Pine. Mt (GA, NC, SC, VA), Pd (NC, SC, VA), Cp (SC, VA): moist to dry forests, bottomlands, dry, rocky ridges in humid gorges; common (rare in Coastal Plain). April; August-September. Widespread in ne. North America, south to VA, w. and (rarely) c. NC, nw. SC, n. GA, e. TN, KY, IN, n. IL, e. IA, and MN. *P. strobus* was probably the tallest tree in e. North America, reaching heights of 60-70 meters. It was a very important timber tree historically. In NC a notable relict and disjunct stand of *P. strobus* occurs on bluffs of the Deep River in the eastern Piedmont of Chatham County; in VA *P. strobus* is widely but irregularly distributed in the lower Piedmont. [= RAB, C, F, FNA, G, K, W, Z; = *Strobus strobus* (Linnaeus) Small -- S]

***Pinus taeda*** Linnaeus, Loblolly Pine, Old Field Pine. Cp, Pd (GA, NC, SC, VA): forests, fields, pine plantations; common, much more abundant and widespread than formerly, occurring further west than as a native. March-April; October-November. Widespread in se. North America, ranging north to s. NJ, VA, TN, AR, and se. OK. See *P. elliotii* for additional characters to distinguish these two species. [= RAB, C, F, FNA, G, K, S, W, Z]

\* ***Pinus thunbergiana*** Franco, Japanese Black Pine. Cp (GA?, NC, SC): planted and persisting, sometimes appearing native, on barrier islands; rare, native of Japan. Growing in maritime situations in its native land, this tree's strong resistance to salt spray is the reason for its horticultural use in our area. Following moderate storm events on the coast, *P. thunbergiana*'s needles remain green and undamaged, even when needles of *P. taeda*, native to such situations, are salt-killed. [= K; =? *P. thunbergii* Parlin]

***Pinus virginiana*** P. Miller, Virginia Pine, Scrub Pine, Jersey Pine. Mt, Pd (GA, NC, SC, VA), Cp (NC, SC, VA): dry forests and woodlands, especially on slopes and ridges, also common in certain areas as a weedy successional tree on nearly any kind of site; common (rare in the Coastal plain). March-May; September-November. Primarily a Central and Southern Appalachian endemic: s. NY, NJ, and PA, south through VA, WV, s. OH, s. IL, KY, TN, and NC to nw. SC, n. GA, n. AL, and ne. MS. A small, scrubby pine, occurring in very dense, monospecific stands in the upper Piedmont as a result of secondary succession of old fields. [= RAB, C, F, FNA, G, K, S, W, Z]

\* ***Pinus sylvestris*** Linnaeus var. *sylvestris*, Scots Pine, is introduced and at least weakly naturalized south to MD (Kartesz 1999) and e. WV (Morton et al. 2004). [= FNA; < *P. sylvestris* – C, F, G, K]

The following pines occur on barrier islands in NC and SC: *P. taeda*, *P. palustris*, *P. elliotii* var. *elliotii*, *P. thunbergii*, and *P. pinaster* (the latter two not native). In the Coastal Plain, the pines are *P. palustris*, *P. serotina*, *P. echinata*, *P. taeda*, *P. glabra*, and *P. elliotii* var. *elliotii*. In the Piedmont, three pines are common and typically present in disturbed upland soils. The auxiliary key is useful in separating these sometimes confusing trees.

A genus of about 14 species, trees, of North America and e. Asia (China, Japan, and Taiwan). References: Taylor in FNA (1993b); Page in Kramer & Green (1990).

- 1 Most of the leaves 8-13 mm long, those originating from the sides and lower surface of the twig spreading more or less distichously in a horizontal plane, normally sized, those borne on the upper surface of the twig more or less appressed, dwarf, mostly 1/6 to 1/2 as long as the adjacent lateral leaves, 1-3 (-6) mm long, the whitened undersurface (consisting of rows of stomata) exposed upward; leaf margins minutely serrulate; leaf apices obtuse to rounded; seed cones 12-25 mm long . . . . . **T. canadensis**
- 1 Most of the leaves 10-18 mm long, those originating from the sides and lower surface of the twig spreading more or less distichously in a horizontal plane, normally sized, those borne on the upper surface of the twig not appressed, spreading at a 60-90 degree angle from the twig, more or less normally sized, mostly 3/4 to as long as the adjacent lateral leaves, 8-15 mm long, the whitened undersurface (consisting of rows of stomata) not exposed upward; leaf margins entire; leaf apices minutely retuse (notched), truncate, or rounded; seed cones 20-38 mm long . . . . . **T. caroliniana**

**Tsuga canadensis** (Linnaeus) Carrière, Eastern Hemlock, Canada Hemlock. Mt (GA, NC, SC, VA), Pd (NC, VA), Cp (VA): in a wide variety of habitats in the mountains, most typically and abundantly in moist sites in ravines or coves along streams, but likely to be found in all but the driest habitats between 300 and 1500 m (even occurring in peaty bogs, where it has a sickly yellow color and short life expectancy); in the western piedmont of NC limited to progressively rarer microhabitats (primarily north-facing river bluffs), reaching its eastward limit in NC at a disjunct stand at Hemlock Bluff State Natural Area, Wake County (but uncommon in the piedmont of VA and even present, though rare, in the coastal plain of VA); common (rare in Piedmont south of VA, rare in Coastal Plain in VA only). March-April; September-November. Widespread in ne. North America, south to w. and c. VA, w. and (rarely) c. NC, nw. SC, n. GA, n. AL, TN, KY, IN, WI, and MN. One of the largest trees commonly encountered nowadays in our area, but probably not naturally larger than many other trees -- because of its low timber value, it is often left by loggers. The hemlock woolly adelgid is severely affecting this species. [= RAB, C, F, FNA, G, K, S, W, Z]

**Tsuga caroliniana** Engelm., Carolina Hemlock. Mt (GA, NC, SC, VA), Pd (NC, SC, VA): primarily in open forests on ridge tops, rocky bluffs, or gorge walls, generally in drier and rockier sites than *T. canadensis*, but the two sometimes growing in close proximity or even intermixed in humid gorges; very limited in the western Piedmont, apparently reaching its eastern limit in NC at Hanging Rock State Park, Stokes County, and ranging east to Halifax County in the Piedmont of VA; uncommon (rare in piedmont) (GA Special Concern). March-April; August-September. *T. caroliniana* is a rather narrow Southern Appalachian endemic, occurring only in w. NC, e. TN, sw. and sc. VA, nw. SC, and n. GA. Carolina Hemlock has achieved a substantial reputation in NC as a Christmas tree, and is finally coming into favor as an ornamental; Coker and Totten (1945) wrote "the Carolina Hemlock is a very beautiful tree in cultivation, perhaps the handsomest of any eastern American conifer, combining in a remarkable way delicacy, symmetry, and strength." The hemlock woolly adelgid threatens this species. [= RAB, C, F, FNA, G, K, S, W, Z]

The folk taxonomy of conifers in our area is an interesting, though tangled, story. The town of Spruce Pine, NC is apparently named for *Tsuga canadensis*. Spruce Pinnacle in Buncombe County, NC is crowned with old *Tsuga caroliniana*. *Picea rubens* and *Abies fraseri* are called "He Balsam" and "She Balsam" (considered the male and female of a single species), Tamarack Post Office in Watauga County, NC and Tamarack Ridge in Highland County, VA are named for the abundance of *Picea rubens*! The generally used common name for *Juniperus* is "cedar," and *Chamaecyparis* is called "juniper."

**TAXACEAE** S.F. Gray 1821 (Yew Family)

A family of about 4 genera and ca. 16-20 species, shrubs and trees, of isolated regions of the Northern Hemisphere and New Caledonia. References: Hils in FNA (1993b); Price (1990); Page in Kramer & Green (1990).

- 1 Leaves flexible, the tips pointed but not piercing to the touch; fleshy "cone" ca. 5 mm long, ca. 5 mm in diameter, red when ripe, the seed exposed at the top by a gap in the aril . . . . . **Taxus**
- 1 Leaves stiff, the tips piercing to the touch; fleshy "cone" 2.5-3 cm long, ca. 2 cm in diameter, dark green to purple when ripe, seed entirely surrounded by fleshy tissue . . . . . **Torreya**

**Taxus** Linnaeus 1753 (Yew)

The genus consists of about 8 very closely related species, trees and shrubs, of temperate regions of the Northern Hemisphere. The species have been termed "discouragingly similar" by Hils in FNA (1993b). In e. North America, *T. canadensis* occurs in ne. North America, and *T. floridana* Chapman is endemic to panhandle FL. *T. brevifolia* Nuttall, Pacific Yew, of British Columbia and Alberta south to MT, ID, OR, and CA, has recently been widely publicized as the source of an anti-cancer drug, present in all species of the genus. *T. baccata* Linnaeus is native to Europe, and 3-4 additional species occur in Japan and e. mainland Asia (Price 1990). References: Hils in FNA (1993b); Farjon (1998)=Z; Page in Kramer & Green (1990).

- 1 Leaf undersurfaces usually lacking cuticular papillae along the stomatal bands; shrubs to 2 m tall; [of w. NC and VA northwards] . . . . . **T. canadensis**
- 1 Leaf undersurfaces with cuticular papillae along the stomatal bands; shrubs or small trees to 10 m tall; [of Panhandle FL] . . . . . **[T. floridana]**

**Taxus canadensis** Marshall, Canada Yew, American Yew. Mt (NC, VA), Pd (VA): cliffs, bluffs, and rocky slopes over calcareous or mafic rocks, red spruce and hemlock swamps and bogs; uncommon in VA, rare in NC (NC Rare). April-May. Newfoundland, Labrador, MN, and s. Manitoba south to nw. NC, ne. TN, KY, and IA. *Taxus* was first found in NC in 1968 (McDowell 1969). In our area, *Taxus* occurs primarily on limestone and mafic bluffs, but at its southernmost site in the "hanging valley" of Long Hope Creek (Ashe and Watauga counties, NC), *Taxus* is found in red spruce swamps and bog edges, where it is locally rather

common. Deer have a devastating effect on populations of this species in our area. [= C, F, FNA, G, K, W, Z; = *T. baccata* Linnaeus ssp. *canadensis* (Marshall) Pilger]

\* *Taxus baccata* Linnaeus, English Yew. Planted as hedges and ornamentals, escaping locally, as in Rock Creek Park, DC (Shetler & Orli 2000). [= K, Z; = *T. baccata* ssp. *baccata*] {not keyed}

\* *Taxus cuspidata* Siebold & Zuccarini, Japanese Yew. Planted as hedges and ornamentals, possibly escaping locally (Shetler & Orli 2000). [= K; > *T. cuspidata* var. *cuspidata* – Z; = *T. baccata* Linnaeus ssp. *cuspidata* (Siebold & Zuccarini) Pilger] {not keyed}

*Taxus floridana* Nuttall ex Chapman, Florida Yew. Endemic to Panhandle FL. [= FNA, K, S, Z; = *T. baccata* Linnaeus ssp. *floridana* (Nuttall ex Chapman) Pilger; = *T. baccata* var. *floridana* (Nuttall ex Chapman) Silba]

#### ***Torreya* Arnott 1838 (*Torreya*, Stinking Cedar)**

The genus consists of 6-7 species, trees, of temperate regions of the Northern Hemisphere -- 1 in FL and adjacent GA, 1 in CA, 1 in Japan, and 4 in c. and s. China and adjacent Burma (Price 1990). References: Hils in FNA (1993b); Page in Kramer & Green (1990).

***Torreya taxifolia*** Arnott, Florida Torreya. Cp (GA), \*Mt (\*NC): moist ravines and bluffs, and also rarely established near plantings; rare (US Endangered, GA Endangered). An endangered endemic of ravines along the Apalachicola River in panhandle FL and sw. GA. Pittillo and Brown (1988) report that "young saplings [are] established downslope and beneath transplanted trees south of Highlands [Macon County, NC]." Godfrey (1988) reports that the national champion Florida Torreya is in Warren County, NC, with "a near-basal circumference of 9 feet, a spread of 52 feet, and a height of 60 feet. It is estimated that it may have been planted there about 1830." [= FNA, K; = *Tumion taxifolium* (Arnott) Greene -- S]

#### **ZAMIACEAE (Sago-palm Family)**

A family of about 9-11 genera and 100-185 species, of tropical and warm temperate North America, Central America, South America, Africa, and Australia. References: Landry in FNA (1993b); Johnson & Wilson in Kramer & Green (1990); Jones (1993).

#### ***Zamia* Linnaeus**

A genus of about 30-60 species, of extreme se. North America, West Indies, Central America, and South America. References: Landry in FNA (1993b); Johnson & Wilson in Kramer & Green (1990); Ward (2001)=Y; Stevenson (1991)=Z.

***Zamia floridana*** Alphonse de Candolle var. ***umbrosa*** (Small) D.B. Ward, Coontie. Cp (GA): maritime forests, pinelands; rare (GA Special Concern). E. GA (Glynn Co.) south to FL. *Zamia floridana* var. *floridana* is more widespread in the FL Peninsula. Ward (2001), Landry in FNA (1993b), and Stevenson (1991) conclude that North American *Zamia* belongs to one of several *Zamia* species in the West Indies. Ward (2001) concludes that *Z. floridana* is the correct name for this taxon, and that varietal status is warranted for the "*umbrosa*" entity. [= Y; < *Zamia integrifolia* Linnaeus f. in Aiton -- FNA, S, Z; < *Z. pumila* Linnaeus -- K, misapplied; = *Z. umbrosa* Small -- S; < *Z. floridana* Alphonse de Candolle]