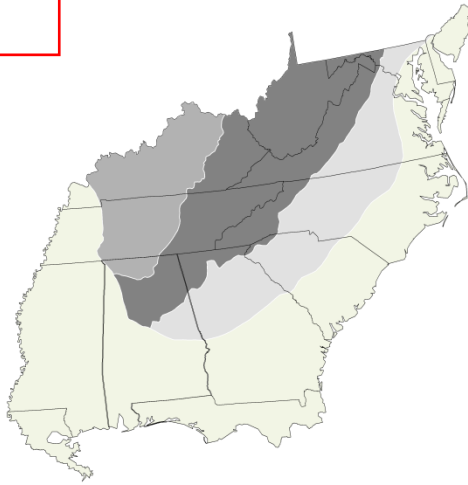


This version of the flora has maps reduced to a few pixels to reduce file size. For a full version, see <http://herbarium.unc.edu/flora.htm>

This version is also divided into parts to see if this will work better on mobile devices. This is part 1 of 4: Lycopodiophyta (Clubmosses), Monilophyta (Ferns), Acrogymnospermae (Extant Gymnosperms), Magnoliids And Primitive Angiosperms, pages 1-125

Flora of the Southern and Mid-Atlantic States

Working Draft of 28 September 2012



by
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INTRODUCTION

The Flora

Floras serve as the basic reference of the plant biota of an area; they are critical tools that serve botanists, conservationists, ecologists, foresters, gardeners, agronomists, researchers, and the general public. In the nineteenth and early twentieth centuries, the botanical exploration of an area and writing a flora to summarize that information was seen as a basic societal need leading to the discovery of economically valuable information. Financial support for the research and writing of floras has waned in recent decades, though, as they have been increasingly regarded as “old science” and resources have shifted to areas of plant science seen as more “cutting edge.” Even in taxonomic research, the advent of molecular techniques has largely supplanted detailed taxonomic research (at generic levels and below) and the writing of floras, and the great majority of papers in plant systematics now address phylogenetic relationships within a particular group of plants, and mostly at higher taxonomic levels. Traditional monographic taxonomy, with descriptions of taxa, keys to facilitate their identification, distribution maps, and assessments of habitat and relative abundance or rarity, has become increasingly rare.

Yet, paradoxically, the societal uses and needs for the translation of taxonomic information to a useable form, such as floras, have never been greater. Globalization of human societies and economies has meant that plants are regularly introduced far away from their regions of nativity, and many become established and can be either benign or cause economic and conservation damages. Increasing human utilization of land resources has fueled a biodiversity crisis, with many species now considered imperiled. In the United States and elsewhere, this has resulted in considerable governmental and nongovernmental activity focused on biodiversity inventory and conservation, “recovery” of endangered and threatened species, ecological studies and ecological restoration, and assessment and suppression of invasive exotics. All these activities require an accurate and sophisticated understanding of the flora of an area. These activities also generate new information about the taxonomy, distribution, and conservation status of components of a region’s flora which then needs to be incorporated into new iterations

In the southeastern United States, the publication thirty-seven years ago of the Manual of the Vascular Flora of the Carolinas, by A.E. Radford, H.E. Ahles, and C.R. Bell (Radford, Ahles, & Bell 1968), was a landmark. In the decades since its publication, it has served as the primary reference for the identification of plants in the Carolinas, and throughout the southeastern United States (since most other states were not covered by comparable, recent references). The effort to research and write the Manual of the Vascular Flora of the Carolinas took about 11 years, and resulted in a series of publications, the Guide to Vascular Flora of the Carolinas (Radford, Ahles, & Bell 1964), the Atlas of the Vascular Flora of the Carolinas (Radford, Ahles, & Bell 1965), and finally the Manual itself (1968). Once published, the existence of “the Manual” helped generate an interest in and further studies of the flora of the region; since then, 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 changed and advanced. Increasingly, identification of the flora of our area (and other states of the Southeast and Mid-Atlantic) by academic researchers, agency personnel, and the interested public 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.

Chapter 1 consists of 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. At the present time, the Flora includes treatment of all species in the flora area of Delaware, Virginia, West Virginia, North Carolina, South Carolina, Georgia, northern Florida (the Panhandle and northeastern Florida, south to and including Dixie, Gilchrist, Columbia, Union, Bradford, Clay, and Duval counties), Alabama, Mississippi, Tennessee, Kentucky, the District of Columbia, and Maryland, and portions of the additional states of New Jersey (southern New Jersey, south of and including Monmouth and Burlington counties), and Louisiana (the Florida Parishes, east of and including West Feliciana, East Baton Rouge, Ascension, St. James, St. John the Baptist, St. Charles, Jefferson, and Plaquemines parishes) (see Figure 1.A.). Approximately 6800 taxa are keyed and treated, making the Flora a comprehensive resource for understanding the flora of all of the Southeastern United States east of the Mississippi River and south of the Ohio River and Mason-Dixon Line, excluding peninsular Florida.

Sources of information.

This new flora is based on all resources available: herbarium specimens, published literature, grey literature, Natural Heritage databases and rare species lists, and personal communication with a regional network of botanists and taxonomic experts. Herbarium specimens have been consulted at major institutions in the region.

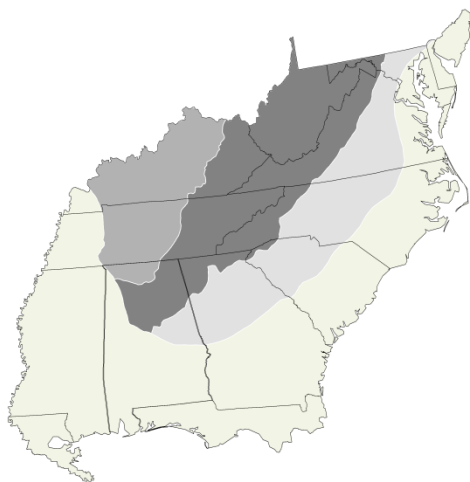


Figure 1.A. Map of the area covered by the Flora.

Criteria for inclusion of taxa.

One of the first challenges that the author of a flora encounters is to decide the criteria for the inclusion of taxa. The general rule in most floras can be simply summarized as “all native taxa and naturalized alien taxa,” but within this simplistic phrase hide many complicated issues, and floras often differ widely in the actual criteria and judgments that they apply (Pyšek et al. 2004; Palmer, Wade, & Neal 1995). In particular, coverage of alien species is very uneven in floras, and the frequent exclusion of many alien species from floras hampers ecological studies, conservation efforts, and efforts to minimize the ecological and economic impacts of invasive aliens.

The following categories of taxa are included and treated fully as “primary” species:

1. Native taxa documented from the Flora (Georgia, South Carolina, North Carolina, Virginia, West Virginia, Delaware, and northern Florida, Alabama, Mississippi, Tennessee, Kentucky, Maryland, District of Columbia, Maryland, eastern Louisiana, and southern New Jersey), whether extant or presumed extinct. Some authors, such as Isely (1990), have “excluded” taxa from a flora if they believed them to be extinct or extirpated. This philosophy seems poorly considered: these taxa may prove not to be extinct or extirpated and their inclusion in the Flora will facilitate possible rediscovery, even if never found again specimens of them in the herbarium need to be identified or confirmed, and their former existence in the region should be documented.
2. Alien taxa introduced by whatever means and demonstrably established and reproducing (sexually or vegetatively) as a component of the flora. Parallel to #1 above, established alien taxa which have been presumably eradicated (such as *Striga asiatica* in the Carolinas) are included, as their eradication may not have been effective, they may be reintroduced, specimens need to be identifiable using the Flora, and their former existence should be documented.
3. Alien taxa substantially cultivated in the Flora area as crops, such as *Triticum aestivale*, *Zea mays*, *Vitis vinifera*, and *Pinus clausa*. Such species are variably represented in herbaria, and are often included in floras only if one or more herbarium specimens indicate that the species is persisting, or has been collected around a dump or in the edge of a field “out of cultivation.” This seems an arbitrary criterion to apply to species which are among the most commonly seen and economically most important in a region, and may cover many thousands of acres or square miles in the region covered by the flora.

Additional categories of taxa are included and treated as “secondary” species:

1. Native taxa with uncertain documentation, this varying from literature reports not definitely verifiable with specimens (some of these old and some new), to sight reports regarded as probably correct. Taxa in this category are included as secondarily-treated taxa, and their imperfect documentation is described.

Species which have been reported from the Flora area but which are excluded for one reason or another are also listed and the reason for their exclusion mentioned or discussed.

Taxonomic philosophy. Taxonomic treatments generally follow recent monographic and revisionary work, but an effort has been 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 Radford, Ahles, and Bell (1968) 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 J.K. Small, P.A. Rydberg, and others (see Weakley 2005 for extensive discussion). Varieties are less frequently recognized than by Fernald (1950), though a considerable number of species and infraspecific taxa “lumped” by Radford, Ahles, and Bell (1968) are recognized (generally following more recent monographic or revisionary work). Some taxa not formally recognized are discussed and characters for their recognition provided in the text, to draw attention to putative taxa that may warrant recognition after further evaluation.

Format and features.

Detailed keys. Keys have been 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; this is not feasible for all groups, of course. 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 and secondary flora areas (North Carolina, South Carolina, Virginia, Georgia, Alabama, Mississippi, Tennessee, Kentucky, West Virginia, Maryland, Delaware, the District of Columbia, and parts of Florida, Louisiana, and New Jersey). 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 characters based on live or fresh plants may differ from those of pressed and dried specimens. Some keys have been adapted from literature cited; where the adaptation is particularly close, credit is given to the source by specific citation.

Habitat. Information is provided about the habitat of the taxon. This information is largely from the field experience of the author, supplemented by information from other botanists, from herbarium labels, and from the literature. For species with wide ecological amplitudes, the habitat may be described simply and broadly (“a wide variety of upland forests”), while the habitat of more localized, specialized, or rare taxa may be described in considerable detail (“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”).

Native status. The native or alien status is stated. Also, an asterisk prior to the species’ name indicates that it is considered alien throughout the primary flora area. Some past floras, including Radford, Ahles, and Bell (1968), were haphazard in their inclusion of this information, which is a very important attribute of each recognized taxon. If there is a question, it 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/fruitlet dates. Flowering and fruiting dates are provided for the primary flora area. 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 the journal *Castanea*). The distribution within the primary area is provided by state and physiographic province.

These distribution statements are being replaced by a map.

The map shows distribution within the Flora area symbolically, with each state × physiographic province area, except that on the maps, the very small areas of the DC Piedmont, the DC Coastal Plain, and the DE Piedmont are not shown separately from the MD Piedmont, the MD Coastal Plain, and the MD Piedmont, respectively. The native/alien status of the taxon is shown by squares for native occurrence and triangles for alien occurrence. Note that some species have distributions including both alien and native distributions, so *Dionaea muscipula* for instance is native in the Coastal Plain of NC and SC, but alien in the Coastal Plain of FL. The abundance in that state × physiographic province area is shown by the symbol, an open symbol is rare, a symbol with a dot is uncommon, and a filled symbol is common.

In the lower right corner is a space designated for distributional information. If the species is endemic to the Flora Area, you will see "EN." If the species is alien, you will see the region of the world to which it is native. If the species is native but not endemic, you will see a compass rose. Eight arrows depict the native distribution of the taxon outside of the Flora area. Arrows can be long (common at least somewhere in that region), or short (only uncommon or rare in that region).

The regions to which the eight arrows point are:

N arrow -- ne. North America (PA and n. NJ north to the Canadian maritime provinces, west through QC to se. ON and e. and s. OH);
 NW arrow -- nw. North America (w. OH, MI, w. ON, and NU west to AK, BC, and OR, north of and including n. MO, NE, WY, ID, and OR);
 W arrow -- w. United States (the western “Southeast” of trans-Mississippi LA, AR, s. MO, OK, and e. TX), west to sw. United States;
 SW arrow -- Mexico, Central America, and South America;
 S arrow -- peninsular FL;
 SE arrow (dashed to indicate oversea) -- West Indies (including Bahamas) and Bermuda;
 E arrow (dashed to indicate oversea) -- Asia and/or Africa;
 NE arrow (dashed to indicate oversea) -- Europe.

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. About 2100 references have been consulted and are cited.

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, and Bell (1968), as RAB; Small (1933, 1938), as S; Fernald (1950), as F; Gleason (1952), as G; Godfrey and Wooten (1979, 1981) as GW; Vascular Flora of the Southeastern States (Cronquist 1980, Isely 1990) as SE; Wofford (1989) as W; Gleason and Cronquist (1991) as C; Kartesz (1999) as K or K1; Kartesz (2010) as K2; and Flora of North America (1993b, 1997, 2000, 2002a, 2002b, 2003a, 2004b, 2005, 2006a, 2006b, 2006c, 2007a, 2009, 2010) as FNA; Brown & Brown (1984) as Md; Wunderlin & Hansen (2003) as WH; Strausbaugh & Core (1978) as WV. Synonymy used in recent monographs and revisions is also cited. All names known to me to be attributed to the *Flora* area in other floras, monographs, and revisions are accounted for.

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” add to the general usefulness and interest of what is intended to be a rigorous, practical, and interesting flora.

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Leaf duration. The longevity of leaves is used in the keys for woody plants. **Evergreen** plants are those that retain full leaf cover through the winter, while **deciduous** plants lose their leaves at the end of the growing season (for some species, sometimes well before autumn). Some plants are also described as **tardily deciduous** or **semi-evergreen**, meaning that they drop leaves gradually into the winter, so that they are sparsely bedecked with leaves or even bare by the time of initiation of new growth in the spring. Unless you are in a position to observe the plant repeatedly through the seasons, leaf duration must be interpreted, and this can be difficult, especially on herbarium specimens. In general, evergreen leaves tend to be darker green (at least on the upper surface), often shinier, and usually thicker in texture and stiffer than deciduous leaves, but there are exceptions to all these tendencies. It can be helpful to see if the specimen or living plant has two obviously different ages of leaves present: older, tougher, more ragged and insect-eaten leaves of last year as well as younger leaves of the year. On many woody plants, it is easy to determine what is new (this year's) growth from older growth, and the younger vs. older leaves may be spatially separated on shoots of the season vs. on older wood. Note, though, that some "evergreen" shrubs or trees essentially replace all their leaves at leaf-out in the spring, all of last year's leaves being sloughed as the current year's leaves are emerging.

Growth form or habit. The basic growth form or habit of the plant is used extensively in the keys. **Woody** plants have substantial secondary or diameter growth of wood, which makes their stems (in general) thicker, stronger, stiffer, and tougher; they also have "perennating structures" (normally buds) borne above ground on their woody stems. **Woody plants** are further subdivided into **trees, shrubs, rosette shrubs, subshrubs, rosette subshrubs, and lianas**. **Trees** are generally more than 5 meters tall at maturity and usually have single stems which are not interconnected by subterranean rhizomes (forming clonal patches). However, some tree species are characteristically multi-trunked or tend to produce a multi-trunked growth form as a result of stump-sprouting following logging, and stressful ecological conditions (such as shallow soil over rock or maritime exposure) can produce trees shorter than 5 meters. **Shrubs** are generally less than 5 meters tall and are often multi-stemmed from the base or near it (though some shrubs are characteristically single stemmed); quite a few are also clonal and produce many above-ground stems from a series of interconnected underground rhizomes). Some species grow as both trees and shrubs or have an ambiguous form; these are generally keyed as both trees and shrubs. Note that trees have seedlings or saplings that are shorter than 5 meters tall and may be multi-stemmed in growth form, especially in burned habitats; these are not keyed as shrubs and can generally be recognized as tree seedlings or saplings by the presence in the habitat of adult trees of the same species and by their lack of sexual reproduction (flowers, fruits, cones, etc.) because of their juvenile condition. **Subshrubs** are somewhat to strongly woody, but short in stature (often < 2 dm tall); while they have woody growth, they are often mistaken for herbs. **Rosette shrubs and rosette subshrubs** have basal leaves (see **Leaf location**, below) from an above-ground but short woody stock. **Lianas** are woody vines: in essence shrubs with specialized structures for climbing, including a) adventitious roots, b) twining growth of main stems, or c) simple or branched tendrils that either twine themselves or have adhesive "holdfast" tips. Some plants are keyed both as lianas and as shrubs. **Herbaceous plants** lack substantial secondary growth of wood and are either annual or have perennating organs (such as buds) on subterranean rhizomes, crowns, caudices, or corms. Herbaceous plants are further subdivided into **herbs and herbaceous vines**. **Herbs** are erect, sprawling, or trailing, but lack specialized adaptations for climbing (twining, tendrils, etc.); whereas **herbaceous vines** have these specialized adaptations. The interpretation of "woodiness", between shrub and herb (and liana and herbaceous vine), can be difficult, especially with herbarium specimens. Some herbaceous plants can become suffrutescent: tough, fibrous, or thick in ways that mimic or approach woodiness. The presence of vegetative buds (not flower buds) in the axils of leaves on the aerial stems clearly indicates a woody plant. Some plants which are ambiguously woody and likely to be mistaken one way or the other are keyed both ways.

Leaf disposition. The disposition of the leaves, whether basal or cauline, is used as a distinction to separate some of the major subkeys (in the woody plants separating Keys A7, B1, and E from the others, and in the herbaceous plants separating Key N from Keys O, P, Q, R, and S), as well as in a few other places. **Basal leaves** arise from underground buds (on rhizomes, crowns, caudices, or corms) or from the very base (ground level) of an aerial stem. **Stem leaves** (cauline leaves) are those which arise from above-ground (aerial) stems of the plant. Many plants, however, have **basally disposed** leaves, where the largest leaves are basal (and usually persistent through the growing season as a "basal rosette"), but smaller stem leaves extend up the above-ground stem. This can be ambiguous, though, and the persistence of basal leaves can be affected by season and conditions. While many taxa are keyed both in Key N and in one or more of Keys O, P, Q, R, and S), if this choice seems at all ambiguous and keying one way does not work well, the other choice should be tried.

Leaf type. Leaves are described as either **simple** or **compound**. Simple leaves are not divided into separate leaflets; the leaf tissue is continuous with all other leaf tissue of the leaf. By contrast, compound leaves are separated into 2 or more separate leaflets, connected only by various stalks (petiolules, rachises, rachillas) that lack leaf tissue. Simple leaves may be **unlobed, pinnately lobed, or palmately lobed**, and the lobes may be variously shallow or cut nearly to the midvein or base of the leaf. Perhaps the easiest way to determine whether leaf lobing is pinnate or palmate is to look at the major veins in the leaf. Pinnately lobed leaves have lobes arrayed in a line along either side of the midvein, and the lobes are associated with the major secondary veins of the (pinnately veined) leaf. The lobes of palmately lobed leaves are associated with the 3 or more palmate veins that arise together from the base of the leaf blade (note that the lobes of palmately lobed leaves are sometimes themselves sublobed, and that these sublobes are often pinnately arrayed: the leaf is still considered palmately lobed). **Compound leaves** are further classified by the number of leaflets, whether the leaflets are arrayed in a pinnate or palmate manner, and whether there is a single order of division or 2 or more orders of division. **Palmately compound** leaves have all leaflets attached at a single point, at the end of the petiole. Palmately compound leaves in our flora have from 3 to ca. 21 leaflets and are never further compound beyond the single order of division (in other words, the leaflets are not themselves compound). **Pinnately compound** leaves have leaflets attached to one or more axes (rachises, rachillas) that extend beyond the end of the petiole, and many taxa have 2 or more orders of division. Bifoliolate (**2-foliolate**) leaves are very rare in our flora. Trifoliolate leaves (**3-foliolate**, and sometimes called "ternate") are very common in our flora and can be either **palmately 3-foliolate** or (especially in the Fabaceae) **pinnately 3-foliolate**. Pinnately compound leaves have a short rachis extending past the end of the petiole (and the point of attachment of the 2 lateral leaflets via their petiolules), with the terminal leaflet attached at the end of this rachis via its petiolule; the joint between the rachis and the terminal petiolule is usually obvious because of a change in diameter, color, vestiture, and/or texture. The distinction between palmately 3-foliolate and pinnately 3-foliolate leaves is not used in the Key to Genera and Families but is important in the some other keys, especially the key to genera of the Fabaceae. Pinnately compound leaves with 4 or more leaflets are very common in our flora, especially in some families. **Even-pinnately compound** leaves (the less common situation) have an even number of leaflets, often paired along the rachis or rachillas, and lack a terminal leaflet at the tip of the rachis or rachilla and extending along its axis; these taxa are concentrated in the Fabaceae and a few other smaller families. **Odd-pinnately compound** leaves have a terminal leaflet and therefore usually an odd number of leaflets. Odd-pinnately compound leaves with 2 or more orders of division are typically described in the keys as **complexly compound**. Other floras variously describe leaves of this sort as 2-pinnate, 3-pinnate, decomposed, biternate, or other terms, but these have largely been avoided in the keys in this work because the "compoundness" is often complex, mixed between pinnate and ternate, and therefore difficult to describe accurately with such terminology. For instance, many members of the Apiaceae have complexly compound leaves, which are initially 3-forked (ternate), each of these forks may then be 3-forked again (though with the lateral forks supporting fewer or smaller leaflets than the terminal one), and these 3-order divisions are then often pinnately compound. Note that **deeply lobed leaves** can sometimes be easily mistaken for **compound leaves**. Compound leaves have no leaf tissue connecting the individual leaflets, whereas lobed leaves have at

least a narrow flange of leaf tissue along the rachis or rachilla that connects the leaf tissue of one lobe with the leaf tissue of the next. In some taxa, this is difficult to interpret, and these have generally been keyed both ways.

Lobes and teeth. The presence, absence, number, and shape of **lobes** or **teeth** along the margin of the leaf are very useful vegetative characters. The term “tooth” or “teeth” is here used in a broad sense to include any of the small marginal projections covered under the terms dentate, denticulate, serrate, serrulate, crenate, crenulate, spinose, spinulose, doubly serrate (biserrate), or erose. In other words, teeth can be rounded, pointed, or spine-tipped, and of various shapes and sizes. The term “tooth” or “teeth” does not include undulations out of the main plane of the leaf, hairs, or epidermal projections in the plane of the leaf margin, described by terms such as ciliate, ciliolate, or scabrous-margined. Teeth are often regular in size and position but in some species are irregular in form, shape, and even presence (these species are keyed in several places). The term “lobe” or “lobes” is also used in a broad sense to mean a larger feature of the leaf margin. Relative to teeth, lobes are typically both actually larger and relatively larger in relation to the size of the leaf, and also more widely spaced, often with a sinus (the depression between 2 lobes) extending $1/10^{\text{th}}$ to $9/10^{\text{th}}$ of the way from the outer leaf outline to the midrib. Lobes are typically spaced 1 cm or more apart, though the term is also applied to more closely spaced features with relatively deep sinuses (at least $3/10^{\text{th}}$ of the way to the midrib), especially in pteridophytes and in flowering plants with small leaves. Teeth are truly marginal, typically meeting 2 or 3 of the following 3 conditions: spaced < 1 cm apart, the sinuses between them usually extending $< 1/10^{\text{th}}$ of the way to the midrib, and the tooth itself (measured on its shorter side if it not equilateral) < 4 mm long. Occasionally we have also used the number of “**points**” as a character in the keys. This is the total number of lobe points and tooth points along one side of the leaf (base to apex on one side of the midvein). Note that some leaves are unlobed except for the presence of 2 basal lobes (one on either side, often described as cordate, sagittate, auriculate, or hastate depending on the shape, size, and orientation of the lobes); this situation is not keyed in the “lobed” sections of the key (as noted in the pertinent couplets).

Learning families. Learning plant families, especially those that are particularly important in Virginia’s flora or that are especially distinctive, is an extremely useful aid in identifying plants. While “learning” a family often starts with understanding its distinctive characteristics, often including some rather technical characteristics, with experience it becomes a more “gestalt” sense that, for instance, “that plant just looks like Asteraceae”, even if the features that would allow it to be keyed are not present. Knowing plant families often allows one to bypass the [Key to Genera and Families](#) entirely or facilitates decisions at particular couplets in it. A few of the families that are particularly useful to learn are Apiaceae, Asteraceae, Brassicaceae, Cyperaceae, Euphorbiaceae, Fabaceae, Juncaceae, Lamiaceae, Poaceae, Ranunculaceae, Rosaceae, and Rubiaceae.

Sluething characters. Some characters used in the key may seem initially impossible to find on your plant or specimen, but may actually be findable or deducible. Old fruits can sometimes be found on woody species, or on the ground under the tree or shrub. Old flower stalks (from the previous year) are sometimes present in perennial herbs, allowing the size of the plant and the type of inflorescence to be assessed. The calyx is often persistent after the petals have fallen, and calyx merosity (number in the whorl) and symmetry is usually the same as the merosity and symmetry of the corolla (though not always). Various fruit characters can sometimes be deduced from the flowers, and various flower characters can be deduced from the fruits. When capsules are immature (sometimes even in the stage of an ovary while in flower), dehiscence can often be deduced by the presence of visible lines on the fruit (sutures, visible at $10\times$). The number of carpels and locules can usually be determined from either the ovary or the immature or mature fruit, by making a careful \times -section. Stamens are sometimes present as shriveled remnants on fruits, allowing the number of stamens to be determined. Hair types (e.g., simple vs. stellate) may seem impossible if the leaf appears superficially glabrous, but hairs often remain to the end of the season on even apparently glabrous leaves in protected places, especially on the lower surface in the main vein axils. The bulbous or papillose bases of some hairs remain after the rest of the hair has worn off. Hairs with bulbous or papillate bases. Deducing the presence of stipules is often possible by looking for scars (usually linear) that extend beyond the leaf scar proper.

Winter identification. Note that no attempt has been made to make the key work consistently for plants in winter condition. Woody plants with evergreen foliage will generally be “keyable” in Keys B, D, E, F, G, H, I, and J, but deciduous species will not; there are various winter twig and bud keys available in print and online for the winter identification of trees and shrubs. Herbaceous plants with winter rosettes or otherwise green winter foliage will generally be found in Key N, but an impractical number of ambiguous or “dead end” leads will be encountered.

Botanical terminology. While the use of specialized terminology and jargon has been reduced, some of these terms are useful and unavoidable, and provide a precise meaning without a lengthy explanation. Terms can be found in the glossary, and there are print and online resources that provide definitions and often illustrations as well. Particularly recommended at the time of writing is Harris and Harris (2001), [Plant Identification Terminology: an Illustrated Glossary](#).

Characteristics of major groups of vascular plants. At various points in the key, a kind of shorthand is used in key leads to indicate the main evolutionary group involved: Lycophytes, Pteridophytes, Gymnosperms, Basal Angiosperms, Eudicots, and Monocots. This shorthand is not placed in every couplet in which it could be, but is used where it is likely to be helpful to the user. While the readily visible characteristics of these groups have many exceptions, the following table} will aid in their recognition (note that this table is pragmatically based only on the characteristics of those taxa in our flora).

	Lycophytes	Pteridophytes	Gymnosperms	Basal Angiosperms	Eudicots	Monocots
Leaf size	Very small (< 20 mm long), or linear quill leaves in <i>Isoetes</i>	Very small scale to very large	Very small scale leaves to very large pinnately compound leaves	Small to large (> 3 cm long)	Very small scale to large	Very small scale to giant leaves
Leaf complexity	Simple	Usually complexly compound (1-5× compound), but also simple or variously less complicatedly compound	Simple and scale-like or needle-like (or 1-pinnately compound in Zamiaceae and Cycadaceae, and fan-shaped and dichotomously veined in <i>Ginkgo</i>)	Simple (or dichotomously compound in <i>Cabomba</i>)	Simple to complexly compound	Simple with few exceptions (except palmately or pedately compound in <i>Arisaema</i> and palmately or pinnately compound in the giant leaves of <i>Arecaceae</i>)
Leaf or leaflet toothing	Entire or minutely toothed	Often toothed (diversely so), but sometimes entire	Entire or minutely toothed	Entire	Entire or variously toothed	Entire (often marginally scabrous or ciliate; rarely with spinulose teeth in some aquatics)
Leaf or leaflet lobing	Leaves not lobed (leaflets never present)	Leaves and/or leaflets often lobed (diversely so)	Leaves or leaflets not lobed	Leaves not lobed (except the base sometimes cordate or auriculate)	Leaves and/or leaflets often lobed (diversely so)	Leaves or leaflets not lobed
Leaf arrangement	Alternate, opposite, or whorled	Alternate	Alternate, opposite, whorled, or fascicled	Alternate (rarely opposite, in <i>Cabomba</i> , <i>Calycanthus</i> , and <i>Asarum</i>)	Alternate, opposite, or whorled	Almost always alternate (rarely opposite or whorled)
Leaf disposition	Cauline scale leaves (basal quill leaves in <i>Isoetes</i>)	Basal	Cauline (or basal in Zamiaceae and Cycadaceae)	Cauline (or basal in Nymphaeaceae and <i>Brasenia</i>)	Cauline or basal	Cauline or basal
Leaf venation	A single unbranched vein	Complex and variable, often with some dichotomous portions	Single midvein or several parallel (dichotomous in <i>Ginkgo</i>)	1° and 2° veins pinnate or palmate, ultimate veins netted or free	1° and 2° veins pinnate or palmate, ultimate veins netted or free	1° and 2° veins parallel or penni-parallel, smaller veins cross-veins at right angles
Reproductive structures	Spores , borne in sporangia axillary to scale leaves (or in <i>Isoetes</i> embedded in the base of quill leaves)	Spores , mostly borne on the undersurface of leaves, but also in a variety of specialized structures (but not as in Lycophytes)	Seeds, borne naked on scales, or in berry- or drupe-like structures	Seeds, borne in fruits	Seeds, borne in fruits	Seeds, borne in fruits
Perianth	N.A.	N.A.	N.A.	Typically many-merous , the segments borne spirally or in whorls	Typically 4-5-merous (sometimes many), the segments in whorls	Typically 3-merous , the segments in whorls
# of carpels	N.A.	N.A.	N.A.	Typically > 6 (rarely 1-6)	Typically 4-5 or 1-2 , sometimes many, very rarely 3	Typically 3 (rarely 1, 2, 4, or 6)
Carpel fusion	N.A.	N.A.	N.A.	Usually separate (sometimes fused)	Usually fused, sometimes separate	Always fused
Perianth connation	N.A.	N.A.	N.A.	Perianth segments typically separate (fused in Nymphaeaceae or Aristolochiaceae)	Perianth segments often fused , but also often separate	Perianth segments typically separate (sometimes fused)

- 1 Plant minute, consisting of filaments or thalli (undifferentiated into leaves, stems, and roots), generally a single cell thick, usually with abundant single-celled gemmae (specialized bud-like groups of cells for asexual reproduction), a free-living fern gametophyte, superficially resembling bryophytes in lacking vascular tissue, reproducing only vegetatively (by gemmae); [usually growing on vertical or overhanging bedrock (epipetric)]; [Pteridophytes] **Key A1 – pteridophytes reduced to thalloid or filamentous, free-living gametophytes**
- 1 Plant more complex, with stems (or rhizomes), leaves, roots, the leaves generally > 1 cell thick (except in sporophytes of *Didymoglossum*, *Crepidomanes*, *Vandenboschia*, and *Hymenophyllum*), with vascular tissue, reproducing by seeds or spores (and often also with various vegetative means of reproduction); [growing in very diverse habitats, including epipetric on bedrock]; [Lycophytes, Pteridophytes, Gymnosperms, Monocots, Basal Angiosperms, and Eudicots].
- 2 Plants floating aquatics, never rooted to the substrate (though sometimes stranded by dropping water levels); plants often thalloid in structure (lacking clear differentiation of stems and leaves)..... **Key C1 – floating aquatics**
- 2 Plants terrestrial, wetland, or aquatic, normally rooted to the substrate (sometimes becoming detached and then floating in the water column, though usually not on the water surface, and lacking obvious adaptations for surface flotation); plants generally with clear differentiation of stems and leaves (with some exceptions).
- 3 Plants woody, either trees, shrubs, lianas (woody vines), subshrubs, or rosette shrubs, with perennating structures (buds) borne on long-lived, above-ground, woody stems or caudices.
- 4 Stems fleshy and flattened, green and photosynthetic (becoming gray on older stems), the nodes scattered on the flattened pads and bearing glochidia and also often spines; leaves absent **Key D – cacti**
- 4 Stems not fleshy and flattened, usually brown, gray, or tan (sometimes green and photosynthetic), lacking glochidia (sometimes bearing spines, prickles, or thorns); leaves present, usually obvious, sometimes scale-like.
- 5 Plants rosette shrubs or subshrubs, the leaves strongly basally disposed and few to many, the above-ground stem stout (> 1 cm in diameter), usually < 1 dm tall; leaf arrangement alternate (but often with very short internodes).
- 6 Leaves “fern-like”, 1-pinnate-pinnatifid or more divided, deciduous; plants lacking both flowers and seeds, reproducing by spores; [Pteridophytes] **Key A7 – medium to large terrestrial pteridophytes**
- 6 Leaves either simple, 1-pinnate, or palmately compound, evergreen; plants bearing seeds, with or without flowers; {Gymnosperms, Monocots, and Eudicots}.
- 7 Leaves 1-pinnate; plants bearing seeds in cone-like strobili; [Gymnosperms] **Key B1 – cycads**
- 7 Leaves simple or palmately compound; [Monocots and Eudicots]..... **Key E – angiosperm shrubs and subshrubs with basal leaves**
- 5 Plants trees, shrubs, or lianas, the leaves usually many and cauline (borne along the stem), the above-ground stem usually > 2 dm long, if shorter, then not stout (< 0.5 cm in diameter); leaf arrangement alternate, opposite, or whorled.
- 8 Leaf venation dichotomous (with even Y-forks, the veins alike, no vein dominant); leaf fan-shaped, deltoid, 3-8 cm wide; leaves alternate, borne in clusters or short, spur shoots; [Gymnosperms] **Key B2 – ginkgo**
- 8 Leaf venation various, parallel, pinnate-reticulate, palmate-reticulate, with differentiation into primary, secondary, and finer levels of venation, most vein branches showing dominance by one of the two veins; leaf shape various, but not fan-shaped and ginkgo-like; leaves alternate, opposite, whorled, or fascicled; [Gymnosperms, Eudicots, Basal Angiosperms, Monocots].
- 9 Leaves stiff, needle or scale-like, in x-section flat, nearly terete, or variously angled, with or without an obvious midvein and generally lacking noticeable secondary venation; leaf arrangement alternate, opposite, whorled, or grouped into fascicles of 2-5 with a scarious sheath at the base; seeds not enclosed by an ovary or a true fruit, **either** borne naked on the upper surface of ovuliferous scales aggregated into a cone (the cone sometimes modified and fleshy and “berrylike) **or** the seed solitary and mostly or completely enclosed in a fleshy or leathery aril or receptacle; [Gymnosperms] **Key B3 – gymnosperm trees and shrubs with scale or needle leaves**
- 9 Leaves generally not stiff (some exceptions), usually broader and with well-developed leaf blades (therefore flat in x-section), usually with a midvein and well developed secondary and tertiary venation (some exceptions); leaf arrangement alternate, opposite, or whorled; seeds borne in fruits, which develop from ovaries; [Eudicots, Basal Angiosperms, and Monocots].
- 10 Leaves alternate; [Eudicots, Basal Angiosperms, and Monocots].
- 11 Leaves compound; [Eudicots and Monocots] **Key F – woody angiosperms with alternate, compound leaves**
- 11 Leaves simple; [Eudicots, Basal Angiosperms, and Monocots]..... **Key G – woody angiosperms with alternate, simple leaves**
- 10 Leaves opposite or whorled; [Eudicots].
- 12 Leaves whorled **Key H – woody angiosperms with whorled leaves**
- 12 Leaves opposite.
- 13 Leaves compound **Key I – woody angiosperms with opposite, compound leaves**
- 13 Leaves simple **Key J – woody angiosperms with opposite, simple leaves**
- 3 Plants herbaceous, herbs, or herbaceous vines (though sometimes with a tough, semi-woody texture), annual, biennial, or perennial, if the latter, with perennating structures borne below-ground (or on the ground surface) as crowns, offsets, etc., or as buds on woody rhizomes.
- 14 Plants aquatics, all of the plant (except sometimes the reproductive structures) normally submerged or suspended in water, or floating on its surface; {some ambiguously aquatic taxa keyed both here and under 14b} **Key C – aquatics**
- 14 Plants terrestrial or amphibious, all or most of the plant, including most of its leaves and its reproductive structures normally borne in the air, emergent plants may have their bases permanently submerged, and other wetland plants may be occasionally submerged by high waters.
- 15 Plants completely lacking chlorophyll (white, pink, orange, tan, red), strictly parasitic or mycotrophic; [Eudicots and Monocots]... **Key K – holoparasites and holomycotrophs**
- 15 Plants with chlorophyll (usually all or partially green, the green pigment sometimes wholly or partly masked by non-green pigments), at least in part autotrophic (many are also partially mycotrophic or parasitic).
- 16 Plant reproducing by spores; [Lycophytes and Pteridophytes] **Key A – lycophytes and pteridophytes**
- 16 Plant reproducing by seeds, developing in fruits derived from flowers; [Eudicots, Basal Angiosperms, and Monocots].
- 17 Plants epiphytic, normally growing attached to plants and not rooting in soil; [note that epiphytic Pteridophytes are not keyed here, and should be sought in Keys A4 and A6] **Key L – epiphytic angiosperms**
- 17 Plants terrestrial, rooted in soil (sometimes on logs or in tree knotholes, hollows, or tree-limb crotches where soil has accumulated, but not truly epiphytic).
- 18 [Monocots; see combination of features in Table 1] **Key M – monocots**
- 18 [Eudicots and Basal Angiosperms; see combination of features in Table 1]

- 19 Leaves strictly basal, or strongly "basally disposed" (the basal leaves the largest, and usually persistent through most of the growing season)..... **Key N – herbaceous dicots with primarily basal leaves**
- 19 Leaves cauline (if plant with basal leaves, these not noticeably the largest, often senescing early) [note: many taxa keyed in both leads].
- 20 Leaves alternate.
- 21 Leaves compound..... **Key O – herbaceous dicots with alternate, compound leaves on the stem**
- 21 Leaves simple..... **Key P – herbaceous dicots with alternate, simple leaves on the stem**
- 20 Leaves opposite or whorled or appearing whorled (a few plants have leaves or leaf-like structures which appear whorled but anatomically are opposite or alternate with leaflets divided to the stem).
- 22 Leaves whorled (some taxa with normally opposite leaves can have occasional developmental errors that result in an individual plant having 3-whorled leaves; these are not accommodated in the key as "whorled" [if a plant does not key readily as "whorled", try it as "opposite"]) or appearing so
- **Key Q – herbaceous dicots with whorled leaves on the stem**
- 22 Leaves opposite.
- 23 Leaves compound **Key R – herbaceous dicots with opposite, compound leaves on the stem**
- 23 Leaves simple..... **Key S – herbaceous dicots with opposite, simple leaves on the stem**

Key A – lycophytes and pteridophytes

- 1 Plant minute, consisting of filaments or thalli (undifferentiated into leaves, stems, and roots), generally a single cell thick, usually with abundant single-celled gemmae (specialized budlike groups of cells for asexual reproduction), and superficially resembling bryophytes in lacking vascular tissue; [usually epipetric on vertical or overhanging bedrock; [Pteridophytes]
- **Key A1 – pteridophytes reduced to thalloid or filamentous, free-living gametophytes**
- 1 Plant more complex, with vascular tissue, with stems (or rhizomes), leaves, and roots, the leaves generally > 1 cell thick (except in sporophytes of *Didymoglossum*, *Crepidomanes*, *Vandenboschia*, and *Hymenophyllum*), reproducing by spores; [growing in very diverse habitats, including on bedrock]; [Lycophytes, Pteridophytes].
- 2 Plant aquatic, either floating and unattached, or rooting and largely submersed
- **Key A2 – pteridophytes and lycophytes growing as floating or rooted aquatic**
- 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; [Lycophytes or Pteridophytes]
- **Key A3 – lycophytes and pteridophytes with leaves not "fern-like"**
- 3 Leaves "fern-like," variously lobed or divided, ranging from pinnatifid to 4-pinnate; [Pteridophytes].
- 4 Leaf blades (not including the petiole) small, < 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 A4 – small 'fern-like' epipetric or epiphytic pteridophytes**
- 5 Terrestrial, growing in soil, not associated with rock outcrops **Key A5 – small 'fern-like' terrestrial pteridophytes**
- 4 Leaf blades medium to large, > 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 A6 – medium to large 'fern-like' epipetric or epiphytic pteridophytes**
- 6 Terrestrial, growing in soil, not associated with rock outcrops ... **Key A7 – medium to large 'fern-like' terrestrial pteridophytes**

Key A1 – pteridophytes reduced to thalloid or filamentous, free-living gametophytes

- 1 Gametophytes filamentous [*Crepidomanes*] **HYMENOPHYLLACEAE (F9)**
- 1 Gametophytes thalloid, ribbon-like and branched.
- 2 Gemmae absent or spatulate (the gemma > 1 cell wide).....[*Hymenophyllum*] **HYMENOPHYLLACEAE (F9)**
- 2 Gemmae with cells uniseriate (the gemma 1 cell wide).....[*Vittaria*] **PTERIDACEAE (F31)**

Key A2 – pteridophytes and lycophytes growing as floating or rooted aquatics

- 1 Plant with at least some leaves palmately or pinnately lobed or 1-4× pinnately divided ("fern-like") and > 2 cm long.....
- [*Ceratopteris*] **PTERIDACEAE (F31)**
- 1 Plant either a floating aquatic with leaves <5 cm long, or with clover-like or linear leaves.
- 2 Plant a floating aquatic.....[*Azolla*, *Salvinia*] **SALVINIACEAE (F17)**
- 2 Plant a rooted aquatic.
- 3 Plant clover-like, with 4 leaf segments borne terminally[*Marsilea*] **MARSILEACEAE (F16)**
- 3 Leaves linear.
- 4 Plants cormose or with short rhizomes; leaves numerous, undivided leaves[*Isoetes*] **ISOETACEAE(L2)**
- 4 Plants with creeping rhizomes; leaves few, reduced to a winged petiole.....[*Pilularia*] **MARSILEACEAE (F16)**

Key A3 – lycophytes and 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 (F4)**
- 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, 1-60 cm long, 20× 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 (F16)**

- 3 Leaves numerous from a corm or short-creeping rhizome; sporangia **either** borne in the expanded leaf bases (*Isoetes* in ISOETACEAE) **or** in 2 rows at the tip of the linear fertile leaves (*Schizaea* in SCHIZAEACEAE), **or** in a sub-marginal groove on either side of the midrib (*Vittaria* in PTERIDACEAE).
- 4 Leaves straight and stiff, arching, or flaccid, from a 2-3-lobed corm; sporangia borne in the expanded, hyaline leaf bases.....[*Isoetes*] **ISOETACEAE (L2)**
- 4 Leaves **either** straight and stiff **or** notably spiral-curly, from a short-creeping rhizome; sporangia borne in 2 rows **either** at the expanded pectinate tip of the fertile leaves **or** along much of the length of the linear leaves.
- 5 Leaves 10-60 cm long, straight, stiff; plants epiphytic or rarely epipetric, the leaves pendent..... [*Vittaria*] **PTERIDACEAE (F31)**
- 5 Leaves 1-12 cm long, spiral-curly; plants terrestrial in peaty substrate, the leaves erect..... [*Schizaea*] **SCHIZAEACEAE (F14)**
- 2 Leaves various (scale-like, awl-like, moss-like, or flat), but not linear and grass-like, mostly 1-10× as long as wide.
- 6 Leaves inconspicuous, reduced to a few nerveless scales (< 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 (F6)**
- 6 Leaves either larger or, if scale-like, with nerves and longer than the internodes (the leaves thus overlapping); sporangia yellowish to brownish, 1-locular, < 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* in LYCOPODIACEAE).
- 7 Plant with leaves very numerous and overlapping along the creeping, ascending, or erect stems, the leaves 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; [Lycophytes].
- 8 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 each of one size..... **LYCOPODIACEAE (L1)**
- 8 Sporangia borne in flattened or quadrangular strobili sessile at the tips of leafy branches; spores and sporangia each of two sizes, the megasporangia larger and borne basally in the strobili..... [*Bryodesma*, *Lycopodioides*] **SELAGINELLACEAE (L3)**
- 7 Plant with leaves not as above (see below for details); [Pteridophytes].
- 9 Plant with 1 (-2) leaves, divided into separate sterile and fertile segments, 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 (F5)**
- 9 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).
- 10 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..... [*Didymoglossum*] **HYMENOPHYLLACEAE (F9)**
- 10 Leaf blades (2-) 8-30 cm long, cordate at the base, the tip long-attenuate, often proliferous (bearing a plantlet at the tip); sporangia grouped into 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*] **ASPENIACEAE (F33)**

Key A4 – small ‘fern-like’ pteridophytes, epipetric or epiphytic, growing on rock, tree bark, or walls

- 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).
- 2 Leaves pinnatifid, the pinnae not lobed.
- 3 Leaf blades with a long-attenuate apex, blade lobed for up to 2/3 its length; sori elongate..... [*Asplenium*] **ASPENIACEAE (F33)**
- 3 Leaves without a long-attenuate apex, blade lobed for > 4/5 of its length; sori round **POLYPODIACEAE (F48)**
- 2 Leaves bipinnatifid, at least the lowermost pinnae deeply lobed.
- 4 Leaves of a very delicate texture, 1 cell thick; sori borne in cups on the leaf margins; [of rock outcrops with high air humidity]..... [*Hymenophyllum*] **HYMENOPHYLLACEAE (F9)**
- 4 Leaves of an herbaceous, subcoriaceous, or coriaceous texture, > 1 cell thick; sori otherwise; [of various habitats, not strictly of moist sites].
- 5 Lowermost (and other) pinnae with numerous, rather even lobes..... [*Phegopteris*] **THELYPTERIDACEAE (F35)**
- 5 Lowermost pinnae with a few, irregular lobes (the upper pinnae unlobed) [*Pteris*] **PTERIDACEAE (F31)**
- 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).
- 6 Leaves pinnate or pinnate-pinnatifid.
- 7 Leaves of a very delicate texture, 1 cell thick; sori borne in cups on the leaf margins; [of rock outcrops with high air humidity]..... [*Vandenboschia*] **HYMENOPHYLLACEAE (F9)**
- 7 Leaves of an herbaceous, subcoriaceous, or coriaceous texture, > 1 cell thick; sori otherwise; [of various habitats, not strictly of moist sites].
- 8 Pinnae > 1 cm wide; leaves subcoriaceous to coriaceous; veins anastomosing, rejoining to form a netlike pattern..... [*Cyrtomium*] **DRYOPTERIDACEAE (F42)**
- 8 Pinnae < 1 cm wide; leaves herbaceous to subcoriaceous; veins free, not rejoining.
- 9 Sori on the undersurface of the leaf, located away from the margins [*Asplenium*] **ASPENIACEAE (F33)**
- 9 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 **PTERIDACEAE (F31)**
- 6 Leaves bipinnate or more divided.
- 10 Leaf blade pentagonal or broadly triangular in outline, ca. 1× as long as wide.
- 11 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 (F42)**
- 11 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*] **CYSTOPTERIDACEAE (F32)**
- 10 Leaf blade elongate, mostly lanceolate, generally > 4× as long as wide (except in *Adiantum capillus-veneris*, with leaf blade often only 1.5-3× as long as wide, but not notably triangular or pentagonal in outline).
- 12 Sori marginal, usually more-or-less hidden under the revolute margin of the pinnule..... **PTERIDACEAE (F31)**
- 12 Sori not marginal, either exposed, or slightly to strongly hidden by indusia.

- 13 Leaf blades 3-12 cm long; sori elongate, covered by a flap-like, entire indusium..... [*Asplenium*] **ASPENIACEAE (F33)**
 13 Leaf blades 4-30 (-50) cm long; sori globular, surrounded or covered by an entire, ciliate, or divided indusium.
 14 Veins reaching the margin; indusium attached under one side of the sorus, hood-like or pocket-like, arching over the sorus; petioles glabrous or sparsely beset with scales, the petiole bases not persistent..... [*Cystopteris*] **CYSTOPTERIDACEAE (F32)**
 14 Veins ending short of the margin; indusium attached under the sorus, **either** cup-like (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*] **WOODSIACEAE (F36)**

Key A5 – small ‘fern-like’ pteridophytes, terrestrial, growing in soil, not associated with rock outcrops

- 1 Petiole branched once dichotomously, each branch then bearing 3-7 pinnae on the same side of the rachis, the overall outline of the blade in the shape of a fan and often broader than long..... [*Adiantum*] **PTERIDACEAE (F31)**
 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, Botrypus*] **OPHIOGLOSSACEAE (F5)**
 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 (F35)**
 4 Leaves dimorphic, the sori borne on leaves significantly different from normal leaves.
 5 Fertile leaf woody, with bead-like segments; margins of sterile pinnae entire, often wavy or the lowermost even somewhat lobed; pinnae mostly with obtuse apices, tending to be borne oppositely [*Onoclea*] **ONOCLEACEAE (F38)**
 5 Fertile leaf stiff but herbaceous, the pinnae linear, not at all bead-like; margins of sterile pinnae finely serrulate, otherwise slightly wavy or straight; pinnae mostly with acute apices, tending to be borne alternately [*Woodwardia*] **BLECHNACEAE (F39)**
 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.
 7 Sporangia borne on normal leaf blades [*Gymnocarpium*] **CYSTOPTERIDACEAE**
 7 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 (F5)**
 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).
 8 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 (F5)**
 8 Leaf blades 10-30 (-100) cm long; sporangia either borne on normal leaf blades or on slightly dimorphic blades.
 9 Leaves dark green, subcoriaceous in texture, evergreen [*Rumohra*] **DRYOPTERIDACEAE (F42)**
 9 Leaves light to medium green, herbaceous in texture, deciduous to semi-evergreen.
 10 Sori continuous along the midrib of the pinna [*Blechnum*] **BLECHNACEAE (F39)**
 10 Sori distinct.
 11 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; petiole with 2 vascular bundles, uniting upwards into 1 ×-shaped bundle [*Asplenium (platyneuron)*] **ASPENIACEAE (F33)**
 11 Sori round; leaf blades monomorphic (or slightly dimorphic in *Cystopteris*); the larger leaf blades 5-15 cm wide; petiole with 2 vascular bundles, uniting upwards into 1 U-shaped or V-shaped bundle.
 12 Leaf vestiture nearly lacking (if present, not of unicellular acicular hairs or gland-tipped hairs) [*Cystopteris*] **CYSTOPTERIDACEAE**
 12 Leaf vestiture of unicellular acicular hairs 0.2-1 mm long intermixed with short-stalked or sessile yellowish glands [*Thelypteris*] **THELYPTERIDACEAE (F35)**

Key A6 – medium to large ‘fern-like’ pteridophytes, epipetric on rock or walls, or epiphytic on tree trunks

- 1 Leaf 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 (> 10 cm apart) [*Lygodium*] **LYGODIACEAE (F13)**
 1 Leaf not vine-like, 0.3-3 m long, the branching not as described above, the pinnae regularly and more-or-less closely spaced (mostly < 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*] **PTERIDACEAE (F31)**
 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 < 7 cm wide when > 30 cm long [*Asplenium*] **ASPENIACEAE (F33)**
 4 Sori circular or globular, the indusium peltate, reniform, or cuplike; leaf blades > 5 cm wide when > 30 cm long.
 5 Leaves pinnatifid **POLYPODIACEAE (F48)**
 5 Leaves 1-pinnate or 1-pinnate-pinnatifid.
 6 Leaves 1-pinnate, the pinnae toothed and each with a slight to prominent lobe near the base on the side toward the leaf tip; indusia peltate, reniform, or crescent-shaped.
 7 Leaves pale green, thin in texture; pinnae articulate to rachis, deciduous with age; rhizome bearing elongate, thin, wiry stolons; indusia reniform or crescent-shaped [*Nephrolepis*] **NEPHROLEPIDACEAE (F44)**

- 7 Leaves dark-green, subcoriaceous to coriaceous; pinnae not articulate and deciduous with age; rhizome not producing stolons; indusia peltate **DRYOPTERIDACEAE (F42)**
- 6 Leaves 1-pinnate-pinnatifid, the pinnae pinnatifid, generally lacking a prominent basal lobe; indusia either reniform or cuplike.
- 9 Vascular bundles in the petiole 3-7 [*Dryopteris*] **DRYOPTERIDACEAE (F42)**
- 9 Vascular bundles in the petiole 2.
- 10 Indusium reniform, arching over the sorus [*Thelypteris*] **THELYPTERIDACEAE (F35)**
- 10 Indusium cuplike, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments [*Woodsia*] **WOODSIACEAE (F36)**
- 2 Leaves 2-pinnate or more divided, the pinnae divided to their midribs.
- 11 Sori marginal and borne on the underside of the false indusium (modified, marginal flaps of the leaf margin); 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 (F31)**
- 11 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.
- 12 Outline of leaf blade narrowed to base, the widest point > 7 pinna pairs above the base, the lowermost pinnae < 1/4 as long as the longest pinnae; rhizomes long-creeping, the leaves scattered, forming clonal patches [*Thelypteris*] **THELYPTERIDACEAE (F35)**
- 12 Outline of the leaf blade slightly if at all narrowed to the base, the widest point < 5 pinna pairs from the base, the lowermost pinnae > 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* in DENNSTAEDTIACEAE).
- 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 cup-like, 2-parted, the outer part a modified tooth of the leaf blade; leaf blades conspicuously puberulent with septate glandular hairs [*Dennstaedtia*] **DENNSTAEDTIACEAE (F30)**
- 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 cup-like 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 (F42)**
- 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] [*Macrothelypteris*] **THELYPTERIDACEAE (F35)**
- 15 Leaves 5-25 (-30) cm wide, with scales and minute glands (sometimes also with septate hairs); [native species].
- 16 Leaves 1-pinnate-pinnatifid; indusium cup-like, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments [*Woodsia*] **WOODSIACEAE (F36)**
- 16 Leaves 2-pinnate-pinnatifid; indusium flap-like, pocket-like, or hood-like, attached at one side of the sorus and arching over it.
- 17 Leaves 10-30 cm wide, the tip acute to acuminate; indusium flap-like [*Athyrium*] **ATHYRIACEAE (F40)**
- 17 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like [*Cystopteris*] **CYSTOPTERIDACEAE (F32)**

Key A7 – medium to large ‘fern-like’ pteridophytes, terrestrial, growing in soil, not associated with rock outcrops

- 1 Leaf 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 (> 10 cm apart)
- 2 Vine-like leaves scrambling or trailing; sporangia borne 6-12 per sorus [*Dicranopteris*] **GLEICHENIACEAE (F10)**
- 2 Vine-like leaves twining; sporangia borne singly, each subtended by an indusium-like flap [*Lygodium*] **LYGODIACEAE (F13)**
- 1 Leaf not vine-like, 0.3-3 m long, the branching not as described above, the pinnae regularly and more-or-less closely spaced (mostly < 10 cm apart).
- 3 Leaf blades broadly (about equilaterally) triangular, pentagonal, or flabellate in outline, 0.7-1.3× as long as wide.
- 4 Leaf blades flabellate or fan-shaped in outline, the petiole branched once dichotomously, each branch bearing 3-7 pinnae on one side of the rachis only [*Adiantum (pedatum)*] **PTERIDACEAE (F31)**
- 4 Leaf blades pentagonal or broadly triangular in outline, the petiole not branched dichotomously.
- 5 Leaf blade pentagonal in outline, the terminal pinna the largest; sori submarginal, roundish, the indusium reniform; [alien, rarely naturalized] [*Arachniodes*] **DRYOPTERIDACEAE (F42)**
- 5 Leaf blade broadly triangular in outline, the basal pinnae the largest; sori marginal, linear, indusium absent, the sporangia either protected by the revolute leaf margin and a minute false indusium (*Pteridium*), or borne in a stalked, specialized, fertile portion of the blade (*Botrypus*); [native, collectively common].
- 6 Sporangia borne in a stalked, specialized, fertile portion of the blade; texture of mature blades somewhat fleshy; plants solitary from a short underground rhizome with thick, mycorrhizal roots; [primarily of moist forests] [*Botrypus*] **OPHIGLOSSACEAE (F5)**
- 6 Sporangia borne in marginal, linear sori, indusium absent, the sporangia protected by the revolute leaf margin and a minute false indusium; texture of mature leaf blades hard and stiff; plants colonial from deep-seated rhizomes; [primarily of moist to dry woodlands and savannas] [*Pteridium*] **DENNSTAEDTIACEAE (F30)**
- 3 Leaves elongate in outline, mostly ovate, lanceolate, oblanceolate, or narrowly triangular, 1.5-10× or more as long as wide.
- 7 Leaves 2-pinnate or more divided, the pinnae divided to their midribs.
- 8 Leaf blade divided into sterile and fertile portions, the sterile 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 [*Osmunda (spectabilis)*] **OSMUNDACEAE (F8)**
- 8 Leaf blade not divided into sterile and fertile portions (though often not all pinnules on a leaf bearing sporangia), the sporangia-bearing pinnules only slightly if at all reduced in size, both fertile and sterile pinnules usually 4-20 mm long and 2-10 mm wide.
- 9 Rhizomes long-creeping, leaves scattered, forming clonal patches; vascular bundles in the petiole either 1, U-shaped (even in the lower petiole) or > 3; sori very small, marginal in sinuses, the indusium cup-like, 2-parted, the outer part a modified tooth of the leaf blade; leaf blades conspicuously puberulent with septate hairs or glabrous to puberulent with glandular trichomes

- **DENNSTAEDTIACEAE (F30)**
- 9 Rhizomes short-creeping, the leaves clustered, not forming clonal patches; vascular bundles in the lower 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.
- 10 Vascular bundles (3-) 5 (-7) in the petiole **DRYOPTERIDACEAE (F42)**
- 10 Vascular bundles 2 in the petiole.
- 12 Leaves 25-65 cm wide, with whitish, straight, acicular, septate hairs; [species adventive and weedy]
..... [*Macrothelypteris*] **THELYPTERIDACEAE (F35)**
- 12 Leaves 5-25 (-50) cm wide, with scales and minute glands (sometimes also with septate hairs); [native species, widespread].
- 13 Leaves 1-pinnate-pinnatifid; indusium cup-like, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments [*Woodsia (obtusata)*] **WOODSIACEAE (F36)**
- 13 Leaves 2-pinnate-pinnatifid; indusium flap-like, pocket-like, or hood-like, attached at one side of the sorus and arching over it.
- 14 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like
..... [*Cystopteris (bulbifera)*] **CYSTOPTERIDACEAE (F32)**
- 14 Leaves 10-30 cm wide, the tip acute to acuminate; indusium flap-like **ATHYRIACEAE (F40)**
- 7 Leaves 1-pinnate-pinnatifid or less divided, the pinnae entire, toothed, lobed or pinnatifid.
- 15 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.
- 16 Fertile leaf woody, with bead-like segments; margins of sterile pinnae entire, often wavy or the lowermost even somewhat lobed; pinnae mostly with obtuse apices, tending to be borne opposite [*Onoclea*] **ONOCLEACEAE (F38)**
- 16 Fertile leaf stiff but herbaceous, the pinnae linear, not at all bead-like; margins of sterile pinnae finely serrulate, otherwise slightly wavy or straight; pinnae mostly with acute apices, tending to be borne alternate
..... [*Woodwardia (areolata)*] **BLECHNACEAE (F39)**
- 15 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.
- 17 Rhizomes long-creeping, leaves scattered, forming clonal patches.
- 18 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 (F39)**
- 18 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 (F35)**
- 17 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 *Matteuccia*)
- 19 Plants moderately to very robust, the leaves typically 6-50 dm tall; leaves **either** strongly dimorphic, the fertile leaves very unlike the sterile, brown at maturity (*Matteuccia* and *Osmundastrum cinnamomeum*), **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*), **or** the fertile pinnae toward the tip of the leaf and with sporangia entirely covering the lower surface (*Acrostichum*); rachises scale-less, petioles scale-less (except at the base in *Matteuccia*).
- 20 Leaves 1.5-5 m long; fertile pinnae with sporangia covering the lower surface; [of n. FL southward]
..... [*Acrostichum*] **PTERIDACEAE (F31)**
- 20 Leaves 0.6-2.5 m long; fertile portions otherwise.
- 21 Leaves strongly tapering to the base from the broadest point (well beyond the midpoint of the blade), the basal-most pinnae much < 1/2 as long as the largest pinnae [*Matteuccia*] **ONOCLEACEAE (F38)**
- 21 Leaves slightly if at all tapering to the base, about equally broad through much of their length, the basal-most pinnae much > 1/2 as long as the largest pinnae [*Osmunda (claytoniana)*, *Osmundastrum*] **OSMUNDACEAE (F8)**
- 19 Plants mostly less robust, the leaves 3-10 dm tall (except *Dryopteris ludoviciana*, *D. celsa*, *D. goldiana*, and *Nephrolepis exaltata* 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 scale-less, but at least the petiole and often also the rachis scaly if the plants over 1 m tall.
- 22 Sori elongate, the indusium elongate, attached along one side as a flap.
- 23 Petiole and rachis lustrous brownish-black; fertile leaves 2-8 (-12) cm wide [*Asplenium*] **ASPENIACEAE (F33)**
- 23 Petiole and rachis green; fertile leaves 10-20 (-30) cm wide.
- 24 Leaves 1-pinnate-pinnatifid (the pinnae pinnatifid) [*Deparia*] **ATHYRIACEAE (F40)**
- 24 Leaves 1-pinnate (the pinnae entire) [*Homalosorus*] **DIPLAZIOPSIDACEAE (F34)**
- 22 Sori roundish, the indusium kidney-shaped or roundish, attached by a central stalk.
- 25 Leaves 1-pinnate, the pinnae toothed and each with a slight to prominent lobe near the base on the side toward the leaf tip (except *Nephrolepis exaltata* in NEPHROLEPIDACEAE); indusium peltate (*Polystichum* in DRYOPTERIDACEAE) or reniform or crescent-shaped (*Nephrolepis* in NEPHROLEPIDACEAE).
- 26 Leaves pale green, thin in texture; pinnae articulate to rachis, deciduous with age; thin, rhizome bearing elongate, thin, wiry stolons; [mostly, if not entirely, alien in our area, rare] [*Nephrolepis*] **NEPHROLEPIDACEAE (F44)**
- 26 Leaves dark-green, subcoriaceous to coriaceous; pinnae neither articulate nor deciduous with age; rhizome not producing stolons; [native, common] [*Polystichum*] **DRYOPTERIDACEAE (F42)**
- 25 Leaves 1-pinnate-pinnatifid, the pinnae pinnatifid, generally lacking a prominent basal lobe; indusium reniform.
- 27 Vascular bundles in the petiole 4-7 [*Dryopteris*] **DRYOPTERIDACEAE (F42)**
- 27 Vascular bundles in the petiole 2, uniting above [*Thelypteris*] **THELYPTERIDACEAE (F35)**

Key B – gymnosperms

- 1 Leaves 1-pinnately compound **Key B1 – cycads**
- 1 Leaves simple.
- 2 Leaves broad and fan-shaped, > 30 mm wide, with conspicuous dichotomous venation, seasonally deciduous **Key B2 – ginkgo**

- 2 Leaves needle-like or scale-like, < 5 mm wide, evergreen (seasonally deciduous in *Larix* and *Taxodium*).....
**Key B3 – gymnosperm trees and shrubs with scale or needle leaves**

Key B1 – cycads

- 1 Pinnae with a single, thick and prominent midrib.....[*Cycas*] **CYCADACEAE (G1)**
 1 Pinnae with many parallel veins.....[*Zamia*]**ZAMIACEAE (G2)**

Key B2 – ginkgo

- One family and genus.....[*Ginkgo*] **GINKGOACEAE (G3)**

Key B3 – gymnosperm trees and shrubs with scale or needle leaves

- 1 Leaves opposite or in whorls of 3.
 2 Leaves scale-like or acicular and <16 mm long; mature cones either dry and cone-like, or fleshy and < 9 mm in diameter.....
**CUPRESSACEAE (G11)**
 2 Leaves linear, 15-45 mm long; mature female “cones” fleshy and berry-like, > 15 mm in diameter
 3 Leaves with distinct midrib on the upper surface; 2 stomatal bands on the lower surface each ca. 1 mm wide; berry-like “cone” stalked..
[*Cephalotaxus*] **CEPHALOTAXACEAE (G12a)**
 3 Leaves without distinct midrib; 2 stomatal bands on the lower surface each ca. 0.5 mm wide; berrylike “cone” sessile.....
[*Torreya*] **TAXACEAE (G12b)**
 1 Leaves **either** alternate, **or** in fascicles of 2-5 (basally bound by a scarious sheath), **or** on short shoots in clusters of many 10-60 leaves in
 apparent whorls.
 4 Leaves **either** borne in fascicles of 2-5 (basally bound by a scarious sheath) (*Pinus*) **or** on short shoots in clusters of many leaves in
 apparent whorls (*Cedrus*, *Larix*).....[*Cedrus*, *Larix*, *Pinus*] **PINACEAE (G7)**
 4 Leaves alternate.
 5 Leaves 4-angled in cross-section.....[*Picea*] **PINACEAE (G7)**
 5 Leaves distinctly flattened (2-sided) in cross-section.
 6 Leaves very soft in texture, seasonally deciduous as twiglets; [primarily Coastal Plain].....[*Taxodium*] **CUPRESSACEAE (G11)**
 6 Leaves stiffer in texture, evergreen; [collectively more widespread].
 7 Leaves tapering from base to a long-acuminate tip.....[*Cunninghamia*] **CUPRESSACEAE (G11)**
 7 Leaves with parallel margins for most of their length, or widest near middle and gradually tapering to base and apex, the apex
 acute, obtuse, or retuse.
 8 Cone dry, brown, and woody at maturity.....[*Abies*, *Tsuga*] **PINACEAE (G7)**
 8 “Cone” fleshy, red or purplish at maturity
 9 Seed surrounded by a fleshy scale, appearing drupe-like, this also subtended by a swollen and fleshy receptacle.....
[*Podocarpus*] **PODOCARPACEAE (G9)**
 9 Seed partially or fully enclosed in a fleshy aril, the subtending receptacle neither swollen nor fleshy.....
[*Taxus*, *Torreya*] **TAXACEAE (G12b)**

Key C – aquatics

- 1 Plants floating aquatics, never rooted to the substrate (though sometimes stranded by dropping water levels); plants sometimes thalloid in
 structure, lacking clear differentiation of stems and leaves.....**Key C1 – floating aquatics**
 1 Plants rooted aquatics (sometimes uprooted and then floating in the water column, or rooted in floating, peaty vegetation mats); plants always
 with clear differentiation of stems and leaves (except *Podostemum*).
 2 Leaves or leaf-like stems basal, or arising in clusters from along a buried rhizome.
 3 Leaves variously compound or divided.....**Key C2 – rooted aquatics with basal leaves, compound or divided**
 3 Leaves or leaf-like stems simple.
 4 Leaves broad, usually long-petiolate, with strong differentiation between petiole and blade, the blade margins not parallel, the blade
 < 6× as long as wide and > 2.5 cm wide.....**Key C3 – rooted aquatics with basal and simple, broad leaves**
 4 Leaves or leaf-like stems linear, sessile or essentially so (lacking strong differentiation of a blade and a petiole), the blade margins
 more-or-less parallel or tapering from base towards apex, the blade > 10× as long as wide and < 2 cm wide.....
**Key C4 – rooted aquatics with basal and simple, linear leaves**
 2 Leaves cauline.
 5 Leaves variously compound or divided.....**Key C5 – rooted aquatics with cauline leaves, compound or divided**
 5 Leaves simple.
 6 Leaves alternate.....**Key C6 – rooted aquatics with simple, cauline, alternate leaves**
 6 Leaves opposite or whorled.....**Key C7 – rooted aquatics with simple, cauline, opposite or whorled leaves**

Key C1 – floating aquatics

- 1 Individual leaves > 2 cm wide.
 2 Leaves obovate, cuneate at the base, sessile, pale green; plants floating because of “unwetttable” leaf surfaces.....[*Pistia*] **ARACEAE**
 2 Leaves orbicular, cordate or truncate at the base, petiolate, dark green; plants floating because of petioles inflated as bladders, or inflated
 cells centrally located on each leaf.
 3 Petiole terete, not air-filled; plants floating because of inflated cells centrally located on each leaf (most easily seen on the lower
 surface).....[*Limnobium*] **HYDROCHARITACEAE**

- 3 Petiole conspicuously expanded into an air-filled bladder; plants floating because of petioles inflated as bladders [Eichhornia (crassipes)] **PONTEDERIACEAE**
- 1 Individual leaves or “fronds” < 2 cm wide, or leaves absent.
 - 4 Submersed portions of the plant with numerous small (< 4 mm in diameter) bladder-traps [Utricularia] **LENTIBULARIACEAE**
 - 4 Submersed portions of plant lacking small bladder traps.
 - 5 Plants unbranched, or if branched, irregularly so; upper surface of leaves glabrous, waxy **ARACEAE**
 - 5 Plants dichotomously forked, upper surface of leaves velvety or variously hairy [Azolla, Salvinia] **SALVINIACEAE**

Key C2 – rooted aquatics with basal leaves, compound or divided

- 1 Leaves palmately 4-foliolate, with very clear differentiation of the long petiole from the 4 leaflets [Marsilea] **MARSILEACEAE**
- 1 Leaves pinnately compound.
 - 2 Plants usually attached to rocks in flowing water of streams and rivers; [mainly of the Piedmont, Mountains, and Interior Low Plateau] [Podostemum] **PODOSTEMACEAE**
 - 2 Plants in mud or soil of stagnant waters; [of the Coastal Plain] [Ceratopteris] **PTERIDACEAE**

Key C3 – rooted aquatics with basal and simple, broad leaves

- 1 Leaves peltate.
 - 2 Leaf blades oval in shape, ca. 1.5-2× as long as wide, at maturity floating on the water’s surface; underwater portions of fresh plant coated in transparent mucilage [Brasenia] **CABOMBACEAE**
 - 2 Leaf blades orbicular in shape, ca. 1× as long as wide, at maturity floating on the water’s surface, emersed, or submersed; underwater portions of fresh plant not mucilaginous (though possibly with green algae, etc.).
 - 3 Leaves small, < 8 cm in diameter, at maturity emersed or submersed [Hydrocotyle] **ARALIACEAE**
 - 3 Leaves large, > 20 cm in diameter, at maturity floating on the water’s surface or emersed [Nelumbo] **NELUMBONACEAE**
- 1 Leaves not peltate, the petiole attached at a cuneate, cordate, or sagittate base.
 - 4 Leaf blades cuneate, rounded, or truncate at the base.
 - 5 Main veins palmate from the leaf base and also diverging from the midvein, the secondary and tertiary veins then reticulating; inflorescence a spike; [Eudicots] [Plantago (cordata)] **PLANTAGINACEAE**
 - 5 Main veins either parallel or palmate from the leaf base with cross-veins at nearly right angles to the main veins; inflorescence either a diffuse raceme or panicle of white flowers, or a linear spadix of tightly packed golden-yellow flowers; [Monocots].
 - 6 Inflorescence diffuse, a raceme or panicle with whorled branches or pedicels, the flowers widely spaced and white; leaves green, wettable [Helanthium, Sagittaria, Alisma, Echinodorus] **ALISMATACEAE**
 - 6 Inflorescence tightly packed with flowers, an elongate, golden yellow spadix; leaves blue-green, “unwetable” [Orontium] **ARACEAE**
 - 4 Leaf blades cordate or sagittate at the base.
 - 7 Leaf blades sagittate, the two lobes distinctly acute; leaf apex acute; leaf blade 1.3-3× as long as wide [Sagittaria] **ALISMATACEAE**
 - 7 Leaf blades cordate, the two lobes rounded or sub-acute; leaf apex rounded or apiculate; leaf blade 0.8-8× as long as wide.
 - 8 Leaf blade margins sharply serrate, dentate, and/or incised [Hydrocotyle] **ARALIACEAE**
 - 8 Leaf blade margins entire or obscurely crenate.
 - 9 Flowers 4-5-merous (sepals 4-5, petals 4-5, stamens 4-5); [Eudicots]
 - 10 Leaves emersed or submersed, on stout, stiff petioles (the submersed and winter leaves cuneate-based and lanceolate); flowers 4-merous (sepals 4, petals 4, stamens 4); inflorescence a spike [Plantago (cordata)] **PLANTAGINACEAE**
 - 10 Leaves floating, on slender, flexuous petioles (all leaves cordate-based); flowers 5-merous (sepals 5, petals 5, stamens 5); inflorescence an umbel [Nymphoides] **MENYANTHACEAE**
 - 9 Flowers 3-merous or many (>5-) -merous; [Basal Angiosperms or Monocots].
 - 11 Perianth parts numerous (usually showing differentiation into sepals and petals, though often with some intergradation), borne in a spiral; stamens numerous; leaves usually > 10 cm long or > 10 cm wide, or both (a few northern species of Nymphaea with leaves as small as 2.5 cm × 2.5 cm); [Basal Angiosperms] [Nuphar, Nymphaea] **NYMPHAEACEAE**
 - 11 Perianth parts 3-6 (not differentiated into sepals and petals); stamens either 3 or 9-12 (-18); leaves 1-10 cm long, 1-10 cm wide; [Monocots].
 - 12 Leaves with a central area of spongiform cells (most easily seen on the lower leaf surface); flowers unisexual, white, the sepals and petals separate; stamens 9-12 (-18) [Limnobium] **HYDROCHARITACEAE**
 - 12 Leaves lacking a central area of spongiform cells; flowers white to blue, the perianth segments united below into a perianth tube 3-45 mm long; stamens 3 [Heteranthera, Pontederia] **PONTEDERIACEAE**

Key C4 – rooted aquatics with basal and simple, linear leaves

- 1 Leaves thread-like or quill-like, about as thick as wide.
 - 2 Plants bulbous at base, and with the leaf bases expanded and containing sporangia; plant tufted or with very short rhizomes; [Lycophytes] [Isoetes] **ISOETACEAE**
 - 2 Plants either somewhat bulbous or not at the base, the leaf-bases not containing sporangia; plant rhizomatous; [Pteridophytes, Eudicots, Monocots].
 - 3 New leaves unfurling with circinate vernation (a fiddlehead); plants reproducing by spores, from sporocarps on short stalks from the rhizome; [Pteridophytes] [Pilularia] **MARSILEACEAE**
 - 3 New leaves lacking circinate vernation; plants reproducing by flowers and seeds.
 - 4 Perianth differentiated, with **either** 3 sepals and 3 petals **or** 5 sepals and 5 petals; stamens **either** 7-many **or** stamens 4.
 - 5 Sepals 5; petals 5; stamens 4; [Eudicots] [Limosella] **PLANTAGINACEAE**
 - 5 Sepals 3; petals 3; stamens 7-many; [Monocots] [Sagittaria] **ALISMATACEAE**
 - 4 Perianth undifferentiated, with 0, 3, or 6 tepals; stamens 1, 2, or 3; [Monocots].

- 6 Gynoecium of 2 or more pistils, each pistil with 1 carpel and with 1 stigma[*Triglochin*] **JUNCAGINACEAE**
- 6 Gynoecium of 1 pistil, each pistil with (2-) 3 carpels and (2-) 3 stigmas.
 - 7 Fruit a capsule; perianth of 6 tepals[*Juncus*] **JUNCACEAE**
 - 7 Fruit an achene; perianth absent **CYPERACEAE**
- 1 Leaves ribbon-like or strap-like, distinctly flattened (sometimes only near the tip of the leaf).
 - 8 Subterranean portions of plant bearing bladder-traps; flowers yellow or purple, bilaterally symmetrical[*Utricularia*] **LENTIBULARIACEAE**
 - 8 Subterranean portions of plant lacking bladder traps; flowers white, green, gray, radially symmetrical (except bilaterally symmetrical in *Glossostigma* in PHRYMACEAE).
 - 9 Leaves broadened towards the tip; [Monocots, Eudicots].
 - 10 Flowers 3-merous; [Monocots]..... [*Helanthium, Sagittaria*] **ALISMATACEAE**
 - 10 Flowers 4- or 5-merous; [Eudicots].
 - 11 Leaves phyllodial, with obvious cross-partitions (septa); leaves alternate [*Lilaeopsis*] **APIACEAE**
 - 11 Leaves not phyllodial; leaves opposite.....[*Glossostigma*] **PHRYMACEAE**
 - 9 Leaves parallel-margined or tapering towards the apex over much of their length; [Monocots].
 - 12 Leaves tapering towards the apex over much of their length; plant either tufted and not rhizomatous, or short rhizomatous;.
 - 13 Plant tufted, not rhizomatous; leaves spreading radially; inflorescence a tightly button-like head of very numerous small flowers, white, gray, tan, yellowish, or blackish; roots thickened, septate (not requiring magnification), unbranched [*Eriocaulon*] **ERIOCAULACEAE**
 - 13 Planted short-rhizomatous; leaves distichous, equitant; inflorescence **either** a subglobular, ovoid, or cylindrical head, of spirally imbricate scales, **or** a diffuse corymb; roots not thickened, not septate, branched.
 - 14 Inflorescence a diffuse corymb; rhizomes and roots bright red.....[*Lachnanthes*] **HAEMODORACEAE**
 - 14 Inflorescence a subglobular, ovoid, or cylindrical head of spirally imbricate scales subtending individual flowers; rhizomes and roots not bright red[*Xyris*] **XYRIDACEAE**
 - 12 Leaves parallel-margined; plant usually rhizomatous.
 - 15 Plants of marine habitats, growing submersed in salt water; [of FL and the Gulf Coast of AL, MS, and LA] [*Thalassia*] **HYDROCHARITACEAE**
 - 15 Plants of freshwater or slightly to somewhat brackish habitats; [collectively widespread].
 - 16 Leaves lacking any midvein; flowers and fruits in globose heads.....[*Sparganium*] **TYPHACEAE**
 - 16 Leaves with a midvein; flowers and fruits solitary or in diffuse inflorescences.
 - 17 Leaves lacking a distinct lacunar band along the midvein..... [*Helanthium, Sagittaria*] **ALISMATACEAE**
 - 17 Leaves with a distinct, broad lacunar band along the midvein [*Vallisneria*] **HYDROCHARITACEAE**

Key C5 – rooted aquatics with cauline leaves, compound or divided

- 1 Leaves (or leaf-like adventitious roots) 1-pinnately compound or divided (with a central axis bearing pinnae, the pinnae not further divided).
 - 2 Leaves crowded at the upper end of stem, supported by inflated branches.....[*Hottonia*] **PRIMULACEAE**
 - 2 Leaves (or leaf-like adventitious roots) spaced along the stem, no branches inflated.
 - 3 Emersed leaves diamond-shaped, the blade < 2× as long wide, serrate only in the upper portion of its length.....[*Trapa*] **LYTHRACEAE**
 - 3 Emersed leaves lanceolate, the blade > 4× as long as wide, serrate along its length[*Myriophyllum, Proserpinaca*] **HALORAGACEAE**
 - 1 Leaves dichotomously or otherwise complexly (2-3×) compound or divided.
 - 4 Plants bearing numerous bladder-like traps.....[*Utricularia*] **LENTIBULARIACEAE**
 - 4 Plants lacking bladder-like traps.
 - 5 Leaves opposite or whorled; leaf segments dichotomously branched.
 - 6 Leaves opposite; leaf segments entire.....[*Cabomba*] **CABOMBACEAE**
 - 6 Leaves whorled; leaf segments entire or toothed.....[*Ceratophyllum*] **CERATOPHYLLACEAE**
 - 5 Leaves alternate; leaf segments complexly (but not dichotomously) branched.
 - 7 Leaf dissection 2-pinnate to 3-pinnate; flowers in racemes; petals 4, white[*Rorippa*] **BRASSICACEAE**
 - 7 Leaf dissection 2-ternate to 3-ternate; flowers solitary; petals 5, yellow or white[*Ranunculus*] **RANUNCULACEAE**
- {add [*Limnophila*] **PLANTAGINACEAE**}

Key C6 – rooted aquatics with simple, cauline, alternate leaves

- 1 Leaves broad, < 4× as long as wide.
 - 2 Floating leaves peltate.....[*Cabomba, Brasenia*] **CABOMBACEAE**
 - 2 Floating or emersed leaves cuneate to rounded at base.
 - 3 Floating leaves diamond-shaped, prominently serrate [*Trapa*] **LYTHRACEAE**
 - 3 Floating or emersed leaves elliptic or suborbicular.
 - 4 Leaves emersed, lanceolate to narrowly elliptic; flowers 5-merous; [Eudicots] [*Hydrolea*] **HYDROLEACEAE**
 - 4 Leaves emersed or floating, suborbicular or elliptic (if emersed, then suborbicular; flowers 3-merous; [Monocots].
 - 5 Leaves emersed, suborbicular[*Eichhornia (azurea)*] **PONTEDERACEAE**
 - 5 Leaves floating, elliptic..... [*Potamogeton*] **POTAMOGETONACEAE**
- 1 Leaves narrow, > 4× as long as wide.
 - 6 Leaves 0.3-1.4 cm long, very numerous and tightly spaced [*Mayaca*] **MAYACACEAE**
 - 6 Leaves 2-35 cm long, fewer and scattered along the stem.
 - 7 Leaf divided into a sheath and blade, with a ligule 0.5-8 mm long at the juncture; inflorescence a spike, raceme, or panicle of spikelets ..[*Luziola, Torreyochloa*] in **POACEAE**
 - 7 Leaf not divided into a sheath and blade, but if basally sheathing lacking a ligule (though sometimes with 1-2 conspicuous stipules); inflorescence various, but not as above.

- 8 Leaves terete, to 35 cm long, 0.3-2 mm wide; plants of marine habitats, growing submersed in salt water; [of FL and the Gulf Coast of AL, MS, and LA] [Syringodium] **CYMODOCEACEAE**
- 8 Leaves flat or terete, to 200 cm long; plants of fresh or brackish waters (if of marine waters, *Zostera*, the leaves obviously flat, 1.5-6 mm wide); [collectively widespread].
- 9 Leaves filiform, terete or nearly so; stipules present, adnate to the leaf base and forming a sheath around the stem > 10 mm long.
- 10 Stipule free at its tip, the sheathing portion not appearing inflated; flowers > 2, in an interrupted spike [Stuckenia] **POTAMOGETONACEAE**
- 10 Stipule adnate its entire length to the leaf base, appearing inflated; flowers usually 2, on a flexuous, elongate peduncle [Ruppia] **RUPPIACEAE**
- 9 Leaves flat; stipules absent, or if present, **either** free **or** adnate to the leaf base and forming a sheath for < 10 mm.
- 11 Leaves lacking a midvein; perianth parts 6, yellow [Heteranthera] **PONTERIACEAE**
- 11 Leaves with a midvein; perianth parts 0 or 4, variously colored (not yellow).
- 12 Plants pubescent (at least on the upper stem); leaves pinnately veined; [Eudicots] [Hydrolea] **HYDROLEACEAE**
- 12 Plants nearly or entirely glabrous; leaves with parallel venation; [Monocots].
- 13 Inflorescences of flowers solitary or in 2-4 flowered racemes, axillary; spathe lacking; perianth conspicuous with 3 pink to purple petals [Murdannia] **COMMELINACEAE**
- 13 Inflorescence a spike, terminal or axillary; with or without a spathe; perianth lacking.
- 14 Inflorescence a cylindrical, interrupted spike, lacking a spathe; leaves either parallel-margined or variously with a narrow blade differentiated from a petiole; [of fresh to brackish waters] [Potamogeton] **POTAMOGETONACEAE**
- 14 Inflorescence **either** a flattened spike sheathed by a spathe-like bract, **or** solitary; leaves parallel-margined, to 20 dm long; [of saline (marine) to brackish waters]
- 15 Leaves with a notched or tricuspidate apex; flowers solitary; [from e. NC southward] [Halodule] **CYMODOCEACEAE**
- 15 Leaves with a rounded apex; flowers in a flattened spike sheathed by a spathe-like bract; [from e. NC northward]..... [Zostera] **ZOSTERACEAE**

Key C7 – rooted aquatics with simple, cauline, opposite or whorled leaves

- 1 Leaves whorled, most nodes with 3 or more leaves.
- 2 Leaves tipped by a callus (visible at 10× magnification); leaf margins entire; flowers many, grouped in a terminal involucre head; [Eudicots] [Sclerolepis] **ASTERACEAE**
- 2 Leaves not callus-tipped; leaf margins finely toothed or at least with conical protrusions remaining from the disintegration of better-developed deciduous teeth; flowers solitary on elongate, flexuous stalks; [Monocots] [Elodea, Egeria, Hydrilla] **HYDROCHARITACEAE**
- {add [Limnophila] **PLANTAGINACEAE**}
- 1 Leaves opposite, no nodes with 3 or more leaves.
- 3 Leaves in 2-3 pairs, appearing verticillate; plants of marine waters; [of FL, MS, LA and southward] [Halophila] **HYDROCHARITACEAE**
- 3 Leaves along stem at 2-many nodes; plants of fresh to brackish waters; [collectively widespread].
- 4 Flowers 3-merous; [Monocots].
- 5 Leaf margins (or at least leaf sheaths) serrate or minutely spiny; fruits sessile, entire; leaves 5-15× as long as wide [Najas] **HYDROCHARITACEAE**
- 5 Leaf margins (including sheaths) entire; fruit stalked, dentate on one side; leaves >20× as long as wide [Zamichellia] **POTAMOGETONACEAE**
- 4 Flowers 4- or 5-merous; [Eudicots].
- 6 Leaves 1-12 cm long; flowers borne in axillary or terminal spikes or clusters [Hygrophila] **ACANTHACEAE**
- 6 Leaves 0.5-3 (-5) cm long; flowers solitary, axillary.
- 7 Carpels 4-5, separate; fruit an aggregate of follicles; leaves succulent [Crassula] **CRASSULACEAE**
- 7 Carpels 2-5, fused; fruit capsular (variously dehiscent); leaves thin in texture or somewhat succulent (e.g. *Bacopa* in **PLANTAGINACEAE**).
- 8 Leaves dimorphic, the terminal leaves usually spatulate (strongly expanded towards the apex); corolla absent; stamen 1 [Callitriche] **PLANTAGINACEAE**
- 8 Leaves monomorphic, obovate, oblanceolate, or parallel-margined; corolla present (absent in *Didiplis* in **LYTHRACEAE**); stamens 2-6.
- 9 Flower radially symmetrical, 3-4-merous; petals absent or separate
- 10 Stems lacking ridges running down from leaf bases [Elatine] **ELATINACEAE**
- 10 Stems with ridges running down from leaf bases [Didiplis, Rotala] **LYTHRACEAE**
- 9 Flower bilaterally symmetrical, 4-5-merous; petals present, fused at least basally, forming a tube.
- 11 Corolla 4-merous [Hemianthus, Lindernia, Micranthemum] **LINDERNIACEAE**
- 11 Corolla 5-merous [Bacopa, Gratiola] **PLANTAGINACEAE**
- {make sure [Gratiola amphiantha] **PLANTAGINACEAE** is adequately covered and make sure the *Callitriche* lead is clear relative to it}

Key D – cacti

- One genus and family [Opuntia] **CACTACEAE**

Key E – angiosperm shrubs and subshrubs with basally-disposed leaves

- 1 Leaves giant, either pinnately compound and > 10 dm long, or palmately divided into numerous segments and > 6 dm wide; [Monocots] [Rhapidophyllum, Sabal, Serenoa] **ARECACEAE**
- 1 Leaves simple or 3-foliolate; leaves < 9 dm long and < 2 dm wide; [Eudicots or Monocots].

- 2 Leaves linear-lanceolate, flat, > 3 dm long; flowers 3-merous; rosette shrubs; [Monocots].
- 3 Leaves 10-60 mm wide; capsules 25-80 mm long[*Yucca*] **AGAVACEAE**
- 3 Leaves 4-10 mm wide; capsules 4-8 mm long[*Nolina*] **RUSCACEAE**
- 2 Leaves either broader or distinctly fleshy and essentially terete in \times -section, < 2 dm long; flowers 5-merous; rosette subshrubs; [Eudicots].
- 4 Leaves trifoliolate[*Sibbaldia*] **ROSACEAE**
- 4 Leaves simple.
- 5 Leaves toothed; flowers white (to pale pink).....[*Galax, Shortia*] **DIAPENSIACEAE**
- 5 Leaves entire; flowers bright pink.
- 6 Leaves linear, terete in \times -section.....[*Phemeranthus*] **MONTIACEAE**
- 6 Leaves elliptic, flat in \times -section [*Talinum*] **TALINACEAE**

Key F – woody angiosperms with alternate, compound leaves

- 1 Leaves trifoliolate.
- 2 Plant a liana, climbing by twining, by tendrils, or by adventitious roots.
- 3 Leaves untoothed and unlobed.....[*Lackeya*] **FABACEAE**
- 3 Leaves coarsely toothed or lobed.
- 4 Leaflets obovate or broadly elliptic (broadest at or above the middle), the teeth or lobes primarily or solely in the apical half of the leaf; plant climbing by leaf-opposed tendrils.....[*Cissus*] **VITACEAE**
- 4 Leaflets orbicular or ovate (broadest at the middle or below the middle), the teeth or lobes primarily or solely in the basal half of the leaf; plant climbing by stem twining or by dense, reddish adventitious roots.
- 5 Plant climbing by the stem twining; [plant not actually woody, but so robust as to often be assumed to be so][*Pueraria*] **FABACEAE**
- 5 Plant climbing by dense, reddish adventitious roots attaching the stem to tree trunks or rock outcrops.....[*Toxicodendron*] **ANACARDIACEAE**
- 2 Plant a shrub (sometimes scrambling or occasionally high-climbing with the support of other vegetation, but lacking the specialized climbing structures listed above).
- 6 Stems armed with small prickles or stout thorns.
- 7 Stems with stout thorns at the nodes; fruit a hesperidium (orange-like, but densely hairy)[*Citrus*] **RUTACEAE**
- 7 Stems with many small prickles along the internodes; fruit **either** a legume, **or** an aggregate of drupelets, **or** a hip.
- 8 Leaflets with 2 rounded lateral lobes near the base, otherwise entire; fruit a legume.....[*Erythrina*] **FABACEAE**
- 8 Leaflets serrate and sometimes also cleft; fruit **either** an aggregate of drupelets **or** a hip..... [*Rosa, Rubus*] **ROSACEAE**
- 6 Stems unarmed.
- 9 Leaflets serrulate, crenulate, serrate, with a few coarse and jagged teeth, or shallowly lobed.
- 10 Leaflets serrulate or crenulate[*Ptelea*] **RUTACEAE**
- 10 Leaflets serrate, with a few coarse and jagged teeth, or shallowly lobed.
- 11 Leaflets with 2 prominent, rounded lobes near the base; fruit a legume; flowers > 3 cm long, corolla red, in a terminal raceme...[*Erythrina*] **FABACEAE**
- 11 Leaflets serrate and sometimes also cleft, or with a few coarse and jagged teeth; fruit a tan or red drupe; flowers < 1 cm across, corollas green, yellow, or white, in axillary or terminal panicles or racemes..... [*Rhus (aromatica), Toxicodendron*] **ANACARDIACEAE**
- 9 Leaflets entire and unlobed.
- 12 Terminal leaflet sessile.
- 13 Leaflets < 2 cm long; stems and branches dark green.....[*Cytisus*] **FABACEAE**
- 13 Leaflets 5-15 cm long; stems and branches tan to brown.....[*Ptelea*] **RUTACEAE**
- 12 Terminal leaflet with a petiolule.
- 14 Leaves pinnately trifoliolate, a rachis present as an extension of the petiole past the point of attachment of the 2 lateral leaflets, the terminal leaflet borne on a petiolule at the terminus of the rachis, with an obvious joint present between the rachis and petiolule.....[*Erythrina, Lespedeza*] **FABACEAE**
- 14 Leaves palmately trifoliolate, the terminal leaflet typically with a longer petiolule than the lateral leaflets, but lacking a rachis (the petiolule of the terminal leaflet attached at the same point as the 2 lateral leaflets and unjointed)[*Toxicodendron*] **ANACARDIACEAE**
- 1 Leaves with 5-many leaflets (poorly developed leaves in some species with only 3 leaflets).
- 15 Leaves palmately or palmately-pedately compound.
- 16 Leaves palmately-pedately 5-foliolate (the lateral 2 leaflets on each side borne on a common Y-shaped stalk)....[*Cayratia*] **VITACEAE**
- 16 Leaves palmately compound (all the leaflets attached at a single point).
- 17 Leaves > 6 dm wide.....[*Rhaphidophyllum, Sabal, Serenoa*] **ARECACEAE**
- 17 Leaves < 3 dm wide.
- 18 Leaflets with entire margins.....[*Akebia*] **LARDIZABALACEAE**
- 18 Leaflets with serrate margins.
- 19 Stems armed with prickles.....[*Rubus*] **ROSACEAE**
- 19 Stems unarmed.
- 20 XXXX.....[*Eleutherococcus*] **ARALIACEAE**
- 20 YYYY.....[*Parthenocissus*] **VITACEAE**
- 17 Leaves pinnately, bipinnately, or complexly compound.
- 21 Leaves at least in part 2-pinnate or otherwise more complexly compound than 1-pinnate.
- 22 Leaves evenly 2-pinnately compound[*Albizia, Calliandra, Dichrostachys, Gleditsia, Leucaena, Mimosa, Parkinsonia, Vachellia*] **FABACEAE**
- 22 Leaves oddly 2-pinnately compound, or more complexly compound than 1-pinnate.
- 23 Plant a liana, climbing by tendrils[*Ampelopsis*] **VITACEAE**
- 23 Plant a shrub or tree, not climbing.
- 24 Plant armed with prickles on the stem, and sometimes also on the axes and main veins of the leaves ... [*Aralia*] **ARALIACEAE**
- 24 Plant unarmed.

- 25 Plant a shrub, < 2.5 m tall.
- 26 Foliage green; leaflets ovate, acute at the tip; flowers 3-merous, the tepals white or cream; fruit a red berry.....
.....[*Nandina*] **BERBERIDACEAE**
- 26 Foliage blue-green; leaflets obovate, rounded or notched at the tip; flowers 4-5-merous, the sepals green, the petals yellow; fruit a capsule..... [Ruta] **RUTACEAE**
- 25 Plant a tree, > 3 m tall when flowering and fruiting.
- 27 Leaflets entire[*Gymnocladus*] **FABACEAE**
- 27 Leaflets serrate.
- 28 Fruit a globose drupe, tan at maturity, 10-15 mm in diameter; inflorescence an axillary panicle; corolla lavender.....
..... [Melia] **MELIACEAE**
- 28 Fruit an inflated capsule, 30-50 mm long; inflorescence a terminal thyrse; corolla yellow
..... [Koelreuteria] **SAPINDACEAE**
- 21 Leaves 1-pinnately compound
- 29 Leaves even-pinnately compound (generally with 2 leaflets at the apex of the rachis, these obviously and symmetrically paired).
- 30 Leaflets rounded to obtuse at the apex (or acute to acuminate in *Gymnocladus*); fruit a legume; inflorescence various, but not as below [Abrus, Gleditsia, Gymnocladus, Parkinsonia, Senna, Sesbania] **FABACEAE**
- 30 Leaflets acuminate at the apex; fruit a drupe; inflorescence a panicle with many, small, radially symmetrical flowers
- 31 XXXX [Pistacia] **ANACARDIACEAE**
- 31 YYYY [Sapindus] **SAPINDACEAE**
- 29 Leaves odd-pinnately compound (generally with a single leaflet at the terminus of the rachis).
- 32 Leaves very large, > 10 dm long..... [Butia, Cocos, Phoenix] **ARECACEAE**
- 32 Leaves small to large, < 10 dm long.
- 33 Stems armed with prickles or stipular or nodal spines; leaves often also with prickles.
- 34 Leaves with conspicuous leafy stipules, often adnate to the petiole; plant a liana or small to medium shrub; leaves serrate, often sharply and prominently so; leaves not strongly aromatic when fresh, lacking pellucid punctate glands on the surface...
..... [Rosa, Rubus] **ROSACEAE**
- 34 Leaves lacking leafy stipules; plant a tree or tall shrub; leaves entire or obscurely crenate or serrate; plant a tree or tall shrub; leaves **either** strongly aromatic when fresh, with conspicuous pellucid punctate glands **or** not aromatic and not pellucid-punctate.
- 35 Leaves not aromatic when fresh, lacking pellucid punctate glands; leaves never with prickles on the rachis; leaflet apices rounded..... [Robinia] **FABACEAE**
- 35 Leaves strongly aromatic when fresh, with conspicuous pellucid punctate glands; leaves often with prickles on the rachis; leaflet apices usually acuminate..... [Zanthoxylum] **RUTACEAE**
- 33 Stems unarmed (leaflets with spinose margins in some species, or the stem with dense hispid hairs).
- 36 Leaflets entire.
- 37 Plant a liana, climbing by twining..... [Wisteria] **FABACEAE**
- 37 Plant an upright shrub or tree, not climbing.
- 38 Plant a medium or tall tree.
- 39 Leaves with stipules; flowers bilaterally symmetrical, papilionaceous, white, cream, or pink; stamens 10; fruit a legume [Cladrastis, Maackia, Robinia, Stypholobium] **FABACEAE**
- 39 Leaves without stipules; flowers radially symmetrical, whitish; stamens 5, fruit a drupaceous berry
..... [Phellodendron] **RUTACEAE**
- 38 Plant a shrub or small tree to 7 (-10) m tall.
- 40 Leaf 2-5 cm long, with 5-7 leaflets [Dasiphora] **ROSACEAE**
- 40 Leaf > 8 cm long, with 5-many leaflets.
- 41 Flowers bilaterally symmetrical, papilionaceous (reduced in *Amorpha* to a single petal); stamens 10; fruit a legume; leaves with stipules; [Amorpha, Indigofera, Robinia, Stypholobium] **FABACEAE**
- 41 Flowers radially symmetrical, stamens 4-5; fruit a drupe; leaves without stipules
..... [Schinus, Rhus, Toxicodendron] **ANACARDIACEAE**
- 36 Leaflets serrate or crenate.
- 42 Leaflets crenate, the teeth rounded and often inconspicuous.
- 43 Leaflets with obscure crenations, not as below nor bearing glands; leaf rachis narrowly to conspicuously winged, especially towards the tip; fruit a drupe; plant a shrub or small tree [Rhus, Schinus] **ANACARDIACEAE**
- 43 Leaflets (especially the basal and on the basalscopic side) with 1-5 large rounded teeth, each bearing a prominent dark green gland; leaf rachis not winged; fruit a schizocarp, with 2-5 samaroid mericarps; plant a medium to large tree.....
..... [Ailanthus] **SIMAROUBACEAE**
- 42 Leaflets serrate.
- 44 Leaf serrations spinose [Berberis] **BERBERIDACEAE**
- 44 Leaf serrations not spinose.
- 45 Inflorescences axillary.
- 46 Plant a tree, freely branched; rhizome inner bark not brightly colored; flowers unisexual, the male flowers in catkins, the female flowers solitary or few in a spike, the perianth greenish or tan and inconspicuous; fruit a nut covered by a dehiscent or indehiscent involucre..... [Carya, Juglans, Pterocarya] **JUGLANDACEAE**
- 46 Plant a short shrub, < 1 m tall, little branched; rhizome inner bark of fresh plants bright yellow; flowers bisexual, petals absent, the 5 petaloid sepals maroon; inflorescence a drooping panicle from the base of the new year's growth; fruit an aggregate of follicles..... [Xanthorhiza] **RANUNCULACEAE**
- 45 Inflorescences terminal.
- 47 Inflorescence corymbose (flat-topped or rounded, as wide as long or wider); fruit a red pome.....
..... [Sorbus] **ROSACEAE**
- 47 Inflorescence paniculate (longer than wide); fruit various (see below), but not as above.
- 48 Leaves stipulate; flowers bright white; fruit an aggregate of 5 follicles [Sorbaria] **ROSACEAE**
- 48 Leaves lacking stipules; flowers cream or yellow; fruit **either** a drupe **or** an inflated membranaceous capsule.
- 49 Fruit a drupe [Rhus] **ANACARDIACEAE**
- 49 Fruit an inflated membranaceous capsule [Koelreuteria] **SAPINDACEAE**

Key G – woody plants with alternate, simple leaves

- 1 Leaves palmately or pinnately lobed.
 - 2 Leaves pinnately lobed (the midvein dominant, with 2, 4, or more lateral veins diverging into the lobes from the midvein above the base of the leaf blade)..... **Key G1 – woody plants with alternate, simple, pinnately lobed leaves**
 - 2 Leaves palmately lobed (3, 5, or more veins diverging from the base of the leaf blade into the lobes) **Key G2 – woody plants with alternate, simple, palmately lobed leaves**
- 1 Leaves not lobed (entire or serrate, sometimes coarsely so), or only with 2 small auriculate lobes at the base of an otherwise unlobed leaf blade (such as various *Magnolia* species).
 - 3 Woody grasses (bamboos), infrequently flowering, with hollow stems[see **Poaceae, Key A**]
 - 3 Lianas, shrubs, or trees, not grasses, generally with solid stems.
 - 4 Lianas (plant generally with obvious adaptations for climbing, such as adventitious roots, twining stems, or tendrils) **Key G3 – lianas with alternate, simple, and unlobed leaves**
 - 4 Shrubs, subshrubs, or trees (sometimes scrambling or occasionally high-climbing with the support of other vegetation, but lacking the specialized climbing structures listed above).
 - 5 Shrubs or subshrubs.
 - 6 Leaves entire..... **Key G4 – shrubs and subshrubs with alternate, simple, unlobed, entire leaves**
 - 6 Leaves serrate, crenate, serrulate, crenulate, or doubly serrate..... **Key G5 – shrubs and subshrubs with alternate, simple, unlobed, toothed leaves**
 - 5 Trees.
 - 7 Leaves entire (sometimes ciliate or scabrous on the margin) **Key G6 – trees with alternate, simple, unlobed, entire leaves**
 - 7 Leaves serrate, crenate, serrulate, crenulate, or doubly serrate..... **Key G7 – trees with alternate, simple, unlobed, toothed leaves**

Key G1 – woody plants with alternate, simple, pinnately lobed leaves

- 1 Shrubs or subshrubs.
 - 2 Leaves 1-2 (-4) cm long, 0.11-0.3 (-0.5) mm wide, each with > 40 terete lobes; plant white or silvery-gray; inflorescence an involucre head.....[*Santolina*] **ASTERACEAE**
 - 2 Leaves longer and/or wider, with a few to many flattened (< 30) lobes; plant green; inflorescence various, but not as above.
 - 3 Leaves > 6× as long as wide, the 14-30 lateral lobes evenly arrayed from leaf base to leaf apex; fresh plants strongly aromatic; leaf surfaces dotted with golden-yellow glands, and also pubescent.....[*Comptonia*] **MYRICACEAE**
 - 3 Leaves < 4× as long as wide, the 2-12 lateral lobes **either** evenly arrayed from leaf base to leaf apex, **or** strongly basally oriented; fresh plants not aromatic; leaf surfaces variously pubescent, but lacking golden-yellow glands.
 - 4 Leaf blades 4-30 cm long; leaf lobing evenly from base to apex, or predominantly towards the tip of the leaf; flowers small, in catkins [*Quercus*] **FAGACEAE**
 - 4 Leaf blades 2-7 cm long; leaf lobing predominantly basal (hastate, or with larger basal lobes becoming smaller and more like serrations towards the apex); flowers larger, in various diffuse inflorescences.
 - 5 Leaves hastate, with 2 acute basal lobes, merely serrate towards the apex; [alien species, of s. GA southward] [*Pavonia*] **MALVACEAE**
 - 5 Leaves lobate towards base, the lobes rounded in outline, progressively less lobed towards the apex, becoming doubly serrate upwards; [native and alien species, collectively widespread]..... [*Neillia, Neviusia, Physocarpus*] **ROSACEAE**
 - 1 Trees.
 - 6 Leaves even-pinnately lobed, with 4 (or sometimes 6 or 8) lobes, the apex a very broad V-notch or truncate [*Liriodendron*] **MAGNOLIACEAE**
 - 6 Leaves odd-pinnately lobed, with 3, 5, 7, etc. lobes (or sometimes with 2 lobes, but one obviously central and the other smaller and to the side, mitten-like), the apex obtuse to acute.
 - 7 Leaf lobe margins entire.
 - 8 Leaves deeply 2- or 3-lobed (or rarely with 1-4 additional very small, tooth-like lobes towards the base), most branches with a mixture of unlobed, 2-lobed (mitten), and 3-lobed leaves; fruit a blackish-seeded drupe; fresh plants strongly aromatic [*Sassafras*] **LAURACEAE**
 - 8 Leaves shallowly or deeply 3-25-lobed; fruit either an acorn or a rather fleshy spherical multiple fruit; fresh plants not aromatic.
 - 9 Leaves shallowly or deeply 3-25-lobed; fruit a nut in a cupule (an acorn)..... [*Quercus*] **FAGACEAE**
 - 9 Leaves shallowly 3-lobed (or mostly unlobed); fruit a rather fleshy multiple fruit..... [*Maclura*] **MORACEAE**
 - 7 Leaf lobe margins serrate.
 - 10 Leaves irregularly toothed, the teeth tipped by a soft bristle; fruit a nut in a cupule (an acorn); small to large trees [*Quercus*] **FAGACEAE**
 - 10 Leaves evenly and rather finely serrate, not bristly-tipped; fruit at least somewhat fleshy, either a pome or a multiple of nutlets surrounded by a fleshy calyx; small trees.
 - 11 Petals absent (the individual flowers inconspicuous and aggregated into catkins); fruit a multiple, of nutlets surrounded by a fleshy calyx (mulberry) or a syconium (fig); leaves mainly larger, at least some on a branch > 8 cm long [*Broussonetia, Morus, Ficus*] **MORACEAE**
 - 11 Petals 5, conspicuous, white or pink; fruit a pome; leaves mainly small, generally < 8 cm long..... [*Crataegus*] **ROSACEAE**

Key G2 – woody plants with alternate, simple, palmately lobed leaves

- 1 Lianas.
 - 2 Lianas climbing by adventitious roots.....[*Hedera*] **ARALIACEAE**
 - 2 Lianas climbing by twining or by tendrils.
 - 3 Lianas climbing by twining..... [*Calycocarpum, Cocculus, Menispermum*] **MENISPERMACEAE**
 - 3 Lianas climbing by tendrils.

- 4 Tendrils branched, leaf-opposed; leaves mostly 5-7-lobed, the margins also serrate or dentate [Ampelopsis, Muscadinia, Parthenocissus, Vitis] VITACEAE
- 4 Tendrils simple (though paired in *Smilax* in SMILACACEAE), axillary; leaves 3-lobed, the margins entire, serrulate, or prickly.
- 5 Leaves longer than wide, entire or prickly-margined; stems armed with prickles; flowers 6-merous, greenish, in umbels borne in leaf axils; tendrils stipular, 2 per leaf axil, adnate to the petiole basally.....[*Smilax*] SMILACACEAE
- 5 Leaves wider than long, entire or serrulate; stems not armed; flowers 5-merous, blue-purple or yellow, solitary or in small fascicles in leaf axils; tendrils 1 per leaf axil.....[*Passiflora*] PASSIFLORACEAE
- 1 Trees or shrubs.
- 6 Trees.
- 7 Leaves giant, > 6 dm long and wide; tree monopodial, with a single, unbranched stem; [Monocots]..... ARECACEAE
- 7 Leaves < 5 dm long and wide; tree branching; [Eudicots].
- 8 Leaf blades (3-) 5 (-7) lobed, to 15 cm wide and long, each lobe finely serrate-crenate (>3 teeth per cm of margin) and rarely with a small sub-lobe; multiple fruit spherical and spiky, consisting of multiple bird-beak-like loculicidal capsules; buds axillary..... [Liquidambar] ALTINGIACEAE
- 8 Leaves 3 (-5)-lobed, to 35 cm wide and long, each lobe coarsely toothed or sublobed, the teeth or sublobes (at most 1-2 per cm of margin) attenuate-acuminate; multiple fruit spherical and merely rough on the surface, consisting of multiple achenes with tawny bristles; buds infrapetiolar (completely hidden in the swollen petiole base).....[*Platanus*] PLATANACEAE
- 6 Shrubs.
- 9 Leaf lobe margins entire (or undulate to sublobed at the tip).....[*Manihot*] EUPHORBIACEAE
- 9 Leaf lobe margins serrate.
- 10 Leaves glabrous..... [Ricinus] EUPHORBIACEAE
- 10 Leaves pubescent (slightly or strongly).
- 11 Pubescence of simple hairs; plants armed or not with nodal spines
- 12 Leaves 10-30 cm long and wide; fruit a berry; inflorescence of solitary to a few flowers, or a raceme [Ribes] GROSSULARIACEAE
- 12 Leaves 2-10 cm long and wide; fruit an aggregate of drupelets; inflorescence a cyme[*Rubus (odoratus)*] ROSACEAE
- 11 Pubescence of stellate hairs; plants unarmed.
- 13 Leaves >30 cm wide [Tetrapanax] ARALIACEAE
- 13 Leaves < 15 cm wide [Hibiscus, Urena] MALVACEAE
- {add: *Vernicia* in EUPHORBIACEAE, *Firmiana* in MALVACEAE, *Kalopanax* in ARALIACEAE, *Ficus* in MORACEAE}

Key G3 – lianas with alternate, simple, and unlobed leaves

- 1 Leaves serrate.
- 2 Leaves suborbicular, elliptic, or obovate, most of them 1.2-2.6× as long as wide; leaf margin crenulate; fruit a leathery capsule..... [Celastrus] CELASTRACEAE
- 2 Leaves orbicular, most of them 0.8-1.2× as long as wide; leaf margin serrate, serrulate, or dentate; fruit fleshy, indehiscent [Ampelopsis, Muscadinia, Vitis] VITACEAE
- {add to 1a: *Actinidia* in ACTINIDIACEAE, *Pieris* in ERICACEAE, *Ficus* in MORACEAE, *Gouania* in RHAMNACEAE; *Schisandra* in SCHISANDRACEAE}
- 1 Leaves entire.
- 3 Stems with well-developed prickles; tendrils paired, stipular (diverging from the leaf petiole above its base); [Monocots]..... [Smilax] SMILACACEAE
- 3 Stems lacking prickles; tendrils either absent or (if present) not stipular and paired; [Eudicots or Basal Angiosperms].
- 4 Plant climbing by dense, reddish adventitious roots[*Hedera*] ARALIACEAE
- 4 Plant climbing by twining or by tendrils.
- 5 Plant climbing by tendrils.....[*Antigonon, Brunnicchia, Fallopia*] POLYGONACEAE
- 5 Plant climbing by twining.
- 6 Leaves elliptic or ovate, obviously longer than broad, most leaves > 1.4× as long as wide; leaf blade base narrowly cuneate, broadly cuneate, rounded, or subcordate.
- 7 Leaves 3-8 cm long, rounded to broadly cuneate at the base and rounded or obtuse at the apex; lateral leaf veins straight, parallel, not forking; inflorescence a terminal thyrse or panicle[*Berchemia*] RHAMNACEAE
- 7 Leaves 6-15 cm long, cuneate at the base and acuminate at the apex; lateral leaf veins forking at or beyond the middle; inflorescence a solitary, axillary flower [Schisandra] SCHISANDRACEAE
- 6 Leaves orbicular to very widely ovate, most leaves <1.4× as long as wide; leaf blade base deeply cordate, subcordate, rounded, or broadly cuneate
- 8 Leaf venation pinnate, but “pseudopalmate”, with 3 primary veins from the marginal point of attachment of the petiole, the 2 lateral veins then promptly rebranching (< 1 cm from the leaf base) into 2-3 prominent veins (the remainder of the venation pinnate along the midvein); basalmost pair of primary veins exposed (lacking leaf tissue) on their basal side for > 2 mm; leaf blade base deeply cordate; leaf with no tendency to lobing, the leaf outline convex from the base to the apex (except in the immediate vicinity of the petiole and sometimes immediately near a slightly acuminate apex).....[*Aristolochia, Isotrema*] ARISTOLOCHIACEAE
- 8 Leaf venation palmate, with (3-) 5-9 primary veins from the point of attachment of the petiole (marginal attachment in *Cocculus* and peltate in *Menispermum*), these primary veins then rebranching well above the leaf base; basalmost pair of primary veins completely included within leaf tissue; leaf blade base cordate, subcordate, rounded, or broadly cuneate; leaf with a tendency to lobing, the leaf outline with 1 or more concave areas between the base and the apex.....[*Cocculus, Menispermum*] MENISPERMACEAE

Key G4 – shrubs and subshrubs with alternate, simple, unlobed, entire leaves

- 1 Leaves evergreen.
- 2 Leaves 1-7 mm long, either acicular and spreading or ovate and appressed to the stems.....[*Hudsonia*] CISTACEAE

- 2 Leaves > 10 mm long.
- 3 Leaves linear, > 15× as long as wide; [Monocots][*Yucca*] **AGAVACEAE**
- 3 Leaves broader, < 15× as long as wide; [Eudicots, Basal Angiosperms, or Monocots].
- 4 Inflorescence an involucrate head..... [*Chrysoma, Garberia, Iva*] **ASTERACEAE**
- 4 Inflorescence solitary (*Illicium* in **ILLICACEAE**) or variously branched, spicate, racemose, or fascicled, not an involucrate head.
- 5 Carpels separate; fruit an aggregate of follicles arranged in a whorl; fresh foliage strongly fragrant; [Basal Angiosperms].....
.....[*Illicium*] **ILLICACEAE**
- 5 Carpels fused; fruit a berry, drupe, acorn (nut), capsule, or legume; fresh foliage not strongly fragrant; [Eudicots and Monocots].
- 6 Ovary with 3 carpels; fruit a berry; [Monocots].....[*Danae*] **RUSCACEAE**
- 6 Ovary with 1, 2, 4, or 5 carpels; fruit a berry, drupe, capsule, legume, or nut; [Eudicots].
- 7 Leaves largely covered with silver and/or bronze lepidote scales and/or stellate hairs below (visible at 10× or higher magnification), giving the lower leaf surface a slightly shiny to almost metallic appearance.
- 8 Perianth 4-merous; petals absent; petaloid sepals white to cream, fused and salverform; carpel 1; fruit a fleshy, red drupe .
.....[*Elaeagnus*] **ELAEAGNACEAE**
- 8 Perianth 5-merous; petals green and separate, or absent; sepals greenish, separate; carpels 3; fruit a 3-valved capsule
.....[*Croton*] **EUPHORBIACEAE**
- {add *Lyonia ferruginea* and *L. fruticosa* in **ERICACEAE** under 7a}
- 7 Leaves with various vestiture, but not as above.
- 9 Leaves 1-foliolate on the upper stems, sometimes 3-foliolate below, or all reduced to phyllodial spines; flowers papilionaceous, bright yellow; fruit a legume; stems bright green [*Cytisus, Genista, Ulex*] **FABACEAE**
- 9 Leaves simple throughout; flowers **either** small, inconspicuous, tannish, borne in catkins (*Quercus*), **or** larger and urceolate, **or** with almost separate and spreading petals, white to pink, in various terminal or axillary, branched inflorescences; fruit **either** a nut in a cupule (an acorn), **or** a (3-) 5-valved capsule, **or** a spherical berry or drupe; stems generally brown or tan (sometimes green).
- 10 Flowers small, inconspicuous, tannish, borne in catkins; fruit a nut in a cupule (an acorn)..... [*Quercus*] **FAGACEAE**
- 10 Flowers white to pink, **either** urceolate **or** with almost separate and spreading petals, in various terminal or axillary inflorescences; fruit **either** a (3-) 5-valved capsule, **or** a spherical berry with 10+ seeds, **or** a 4-8 seeded fleshy drupe, or a 1-seeded dry drupe.
- 11 Flowers white to pink, urceolate (rarely with spreading petals united at least basally, e.g., *Bejaria* and some *Vaccinium*), in various terminal or axillary inflorescences; fruit **either** a (3-) 5-valved capsule **or** a spherical berry with 10+ seeds ... [*Andromeda, Arctostaphylos, Bejaria, Kalmia, Lyonia, Rhododendron, Vaccinium*] **ERICACEAE**
- 11 Flowers white, petals spreading, separate even at the base, in axillary fascicles or racemes; fruit either a fleshy drupe with 4-8 pyrenes, or a dry single-seeded drupe.
- 12 Inflorescence an axillary fascicle or cluster; fruit a fleshy drupe with 4-8 pyrenes..... [*Ilex*] **AQUIFOLIACEAE**
- 12 Inflorescence an axillary raceme; fruit a dry drupe with 1 seed.....[*Cliftonia, Cyrilla*] **CYRILLACEAE**
- {add to 1a: *Scaevola* in **GOODENIACEAE**, *Licania* in **CHRYSOBALANACEAE**, *Morella (inodora)* in **MYRICACEAE**, *Cleyera* in **PENTAPHYLACACEAE**, *Pittosporum* in **PITTOSPORACEAE**, *Myrsine* in **PRIMULACEAE**, *Pyracantha* in **ROSACEAE**, *Dodonaea* in **SAPINDACEAE**, *Cestrum* in **SOLANACEAE**, *Thymelaea* in **THYMELAEACEAE**}
- 1 Leaves deciduous.
- 13 Inflorescence an involucrate head [*Ampelaster, Baccharis, Iva, Palafoxia*] **ASTERACEAE**
- 13 Inflorescence branched, spicate, or consisting of a solitary flower or axillary clusters or whorls, not an involucrate head.
- 14 Inflorescence a catkin; flowers unisexual; plants dioecious..... [*Salix*] **SALICACEAE**
- 14 Inflorescence various, not a catkin; flowers bisexual; plants hermaphroditic.
- 15 Flowers 3-merous, yellow or yellow-green or brown; fruit fleshy, red or greenish-yellow at maturity; ovary superior; [Basal Angiosperms or Eudicots].
- 16 Leaves elliptic or narrowly elliptic, broadest near the middle; fresh plants strongly fragrant with a citrus-like aroma; stems unarmed; fruit a drupe, with a single seed.....[*Lindera, Litsea*] **LAURACEAE**
- 16 Leaves spatulate or obovate, broadest near the apex; stems **either** armed with nodal spines **or** unarmed; fresh plants **either** not fragrant **or** fragrant with a strange, musky odor; fruit a berry, with several seeds.
- 17 Leaves 4-20 cm long; stems unarmed; fresh plants fragrant with a strange, musky odor; berry oblong, 3-7 -10 cm long, greenish-yellow when ripe.....[*Asimina*] **ANNONACEAE**
- 17 Leaves 1-3 cm long; stems armed with nodal spines; fresh plants not fragrant; berry ellipsoid, 0.8-1.1 cm long, red when ripe ...
.....[*Berberis*] **BERBERIDACEAE**
- 15 Flowers 4-5-merous, white, pink, greenish, yellow, blue, or lavender; fruit fleshy or dry, black, blue, brown, tan, or red at maturity; ovary superior or inferior; [Eudicots].
- 18 Fruit a 4-5-valved capsule with many seeds; inflorescence either terminal, a corymb or panicle, or an axillary whorl.....
..... [*Elliottia, Kalmia, Rhododendron*] **ERICACEAE**
- 18 Fruit either a drupe or berry (indehiscent, and variously fleshy or dry) or a dry 3-valved capsule with 1 seed; inflorescence axillary (solitary, clusters, fascicles, or racemes), or in a terminal raceme (*Pyrrularia* in **SANTALACEAE**).
- 19 Leaves largely covered with silver and/or bronze shiny lepidote scales below, giving the lower leaf surface an almost metallic appearance.....[*Elaeagnus*] **ELAEAGNACEAE**
- 19 Leaves with various vestiture, but not as above.
- 20 Ovary inferior or half-inferior; inflorescence an axillary cluster or raceme, or a terminal raceme.
- 21 Fruit a spherical berry, with 10 or more seeds [*Gaylussacia, Vaccinium*] **ERICACEAE**
- 21 Fruit an elongate drupe (definitely longer than thick), with 1 seed.
- 22 Fruit 15-30 mm long; inflorescence a terminal raceme [*Pyrrularia*] **SANTALACEAE**
- 22 Fruit 6-10 mm long; inflorescence an axillary fascicle.....[*Symplocos*] **SYMPLOCACEAE**
- 20 Ovary superior; inflorescence an axillary cluster or an axillary raceme (borne themselves in clusters).
- 23 Fruits elongate, 8-20 mm long.
- 24 Fruit a red or orange berry, 8-20 mm long; leaves usually on spur-shoots; [of salty coastal areas, or aliens of disturbed situations] [*Lycium*] **SOLANACEAE**
- 24 Fruit a yellowish-green drupe, 12-15 mm long; leaves on main stems; [of rich forests, mainly inland]
.....[*Dirca*] **THYMELAEACEAE**
- 23 Fruits spherical, < 10 mm long.

- 25 Inflorescence a narrowly cylindrical raceme, clustered several to many at the tip of the previous year's wood and below the current season's growth; fruit < 3 mm in diameter.....[*Cyrilla*] **CYRILLACEAE**
- 25 Inflorescence an axillary cluster; fruit > 4 mm in diameter
- 26 Fruit dry, opening by 3 valves, 1-seeded; leaf pubescence stellate.....[*Styrax*] **STYRACACEAE**
- 26 Fruit fleshy, with 4-8 seeds; leaf pubescence simple or absent.
- 27 Fruit yellow to red, the pedicel 10-30 mm long; leaf venation pinnate, but irregular and reticulated
.....[*Ilex (mucronata)*] **AQUIFOLIACEAE**
- 27 Fruit dark red to black, the pedicel < 10 mm long; leaf venation very neatly pinnate, with the secondary veins nearly straight and parallel to one another [Frangula, Rhamnus] **RHAMNACEAE**
- {add: *Ditrysinia* in EUPHORBIACEAE, *Glochidion* in PHYLLANTHACEAE, *Phyllanthopsis* in PHYLLANTHACEAE, *Leitneria* in SIMAROUBACEAE, *Nierembergia* in SOLANACEAE, *Edgeworthia* in THYMELAEACEAE, *Ipomoea (I. carnea)* in CONVOLVULACEAE

Key G5 – shrubs and subshrubs with alternate, simple, unlobed, toothed leaves

- 1 Subshrubs or dwarf shrubs, aboveground stems creeping or erect, < 15 cm tall; leaves evergreen.
- 2 Leaves 1.5-3 cm wide, coarsely toothed; flowers lacking sepals and petals; [alien species, sparingly naturalized or spreading in suburban situations].....[*Pachysandra*] **BUXACEAE**
- 2 Leaves < 1.5 cm wide, finely toothed or entire; flowers with sepals and petals; [native species, collectively widespread and common].
- 3 Leaves fleshy, terete in x-section; petals 5, bright pink [Talium] **TALINACEAE**
- 3 Leaves flat, not fleshy; petals white or pale pink.
- 4 Leaves < 2.5 mm wide; corolla with petals distinct; plant creeping..... [Pyxidantha] **DIAPENSIACEAE**
- 4 Leaves > 5 mm wide; corolla with petals fused (distinct in *Chimaphila*); plant creeping or erect.....
.....[*Chimaphila, Epigaea, Gaultheria, Vaccinium*] **ERICACEAE**
- 1 Shrubs, aboveground stems erect, > 30 cm tall; leaves evergreen or deciduous.
- 5 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela.....
..... [many] **ASTERACEAE**
- 5 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.
- 6 Leaves evergreen.
- 7 Leaves glandular-punctate on one or both surfaces with golden-yellow glands; flowers unisexual, lacking a perianth; fruit a pale gray, waxy drupe with a single seed [Morella] **MYRICACEAE**
- 7 Leaves not glandular punctate; flowers bisexual or unisexual, with a white, pink, or yellow perianth; fruit various, a red, blue, or black drupe or berry with several seeds, or a capsule.
- 8 Petals connate and urceolate, white to pale pink; flowers bisexual; leaves ovate, lanceolate, or elliptic, broadest near the middle or towards the base, the teeth well-distributed along most of the margin on either side; fruit **either** a capsule **or** a red, blue, or black berry..... [Agarista, Chamaedaphne, Gaylussacia, Leucothoe, Pieris, Vaccinium] **ERICACEAE**
- 8 Petals distinct, yellow or white; flowers unisexual or bisexual; leaves oblanceolate or elliptic, broadest towards the tip or near the middle, the teeth usually concentrated in the upper half of the leaf; fruit **either** a black or red drupe with several pyrenes **or** a red berry with several seeds.
- 9 Plants lacking thorns; flowers unisexual, with a white perianth; fruit a black or red drupe with several pyrenes
..... [Ilex] **AQUIFOLIACEAE**
- 9 Plants with nodal, simple or tripartite thorns; flowers bisexual, with a yellow perianth; fruit a red berry with several seeds
..... [Berberis] **BERBERIDACEAE**
- {add to 6a *Ardisia* in PRIMULACEAE, *Raphiotepis* in ROSACEAE, *Camellia* in THEACEAE}
- 6 Leaves deciduous.
- 10 Plants with nodal, simple or tripartite thorns; leaf teeth spinulose [Berberis] **BERBERIDACEAE**
- 10 Plants lacking thorns; leaf teeth acute, blunt, rounded, or callus-tipped, but not spinulose.
- 11 Leaves crenate-wavy, with 1-2 teeth per cm of leaf margin; leaves usually obliquely cordate or angled-truncate at the base; pubescence of leaves and stems stellate [Fothergilla, Hamamelis] **HAMAMELIDACEAE**
- 11 Leaves crenulate, serrate or serrulate, with >2 teeth per cm of leaf margin; leaves cuneate, rounded, or subcordate at base, not oblique; pubescence of leaves and stems absent or simple.
- 12 Leaves prominently 3-veined from the base.
- 13 Ovary 5-locular; stamens many or 5, fused or separate; fruit a 5-valved capsule or of 5 mericarps; flowers yellow or pink, or white with a pink blaze..... [Corchorus, Hibiscus, Melochia, Pavonia, Triumfetta] **MALVACEAE**
- 13 Ovary 3-locular; stamens 5, separate; fruit a 3-valved capsule or drupe; flowers white or pale green.....
..... [Ceanothus, Ziziphus] **RHAMNACEAE**
- 12 Leaves pinnately veined.
- 14 Flowers in catkins; perianth absent or very small; fruit a 1-seeded nut, samara, or waxy drupe (capsule in *Salix* in SALICACEAE).
- 15 Leaves > 4 cm wide, lacking punctate glands; fruit a 1-seeded nut or samara [Alnus, Corylus] **BETULACEAE**
- 15 Leaves < 3 cm wide, **either** punctate-glandular on one or both surfaces **or** lacking punctate glands; fruit a 1-seeded waxy drupe or a capsule.
- 16 Leaves punctate-glandular on one or both surfaces; fruit a 1-seeded waxy drupe. ... [Morella, Myrica] **MYRICACEAE**
- 16 Leaves lacking punctate glands; fruit a capsule [Salix] **SALICACEAE**
- 14 Flowers arrayed variously, but not in catkins; perianth present, conspicuous; fruit a 1-many-seeded capsule, pome, berry, or follicle.
- 17 Ovary inferior; fruit fleshy and indehiscent, a berry or pome.
- 18 Fruit a berry; leaves lacking stipules [Vaccinium] **ERICACEAE**
- 18 Fruit a pome; leaves usually prominently stipular
..... [Amelanchier, Aronia, Chaenomeles, Cydonia, Eriobotrya, Pourthiaea, Rhodotypos] **ROSACEAE**
- 17 Ovary superior; fruit **either** dry and dehiscent, a capsule or an aggregate of follicles or achenes, **or** fleshy and indehiscent, a drupe with 4-8 pyrenes.
- 19 Flower apocarpous; fruit an aggregate of follicles or achenes [Kerria, Neillia, Neviusia, Spiraea] **ROSACEAE**

- 19 Flower syncarpous; fruit **either** a capsule **or** a fleshy drupe.
- 20 Ovary 1-carpellate; fruit a 1-seeded drupe [*Prunus*] **ROSACEAE**
- 20 Ovary 2-8-carpellate; fruit **either** a capsule **or** a drupe with 4-8 pyrenes
- 21 Ovary 2-8-locular; fruit fleshy and indehiscent, a drupe with 2-8 pyrenes; flowers mostly functionally unisexual (or sometimes bisexual in RHAMNACEAE).
- 22 Petals connate at the base; stamens alternate to the petals and opposite to the sepals; fruit 4-8-locular, with 4-8 pyrenes [*Ilex*] **AQUIFOLIACEAE**
- 22 Petals separate (or absent in *Rhamnus alnifolia*); stamens opposite to the petals (when present) and alternate to the sepals; fruit 2-4-locular, with 2-4 pyrenes [*Frangula, Rhamnus*] **RHAMNACEAE**
- 21 Ovary 2-3- or 5-locular; fruit dry and dehiscent, a capsule; flowers bisexual (except *Stillingia* in EUPHORBIACEAE).
- 23 Ovary and capsule 5-locular; stamens 10-many.
- 24 Stamens 10; corolla urceolate, sympetalous [*Eubotrys, Lyonia, Zenobia*] **ERICACEAE**
- 24 Stamens many; corolla spreading, apopetalous [*Stewartia*] **THEACEAE**
- 23 Ovary and capsule 2-3-locular; stamens 2, 5, or 10.
- 25 Leaves > 5× as long as wide; stamens 2; ovary and capsule 3-locular; [plants of the Coastal Plain of SC, GA, AL, and FL] [*Stillingia*] **EUPHORBIACEAE**
- 25 Leaves < 3× as long as wide; stamens 5 or 10; ovary and capsule 2-3-locular; [plants collectively widespread].
- 26 Stamens 5; ovary and capsule 2-locular; leaves elliptic (widest near the middle), the teeth fine (usually > 5 points per cm of margin), and along much of the margin; inflorescence a terminal raceme; hairs of the lower leaf surface simple, erect [*Itea*] **ITEACEAE**
- 26 Stamens 10; ovary and capsule 3-locular; leaves obovate (widest towards the apex), the teeth obscure to coarse (usually < 4 points per cm of margin), and primarily in the upper half of the leaf; inflorescence a terminal or axillary raceme or cyme; hairs of the lower leaf surface **either** simple and appressed, **or** stellate.
- 27 Leaf margins regularly and evenly serrate in the upper half of the leaf (usually nearly entire towards the base); inflorescence an elongate, many flowered (>30) raceme borne at the end of branchlets of the season; corolla of separate petals, the stamens separate; hairs of the lower leaf surface simple and appressed [*Clethra*] **CLETHRACEAE**
- 27 Leaf margins wavy or irregularly dentate, mainly in the upper half of the leaf; inflorescence a few flowered (<20) axillary raceme, cyme, or cluster; corolla fused basally into a tube, the stamens adnate to the tube; hairs of the lower leaf surface stellate [*Styrax*] **STYRACACEAE**

Key G6 – trees with alternate, simple, unlobed, entire leaves

- 1 Leaves evergreen.
- 2 Leaves tiny, scale-like, broadest at the base and more or less clasping the stem, <10 mm long and <1 mm wide [*Tamarix*] **TAMARICACEAE**
- 2 Leaves larger and broader, >40 mm long and >8 mm wide.
- 3 Fruit a hesperidium; petiole flanged or winged for most of its length, constricted at the base of the blade (except linear in *C. medica*) [*Citrus*] **RUTACEAE**
- 3 Fruit various (but not a hesperidium); petiole linear (not flanged or winged with leafy tissue).
- 4 Pubescence of leaves including conspicuous stellate hairs (also with simple hairs) (best seen on lower leaf surfaces, and with at least 10× magnification); plants monoecious, the male flowers in yellow to brownish catkins, the female flowers solitary or in small spikes; fruit a nut in a cupule (an acorn) [*Quercus*] **FAGACEAE**
- 4 Pubescence of leaves absent, or strictly of simple hairs; plants hermaphroditic (dioecious in *Ilex* in AQUIFOLIACEAE); fruit various.
- 5 Flowers solitary, terminal, large (> 5 cm in diameter); pistils many, carpels separate; petals many (typically > 8); leaves mostly > 10 cm long (at least some on a branch longer than 10 cm); fruit an aggregate of follicles, each dehiscent along 1 suture; stipule scar circumferential at each node, encircling the twig [*Magnolia*] **MAGNOLIACEAE**
- 5 Flowers **either** in axillary racemes, panicles, umbels, fascicles, or solitary, **or** in terminal corymbs, umbels, or racemes, small (< 5 cm in diameter); pistil 1, with 1-8 fused carpels; petals 3-8; leaves mostly < 10 cm long (to 15 cm in *Persea* in LAURACEAE and *Sideroxylon* in SAPOTACEAE, to 30 cm long in *Rhododendron* in ERICACEAE); fruit **either** drupaceous, fleshy to dry, but not regularly dehiscent along sutures, or a capsule, dehiscent along 5 sutures; stipule scars absent, linear or triangular, not circumferentially encircling the twig.
- 6 Inflorescence terminal, a corymb, umbel, or raceme; fruit a capsule, dehiscent along 5 longitudinal sutures [*Kalmia, Rhododendron*] **ERICACEAE**
- 6 Inflorescence axillary, a raceme, panicle, umbel, fascicle, or solitary; fruit drupaceous, fleshy to dry, but not regularly dehiscent along sutures.
- 7 Leaves densely covered with silvery peltate scales (use 10× or greater magnification), giving the leaf blade surface a metallic appearance [*Elaeagnus*] **ELAEAGNACEAE**
- 7 Leaves glabrous, glabrescent or variously pubescent, including densely and silkily so, giving the leaf surface a shiny appearance, but not as above.
- 8 Inflorescence an axillary raceme (with an elongate central axis, to which all flowers/fruits are attached).
- 9 Fruit a dry, tan to brown, spherical or winged drupe; stamens 5 or 10; carpels 2-5; leaves oblanceolate (rarely narrowly elliptic), < 2.5 cm wide, the apex obtuse (more rarely acute, retuse, or rounded) ... [*Cliftonia, Cyrilla*] **CYRILLACEAE**
- 9 Fruit a fleshy, black, spherical drupe; stamens 10; carpels 1; leaves elliptic, the apex acute to short-acuminate [*Prunus (caroliniana)*] in **ROSACEAE**
- 8 Inflorescence **either** an axillary umbel or fascicle (or reduced to solitary) **or** an axillary compound inflorescence (panicle or compound cyme), with 2-3 orders of branching.

- 10 Fruit a fleshy and oily 1-seeded drupe; flowers 3-merous, with separate and undifferentiated perianth segments; fresh plants strongly aromatic; inflorescence compound, a panicle or compound cyme (with 2-3 orders of branching); [Basal Angiosperms] [*Cinnamomum, Laurus, Persea*] **LAURACEAE**
- 10 Fruit a fleshy but not oily 1-8-seeded drupe or berry; flowers 4-8-merous, with differentiated sepals and petals, the petals usually basally fused; fresh plants not strongly aromatic; inflorescence an axillary umbel or fascicle (or reduced to solitary), a central axis absent or < 1 cm long; [Eudicots].
- 11 Plants unarmed (or with marginal leaf prickles or spines); stamens 4-7, not epipetalous; fruit a drupe with 4-8 pyrenes; flowers 4-7-merous [*Ilex*] **AQUIFOLIACEAE**
- 11 Plants armed with nodal thorns; stamens 5 and staminodia 5, epipetalous; fruit a berry or drupe with 1 seed; flowers 5-merous [*Sideroxylon*] **SAPOTACEAE**
- 1 Leaves deciduous.
- 12 Leaf base deeply to shallowly cordate, with 3-7 palmate veins from the base; leaf blade about as wide as long or a little longer, mostly 0.9-1.3× as long as wide.
- 13 Juncture of petiole and leaf blade with 2 red glands; corolla radially symmetrical, with 5-8 petals, white with red veins towards the base of the petals; flowers unisexual; fruit globose, 4-8 cm in diameter; main palmate leaf veins 3 (-5) [*Vernicia*] **EUPHORBIACEAE**
- 13 Juncture of petiole and leaf blade eglandular, but the uppermost 1-3 mm of the petiole swollen into a prominent upper pulvinus; corolla bilaterally symmetrical, with 5 petals, pink to purple (rarely white in some cultivars); flowers bisexual; fruit an oblong, flat legume, 6-10 cm long; main palmate leaf veins 5-7 (-9) [*Cercis*] **FABACEAE**
- 12 Leaf base cuneate, rounded, truncate, subcordate, or auriculate (with 2 small "earlobe-like" lobes at the base of the leaf blade), with 1 (mid) vein from the base (3 veins from the base in *Celtis* in CANNABACEAE); leaf blade about as wide as long, or somewhat to much longer, 0.9-1.0× as long as wide.
- 14 Leaves 0.9-1.4× as long as wide (some taxa keyed in both leads).
- 15 Stipule scars circumferential, forming a line around the twig; flowers and aggregate fruits solitary, terminal; [Basal Angiosperms] [*Magnolia (acuminata)*] **MAGNOLIACEAE**
- 15 Stipule scars not circumferential (or not apparent); flowers and simple fruits in inflorescences of 1-many flowers, axillary or terminal, but not simultaneously solitary and terminal; [Eudicots].
- 16 Leaf blade 3-6 cm long, 1-1.5× as long as the flexuous petiole [*Triadica*] **EUPHORBIACEAE**
- 16 Leaf blade 4-30 cm long, > 3× as long as the stiff petiole.
- 17 Petioles 1-5 (or more) cm long; leaves broadly orbicular, rounded at the base, usually rounded (rarely obtuse or nearly acute) at the apex, entire; hairs on foliage simple or absent; fruit a fleshy drupe [*Cotinus*] **ANACARDIACEAE**
- 17 Petioles < 1 cm long; leaves various in shape, often acuminate at the apex and/or cuneate at the base, often with some tendency to toothing; hairs on foliage stellate (use at least 10× magnification), at least in part; fruit **either** a nut borne in a cup (acorn) **or** a dry, subglobose 3-valved capsule, with 1 seed.
- 18 Fruit a dry, subglobose 3-valved capsule, with 1 seed; flowers bisexual, white, conspicuous [*Styrax (grandifolia)*] **STYRACACEAE**
- 18 Fruit a nut in a cupule (an acorn); flowers unisexual, greenish or brownish, individually inconspicuous, the male flowers borne in catkins [*Quercus*] **FAGACEAE**
- 14 Leaves > 1.4× as long as wide.
- 19 Leaves densely covered with silvery peltate scales (use 10× or greater magnification), giving the leaf blade surface a metallic appearance [*Elaeagnus (angustifolia)*] **ELAEAGNACEAE**
- 19 Leaves glabrous, glabrescent or variously pubescent, including densely and silkily so, giving the leaf surface a shiny appearance, but not as above.
- 20 Plants bearing nodal thorns; leaves elliptic to obovate, 3-9 cm long, 1-4 cm wide, 1.5-4× as long as wide.
- 21 Sap clear, not viscous; sepals 4; petals 4, densely long-hairy on their upper (inner) side; fruit a yellow, 1-seeded drupe, 20-30 mm long; [FL southward] [*Ximenia*] **OLACACEAE**
- 21 Sap milky or nearly clear but thick and sticky; sepals 5; petals 5, not densely long-hairy; fruit a black, 5-seeded berry, 5-15 mm long; [widespread in our area] [*Sideroxylon*] **SAPOTACEAE**
- 20 Plants unarmed (except spiny in *Maclura* in MORACEAE); leaves various in shape, from broadest towards the base, near the middle, or towards the apex, 3-80 cm long, 1-30 cm wide, 1.5-10× as long as wide.
- 22 Leaves distinctly widest near the base (at a point < 0.3× of the way from the base of the leaf blade to its apex), gradually long-tapering to an acuminate apex.
- 23 Fruit a spherical, dry drupe, 4-8 mm in diameter, with a single seed; leaf 1.5-6 cm wide [*Celtis (laevigata)*] **CANNABACEAE**
- 23 Fruit a spherical, fleshy multiple, 80-120 mm in diameter; leaf 5-8 cm wide [*Maclura*] **MORACEAE**
- 22 Leaves widest near the middle or towards the tip of the leaf blade (at a point > 0.4× of the way from the base of the leaf blade to its apex).
- 24 Pubescence of the foliage stellate (at least in part; simple hairs sometimes present as well); flowers unisexual, the individual flowers inconspicuous, male flowers in catkins; fruit a nut in a cupule (an acorn) [*Quercus*] **FAGACEAE**
- 24 Pubescence of the foliage simple or absent (except sometimes stellate in STYRACACEAE); flowers bisexual, conspicuous, borne variously, but not in catkins; fruit various.
- 25 Leaf undersurface strongly whitened [*Magnolia (virginiana)*] **MAGNOLIACEAE**
- 25 Leaf surface green (often somewhat paler green than the upper surface, but not whitened).
- 26 Flowers solitary; ovary superior; perianth **either** 3-merous and whorled **or** many-merous and spiraled; leaves mostly > 20 cm long and > 8 cm wide, distinctly broadest towards the apex (> 0.6× of the way from the leaf blade base to apex) (except *Magnolia acuminata*, which is sometimes both shorter, narrower, and broadest near the middle or towards the base); [Basal Angiosperms].
- 27 Flowers axillary, < 2 cm across, brown or maroon; perianth 3-merous, whorled; fresh foliage with a strong musky odor; fruit a fleshy berry; leaves cuneate at the base; twigs lacking circumferential stipule scars at each node [*Asimina (triloba)*] **ANNONACEAE**
- 27 Flowers terminal, > 4 cm across, white, pale yellow, or pink; perianth many-merous, spiraled; fresh foliage not noticeably aromatic; fruit an aggregate of follicles; leaves cuneate or auriculate at the base; twigs with circumferential stipule scars at each node [*Magnolia* (large leaved taxa, auriculate and not)] **MAGNOLIACEAE**

- 26 Flowers in inflorescences of several to many; ovary inferior (or superior in *Diospyros* in EBENACEAE and *Cyrilla* in CYRILLACEAE); perianth 4-5-merous; leaves mostly < 20 cm long and < 10 cm wide, broadest near the middle or towards the apex; [Eudicots].
- 28 Leaves with prominently parallel-arc secondary veins; inflorescence a terminal corymb; leaves clustered at the tips of the twigs, agasoften appearing pseudo-whorled; trichomes of the leaf undersurface predominantly 2-branched (some simple) (use at least 10× magnification); flowers 4-merous; fruit a blue drupe; small tree[*Cornus (alternifolia)*] **CORNACEAE**
- 28 Leaves with secondary veins more obscure and complexly branching into tertiary veins; inflorescence axillary (often on the previous year's wood), solitary to variously fascicled, clustered, or in racemes; leaves arrayed distichously along horizontal or arching twigs, not prominently clustered or pseudo-whorled (except often in *Cyrilla* in CYRILLACEAE, *Symplocos* in SYMPLOCACEAE, and *Nyssa* in NYSSACEAE); trichomes of the leaf undersurface either simple or stellate (or absent); flowers 4-5-merous; fruit a green, blue, or black drupe, an orange berry, or a green to brownish indehiscent capsule; small to large tree.
- 29 Pubescence of foliage and other parts stellate (use at least 10× magnification); petals 4-5, white, 10-25 mm long; fruit dryish, indehiscent, **either** longitudinally 2-4-winged **or** not winged[*Halesia, Styrax*] **STYRACACEAE**
- 29 Pubescence of foliage and other parts simple; petals **either** 0, **or** 4-5 and pink, white, or greenish-yellow, **or** 10 and greenish-yellow; fruit **either** a somewhat to very fleshy drupe or berry or a dry, brownish, spherical drupe, 2-2.5 mm in diameter.
- 30 Leaves < 2.5 cm wide, dark green above, somewhat thickened, and tardily deciduous or semi-evergreen; fruit a dry, brownish, spherical drupe, 2-2.5 mm in diameter; inflorescence a narrowly cylindrical raceme with > 40 flowers[*Cyrilla*] **CYRILLACEAE**
- 30 Leaves > 2.5 cm wide, usually medium-green above, herbaceous in texture, promptly seasonally deciduous; fruit a somewhat to very fleshy drupe or berry, > 5 mm in diameter; inflorescence a solitary flower or cluster, head, or irregular raceme of < 15 flowers.
- 31 Fruit a drupe (green when ripe), cylindrical to barrel-shaped, 8-12 mm long; leaves rather thick and leathery in texture, persistent into the winter, dropping tardily or at latest the following spring; flowers bisexual; stamens 30-50, in 5 fascicles[*Symplocos*] **SYMPLOCACEAE**
- 31 Fruit a berry (orange when ripe) or a drupe (blue-black, yellow, orange, or red when ripe), 8-50 mm long, spherical or ovoid to ellipsoid; leaves thin in texture, promptly deciduous in the autumn; flowers functionally unisexual; stamens 5-16, separate.
- 32 Fruit a spherical berry, 15-50 mm long, orange when ripe, subtended by the enlarged and persistent woody or leathery calyx; vascular bundles 1 per leaf scar; leaves never toothed; leaves whitish-green beneath; leaf midrib and upper petiole with tiny glands on their upper surfaces (reddish initially, then darkening) (use at least 10× magnification); leaves glabrate to tomentose with curly hairs beneath; female and male flowers on separate trees (dioecious); stamens 16; widest point of the leaf usually at the middle or below, the apex acute to acuminate[*Diospyros*] **EBENACEAE**
- 32 Fruit an ovoid or ellipsoid drupe, 8-30 -40 mm long, blue-black, yellow, orange, or red when ripe; vascular bundles 3 per leaf scar; leaves sometimes bearing a few irregular teeth; leaves pale to medium green beneath; leaf midrib and upper petiole lacking reddish to dark glands on their upper surfaces; leaves glabrous or glabrate beneath; female and male flowers on the same tree (monoecious); stamens 5-12; widest point of the leaf usually beyond or at the middle, the apex obtuse to strikingly and abruptly acuminate[*Nyssa*] **NYSSACEAE**

Key G7 – trees with alternate, simple, unlobed, toothed leaves

- 1 Leaves evergreen.
- 2 Petiole flanged or winged, constricted at the base of the blade; fruit a hesperidium.....[*Citrus*] **RUTACEAE**
- 2 Petiole linear (not flanged or winged with leafy tissue); fruit various.
- 3 Leaves 7-20 cm long, usually at least some on a branch > 12 cm long, thick in texture but readily flexible when fresh; inflorescence of a solitary flower, axillary, 5-7cm across; fruit a capsule, ca. 1 cm in diameter [Gordonia] **THEACEAE**
- 3 Leaves 3-12 cm long, thick in texture and also noticeably stiff; inflorescence of 1-several flowers in axillary clusters or cymes, or in catkins, the individual flowers < 1 cm across; fruit **either** a drupe with 4 pyrenes **or** a nut (acorn).
- 4 Leaf with a spinose margin, the marginal spines well-developed, generally arrayed along most of the leaf margin and borne at nearly a right angle to the midvein [Ilex] **AQUIFOLIACEAE**
- 4 Leaf margins serrate with one or a few stiff teeth (sometimes sharpish, but not spines), these usually towards the apex of the leaf and oriented towards the leaf apex [Quercus (virginiana, hemispherica)] **FAGACEAE**
- {add to 2b: [Sapium] **EUPHORBIACEAE**, [Photinia] **ROSACEAE**, [Prunus (caroliniana)] **ROSACEAE**, [Ilex (cassine, myrtifolia)] **AQUIFOLIACEAE**}
- 1 Leaves deciduous.
- 5 Secondary veins neatly pinnate, the veins on each side of the midrib evenly spaced, parallel to one another, and extending nearly or actually to the leaf margin; fruit **either** a 1-seeded nut (dry, with or without samaroid wings, bracts, a subtending cupule, or an enclosing and valvate involucre) **or** a fleshy drupe with 2-4 stones.
- 6 Leaves doubly-serrate, the number of teeth greater than the number of the pinnate secondary veins (sometimes obscurely so in *Planera* in ULMACEAE); fruit a nut or samaroid nut, lacking a cupule or valvate involucre, though sometimes associated with green, leaf-like bracts.
- 7 Flowers unisexual, in catkins, the tree monoecious; leaf base symmetrical..... [Betula, Carpinus, Ostrya] in **BETULACEAE**
- 7 Flowers bisexual, in axillary fascicles, the tree androgynous; leaf base strongly asymmetrical (oblique) or nearly or quite symmetrical[*Planera, Ulmus*] in **ULMACEAE**
- 6 Leaves singly serrate or crenate, the teeth the same number as the secondary veins; fruit **either** a fleshy drupe with 2-4 stones, **or** a nut with a cupule (acorn) or enclosed by a valvate involucre that splits at maturity..
- 8 Fruit **either** a nut with a cupule (acorn) **or** 1-4 nuts enclosed by a valvate involucre that splits at maturity..... [Castanea, Fagus, Quercus] in **FAGACEAE**
- 8 Fruit a fleshy drupe with 2-4 stones..... [Frangula, Rhamnus] in **RHAMNACEAE**

- 5 Secondary veins not as above, usually arching and/or branching or reticulating well before reaching the leaf margin; fruit various.
- 9 Leaves strongly 3-5-veined from the base; leaf blade cordate or truncate, often oblique.
- 10 Inflorescence terminal, a compound cyme; peduncles and pedicels becoming swollen, fleshy, and juicy at maturity; [plant rarely naturalized]..... [*Hovenia*] **RHAMNACEAE**
- 10 Inflorescence axillary, a solitary flower, a fascicle or cluster, or a cyme; peduncles and pedicels remaining stalk-like; [collectively widespread and common].
- 11 Flowers unisexual, plants monoecious; pith of mature twigs chambered with hollow sections between soft partitions [*Celtis*] **CANNABACEAE**
- 11 Flowers bisexual; plants hermaphroditic; pith of mature twigs continuous without hollow sections between partitions.
- 12 Flowers unisexual, the pistillate inflorescence an axillary cyme; fresh leaves and stems lacking white latex; fruit simple, a 1-seeded nut; main leaf veins splitting several times towards the leaf margin and leading into the teeth without rejoining and forming a marginal vein; basal veins 5, palmate, all joining together at the summit of the petiole; main lateral leaf veins (above the basal veins) usually opposite; winter buds with 3 entire bud scales (1 much smaller than the other 2) [*Tilia*] **MALVACEAE**
- 12 Flowers unisexual, the pistillate inflorescence a head, the staminate inflorescence a catkin, borne on the same tree (monoecious) or on separate trees (dioecious); fresh leaves and stems with white latex; fruit a multiple of fleshy achenes; main leaf veins splitting towards the margin but then rejoining to form a rather prominent, looping marginal vein; basal veins 3, palmate, sometimes an additional prominent vein on each side joining the lateral vein above its divergence from the petiole end; main lateral leaf veins (above the basal veins) mainly alternate; winter buds with 5 ciliate-margined bud scales [*Broussonetia*, *Morus*] **MORACEAE**
- 9 Leaves pinnately veined; leaf blade base cordate, subcordate, truncate, rounded, or cuneate base, not oblique.
- 13 Inflorescence a terminal raceme of racemes, with more than 50 flowers; petals connate, urceolate; fruit a 5-valved capsule, < 6 mm in diameter; fresh leaves with a sour taste [*Oxydendrum*] **ERICACEAE**
- 13 Inflorescence various, either with < 30 flowers or if with > 50 flowers a catkin (with a single axis); corolla with separate petals (or petals absent); fruit various, fleshy or dry, if a 5-valved capsule (*Franklinia* in THEACEAE), then 15-20 mm in diameter; fresh leaves without a sour taste.
- 14 Pubescence stellate (look especially in vein axils on the undersurface of the leaf) [*Halesia*, *Styrax*] **STYRACACEAE**
- 14 Pubescence simple.
- 15 Flowers solitary, very large and showy, 7-9 cm across; fruit a subglobose capsule 1.5-2 cm in diameter [*Franklinia*] **THEACEAE**
- 15 Flowers grouped into inflorescences, each flower less than 2 cm across; fruit **either** fleshy and indehiscent, a drupe or pome, **or** dry and dehiscent, an ovoid or lanceolate capsule < 0.7 cm in diameter.
- 16 Flowers unisexual, borne in axillary catkins; trees dioecious; fruit dehiscent, a lanceolate or ovoid capsule [*Populus*, *Salix*] **SALICACEAE**
- 16 flowers bisexual (unisexual in *Ilex* in AQUIFOLIACEAE), borne variously in terminal or axillary clusters, cymes, racemes, or umbels, but not at all catkin-like; trees hermaphroditic (dioecious in AQUIFOLIACEAE); fruit indehiscent, a fleshy drupe or pome with 1-many seeds.
- 17 Pith of twigs with transverse diaphragms and also continuous between the diaphragms (make a longitudinal section of twig and use at least 10× magnification; look for translucent diaphragms spaced at < 1 mm apart, with whiter pith tissue between them); fruit distinctly longer than broad, a 1-seeded drupe [*Nyssa*] **NYSSACEAE**
- 17 Pith of twigs lacking diaphragms, continuous and homogeneous; fruit either suborbicular to spherical or pear-shaped, **either** a several- to many-seeded pome, **or** a berry-like drupe with 4-8 seeds, **or** a 1-seeded drupe.
- 18 Vascular bundle scars 1 in each leaf scar; fruit a berrylike drupe with 4-8 bony pyrenes; ovary superior, the calyx persistent at the base of the fruit [*Ilex*] **AQUIFOLIACEAE**
- 18 Vascular bundle scars (2-) 3 in each leaf scar; fruit a pome or 1-seeded drupe; ovary **either** inferior and the calyx persistent at the summit of the fruit (*Amelanchier*, *Crataegus*, *Malus*, *Pyrus*) **or** superior and the calyx not at all persistent at the base of the fruit (*Prunus*) [*Amelanchier*, *Crataegus*, *Malus*, *Prunus*, *Pyrus*] **ROSACEAE**

Key H – woody plants with whorled leaves

- 1 Leaves tiny, bract-like, triangular, 6-14 (-17) per node [*Casuarina*] **CASUARINACEAE**
- 1 Leaves **either** needle-like, scale-like, **or** flattened and large, (2-) 3-4 (-6) per node.
- 2 Leaves needle-like or scale-like, terete, angled, or flat in x-section, < 2 cm long; leaves (2-) 3-4 (-6) per node [*Ceratiola*, *Corema*, *Erica*] **ERICACEAE**
- 2 Leaves flat, > 3 cm long; leaves (2-) 3 per node; [Eudicots].
- 3 Plant a subshrub, < 3 dm tall, with < 10 leaves per stem.
- 4 Leaves entire, broadly elliptic; flowers in a hemispherical head, subtended by 4 large white bracts [*Cornus (canadensis)*] **CORNACEAE**
- 4 Leaves serrate, narrowly ovate or narrowly obovate; flowers solitary, not subtended by bracts [*Chimaphila*] **ERICACEAE**
- 3 Plant a shrub or tree, > 3 dm tall, with many > 10 leaves per stem.
- 5 Leaves toothed, and most leaves also lobed [*Broussonetia*] **MORACEAE**
- 5 Leaves entire, not lobed.
- 6 Leaves cordate at base; leaves about as long as wide; medium to large tree.
- 7 Flowers white to yellow; capsules linear, >10× as long as wide; leaf undersurface with curly simple hairs; nectar glands present in the main vein axils on the undersurface of the leaf (visible from the underside or the upperside in fresh leaves and herbarium specimens as a triangle 1-4 mm on a side) [*Catalpa*] **BIGNONIACEAE**
- 7 Flowers lavender; capsules ellipsoid, < 2× as long as wide; leaf undersurface with branched (dendritic or stellate) hairs; nectar glands absent [*Paulownia*] **PAULOWNIACEAE**
- 6 Leaves cuneate to rounded at base; leaves > 1.5× as long as wide; shrub to small tree.
- 8 Leaves rounded at the tip [*Kalmia*] **ERICACEAE**
- 8 Leaves acute to acuminate at the tip.
- 9 Leaves lanceolate (> 2.5× as long as wide), the secondary venation not prominent; inflorescences axillary; flowers pink [*Decodon*] **LYTHRACEAE**

- 9 Leaves ovate (< 2× as long as wide), the secondary venation prominent and arching-parallel; inflorescences terminal; flowers white, red, or orange.
 10 Flowers in a monochasial helicoid cyme; corollas red to orange[*Cephalanthus, Hamelia*] RUBIACEAE
 10 Flowers in a spherical or hemispherical head; corollas white or greenish-yellow.
 {add [*Nerium*] APOCYNACEAE}

Key I – woody plants with opposite, compound leaves

- 1 Leaves 2-3-foliolate.
 2 Leaves 2-foliolate, with a branched tendril in the terminal position; liana[*Bignonia, Macfadyena*] BIGNONIACEAE
 2 Leaves 3-foliolate, lacking tendrils; shrub, liana, or tree.
 3 Plant an upright shrub or tree.
 4 Leaflets 3-5 (-7), coarsely and jaggedly serrate, with < 5 teeth per leaflet side; fruit a schizocarp of 2 samaroid mericarps (maple “keys”)[*Acer*] SAPINDACEAE
 4 Leaflets 3, evenly serrulate, with > 10 teeth per leaflet side; fruit an inflated capsule [Staphylea] STAPHYLEACEAE
 3 Plant a liana or sprawling shrub.
 5 Flowers yellow with fused petals; stems stiff, green.....[*Jasminum*] OLEACEAE
 5 Flowers **either** white, radially symmetrical, with separate petaloid sepals (*Clematis*), or blue, bilaterally symmetrical, with fused petals (*Vitex*).
 6 Leaves 3-more-foliolate; flowers white, radially symmetrical, uniseriate, with white petaloid sepals and no petals.....
[*Clematis*] RANUNCULACEAE
 6 Leaves 1 (-3) foliolate; flowers blue, bilaterally symmetrical, biseriolate, with green calyx and blue corolla.... [Vitex] LAMIACEAE
 1 Leaves 4-15-foliolate.
 7 Leaves palmately compound.
 8 Leaflets serrate; flowers white, yellow, or red; fruit a leathery capsule, 2-9 cm in diameter, with 1-3 (-6) large seeds, each with a large pale hilum contrasting with the dark brown color of the rest of the seed [Aesculus] SAPINDACEAE
 8 Leaflets entire; flowers blue; fruit a 4-seeded drupe, < 0.5 cm in diameter..... [Vitex] LAMIACEAE
 7 Leaves pinnately compound, bipinnately compound, or more complexly compound.
 9 Plant a liana (woody vine).
 10 Leaves pinnately compound, with 7-15 coarsely serrate leaflets; perianth biseriolate, with a green synsepalous calyx and an orange sympetalous corolla; fruit an elongate capsule, with many winged seeds; stems to 20 cm in diameter, with tan bark.....
[*Campsis*] BIGNONIACEAE
 10 Leaves **either** pinnately compound, the leaflets 3-7 and coarsely serrate, **or** more complexly compound, the leaflets 5-many, not serrate though often lobed; perianth uniseriate, with a white, pink, or purplish aposepalous calyx and no corolla; fruit an aggregate of plumose achenes; stems to 1 cm in diameter, brown or green[*Clematis*] RANUNCULACEAE
 9 Plant a tree or shrub, with stiff branches.
 11 Leaves 3-7-foliolate and strictly 1-pinnate; leaflets with a few very coarse teeth; 1st year stems green; fruit a pair of winged, asymmetrical samaroid mericarps[*Acer (negundo)*] SAPINDACEAE
 11 Leaves 3-15-foliolate, 1-pinnate or partially 2-pinnate; leaflets evenly serrate with many teeth or entire; 1st year stems tan to brown (very new growth may be green); fruit either a symmetrical (winged) samara (*Fraxinus*) or a purplish-black, many-seeded berry (*Sambucus*).
 12 Fruit a purplish-black or red, 4-seeded berry (*Sambucus*); plant a shrub or small tree; stems hollow or pithy; petiole prominently grooved on the upper side; fresh leaves somewhat fleshy in texture [Sambucus] ADOXACEAE
 12 Fruit a green or tan, symmetrical (winged) samara; plant a small to large tree; stems solid and woody; petiole nearly round in ×-section (not grooved); fresh leaves membranaceous in texture [Fraxinus] OLEACEAE

Key J – woody plants with opposite, simple leaves

- 1 Leaves palmately or pinnately lobed, and also serrate
 **Key J1 – woody plants with opposite, simple, palmately or pinnately lobed leaves**
 1 Leaves not lobed, serrate, crenate, spinose-serrate, or entire.
 2 Leaves serrate, serrulate, crenate, or spinose-serrate **Key J2 – woody plants with opposite, simple leaves with toothed margins**
 2 Leaves entire.
 3 Plants with obvious adaptations for climbing **Key J3 – lianas with opposite, simple leaves with entire margins**
 3 Plants without adaptations for climbing.
 4 Shrubs and subshrubs **Key J4 – shrubs and subshrubs with opposite, simple leaves with entire margins**
 4 Trees..... **Key J5 – trees with opposite, simple leaves with entire margins**

Key J1 – woody plants with opposite, simple, palmately or pinnately lobed leaves

- 1 Leaves pinnately lobed.
 2 Leaves harshly scabrous on the upper surface; leaves typically a mix of alternate, opposite, and whorled[*Broussonetia*] MORACEAE
 2 Leaves glabrous or glabrescent on the upper surface; leaves strictly opposite.....[*Hydrangea (quercifolia)*] HYDRANGEACEAE
 1 Leaves palmately lobed.
 3 Plants climbing by twining; stems with retrorse prickles; foliage scabrous.....[*Humulus*] CANNABACEAE
 3 Plants erect trees or shrubs; stems not prickly; foliage smooth or pubescent, but not scabrous.
 4 Leaves 3-9-lobed, the margins generally serrate or sublobed; fruit either a drupe or a schizocarp of 2 samaroid mericarps (maple “keys”).
 5 Fruit a schizocarp of 2 samaroid mericarps (maple “keys”); stamens (4-) 8 (-12); small to large trees; petioles >1× as long as the leaf blade.....[*Acer*] SAPINDACEAE
 5 Fruit a drupe; stamens 5; shrubs; petioles < ¾× as long as the leaf blade [Viburnum (*acerifolium*)] ADOXACEAE

- 4 Leaves 3-lobed, the margins entire; fruit a capsule.
- 6 Flowers white to yellow; capsules linear, >10× as long as wide; leaf undersurface with curly simple hairs; nectar glands present in the main vein axils on the undersurface of the leaf (visible from the underside or the upperside in fresh leaves and herbarium specimens).....[*Catalpa*] **BIGNONIACEAE**
- 6 Flowers lavender; pods ellipsoid, < 2× as long as wide; leaf undersurface with branched (dendritic) stellate hairs; nectar glands absent[*Paulownia*] **PAULOWNIACEAE**

Key J2 – woody angiosperms with opposite, simple leaves with toothed margins

- 1 Leaves evergreen.
- 2 Plant a shrub, erect, not requiring support.
- 3 Leaves with spiny margins.....[*Osmanthus*] **OLEACEAE**
- 3 Leaves with crenate or serrate margins.
- 4 Leaves slightly to strongly fleshy; inflorescence a head; [of maritime situations].....[*Iva*] **ASTERACEAE**
- 4 Leaves not fleshy; inflorescence otherwise; [collectively widespread].
- 5 Leaves > 7 cm long, typically spotted with yellow, coarsely toothed; fruit a red drupe; [commonly cultivated, rarely seeding down nearby].....[*Aucuba*] **GARRYACEAE**
- 5 Leaves < 7 cm long, not yellow-spotted, serrulate; fruit a capsule or purplish drupe; [plants native or cultivated].
- 6 XXXX[*Euonymus*] **CELASTRACEAE**
- 6 YYYY[*Sageretia*] **RHAMNACEAE**
- 2 Plant a subshrub, creeping shrub, or liana.
- 7 Leaves spinose-serrate; [aliens, rarely naturalized].....[*Crossopetalum*] **CELASTRACEAE**
- 7 Leaves serrate (not spinose), serrulate, or crenate; [aliens and natives, collectively widespread].
- 8 Leaves slightly to strongly fleshy; inflorescence a head; [of maritime situations].....[*Iva*] **ASTERACEAE**
- 8 Leaves not fleshy; inflorescence otherwise; [collectively widespread].
- 9 Leaves on vigorous shoots with a few coarse rounded teeth towards the base (most leaves entire)[*Lonicera*] **CAPRIFOLIACEAE**
- 9 Leaves serrulate to serrate, the teeth uniformly around the margin or concentrated towards the tip; fruit dry, either indehiscent and 1-seeded or capsular and with several seeds.
- 10 Flowers 4- or 5-merous; petals separate; fruit capsular, dehiscent, several-seeded; [collectively widespread in our area][*Euonymus*, *Paxistima*] **CELASTRACEAE**
- 10 Flowers 5-merous; petals fused; fruit indehiscent, 1-seeded; [montane, from e. TN, WV, and w. MD northwards in our area].....[*Linnaea*] **LINNAEACEAE**
- 1 Leaves deciduous.
- 11 Leaves slightly to strongly fleshy; inflorescence a head, subtended by an involucre of phyllaries; [of maritime situations].....[*Iva*] **ASTERACEAE**
- 11 Leaves not fleshy; inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers in a head subtended by bracts, but then with other features differing, such as stamens 4, or green calyx present, or petals separate, or fruit a schizocarp of mericarps, etc.); [collectively widespread].
- 12 Lianas climbing by twining or by adventitious roots.
- 13 Stems with retrorse prickles; foliage scabrous.....[*Humulus*] **CANNABACEAE**
- 13 Stems not prickly; foliage smooth to variously hairy, but not scabrous.
- 14 Leaves on vigorous shoots with a few coarse rounded teeth towards the base (most leaves entire), the larger leaves < 3 cm wide; lianas climbing by twining; fruit a fleshy berry; flowers 5-merous, with a fused, tubular corolla[*Lonicera*] **CAPRIFOLIACEAE**
- 14 Leaves serrate, the teeth towards the leaf apex, the larger leaves > 4 cm wide; lianas climbing by adventitious roots; fruit a capsule; flowers 7-10-merous, with separate petals[*Decumaria*] **HYDRANGEACEAE**
- 12 Upright shrubs or trees, lacking any adaptations for climbing.
- 15 Trees; leaves often a mix of alternate and opposite.
- 16 Leaves harshly scabrous on the upper surface; fruit a multiple of achenes; leaf venation pinnate but irregular[*Broussonetia*] **MORACEAE**
- 16 Leaves not scabrous; fruit a 2-4-seeded drupe; leaf venation neatly pinnate, the lateral veins nearly straight and parallel to one another[*Frangula*, *Rhamnus*] **RHAMNACEAE**
- 15 Shrubs; leaves strictly opposite (or often a mix of alternate and opposite in RHAMNACEAE).
- 17 Leaves strongly triple-veined from at or near the base of the blade, the 2 lateral veins arching towards the tip and rejoining the midvein or nearly so (becoming diffuse before rejoining); petals 4, white; stamens 15-90....[*Philadelphus*] **HYDRANGEACEAE**
- 17 Leaves pinnate-veined; petals various, not both 4 and white (except sometimes in *Hydrangea*); stamens 1-15 (except 15-30 in *Exochorda* in ROSACEAE).
- 18 Inflorescence head-like; flowers sympetalous and 4-lobed; fruit 2 seeded[*Lantana*] **VERBENACEAE**
- 18 Inflorescence more diffuse, with internal axes and pedicels; flowers not both sympetalous and 4-lobed (except in *Forsythia* and *Buddleja*); fruit 1-seeded, 2-4-seeded, or 4-many-seeded.
- 19 Plants in flower.
- 20 Corolla absent; flowers inconspicuous and small, in axillary fascicles or catkins.
- 21 Flowers in catkins; leaves usually a mix of opposite and alternate[*Salix (purpurea)*] **SALICACEAE**
- 21 Flowers in axillary fascicles; leaves strictly opposite (subopposite).....[*Forestiera*] **OLEACEAE**
- 20 Corolla present; flowers larger, in terminal cymes, corymbs, racemes, panicles, or in axillary cymes or fascicles.
- 22 Petals separate; stamens 8-10 -30 (or 4-6 in RHAMNACEAE and *Euonymus* in CELASTRACEAE).
- 23 Flowers 1-few, in axillary cymes; stamens 4-6; stems brown, tan, gray, or green.
- 24 Leaf venation pinnate, but irregular and reticulated; stems green[*Euonymus*] **CELASTRACEAE**
- 24 Leaf venation neatly pinnate, the lateral veins nearly straight and parallel to one another; stems brown, tan, or gray.....[*Frangula*, *Rhamnus*] **RHAMNACEAE**
- 23 Flowers many, in terminal racemes, panicles, or corymbs; stamens 8-10 -30; stems brown, tan or gray.
- 25 Inflorescence a raceme; stamens 15-30.....[*Exochorda*] **ROSACEAE**

- 25 Inflorescence a terminal panicle or corymb; stamens 8-15 [*Deutzia, Hydrangea*] **HYDRANGEACEAE**
- 22 Petals fused, at least basally, and often strongly tubular; stamens 2, 4, or 5.
- 26 Stamens 5.
- 27 Petals white, fused basally only, the lobes spreading [*Viburnum*] **ADOXACEAE**
- 27 Petals pink, yellow, or reddish, fused for most of their length [*Diervilla, Weigela*] **DIERVILLACEAE**
- 26 Stamens 2 or 4.
- 28 Stamens 2; petals yellow; flowers radially symmetrical; inflorescence an axillary fascicle
..... [*Forsythia*] **OLEACEAE**
- 28 Stamens 4; petals white, pink, or lavender; flowers bilabiate; inflorescence a terminal thyrse or panicle or an axillary cyme.
- 29 Petals 4; inflorescence a terminal thyrse [*Buddleja*] **SCROPHULARIACEAE**
- 29 Petals 5; inflorescence a terminal panicle or an axillary cyme.
- 30 Inflorescence an axillary cyme [*Callicarpa*] **LAMIACEAE**
- 30 Inflorescence a terminal panicle [*Kolkwitzia*] **LINNAEACEAE**
- 18 Plants in fruit.
- 31 Fruit a drupe or achene, indehiscent, fleshy at maturity (or dry in *Kolkwitzia*).
- 32 Fruit an achene (1-seeded), dry at maturity [*Kolkwitzia*] **LINNAEACEAE**
- 32 Fruit a drupe (1-4 seeded), fleshy at maturity.
- 33 Inflorescence a terminal corymb [*Viburnum*] **ADOXACEAE**
- 33 Inflorescence axillary, fascicled or a cyme.
- 34 Foliage with stellate hairs; fruit a pink-purple 4-seeded drupe [*Callicarpa*] **LAMIACEAE**
- 34 Foliage glabrous or with simple hairs; fruit a dark red, black, or blue 1-4-seeded drupe.
- 35 Fruit a 1-seeded drupe; [of NC southward and westward] [*Forestiera*] **OLEACEAE**
- 35 Fruit a 2-4-seeded drupe; [widespread in our area] [*Frangula, Rhamnus*] **RHAMNACEAE**
- 31 Fruit a capsule, dehiscent, dry at maturity.
- 36 Inflorescence a catkin, the flowers small (< 5 mm in diameter) and tightly arranged on the inflorescence axis (>5 per cm of the axis) [*Salix*] **SALICACEAE**
- 36 Inflorescence various, but more diffuse, the flowers larger (> 5 mm in diameter, except for some flowers in *Hydrangea* in HYDRANGEACEAE) and loosely arranged (< 5 per cm of axis).
- 37 Capsule prominently 5-angled (star-shaped in ×-section) [*Exochorda*] **ROSACEAE**
- 37 Capsule not angled.
- 38 Inflorescence axillary, fascicled.
- 39 Capsule pink to red; fruits solitary or in axillary cymes [*Euonymus*] **CELASTRACEAE**
- 39 Capsule brown; fruits in axillary fascicles [*Forsythia*] **OLEACEAE**
- 38 Inflorescence terminal, a raceme, panicle, corymb, or compound cyme.
- 40 Inflorescence a flat-topped corymb or rounded compound cyme, as wide as or wider than long
..... [*Hydrangea*] **HYDRANGEACEAE**
- 40 Inflorescence elongated, a raceme or panicle, longer than wide.
- 41 Capsule elongate (>3× as long as wide), 8-25 mm long [*Diervilla, Weigela*] **DIERVILLACEAE**
- 41 Capsule about as long as wide, 3-6 mm long.
- 42 XXXX [*Deutzia*] **HYDRANGEACEAE**
- 42 YYYY [*Buddleja*] **SCROPHULARIACEAE**

Key J3 – lianas with opposite simple leaves with entire margins

- 1 Fresh plants with white, milky juice; pistils 2, united only by the style and stigma; fruit a pair of linear follicles, > 8× as long as thick
..... [*Periploca, Thrysanthella, Trachelospermum, Angadenia, Vinca*] **APOCYNACEAE**
- 1 Fresh plants with clear juice; pistil 1; fruit a capsule (< 3× as long as wide) or paired berries.
- 2 Flowers white, pale yellow, orange, or red, distinctly to obscurely bilaterally symmetrical; leaves at or above the middle, the apex rounded, obtuse, to broadly acute [*Lonicera*] **CAPRIFOLIACEAE**
- 2 Flowers bright yellow, radially symmetrical; leaves widest well below the middle, the apex acuminate [*Gelsemium*] **GELSEMIACEAE**
- {add *Paederia* in **RUBIACEAE**}

Key J4 – shrubs and subshrubs with opposite simple leaves with entire margins

- 1 Aerial and epiphytic, hemiparasitic shrub [*Phoradendron*] **SANTALACEAE**
- 1 Terrestrial, autotrophic shrub or subshrub.
- 2 Creeping or short subshrubs, the stems primarily prostrate, < 2 dm tall.
- 3 Well-developed leaves 4-6 per stem; inflorescence a head subtended by 4 large white bracts [*Cornus (canadensis)*] **CORNACEAE**
- 3 Well-developed leaves many per stem; inflorescence of individual flowers axillary in pairs or clusters or in terminal cymes.
- 4 Flowers yellow; leaves with pellucid or dark punctate glands (use at least 10× magnification) [*Hypericum*] **HYPERICACEAE**
- 4 Flowers white, pale pink, or deep pink; leaves lacking sessile, punctate glands.
- 5 Leaves linear; flowers pale to deep pink, 5-merous [*Phlox*] **POLEMONIACEAE**
- 5 Leaves orbicular or elliptic; flowers white to pale pink, 4-merous or 5-merous
- 6 Leaves elliptic; flowers 5-merous; fruit a brownish capsule [*Kalmia (buxifolia)*] **ERICACEAE**
- 6 Leaves orbicular; flowers 4-merous; fruit a red berry [*Mitchella*] **RUBIACEAE**
- 2 Upright shrubs, > 3 dm tall
- 7 Inflorescence a terminal head of many flowers.
- 8 Head spherical, lacking an involucre of conspicuous bracts or phyllaries [*Cephalanthus*] **RUBIACEAE**
- 8 Head flattened, **either** subtended by 4 large white bracts **or** by an involucre with >5 green phyllaries.
- 9 Head subtended by 4 large white bracts; leaves with prominently parallel-arcing secondary veins; flowers 4-merous
..... [*Cornus (florida, kousa)*] **CORNACEAE**

- 9 Head subtended by an involucre of >5 green phyllaries; leaves with venation otherwise; flowers 5-merous..... [Borrchia, Iva, Palafoxia] **ASTERACEAE**
- 7 Inflorescence otherwise, of a solitary flower, of terminal corymbs, cymes, or panicles, or axillary.
- 10 Inflorescence flat-topped (broader than long), terminal, a compound cyme or corymb.
- 11 Flowers bright yellow; stamens many; leaves < 1.5 cm wide; fruit a capsule; leaves with pellucid or dark punctate glands (use at least 10× magnification)..... [Hypericum] **HYPERICACEAE**
- 11 Flowers white or creamy; stamens 4-5; leaves > 1.5 cm wide; fruit a drupe; leaves lacking sessile, punctate glands.
- 12 Petals 5; foliage with simple hairs [Viburnum] **ADOXACEAE**
- 12 Petals 4; foliage with T-shaped hairs [Cornus] **CORNACEAE**
- 10 Inflorescence terminal and not flat-topped, or axillary and variously shaped.
- 13 Carpels many, separate; stamens many; perianth segments many, maroon, brown, or yellowish; fruit a wrinkled, 3-7 cm long, brown to black aggregate of achenes; flowers solitary in axils; [Basal Angiosperms] [Calycanthus] **CALYCANTHACEAE**
- 13 Carpels 1-5, fused; stamens 1-5; perianth segments 4-5 or 8, white, pink, lavender, or bright yellow; fruit a simple capsule, drupe, or berry; flowers 2-many, in axillary or terminal inflorescences (pistillate flowers sometimes solitary in **SANTALACEAE**; [Eudicots].
- 14 Ovary inferior; corolla absent, radially symmetrical, or bilaterally symmetrical; fruit **either** a berry **or** a 1-seeded drupe.
- 15 Flowers unisexual and plants dioecious; corolla absent; pistillate flowers solitary, either terminal or axillary, staminate flowers in axillary pedunculate umbels; fruit a 1-seeded drupe; leaves acute to acuminate at the apex..... [Buckleya, Nestronia] **SANTALACEAE**
- 15 Flowers bisexual and plants hermaphroditic; corolla present; flowers paired, terminal or axillary, or in axillary spikes; fruit a berry; leaves rounded, obtuse, to acute (or acuminate in *Lonicera maackii*) at the apex [Lonicera, Symphoricarpos] **CAPRIFOLIACEAE**
- 14 Ovary superior; corolla radially symmetrical (absent in *Forestiera* in **OLEACEAE**); fruit **either** a 1-4-seeded drupe **or** a capsule.
- 16 Stamens 8-10, of 2 different lengths in each flower; petals separate, 4-5 (-7), pink purple, 10-15 mm long; stems strongly arching, rooting at the tips; [plants of flooded to saturated wetlands]..... [Decodon] **LYTHRACEAE**
- 16 Stamens **either** (1-) 2 (-4), **or** 4-5, **or** 10, all of the same length; petals fused (separate in **RHAMNACEAE**, but then < 5 mm long and white), white, bright-yellow, lilac, or pink; stems erect (or at least not arching and rooting at the tips); [plants of various habitats].
- 17 Petals separate, 4-5, white; stamens 4-5; fruit a drupe with 2-4 pyrenes [Frangula, Rhamnus] **RHAMNACEAE**
- 17 Petals fused, 4-5, white, bright yellow, lilac, or pink; stamens either (1-) 2 (-4) **or** 10; fruit either a capsule or a 1-seeded drupe.
- 18 Perianth 5-merous; corolla pink; stamens 10; fruit a 5-locular capsule..... [Kalmia (*angustifolia*, *carolina*, *polifolia*)] **ERICACEAE**
- 18 Perianth 4-merous; corolla white, bright yellow, or lilac; stamens (1-) 2 (-4); fruit either a 1-seeded drupe or a 2-locular capsule..... [Chionanthus, Forestiera, Forsythia, Jasminum, Ligustrum, Osmanthus, Syringa] **OLEACEAE**
- [add: [*Lagerstroemia*] **LYTHRACEAE**; [*Punica*] **LYTHRACEAE**; [*Rosmarinus*] **LAMIACEAE**; various other [see spreadsheet]]

Key J5 – trees with opposite simple leaves with entire margins

- 1 Leaves evergreen (dark green, thick in texture); leaves typically opposite to subopposite (offset by < 2mm from the opposing leaf) [Cartrema, Ligustrum] **OLEACEAE**
- 1 Leaves deciduous (medium to pale green, thin in texture); leaves strictly opposite.
- 2 Leaves 1.5-7 cm wide, cuneate to rounded at the base, with prominently parallel-arching secondary veins; flowers 4-merous, radially symmetrical, small (< 8 mm long); fruit a drupe; small trees [Cornus] **CORNACEAE**
- 2 Leaves 10-70 cm wide, cordate or subcordate at the base, with complexly branching secondary and tertiary veins; flowers 5-merous, bilaterally symmetrical, large (20-70 mm long); fruit a capsule; medium to large trees.
- 3 Flowers white to yellow; capsules linear, >10× as long as wide; leaf undersurface with curly simple hairs; nectar glands present in the main vein axils on the undersurface of the leaf (visible from the underside or the upperside in fresh leaves and herbarium specimens as a triangle 1-4 mm on a side)..... [Catalpa] **BIGNONIACEAE**
- 3 Flowers lavender; capsules ellipsoid, < 2× as long as wide; leaf undersurface with branched (dendritic or stellate) hairs; nectar glands absent..... [Paulownia] **PAULOWNIACEAE**
- [add [*Pinckneya*] **RUBIACEAE**, and others from spreadsheet]

Key K – holoparasites and holomycotrophs

- 1 Stems thin, flexible, twining, yellow to bright orange [Cuscuta] **CONVOLULACEAE**
- 1 Stems erect, stiff, straight, variously colored (tan, red, violet, brown, white, pink).
- 2 Flowers radially symmetrical [Hypopitys, Monotropa, Monotropsis] **ERICACEAE**
- 2 Flowers bilaterally symmetrical.
- 3 Petals 3, separate; stamen 1; capsule 1-locular, pendent when mature, opening by 3 slits; [Monocots]..... [Corallorhiza, Hexalectris, and Aplectrum, Tipularia by apparent absence of a green leaf] **ORCHIDACEAE**
- 3 Petals fused into a tube, with 4-5 lobes; stamens 4; capsule 2-locular, ascending or spreading when mature, opening by 2 valves; [Eudicots] [Conopholis, Epifagus, Orobanchae] **OROBANCHACEAE**

Key L – epiphytic angiosperms

{Note that epiphytic Pteridophytes are not re-keyed here; seek them in Keys A4 and A6}

- 1 Stems yellow to bright orange, lacking leaves [Cuscuta] **CONVOLULACEAE**
- 1 Stems green or brown, with leaves (scale-like or larger).

- 2 Leaves opposite, orbicular or oblanceolate, rounded at the apex; [Eudicots] [Phoradendron] SANTALACEAE
 2 Leaves alternate, **either** scale-like, **or** elongate and tapering, **or** lanceolate-elliptic; [Monocots].
 3 Leaves **either** scale-like **or** elongate and tapering; flowers radially symmetrical [Tillandsia] BROMELIACEAE
 3 Leaves lanceolate-elliptic; flowers bilaterally symmetrical..... [Epidendrum] ORCHIDACEAE

Key M – monocots

[Note that strictly aquatic monocots are not re-keyed here; seek them in Key C. Some amphibious monocots are keyed both here and in Key C]

- 1 Leaves lacking a differentiated petiole, **either** with essentially parallel margins for most of the leaf's length, **or** tapering from base to apex, **or** scale like (< 15 mm long, often clasping the stem), **or** with lanceolate leaves slightly dilated above the base and > 6× as long as broad, **or** a grass (the leaf consisting of a sheath, with a ligule and/or constriction at the summit, diverging from the stem into a blade, this sometimes no more than 3× as long as wide, but more often lanceolate to linear); leaves simple and unlobed.....
**Key M1 – monocots with linear, scale, or narrow leaves (or grasses)**
 1 Leaves with a differentiated petiole and blade, the blade > 10 mm long, and the leaf < 6× as long as broad; leaves **either** simple and unlobed, **or** compound, **or** palmately divided**Key M2 – monocots with broad leaves**

Key M1 – monocots with linear, scale, or narrow leaves (or grasses)

- 1 Primary inflorescences of spikelets, these consisting of 1-2-many reduced florets, each subtended by 1-2 scales (and also enclosed in a sac or perigynium in *Carex* in CYPERACEAE), arrayed spirally or distichously, the spikelets then themselves arrayed in various dense or diffuse secondary or tertiary inflorescences; perianth absent, or reduced to chaff, scales, paddles, or bristles.
 2 Leaf sheaths continuous, lacking a split or only irregularly split in age; leaves usually 3-ranked (sometimes reduced to a sheath with a small scale at the summit; stems triangular in ×-section (or roundish), usually with a pith; flowers spirally arrayed in the spikelet (or distichously arrayed, in e.g. *Cyperus*, *Dulichium*, *Kyllinga*); anthers basifixed.....**CYPERACEAE**
 2 Leaf sheaths generally split lengthwise on the side opposite the leaf blade; leaves usually 2-ranked; stems round or flattened in ×-section, usually hollow; flowers distichously arrayed in the spikelet; anthers versatile.....**POACEAE**
 1 Primary inflorescences of dense spikes, spadices, heads, or glomerules; perianth present, often very small and variously colored.
 3 Leaves equitant (the leaves distichous, in a fan-like array, e.g. *Iris*, each leaf clasping the next above in a basal fold, this uniting above so that the main leaf blade, above the basal fold, has only the lower [abaxial] leaf surface visible because of fusion of the 'upper' surfaces.
 4 Inflorescence a very densely flowered spike (spadix), appearing lateral, 1 per plant; fresh plant strongly aromatic.....
 [Acorus] **ACORACEAE**
 4 Inflorescence **either** more diffuse, 1 or several per plant, **or** terminal and cone-like; fresh plant not aromatic.
 5 Inflorescence brownish or tan, spherical, ovoid, or cylindrical, with numerous scale-like bracts arrayed in a cone; flowers individually conspicuous, a single yellow (to whitish) flower at a time emerging from each of the scales.....[*Xyris*] **XYRIDACEAE**
 5 Inflorescence more diffuse.
 6 Inflorescence or flower groups subtended by well-developed, green or scarious spathaceous bracts; inflorescence **either** a fan-shaped pair of cymes, **or** seemingly racemose, **or** solitary.....[*Crocasmia*, *Freesia*, *Gladiolus*, *Iris*, *Sisyrinchium*] **IRIDACEAE**
 6 Inflorescence or flower groups not subtended by spathes (though individual flowers may be subtended by small green bracts); inflorescence a raceme, panicle, or corymb.
 7 Inflorescence a corymb of helicoid cymes; corolla yellow, densely tomentose; roots bright red (*Lachnanthes*) or white to brown (*Lophiola*).
 8 Stamens 6, included; inner 3 tepals > 2 mm longer than the outer 3 tepals; rhizomes and roots of fresh plants bright red.....
[*Lachnanthes*] **HAEMODORACEAE**
 8 Stamens 3, exserted; inner 3 and outer 3 tepals equal in length; rhizomes at roots of fresh plants white to brown.....
[*Lophiola*] **NARTHECIACEAE**
 7 Inflorescence a terminal raceme (the flowers attached to the rachis in groups of 3 or more in *Triantha* in TOFIELDIACEAE); corolla white, cream, or yellow, glabrous; roots white or brown.
 9 Flowers yellow; capsule loculicidal [Narthecium] **NARTHECIACEAE**
 9 Flowers white (yellow in *Harperocallis*, endemic to FL Panhandle); capsule septicidal.....
 [Harperocallis, Pleea, Tofieldia, Triantha] **TOFIELDIACEAE**
 3 Leaves not equitant, sometimes distichous, upper and lower surfaces both present.
 10 Inflorescence **either** a linear spike, terminal, the thicker female portion below, the thinner male portion above, **or** an ovoid, hemispheric, spherical head or glomerule, 1 or several per plant
 11 Inflorescence a linear spike, terminal, the thicker female portion below, the thinner male portion above [Typha] **TYPHACEAE**
 11 Inflorescence an ovoid, hemispheric, or spherical head or glomerule, 1 or several per plant.
 12 Flowers in a single head terminating an elongate scape; leaves basal (often with 1-2 much smaller leaves or bladeless sheaths on the lower part of the scape); inflorescence white, tan, pale yellow, gray, or blackish, the head usually as broad as or broader than long, involucrate [Eriocaulon, Lachnocaulon, Syngonanthus] **ERIOCAULACEAE**
 12 Flowers in multiple heads, not scapose; leaves basal and usually also prominently cauline; inflorescence green, tan, brown, or reddish, the head spherical, not involucrate.
 13 Flowers bisexual, the flowers in various arrays [Juncus, Luzula] **JUNCACEAE**
 13 Flowers unisexual, the male flowers in a terminal head, the female flowers in heads below the male along a usually zigzag stem [Sparganium] **TYPHACEAE**
 10 Individual flowers solitary or in more diffuse inflorescences; perianth present, at least one whorl petal-like in size, color, and texture.
 14 Flowers bilaterally symmetrical; stamen 1 or 2; tepals 6; perianth often differentiated into a lip and 5 petaloid tepals.....
 **ORCHIDACEAE**
 14 Flowers radially symmetrical (sometimes weakly bilaterally symmetrical); stamens 6 (rarely 3); tepals usually 6 (rarely 3), when 6, either undifferentiated (6 tepals) or differentiated into 3 petals and 3 sepals.
 15 Leaves <10 mm long, scale-like or linear; leaves cauline.
 16 Leaves (actually cladophylls) clustered, in whorls of (1-) 2-20 (-25); fruit a berry; perianth undifferentiated, of 6 yellow, white, or green tepals [Asparagus] **ASPARGACEAE**

- 16 Leaves alternate; fruit a capsule; perianth **either** differentiated, the 3 petals yellowish-green or maroon, **or** undifferentiated, the 6 tepals white, blue, or purplish.
- 17 Plants terrestrial, erect; stems and leaves lacking a scaly indumentum; flower solitary, or several to many in heads or racemose cymes; perianth undifferentiated, the 6 tepals white, blue, or purplish [Apteria, Burmannia] **BURMANNIACEAE**
- 17 Plants **either** epiphytic and pendulous in festoons, **or** terrestrial, wetland, or aquatic and sprawling; stems and leaves with or without a scaly indumentum; flowers solitary and axillary; perianth differentiated, the 3 petals either yellowish-green or maroon.
- 18 Plants epiphytic, pendulous in festoons; stems and leaves densely covered by silvery scales; petals yellowish-green [Tillandsia] **BROMELIACEAE**
- 18 Plants of moist to wet habitats, sprawling or aquatic; stems and leaves not covered by silvery scales; petals maroon [Mayaca] **MAYACACEAE**
- 15 Leaves (at least the larger) > 25 mm long, linear or narrowly lanceolate; leaves basal, basally disposed (or rarely mostly or entirely cauline).
- 19 Ovary inferior (or partly inferior; ambiguous taxa keyed both ways).
- 20 Inflorescence axillary, a raceme or umbel (or reduced to a single flower); petaloid tepals yellow [Hypoxis] **HYPOXIDACEAE**
- 20 Inflorescence terminal; petaloid tepals various (including yellow).
- 21 Inflorescence or flower groups subtended by well-developed, green or scarious spathaceous bracts; inflorescence **either** an umbel, **or** fan-shaped pair of cymes, or seemingly racemose, **or** solitary.
- 22 Stamens 6; inflorescence an umbel (or sometimes solitary) [Crinum, Galanthus, Habranthus, Hymenocallis, Leucojum, Lycoris, Narcissus, Nothoscordum, Sternbergia, Tristagma, Zephyranthes] **AMARYLLIDACEAE**
- 22 Stamens 3; inflorescence **either** a fan-shaped pair of cymes **or** seemingly racemose (**or** rarely solitary (e.g. *Crocus*)) [Alophia, Calydorea, Crocosmia, Crocus, Freesia, Herbertia, Nemastylis] **IRIDACEAE**
- 21 Inflorescence or flower groups not subtended by spathes (though individual flowers may be subtended by small green bracts; inflorescence a raceme or panicle.
- 23 Leaves fleshy; anthers 12-15 mm long [Manfreda] **AGAVACEAE**
- 23 Leaves herbaceous; anthers < 5 mm long.
- 24 Tepals connate into a tube; perianth tube exterior farinose; flowers bisexual, white to bright yellow; inflorescence a raceme [Alettris] **NARTHECIACEAE**
- 24 Tepals distinct; perianth not farinose; flowers unisexual or bisexual, white, greenish, or creamy; inflorescence a raceme or panicle (raceme of racemes) [Amianthium, Anticlea, Stenanthium, Veratrum, Zigadenus] **MELANTHIACEAE**
- 19 Ovary superior (or partly inferior; ambiguous taxa keyed both ways).
- 25 Gynoecium of 2 or more pistils, each pistil consisting of 1 carpel and with 1 stigma; [wetland plants].
- 26 Inflorescence a terminal raceme, the flowers (fruits) in whorls of 3; perianth differentiated into showy petals and green sepals, the petals white; leaf not differentiated into a sheath and blade separated by a ligule; fruit an aggregate of achenes. [Alisma, Helanthis, Sagittaria] **ALISMATACEAE**
- 26 Inflorescence a terminal raceme or spike, the flowers (fruits) alternate; perianth not differentiated, consisting of 3 or 6 green or yellow-green tepals; leaf differentiated into an open sheath and blade, with a ligule separating them; fruit an aggregate of achenes or follicles.
- 27 Inflorescence ebracteate, with > 10 flowers; leaf without a terminal pore; carpels ascending, appressed to one another [Triglochin] **JUNCAGINACEAE**
- 27 Inflorescence bracteate, with < 10 flowers; leaf with a terminal pore; carpels widely divergent, at nearly right angles to the axis [Scheuchzeria] **SCHEUCHZERIAACEAE**
- 25 Gynoecium of 1 pistil, with 2-6 stigmas; [wetland and upland plants].
- 28 Leaves strictly or primarily cauline.
- 29 Leaves linear, > 15 cm long, hollow or flat; inflorescence an umbel; fresh plants with an oniony odor [Allium, Nothoscordum] **AMARYLLIDACEAE**
- 29 Leaves linear to lanceolate, < 15 cm long, flat or threadlike; inflorescence various, not an umbel; fresh plants without oniony odor.
- 30 Petals < 2 cm long, white, blue, or pink; leaves alternate [Commelina, Murdannia, Tradescantia] **COMMELINACEAE**
- 30 Petals > 5 cm long, yellow, orange, or red; leaves alternate or whorled [Lilium] **LILIACEAE**
- 26 Leaves strictly or primarily basal (the basal leaves persistent, and larger than any stem leaves).
- 31 Perianth differentiated into 3 bright pink petals and 3 green sepals [Cuthbertia] **COMMELINACEAE**
- 31 Perianth not differentiated, the 6 segments similar in color, shape, and size, of various colors (rarely even pink, in *Helonias* in **HELONIADACEAE**).
- 32 Tepals brown or green, not at all yellow, white, or otherwise more brightly colored; inflorescence branched and complex [Juncus, Luzula] **JUNCACEAE**
- 32 Tepals white, cream, pink, greenish-yellow, yellow, orange, pink, blue, or blue-brown; inflorescence **either** a terminal umbel, subtended by spathes or bracts, **or** a terminal raceme or panicle (or a terminal corymb in *Ornithogalum* in **HYACINTHACEAE**), not subtended by spathes or bracts.
- 33 Inflorescence a terminal umbel, subtended by spathes or bracts; fresh plants with or without an oniony odor [Allium, Nothoscordum] **AMARYLLIDACEAE**
- 33 Inflorescence a terminal raceme or panicle (or a terminal corymb in *Ornithogalum* in **HYACINTHACEAE**), not subtended by spathes or bracts.
- 34 Tepals evidently connate, fused at least basally and sometimes nearly their entire length; filaments adnate to the tepals.
- 35 Tepals 5-8.5 cm long, yellow to orange; anthers dorsifixed (attached near the middle) *Hemerocallis* in **XANTHORRHOACEAE**
- 35 Tepals 0.2-1.0 0.2-1.2 (-2.0) cm long, white, cream, yellow, blue, or blue-brown; anthers basifixed (attached at the base) or dorsifixed (attached at the back).

- 36 Perianth blue or blue-brown, not farinose; leaves 2-7, erect, ascending, or the tips spreading; anthers dorsifixed (attached at the back) [*Chionodoxa, Muscari*] **HYACINTHACEAE**
- 36 Perianth white, cream, or yellow, farinose-roughened on the outer surface; leaves typically > 8, spreading to slightly ascending (often forming a flattish rosette); anthers basifixed (attached at the bottom) [*Alettris*] **NARTHECIACEAE**
- 34 Tepals completely distinct; filaments free (rarely epitepalous).
- 37 Styles 1, lobed only in the upper portion; capsules loculicidal; tepals **either** blue **or** white with a broad green central stripe.
- 38 Tepals blue; inflorescence a raceme [*Camassia*] **AGAVACEAE**
- 38 Tepals white, with a broad green stripe; inflorescence an umbel or raceme [*Ornithogalum*] **HYACINTHACEAE**
- 37 Styles 3, separate to the base; capsules septicidal (sometimes then also secondarily loculicidal); tepals white, greenish, yellowish, or pink.
- 39 Inflorescence ebracteate, lacking bracts subtending pedicels; flowers bisexual (*Helonias*) or predominantly unisexual and on different plants (dioecious) (*Chamaelirium*); tepals pink (*Helonias*) or white to cream (*Chamaelirium*) [*Chamaelirium, Helonias*] **HELONIADACEAE**
- 39 Inflorescences bracteate, with bracts subtending individual pedicels and (if they are present) branches of the inflorescence; tepals white, greenish-white, or cream.
- 40 Leaves narrowly linear, 1-2.5 mm wide, rigid, keeled, and serrulate; stems and leaves strictly glabrous [*Xerophyllum*] **XEROPHYLLIDACEAE**
- 40 Leaves linear or oblanceolate (rarely narrowly linear), > 2 mm wide, flexible, unkeeled, and with entire margins; stems and leaves pubescent with hairs or scales (except *Amianthium*) [*Amianthium, Anticlea, Schoenocaulon, Stenanthium, Veratrum, Zigadenus*] **MELANTHIACEAE**

Key M2 – monocots with broad leaves

- 1 Leaves compound.
- 2 Plants herbaceous; leaves palmately 3-foliolate or pedately compound [*Arisaema, Pinellia*] **ARACEAE**
- 2 Plants woody; leaves either palmately divided or pinnately compound into > 20 segments **ARECACEAE**
- 1 Leaves simple.
- 3 Leaves opposite or whorled, cauline.
- 4 Leaves opposite; flowers bilaterally symmetrical [*Listera*] **ORCHIDACEAE**
- 4 Leaves whorled; flowers radially or bilaterally symmetrical.
- 5 Plant with 2 or more leaf-bearing nodes (all nodes whorled or some alternate).
- 6 Leaves broad, < 2× as long as wide, cordate at the base; flowers unisexual and plants dioecious [*Dioscorea*] **DIOSCOREACEAE**
- 6 Leaves lanceolate, oblanceolate or narrowly elliptic, > 4× as long as wide, cuneate at the base; flowers bisexual and plants hermaphroditic [*Lilium, Medeola*] **LILIACEAE**
- 5 Plant with a single leaf-bearing node.
- 7 Leaves in whorls of 3 leaves [*Trillium*] **TRILLIACEAE**
- 7 Leaves in whorls of 5 or more leaves.
- 8 Stem floccose, wiry (and at maturity with a second smaller whorl with usually 3 leaves subtending the flowers); flowers radially symmetrical [*Medeola*] **LILIACEAE**
- 8 Stem glabrous, fleshy, never with a second whorl; flowers bilaterally symmetrical [*Isotria*] **ORCHIDACEAE**
- 3 Leaves alternate, cauline or basal.
- 9 Inflorescence a spadix (a dense spike of hundreds of flowers, the rachis thickened and somewhat fleshy) subtended by a spathe (a green, white, orange, yellowish-green, or maroon bract) (spathe missing in *Orontium*) [*Arum, Calla, Colocasia, Orontium, Peltandra, Symplocarpus, Xanthosoma*] **ARACEAE**
- 9 Inflorescence otherwise, a raceme, panicle, cyme, etc., the flowers arrayed in a more diffuse manner, the central rachis not thickened, the inflorescence subtended or not by green or scarious spathes.
- 10 Flowers bilaterally symmetrical; stamen 1 or 2; tepals 6; perianth often differentiated into a lip and 5 petaloid tepals **ORCHIDACEAE**
- 10 Flowers radially symmetrical (weakly to strongly bilaterally symmetrical in **PONTEDERIACEAE**); stamens 6 (rarely 3, 4, 5, 9, 12, 15, or 18); tepals usually 6 (rarely 3 or 4), when 6, either undifferentiated (6 or 4 tepals) or differentiated into 3 petals and 3 sepals.
- 11 Inflorescence subtended by spathes (well-developed green or scarious bracts); [plants of uplands and wetlands].
- 12 Perianth not differentiated, consisting of 6 similarly colored and shaped tepals; flowers strongly to slightly bilaterally symmetrical; inflorescence lacking well-developed spathaceous bracts [*Eichhornia (azurea), Heteranthera, Pontederia*] **PONTEDERIACEAE**
- 12 Perianth differentiated into green sepals and more brightly colored petals; flowers radially symmetrical (or weakly bilaterally symmetrical, as in some *Commelina*).
- 13 Ovary superior; fruit a capsule; stamens 6; [plants mainly of uplands (sometimes, *Murdannia* and sometimes *Commelina*, of wetlands)] [*Callisia, Commelina, Gibasis, Murdannia, Tradescantia*] **COMMELINACEAE**
- 13 Ovary inferior; fruit a berry; stamens 9 or 12 (or 15 or 18); [plants of wetlands] [*Limnobium*] **HYDROCHARITACEAE**
- 11 Inflorescence not subtended by spathes, though individual small green bracts sometimes subtending individual flowers.
- 14 Perianth differentiated into green sepals and white petals; gynoecium of 2 or more pistils, each pistil consisting of 1 carpel and with 1 stigma; fruit an aggregate of achenes; inflorescence a raceme or panicle with branching in whorls of 3; [wetland plants] [*Echinodorus, Helanthis, Sagittaria*] **ALISMACEAE**
- 14 Perianth not differentiated into strikingly different whorls (at most, with only subtle variation in the size or shape of the outer and inner whorls of the perianth); gynoecium of 1 pistil, with 2-6 stigmas; fruit simple, a capsule or berry; ; inflorescence various, terminal or axillary, but if a raceme or panicle, not with branching in whorls of 3; [upland (or very rarely wetland) plants].
- 15 Leaves basal or basally disposed.
- 16 Leaves 2 (rarely 3 in *Convallaria* in **RUSCACEAE**).

- 17 Inflorescence a raceme; fruit a berry; tepals united, the perianth urceolate [Convallaria] **RUSCACEAE**
- 17 Inflorescence an umbel or a solitary flower; fruit a capsule; tepals separate or basally fused.
- 18 Flowers in an umbel, white; fresh plants with oniony odor..... [Allium {triccoccum, burdickii}] **ALLIACEAE**
- 18 Flowers solitary, white or yellow; fresh plants without strong odor..... [Erythronium] **LILIACEAE**
- 16 Leaves 4 or more.
- 19 Inflorescence a terminal umbel; fruit a blue or black berry; tepals white or yellow; flowers bisexual..... [Clintonia] **LILIACEAE**
- 19 Inflorescence a terminal raceme or panicle; fruit a capsule; tepals white, green, yellowish, or pink; flowers either bisexual (*Helonias* in **HELONIADACEAE**), or unisexual and primarily on different plants (dioecious) (*Chamaelirium* in **HELONIADACEAE**), or a mix of bisexual and unisexual staminate flowers (*Veratrum* in **MELANTHIACEAE**)
- 20 Inflorescence ebracteate, lacking bracts subtending pedicels; flowers bisexual (*Helonias*) or predominantly unisexual and on different plants (dioecious) (*Chamaelirium*); tepals pink (*Helonias*) or white to cream (*Chamaelirium*)..... [Chamaelirium, Helonias] **HELONIADACEAE**
- 20 Inflorescences bracteate, with bracts subtending individual pedicels and (if they are present) branches of the inflorescence; tepals white, greenish-white, or cream [Veratrum] **MELANTHIACEAE**
- 15 Leaves cauline.
- 21 Leaves both cordate/subcordate (rarely merely rounded at the base) and obviously petiolate.
- 22 Inflorescence an axillary many-flowered umbel; fruit a berry; axillary tendrils often present (absent in some species).... [Smilax] **SMILACACEAE**
- 22 Inflorescence an axillary solitary flower, a few-flowered cyme, or a panicle; fruit a capsule (winged in *Dioscorea*, unwinged in *Croonia*); axillary tendrils never present (plant not climbing, or climbing by twining).
- 23 Tepals 6; stamens 6; flowers unisexual (and generally on separate plants, therefore dioecious); inflorescence of a solitary flowers or a panicle; ovary inferior; [widespread in our area] [Dioscorea] **DIOSCOREACEAE**
- 23 Tepals 4 (-5); stamens 4 (-5); flowers bisexual; ovary superior; [of AL and adjacent GA, FL, and perhaps LA] [Croonia] **STEMONACEAE**
- 21 Leaves not both cordate/subcordate and petiolate (some with cordate clasping or perfoliate leaf bases).
- 24 Leaves alternate and in whorls at some nodes; flowers orange; tepals > 5 cm long; inflorescence a terminal umbel or single flower..... [Lilium] **LILIACEAE**
- 24 Leaves strictly alternate; flowers yellow, white, pink, greenish, or maroon; inflorescence either a terminal cluster, raceme, or panicle, or an axillary raceme, cluster or solitary flower.
- 25 Leaves arrayed spirally around an erect, unbranched stem; fruit a septicidal capsule; flowers a mixture of bisexual and unisexual (staminate) on a plant; perianth greenish white [Veratrum] **MELANTHIACEAE**
- 25 Leaves arrayed distichously (2 ranked) along an arching, unbranched or dichotomously (Y-forking) branched stem; fruit a berry or loculicidal capsule; flowers all bisexual; perianth white, pink, or yellow.
- 26 Stem simple (never branched); inflorescence a terminal raceme or panicle (*Maianthemum*) or axillary racemes or clusters of 1-9 flowers (*Polygonatum*); fruit a berry [Maianthemum, Polygonatum] **RUSCACEAE**
- 26 Stem branched (always at least bifurcate in fertile individuals); fruit a berry or capsule.
- 27 Leaves perfoliate; fruit a capsule..... [Uvularia] **COLCHICACEAE**
- 27 Leaves sessile (though sometimes slightly to strongly clasping); fruit a berry or capsule.
- 28 Stem brown, wiry, puberulent; distalmost 2 leaves on each branch approximate to one another (sometimes subopposite) and with noticeably oblique bases; flowers and fruits terminal on the branches..... [Prosartes] **LILIACEAE**
- 28 Stem green, not wiry, glabrous; distalmost 2 leaves on each branch no closer together than other leaves, with symmetrical bases; flowers (and fruits) either terminal on the branches or solitary and axillary to most leaves.
- 29 Flowers and fruits in single terminal clusters (sometimes appearing axillary, but still only one cluster per branch of the stem); tepals pale to rich yellow [Uvularia] **COLCHICACEAE**
- 29 Flowers and fruits in many axillary clusters (many clusters per branch of the stem, in the axils of most leaves); tepals white to pink [Streptopus] **LILIACEAE**

Key N – herbaceous dicots with mainly basal leaves

- 1 Leaves compound..... **Key N1 – herbaceous dicots with mainly basal, compound leaves**
- 1 Leaves simple..... **Key N2 – herbaceous dicots with mainly basal, simple leaves**

Key N1 – herbaceous dicots with mainly basal, compound leaves

- 1 Leaves **either** 2-3-foliolate **or** palmately 4-11-foliolate (all the leaflets attached at a common point).
- 2 Leaves 2-foliolate; fruit a capsule, opening by a circumscissile lid..... [Jeffersonia] **BERBERIDACEAE**
- 2 Leaves **either** 3-foliolate **or** palmately or pedately 4-11-foliolate.
- 3 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypselum..... [many] **ASTERACEAE**
- 3 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.
- 4 Inflorescence an umbel; ovary inferior; fruit a mericarp of 2 schizocarps [many] **APIACEAE**
- 4 Inflorescence various, usually not an umbel (sometimes an umbel in *Oxalis* in **OXALIDACEAE**); ovary superior; fruit an aggregate, legume, berry, or 2-valved capsule.
- 5 Leaflets **either** entire **or** barely and very shallowly crenulate **or** notched at the tip (but otherwise entire).
- 6 Inflorescence a spadix, surrounded by a spathe; fruit a berry; [Monocots {illogically keyed here because of the likelihood of being mistaken for a dicot}] [Arisaema] **ARACEAE**
- 6 Inflorescence a raceme or umbel, not surrounded by a spathe; fruit a capsule or legume; [Eudicots].
- 7 Flowers bilaterally symmetrical; fruit a legume; [plant of uplands] [many] **FABACEAE**

- 7 Flowers radially symmetrical; fruit a 2-valved or 5-valved capsule; [plant of uplands or wetlands]
- 8 Leaflets not notched at the tip; flowers white; [plants of wetlands][*Menyanthes*] **MENYANTHACEAE**
- 8 Leaflets notched at the tip; flowers pink, white, or yellow; [plants of uplands] [Oxalis] **OXALIDACEAE**
- 5 Leaflets serrate, serrulate, or cleft.
- 9 Petals 4; stamens 6; fruit a silique..... [Cardamine] **BRASSICACEAE**
- 9 Petals 5 or more; stamens 10 or more; fruit **either** a legume **or** an aggregate of achenes or follicles
- 10 Stamens many, fused into a staminal tube; carpels 10-20, in a ring; pubescence stellate (sometimes mixed with simple hairs) [Callirhoe] **MALVACEAE**
- 10 Stamens 10-many, separate, or fused but not all into a staminal tube; carpel **either** 1 (FABACEAE), **or** 3-7 in a ring (RANUNCULACEAE), **or** many and spirally arranged on a conical receptacle (RANUNCULACEAE or ROSACEAE)
- 11 Leaflets serrulate; flowers bilaterally symmetrical; fruit a legume; corolla variously colored, including white..... **FABACEAE**
- 11 Leaflets serrate; flowers radially symmetrical; fruit an aggregate of achenes or of follicles; corolla white or yellowish or greenish.
- 12 Fruit an aggregate of follicles [Coptis, Eranthis, Helleborus] **RANUNCULACEAE**
- 12 Fruit an aggregate of achenes (borne on a fleshy, expanded receptacle in *Fragaria* and some *Potentilla*)
- 13 Flowers lacking a hypanthium [Ranunculus] **RANUNCULACEAE**
- 13 Flowers with a hypanthium [Fragaria, Geum, Potentilla] **ROSACEAE**
- 1 Leaves 1-pinnately compound (all leaflets attached to a central rachis) or more complexly compound (with several orders of branching, some leaflets at least attached to second-order branches from the rachis).
- 14 Leaves 1-pinnately compound (all leaflets attached to a central rachis).
- 15 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [many] **ASTERACEAE**
- 15 Inflorescence, flower, and fruit structure various, but not with the combination of features as above. **FABACEAE**
- 16 Flowers bilaterally symmetrical; fruit a legume **FABACEAE**
- 16 Flowers radially symmetrical; fruit a silique/silicle, or a schizocarp of mericarps, or an achene.
- 17 Petals 4; stamens 6; fruit a silique/silicle..... **BRASSICACEAE**
- 17 Petals 0 or 5 (if 0, the sepals petaloid); stamens 2, 4, 5, or many.
- 18 Stamens 5; fruit a schizocarp of 2 mericarps [Coriandrum, Oxypolis, Pastinaca, Sium] **APIACEAE**
- 18 Stamens 2, 4, or many; fruit an achene [Poteridium, Poterium, Sanguisorba] **ROSACEAE**
- 14 Leaves more complexly compound (with 2 or more orders of branching, some leaflets at least attached to second-order branches from the rachis).
- 19 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [many] **ASTERACEAE**
- 19 Inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers in a head subtended by bracts, but then with other features differing, such as stamens 4, or green calyx present, or petals separate, or fruit a schizocarp of mericarps, etc.).
- 20 Leaf segments or ultimate lobes linear or lanceolate, >2× as long as wide, < 4 mm wide.
- 21 Inflorescence an umbel; ovary inferior; fruit a mericarp of 2 schizocarps..... **APIACEAE**
- 21 Inflorescence various, but not an umbel; ovary superior; fruit an aggregate of follicles or an elongate capsule.
- 22 Carpels 2, fused; fruit an elongate capsule; flowers bilaterally symmetrical..... [Capnoides, Corydalis, Dicentra, Fumaria] **FUMARIACEAE**
- 22 Carpels 5-10 or many, separate; fruit an aggregate; flower radially symmetrical [Nigella, Thalictrum (cooley)] **RANUNCULACEAE**
- 20 Leaf segments or ultimate lobes ovate or elliptic, < 3× as long as wide, > 5 mm wide.
- 23 Inflorescence an umbel; ovary inferior; fruit a mericarp of 2 schizocarps or a 5-seeded drupe. **APIACEAE**
- 24 Fruit a schizocarp of 2 mericarps **APIACEAE**
- 24 Fruit a 5-seeded drupe [Aralia] **ARALIACEAE**
- 23 Inflorescence various, but not an umbel; fruit an aggregate of follicles or achenes, an elongate capsule, or a naked seed resembling a drupe.
- 25 Leaflets with < 10 ultimate 'points' (lobe or tooth terminations), these rounded to broadly acute, often large in comparison to the leaflet and appearing as "sublobes"; pistil 1 or 4-many.
- 26 Corolla bilaterally symmetrical; fruit an elongate capsule; [cultivated alien, rarely persistent near gardens]..... [Lamprocapnos] **FUMARIACEAE**
- 26 Corolla radially symmetrical; fruit an aggregate of follicles or achenes, or a naked seed resembling a drupe; [native plants of moist to dry forests and rock outcrops].
- 27 Leaflets 5-8 cm long, obviously longer than broad; pistil 1; fruit a naked blue seed resembling a drupe; flowers mainly 3-merous [Caulophyllum] **BERBERIDACEAE**
- 27 Leaflets 1-6 cm long, about as long as broad if > 4 cm long; pistils 4-many; fruit an aggregate of follicles or achenes; flowers mainly 4-5-merous [Aquilegia, Enemion, Thalictrum] **RANUNCULACEAE**
- 25 Leaflets with >11 ultimate 'points' (lobe or tooth terminations), these acuminate to acute; pistils 1-8.
- 28 Pubescence of the stem and lower leaf surface glandular; flowers unisexual, on the same plant (monoecious); stamens 10; pistils 2, partly fused; fruit an aggregate of follicles..... [Astilbe] **SAXIFRAGACEAE**
- 28 Pubescence of the stem and lower leaf surface non-glandular (or absent); flowers **either** bisexual (the plants hermaphroditic), **or** unisexual and the male and female flowers on separate plants (the plants dioecious); stamens 15 or more; pistils 1-8, separate; fruit an aggregate of follicles, a follicle, or a red or white berry.
- 29 Flowers bisexual (plants hermaphroditic); carpels 1-8 per flower; inflorescence a raceme, or a panicle of racemes with just a few branches; fruit an aggregate of follicles, a follicle, or a red or white berry [Actaea] **RANUNCULACEAE**
- 29 Flowers unisexual (plants dioecious); carpels 3-4 per pistillate flower; inflorescence a panicle of racemes, with numerous branches; fruit an aggregate of follicles [Aruncus] **ROSACEAE**

Key N2 – herbaceous dicots with mainly basal, simple leaves

- 1 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [many] **ASTERACEAE**
- 1 Inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers in a head subtended by bracts, e.g. *Eryngium* in APIACEAE, but then with other features differing, such as stamens 4, or green calyx present, or petals separate, or fruit a schizocarp of mericarps, etc.).
 - 2 Basal leaves 2-lobed, pinnately lobed, or palmately lobed (not considering cordate, hastate, or auriculate leaf bases as "lobed").
 - 3 Basal leaves 2-lobed, hinged between the lobes, each lobe with stiff, marginal, eyelash-like bristles; [of the Coastal Plain of NC and SC, rarely planted and weakly naturalized elsewhere].....[*Dionaea*] **DROSERACEAE**
 - 3 Basal leaves 3-many-lobed, palmately or pinnately; [collectively widespread].
 - 4 Leaf lobing pinnate.
 - 5 Gynoecium of separate pistils (each with a single carpel); fruit an aggregate [*Geum*] **ROSACEAE**
 - 5 Gynoecium of a single pistil (with 2, rarely more, carpels); fruit simple.
 - 6 Stamens many; sepals 2, petals 4; fresh plants with yellow, orange, or white milky juice..... [many] **PAPAVERACEAE**
 - 6 Stamens 4, 5, or 6; sepals 4 or 5; petals 4 or 5.
 - 7 Petals 4, distinct; stamens 6..... [many] **BRASSICACEAE**
 - 7 Petals 5, fused; stamens 4 or 5.
 - 8 Corolla radially symmetrical; stamens 5[*Hydrophyllum, Phacelia*] **BORAGINACEAE**
 - 8 Corolla 2-lipped but the corolla lobes twisted so as to make the flower asymmetrical; stamens 4..... [Pedicularis] **OROBANCHACEAE**
 - 4 Leaf lobing palmate.
 - 9 Petiole attachment peltate.
 - 10 Leaves < 10 cm in diameter.....[*Hydrocotyle*] **ARALIACEAE**
 - 10 Leaves > 15 cm in diameter.....[*Diphylleia, Podophyllum*] **BERBERIDACEAE**
 - 9 Petiole attachment marginal.
 - 11 Ovary inferior.
 - 12 Petals 4; stamens 8; fruit a capsule.....[*Oenothera*] **ONAGRACEAE**
 - 12 Petals 5; stamens 5; fruit a schizocarp of 2 mericarps.
 - 13 Fruit tuberculate; leaves 3-lobed.....[*Eryngium (prostratum)*] **APIACEAE**
 - 13 Fruit smooth; leaves with 5 or more lobes[*Hydrocotyle*] **ARALIACEAE**
 - 11 Ovary superior, or half-inferior by fusion of a hypanthium a part of the way up the ovary wall.
 - 14 Gynoecium of separate pistils (each with a single carpel); fruit an aggregate.
 - 15 Perianth of 5 green sepals and 5 colored petals.
 - 16 Carpels partly fused, arrayed in a ring of 10-20.....[*Callirhoe, Malva*] **MALVACEAE**
 - 16 Carpels separate, spiral, many [Anemone, Ranunculus] **RANUNCULACEAE**
 - 15 Perianth of a single whorl of 3-12 petaloid sepals (the petals absent or small and rudimentary).
 - 17 Leaves 2, the single flower terminal and associated with the upper leaf; fruit an aggregate of berries [Hydrastis] **HYDRASTIDACEAE**
 - 17 Leaves normally > 2, flowers not as above; fruit an aggregate of achenes, utricles, or follicles.....[*Aconitum, Anemone, Delphinium, Trautvetteria*] **RANUNCULACEAE**
 - 2 Basal leaves not lobed, at most serrate or crenate (and sometimes also cordate, hastate, auriculate, or peltate at the base).
 - 21 Basal leaves petiolate, the blade with a cordate, hastate, auriculate, or peltate base.
 - 22 Leaf margins entire.
 - 23 Inflorescence a terminal and/or axillary raceme, panicle, or cyme of many small flowers; fruit an achene; perianth of 6 tepals [Emex, Eriogonum, Rheum, Rumex] **POLYGONACEAE**
 - 23 Inflorescence **either** a terminal spike, **or** a 1-7-flowered terminal cyme, **or** of a solitary axillary or terminal flower.
 - 24 Flowers bilaterally symmetrical; inflorescence a terminal spike (with > 20 flowers); petals 4, usually scarious, transparent; sepals 4, green; stamens 4.....[*Plantago*] **PLANTAGINACEAE**
 - 24 Flowers radially symmetrical; inflorescence **either** of a solitary flower **or** of a 1-7-flowered terminal cyme; petals 5, 8-12, or 0; sepals 5 (green), 3 (brown), or 5-9 (yellow); stamens 5, 12, or many.
 - 25 Gynoecium of separate pistils (each with a single carpel); fruit an aggregate of achenes or follicles; flowers bright yellow, **either** of 5-9 distinct petaloid sepals, **or** of 8-12 distinct petals subtended by 3-4 green distinct sepals..... [Caltha, Ficaria] **RANUNCULACEAE**
 - 25 Gynoecium **either** of a single pistil with 6 carpels **or** of a single pistil with 4 carpels **or** of 2 nearly separate carpels; fruit a simple capsule (or deeply 2-lobed); flowers white, brown, or greenish, **either** of 5 fused or distinct white petals and 5 fused or distinct green sepals, **or** of 3 fused brown or greenish petaloid sepals.
 - 26 Flowers brown, of 3 fused brown or greenish petaloid sepals (and 0 petals); carpels 6; stamens 12; leaves 4-10 cm wide ... [Asarum, Hexastylis] **ARISTOLOCHIACEAE**
 - 26 Flowers white, of 5 white or whitish petals and 5 green sepals; carpels 2; stamens 5; leaves 1-12 (-15) cm wide
 - 27 Petals separate; sepals separate; plant glabrous [Parnassia] **PARNASSIACEAE**
 - 27 Petals fused; sepals fused; carpels 2; plant pubescent.
 - 28 XXXX; [common, widespread in our area]..... [Dichondra] **CONVOLVULACEAE**
 - 28 YYYY; [rare alien] [Lycianthes] **SOLANACEAE**
 - 22 Leaf margins crenate, serrate, or incised.
 - 29 Gynoecium of separate pistils (each with a single carpel); fruit an aggregate; perianth of 5 green sepals and 5 colored petals.

- 30 Carpels 10-20, partly fused, arrayed in a ring; petals white, pink, red, or purplish [*Callirhoe*, *Malva*] **MALVACEAE**
- 30 Carpels many, separate, spiral; petals yellow or white.
- 31 Flowers lacking a hypanthium; fruit an aggregate of achenes or aggregate of follicles [*Caltha*, *Ficaria*, *Ranunculus*] **RANUNCULACEAE**
- 31 Flowers with a hypanthium; fruit an aggregate of drupelets or aggregate of achenes [*Geum*, *Rubus*] **ROSACEAE**
- 29 Gynoecium of a single pistil (with 1-5 carpels); fruit simple.
- 32 Flowers bilaterally symmetrical; inflorescence of a solitary flower; fruit a 3-locular capsule [*Viola*] **VIOLACEAE**
- 32 Flowers radially symmetrical; inflorescence an umbel (or composite of umbelliform units, or a terminal panicle).
- 33 Ovary superior; inflorescence a terminal panicle or terminal raceme.
- 34 Inflorescence a terminal raceme; perianth of 4 green sepals and 4 white petals; fruit a silique/silicle; fresh foliage in spring and summer with a strong garlic odor; larger leaves < 10 cm in diameter [*e.g. Alliaria*] **BRASSICACEAE**
- 34 Inflorescence a terminal panicle; perianth of 6 cream-colored petaloid sepals; fruit a winged achene; fresh foliage lacking a garlic odor; larger leaves typically > 30 cm in diameter [*Rheum*] **POLYGONACEAE**
- 33 Ovary inferior; inflorescence an umbel (or a composite of umbellate units); fruit a schizocarp of mericarps.
- 35 Petiole attachment peltate [*Hydrocotyle*] **ARALIACEAE**
- 35 Petiole attachment marginal (the blade cleft to the petiole).
- 36 Leaf blades longer than wide, sharply V-cleft at the base and otherwise shallowly denticulate ... [*Centella*] **APIACEAE**
- 36 Leaf blades as broad or broader than long, cleft at the base and also irregularly serrate or crenate around the margin [*Hydrocotyle*] **ARALIACEAE**
- 21 Basal leaves petiolate or not, with a truncate, rounded, or cuneate leaf base.
- 37 Leaves tubular, with a sutured ventral flange, erect or reclining, adapted as a pitfall for insects (flat, phyllodial leaves sometimes present as well, common in the winter in some species, such as *S. oreophila*) [*Sarracenia*] **SARRACENIACEAE**
- 37 Leaves flat, not sutured into a tubular shape.
- 38 Stem leaves opposite; perianth 5-merous, at least the corolla bilaterally symmetrical (barely so in VALERIANACEAE), or the parts curved so as to be asymmetrical (*Pedicularis* in OROBANCHACEAE); stamens 2, 3, or 4.
- 39 Ovary inferior; stamens 3 [*Valeriana*, *Valerianella*] **VALERIANACEAE**
- 39 Ovary superior; stamens 2 or 4.
- 40 Corolla narrowly tubular, the five lobes flaring at nearly 90 degrees and nearly radially symmetrical [*Buchnera*] **OROBANCHACEAE**
- 40 Corolla distinctly 2-lipped (with prominently large upper and lower corolla lobes) or hooded (the upper lip hood-like), distinctly bilaterally symmetrical, or the lobes twisted so as to make the corolla asymmetrical.
- 41 Corolla yellow, the upper lip often slightly to strongly maroon, hooded but the corolla lobes twisted so as to make the flower asymmetrical [*Pedicularis*] **OROBANCHACEAE**
- 41 Corolla white, lavender, or blue, 2-lipped and bilaterally symmetrical.
- 42 Sepals separate to the base or nearly so, not forming a tube [*Lindernia*] **LINDERNIACEAE**
- 42 Sepals connate for at least 0.3× their length to form a tube [*Mazus*] **PHRYMACEAE**
- 38 Stem leaves alternate; perianth radially symmetrical (less commonly bilaterally symmetrical); stamens 5, 6-8, 9, 10 (rarely 4).
- 43 Ovary inferior (or half-inferior in *Samolus*).
- 44 Perianth 4-merous; stamens 8 [*Oenothera*] **ONAGRACEAE**
- 44 Perianth 5-merous; stamens 5.
- 45 Inflorescence an umbel; fruit a schizocarp of 2 mericarps [many] **APIACEAE**
- 45 Inflorescence an axillary or terminal raceme; fruit a capsule [*Samolus*] **PRIMULACEAE**
- 43 Ovary superior.
- 46 Pistils many, each with a single carpel; fruit an aggregate of achenes [*Myosurus*] **RANUNCULACEAE**
- 46 Pistil 1, with 1-5 carpels; fruit simple (a legume, silique/silicle, capsule, utricle, or schizocarp of 4 nutlets).
- 47 Corolla bilaterally symmetrical (barely so in *Limosella* in PLANTAGINACEAE); stamens 2, 4, 6, 8, or 10.
- 48 Stamens 6-8 or 10.
- 49 Petals separate; stamens 10 [*Hydaticea*] **SAXIFRAGACEAE**
- 49 Petals fused; stamens 10 or 6-8.
- 50 Stamens 10, monadelphous **FABACEAE**
- 50 Stamens 6-8, epipetalous [*Polygala*] **POLYGALACEAE**
- 48 Stamens 2 or 4.
- 51 Stamens 2 [*Pinguicula*, *Utricularia*] **LENTIBULARIACEAE**
- 51 Stamens 4.
- 52 [plants of coastal wetlands] [*Limosella*] **PLANTAGINACEAE**
- 52 [plants of uplands or inland seeps or fens]
- 53 Flowers (and subtending bracts) red or yellow [*Castilleja*] **OROBANCHACEAE**
- 53 Flowers purple, blue, or lavender [*Mazus*] **PHRYMACEAE**
- 47 Corolla radially symmetrical; stamens 5, 10, 4-6, or 9.
- 54 Perianth of 6 tepals; stamens 4-6 or 9; carpels 3 [*Eriogonum*, *Rumex*] **POLYGONACEAE**
- 54 Perianth of green sepals and more brightly colored petals; stamens 5 or 10; carpels 2, 3, 4, or 5.
- 55 Leaves covered with sticky, gland-tipped hairs (often red), as flypaper traps for insects [*Drosera*] **DROSERACEAE**
- 55 Leaves lacking sticky gland-tipped hairs.
- 56 Fruit a schizocarp of 4 nutlets (ovary obviously 4-lobed in flower) [many] **BORAGINACEAE**
- 56 Fruit a capsule or silique/silicle (or utricle in *Limonium* in PLUMBAGINACEAE).
- 57 Inflorescence of a solitary, terminal flower; carpels 2-3 (-4).
- 58 Corolla with a long tube and flaring corolla lobes (united > ½ its length) [*Jaborosa*] **SOLANACEAE**
- 58 Corolla of separate petals or united only for a short length (< ¼ its length).
- 59 Leaves serrate [*Shortia*] **DIAPENSIACEAE**
- 59 Leaves entire [*Lepuropetalon*, *Parnassia*] **PARNASSIACEAE**
- 57 Inflorescence of several to many flowers; carpels 5 (3 in *Galax* in DIAPENSIACEAE).
- 60 Inflorescence an umbel; petals recurved, pink to almost white [*Primula*] **PRIMULACEAE**
- 60 Inflorescence a raceme or panicle.

- 61 Fruit a silique/silicle; petals 4; stamens 6.....[*e.g. Draba*] **BRASSICACEAE**
- 61 Fruit either a capsule or a utricle; petals 5; stamens 5 or 10.
- 62 Inflorescence a somewhat to very diffuse panicle, with 3 or more orders of branching, not giving at all the impression that the overall inflorescence is made of racemose units.
- 63 Leaves entire; stamens 5; [plants of tidal marshes].....[*Limonium*] **PLUMBAGINACEAE**
- 63 Leaves serrate or crenate; stamens 10; [plants of various habitats, especially rock outcrops and bottomland forests and streambanks, never in tidal marshes][*Micranthes*] **SAXIFRAGACEAE**
- 62 Inflorescence **either** a single terminal raceme (sometimes spike-like), **or** of 1 to several terminal and axillary racemes (these sometimes combined into a diffuse panicle, but one whose structure is clearly made up of many racemes).
- 64 Inflorescence of 1-several terminal and axillary racemes, the plant typically well-branched, especially from the base; stamens 5.....[*Samolus*] **PRIMULACEAE**
- 64 Inflorescence of a single, terminal raceme, the plant unbranched; stamens 10 (or 5, with 5 staminodes)
- 65 Inflorescence spike-like, the flowers many (> 40), barely pedicelled; capsule 3-locular.....[*Galax*] **DIAPENSIACEAE**
- 65 Inflorescence a raceme, the flowers fewer (< 20) and distinctly pedicelled; capsule 5-locular[*Orthilia, Pyrola*] **ERICACEAE**

Key O – herbaceous dicots with alternate, compound leaves on the stem

- 1 Leaves either 3-foliolate or palmately 4-11-foliolate (all the leaflets attached at a common point).
- 2 Inflorescence an involucrate head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela.....[*Nabalus*] **ASTERACEAE**
- 2 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.
- 3 Leaflets obviously and sharply serrate; pistils 5-many; fruit an aggregate of achenes, drupelets, or follicles.....[*Gillenia, Potentilla, Rubus*] **ROSACEAE**
- 3 Leaflets entire, finely denticulate, or very obscurely toothed (or irregularly serrate or lobed in *Cardamine* in BRASSICACEAE); pistil 1; fruit simple, a legume, capsule, silique, or berry.
- 4 Corolla bilaterally symmetrical; petals 5; fruit a legume; carpel 1 [many] **FABACEAE**
- 4 Corolla radially symmetrical; petals 4 or 5; fruit **either** an elongate capsule **or** a berry; carpels 1, 2, or 5.
- 5 Leaflets radially arranged at the summit of the petiole, not differentiated in size or placement into a terminal leaflet and 2 lateral leaflets; leaflets prominently notched at the apex; petals 5, yellow; inflorescence axillary, cymose or umbelliform; carpels 5[*Oxalis*] **OXALIDACEAE**
- 5 Leaflets differentiated in size and placement into a terminal leaflet and 2 or more lateral leaflets; leaflets not regularly notched at the apex (a few may be slightly retuse); petals 4, white, pink, or yellow; inflorescence terminal and racemose; carpels 1 or 2.
- 6 Carpels 2; fruit a red berry; petals connate, purplish-blue[*Solanum (dulcamara)*] **SOLANACEAE**
- 6 Carpel 1; fruit a capsule; petals separate, white, pink, or yellow.
- 7 Stem leaves 1-3, alternate [or whorled or opposite]; leaflets 3, irregularly serrate, lacerate, or additionally divided or lobed; fruit a silique; carpels 2..... [Cardamine] **BRASSICACEAE**
- 7 Stem leaves >3, alternate; leaflets (1-) 3-7, each entire or obscurely toothed; fruit a capsule; carpel 1..... [Arivela, Cleome, Cleoserrata, Gynandropsis, Hemiscola, Polanisia, Tarenaya] **CLEOMACEAE**
- {add under 2b [*Cynosciadium*] **APIACEAE**; [*Cannabis*] **CANNABACEAE**}
- 1 Leaves **either** 1-pinnately compound (all leaflets attached to a central rachis) **or** more complexly compound (with several orders of branching, some leaflets at least attached to second-order branches from the rachis).
- 8 Inflorescence an involucrate head subtended by phyllaries, heads solitary or many, variously arrayed in secondary inflorescences; fruit a cypsela; ovary inferior..... **ASTERACEAE**
- 8 Inflorescence various, but not as above; fruit various, not as above; ovary superior.
- 9 Leaves 1-pinnately compound (all leaflets attached to a central rachis).
- 10 Flowers bilaterally symmetrical, papilionaceous; fruit a legume; leaves even-pinnately or odd-pinnately compound, the terminal leaflet sometimes replaced by a tendril; leaflets entire or at most minutely denticulate..... [many] **FABACEAE**
- 10 Flowers radially symmetrical (or barely bilaterally symmetrical in *Erodium* in GERANIACEAE); fruit a capsule, capsular but of 5 mericarps, or an aggregate of achenes, nutlets, or follicles (in some cases the # of pistils from many down to 2 or even 1); leaves odd-pinnately compound, never with tendrils; leaflets serrate (or entire to shallowly lobed in *Polemonium* in POLEMONIACEAE, *Cardamine* in BRASSICACEAE, and *Floerkea* in LIMNANTHACEAE).
- 11 Pistils many (only 1-2 in *Agrimonia, Poteridium, Poterium, and Sanguisorba*); fruit an aggregate of achenes, nutlets, or follicles; hypanthium present; stamens 5-many (only 4 in *Poteridium* and *Sanguisorba*).....[*Agrimonia, Drymocallis, Filipendula, Geum, Potentilla, Poteridium, Poterium, Sanguisorba*] **ROSACEAE**
- 11 Pistil 1 (or deeply 2-3-lobed in *Floerkea* in LIMNANTHACEAE); fruit a silique, capsule, schizocarp of 2-3 mericarps, or a capsular schizocarp of 5 mericarps (*Erodium* in GERANIACEAE); hypanthium absent; stamens 3-6.
- 12 Petals 3 {*Floerkea*} **LIMNANTHACEAE**
- 12 Petals 4-5.
- 13 Petals 4, distinct; stamens 6; inflorescence a terminal raceme; fruit a silique/silicle [many, *e.g. Cardamine, Leavenworthia, Descurainia*] **BRASSICACEAE**
- 13 Petals 5, fused (distinct in *Erodium* in GERANIACEAE); stamens 5; inflorescence axillary or terminal, cymose, consisting of subcapitate, umbel-like, or helicoid cymes; fruit **either** a capsule, **or** a capsular schizocarp of 5 mericarps (*Erodium* in GERANIACEAE).
- 14 Flowers slightly bilaterally symmetrical (2 of the petals of different size than the other 3); fruit a capsular schizocarp of 5 mericarps; carpels 5 [*Erodium*] **GERANIACEAE**
- 14 Flowers radially symmetrical; fruit **either** a loculicidal capsule **or** a berry; carpels 2 or 3.
- 15 Fruit a berry; fresh plant rankly fragrant.....[*Solanum (lycopersicum, tuberosum, others)*] **SOLANACEAE**
- 15 Fruit a capsule; fresh plant not aromatic.

- 16 Capsule 2-valvate; carpels 2; leaflets prominently serrate or with some tooth-like sublobes[*Hydrophyllum*, *Phacelia*] **BORAGINACEAE**
- 16 Capsule 3-valvate; carpels 3; leaflets with entire margins..... [*Polemonium*] **POLEMONIACEAE**
- 9 Leaves more complexly compound (with 2 or more orders of branching, some leaflets at least attached to second-order branches from the rachis).
- 17 Leaves 2× even-pinnate; flowers in spikes or spherical heads; **XXXX**..... [*Acaciella*, *Desmanthus*, *Mimosa*, *Neptunia*] **FABACEAE**
- 17 Leaves **either** 2× odd-pinnate **or** more complexly 2-4× ternately or ternately-pinnately compound; **YYYY**.
- 18 Leaf segments linear, less than 2 mm wide.
- 19 Inflorescence an umbel; ovary inferior, of 2 fused carpels; fruit a schizocarp of 2 mericarps..... [many] **APIACEAE**
- 19 Inflorescence **either** a terminal solitary flower **or** terminal raceme or panicle; ovary superior, **either** of 2 fused carpels **or** of 1-5 or many distinct 1-carpellate pistils; fruit **either** a capsule **or** an aggregate of follicles or achenes.
- 20 Ovary of 2 fused carpels; fruit a capsule (1-seeded and indehiscent in *Fumaria*)..... [*Corydalis*, *Fumaria*] **FUMARIACEAE**
- 20 Ovary of 1-5 or many distinct 1-carpellate pistils; fruit an aggregate of follicles or achenes [*Consolida*, *Nigella*] **RANUNCULACEAE**
- 20 Leaf segments broader, lanceolate, ovate, or elliptic, > 5 mm wide.
- 21 Herbaceous vine climbing by axillary tendrils; stamens 8 [*Cardiospermum*] **SAPINDACEAE**
- 21 Erect or sprawling herb; stamens 5-6 or >15.
- 22 Leaflets sharply serrate, with usually many teeth on each leaflet side, the total number of “points” per leaflet > 10.
- 23 Inflorescence an umbel; ovary inferior, of 2 fused carpels; fruit a schizocarp of 2 mericarps; inflorescence an umbel [many, e.g. *Thaspium*, *Zizia*] **APIACEAE**
- 23 Inflorescence a panicle or raceme; ovary superior, of 1-8 carpels; fruit an aggregate of follicles, a single follicle, or an indehiscent berry-like fruit.
- 24 Flowers bisexual; carpels 1-8; fruit an aggregate of follicles, a single follicle, or an indehiscent berry-like fruit..... [*Actaea*] **RANUNCULACEAE**
- 24 Flowers unisexual; carpels (in pistillate flowers) of 3 (-5) carpels; fruit an aggregate of follicles [*Arunca*] **ROSACEAE**
- 22 Leaflets entire, or with 1-several, broad, obtuse, rounded, or broadly acute “sublobes”, especially towards the tip of the leaflet, the total number of “points” per leaflet < 10.
- 25 Inflorescence an umbel; ovary inferior, of 2 fused carpels; fruit a schizocarp of 2 mericarps..... [some, e.g. *Taenidia*] **APIACEAE**
- 25 Inflorescence a raceme, panicle, or cyme; ovary superior, of either 1-2 fused carpels or of many separate 1-carpellate pistils.
- 26 Perianth bilaterally symmetrical, the corolla of 4 fused petals; plant a scandent vine or erect or sprawling herb [*Adlumia*, *Corydalis*, *Fumaria*] **FUMARIACEAE**
- 26 Perianth radially symmetrical, of 1-5 whorls of separate perianth parts; plant an erect herb.
- 27 Perianth of 4-5 whorls of 3 parts each (some of the whorls modified into nectaries); pistil 1, 1-carpellate; fruit a drupelike, blue, naked seed; largest leaflets > 6 cm long, obviously longer than wide..... [*Caulophyllum*] **BERBERIDACEAE**
- 27 Perianth of 1 whorl; of 4-5 parts; pistils many, each 1-carpellate; fruit an aggregate of achenes or an aggregate of follicles; largest leaflets either < 6 cm long, or if longer than 6 cm, also about as wide as long..... [*Aquilegia*, *Enemion*, *Thalictrum*] **RANUNCULACEAE**

Key P – herbaceous dicots with alternate, simple leaves on the stem

- 1 Leaves unlobed (the leaf base sometimes cordate, sagittate, or hastate) **Key P1 – herbaceous dicots with alternate, simple, and unlobed leaves on the stem**
- 1 Leaves palmately or pinnately lobed (leaves with cordate, sagittate, or hastate leaf bases and otherwise unlobed are treated as unlobed), the lobes in some cases not prominent (much broader than long), but strongly associated with the primary veins
- 2 Leaves palmately lobed **Key P2 – herbaceous dicots with alternate, simple, and palmately lobed leaves on the stem**
- 2 Leaves pinnately lobed **Key P3 – herbaceous dicots with alternate, simple, and pinnately lobed leaves on the stem**

Key P1 – herbaceous dicots with alternate, simple, and unlobed leaves on the stem

- 1 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [many] **ASTERACEAE**
- 1 Inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers in a head, e.g. *Eryngium* in **APIACEAE**, but then with other features differing, such as stamens 4, or green calyx present, or fruit a schizocarp of mericarps, etc.).
- 2 Perianth uniseriate (represented only by undifferentiated tepals or sepals) or completely absent; flowers usually unisexual, less commonly bisexual).
- 3 Inflorescence a cyathium, consisting of a single pistillate flower (reduced to a single 3-carpellate pistil) and 2 or more staminate flowers (each reduced to 1 stamen), borne in a cup-like involucre, the involucre bearing pointed or rounded glands, these sometimes brightly colored and petaloid, mimicking an individual flower (the cyathia then secondarily arranged in terminal cymes, or solitary and axillary, etc.); fresh plants with milky juice; fruit a 3-lobed, 3-locular capsule..... [*Euphorbia*] **EUPHORBIACEAE**
- 3 Inflorescence not a cyathium (and staminate or bisexual flowers with > 1 stamen; fresh plants lacking milky juice (except *Stillingia* in **EUPHORBIACEAE**); fruit various, not as above.
- 4 Leaf margins toothed in some manner (serrate, dentate, crenate, etc.)
- 5 Leaf teeth rounded to subacute, resembling shallow lobes, irregular, few (mostly < 6 per leaf side).
- 6 Fruit a single-seeded achene or utricle; [plants of various disturbed or saline, usually sunny habitats] [*Atriplex*, *Chenopodium*, *Cycloloma*, *Dysphania*] **AMARANTHACEAE**
- 6 Fruit a 3-lobed, circumscissilely dehiscent capsule; [plants native of rich moist shaded forests or aliens in suburban woodlands] [*Pachysandra*] **BUXACEAE**

- 5 Leaf teeth sharp to crenate, not lobe-like, regular, many (mostly > 10 per leaf side).
- 7 Leaf bases cuneate [*Acalypha*, *Stillingia*, *Tragia*] **EUPHORBIACEAE**
- 7 Leaf bases cordate to rounded.
- 8 Styles 3; fruit a 3-lobed, 3-carpellate capsule (1 carpel sometimes aborting); inflorescence **either** a terminal or leaf opposed raceme, **or** a dense axillary condensed cyme with conspicuous toothed bracts subtending the flowers [*Acalypha*, *Tragia*] **EUPHORBIACEAE**
- 8 Styles 1 or 2; fruit **either** an achene **or** a multiple of achenes; inflorescence **either** an axillary dense cyme (almost a head), **or** an axillary spike with glomerules, or a terminal or axillary panicle.
- 9 Styles 2; inflorescence a dense axillary cyme (almost a head); fruit a multiple of achenes; plant lacking stinging hairs; [alien plant of weedy situations] [*Fatoua*] **MORACEAE**
- 9 Style 1; inflorescence an axillary spikes with glomerules, or a terminal or axillary panicle; plant **either** with stinging hairs **or** not; [plant a rare alien (*Boehmeria nivea*) or a native of moist forests (*Boehmeria cylindrica*, *Laportea*)] [*Boehmeria (nivea)*, *Laportea*] **URTICACEAE**
- 4 Leaf margins entire.
- 10 Ovary inferior or half-inferior.
- 11 Leaf base cordate; calyx 3-lobed, fused into a bilaterally symmetrical, curved brown or yellowish tube; fruit a capsule [*Aristolochia*, *Endodeca*] **ARISTOLOCHACEAE**
- 11 Leaf base cuneate, rounded, or truncate; calyx of 3-4-5 distinct sepals, radially symmetrical, white or yellow; fruit a dry, nutlike drupe or an achene.
- 12 Leaves subsessile or very short petiolate, elliptic or narrowly elliptic, broadest near the middle; [native] [*Comandra*] **SANTALACEAE**
- 12 Leaves distinctly petiolate, rhombic, widest near the base; [rarely naturalized aliens].
- 13 Inflorescence of a single axillary flower [*Tetragonia*] **AIZOACEAE**
- 13 Inflorescence terminal, spikelike [*Beta*] **AMARANTHACEAE**
- 10 Ovary superior.
- 14 Inflorescence a leaf-opposed (sometimes apparently terminal) spike or raceme; flowers visually white from white petaloid sepals, white bracts, or white stamens.
- 15 Sepals present, 5, petaloid, white; carpels 10, fused; fruit a 1-seeded berry; leaf bases cuneate; plant a robust herb, usually 1-3 m tall, the stems usually magenta; [Eudicots] [*Phytolacca*] **PHYTOLACCACEAE**
- 15 Sepals absent; carpels 3-4, only partially fused; fruit a capsule, a 1-seeded drupe, or a schizocarp of 3-4 mericarps; leaf bases cordate or subcordate; plant an herb 1-12 dm tall, the stems usually green; [Basal Angiosperms].
- 16 Fruit a 1-seeded drupe; stamens 2 [*Peperomia*] **PIPERACEAE**
- 16 Fruit a capsule or schizocarp with 3-4 mericarps; stamens 3 or 6-8 [*Houttuynia*, *Saururus*] **SAURURACEAE**
- 14 Inflorescence not leaf-opposed, **either** simpler (single axillary or glomerules of flowers) **or** more complexly branched (axillary or terminal panicles or complex cymes); flowers white, reddish, scarious, or greenish.
- 17 Stipules tubular, sheathing (= ocreae); flowers subtended by tubular, sheathing bracteoles (= ocreolae); nodes usually prominently swollen; perianth usually of 5-6 white to pink tepals [*Antigonon*, *Fagopyrum*, *Fallopia*, *Persicaria*, *Polygonella* (->*Polygonum*), *Reynoutria*, *Rumex*] **POLYGONACEAE**
- 17 Stipules not tubular or sheathing; flowers not subtended by ocreolae; nodes not swollen; perianth absent or of 3-5 sepals.
- 18 Inflorescence an terminal involucrate cluster; flowers bisexual; stamens 9 [*Eriogonum*] **POLYGONACEAE**
- 18 Inflorescence axillary, or a terminal panicle or raceme that is not involucrate; stamens 3-6.
- 19 Ovary 3-locular; styles 3, each bifid; fruit a capsule, with 6 seeds [*Phyllanthus*] **PHYLLANTHACEAE**
- 19 Ovary 1-locular; styles 1-3, not bifid; fruit a utricle or achene (1-seeded).
- 20 Styles 1-3, if style 1, then stigmas 3; flowers bisexual or unisexual [*Amaranthus*, *Atriplex*, *Bassia*, *Celosia*, *Salsola*, *Suaeda*] **AMARANTHACEAE**
- 20 Styles 1, stigma 1; flowers unisexual [*Parietaria*] **URTICACEAE**
- 2 Perianth biseriate (represented by differentiated whorls of sepals and petals, the sepals usually green or drab in color, the petals often brightly colored); flowers nearly always bisexual (there are exceptions).
- 21 Ovary inferior or half-inferior.
- 22 Petals connate.
- 23 Inflorescence leaf-opposed, a dense, cylindrical spike [*Sphenoclea*] **SPHENOCLEACEAE**
- 23 Inflorescence various, **either** a terminal head, **or** axillary and solitary, **or** variously axillary or terminal and more diffuse.
- 24 Leaves toothed; flowers blue to white [*Lobelia*, *Campanula*, *Jasione*, *Platycodon*, *Triodanis*, *Wahlenbergia*] **CAMPANULACEAE**
- 24 Leaves entire; flowers white [*Samolus*] **PRIMULACEAE**
- 22 Petals distinct.
- 25 Petals 5; stamens 5; inflorescence a head; fruit a schizocarp of 2 mericarps [*Eryngium*] **APIACEAE**
- 25 Petals 4-7; stamens 6 or more; inflorescence various, not a head; fruit a capsule.
- 26 Petals 4-7; stamens 1× or 2× as many as the petals, 4-7, 8, 10, 12, or 14; leaves herbaceous in texture [*Chamerion*, *Epilobium*, *Ludwigia*, *Oenothera*] **ONAGRACEAE**
- 26 Petals 5 (or sometimes doubled in horticultural forms); stamens 6-40 (or more); leaves fleshy in texture [*Portulaca*] **PORTULACACEAE**
- 21 Ovary superior.
- 27 Corolla bilaterally symmetrical, petals connate (except distinct in VIOLACEAE); fruit a capsule or legume (except a 1-seeded indehiscent pod in *Krameria* in KRAMERIACEAE).
- 28 Petals distinct, 5; carpels 3; fruit a 3-loculed capsule [*Hybanthus*, *Viola*] **VIOLACEAE**
- 28 Petals connate, 4, 5, 6, 7, or 8; carpels 1, 2, 4, 5, or 6 (rarely 3 in *Reseda* in RESEDACEAE); fruit a legume or 1-, 2-, or 5-loculed capsule (except a 1-seeded indehiscent pod in *Krameria* in KRAMERIACEAE).
- 29 Petals 5; stamens 4 or 5.
- 30 Pistil 5-carpellate; capsule 5-locular, explosively dehiscent; ; inflorescence axillary, small clusters of flowers [*Impatiens*] **BALSAMINACEAE**
- 30 Pistil 2-carpellate; capsule 2 locular, opening gradually; inflorescence a terminal spike, raceme or panicle (or solitary, axillary flowers in *Chaenorrhinum* in PLANTAGINACEAE).

- 31 Stamens 5; corolla not spurred; capsule septical; pubescence of the stem and leaves either gland-tipped or dendritically branched [*Verbascum*] **SCROPHULARIACEAE**
- 31 Stamens 4; corolla with a distinct spur or sac at the base between the the 2 lower calyx lobes (except not spurred in *Digitalis* and *Schwalbea*); capsule loculicidal (only at the summit in *Antirrhinum* and *Chaenorrhinum*, and septical in *Schwalbea*); pubescence of the stem and leaves neither gland-tipped (except in *Antirrhinum* and *Chaenorrhinum*) nor dendritically branched.
- 32 Capsule septical; corolla not spurred [*Schwalbea*] **OROBANCHACEAE**
- 32 Capsule loculicidal; corolla spurred (except *Digitalis*) [*Antirrhinum*, *Chaenorrhinum*, *Digitalis*, *Kickxia*, *Linaria*, *Nuttallanthus*, *Plantago*] **PLANTAGINACEAE**
- [add under 28a: [*Krameria*] **KRAMERIACEAE**, [*Macranthera*, *Striga*] **OROBANCHACEAE**]
- 29 Stamens 6-10 -25, more than the number (4 or 5) of petals and the number (4 or 5) of the sepals; fruit a legume or a 2-5-carpellate capsule.
- 33 Stamens fused, monadelphous or diadelphous.
- 34 Stamens 6-8, monadelphous; fruit a capsule [*Asemeia*, *Polygala*, *Polygaloides*] **POLYGALACEAE**
- 34 Stamens 10, monadelphous or diadelphous; fruit a legume [*Lupinus*, *Crotalaria*, *Rhynchosia*, others] **FABACEAE**
- 33 Stamens distinct.
- 35 Carpel 1; fruit a legume [*Baptisia*] **FABACEAE**
- 35 Carpels 3-6; fruit a capsule [*Reseda*] **RESEDACEAE**
- 27 Corolla radially symmetrical, petals connate or distinct; fruit various (including a capsule).
- 36 Petals distinct; stamens 5-many.
- 37 Pistils 4-10 (each 1-carpellate) in a ring, these sometimes fused basally, each with its own style/stigma; fruit **either** an aggregate of achenes or follicles **or** a 5 (-7) locular capsule.
- 38 Pistils 5 (-7); inflorescence a compound terminal cyme.
- 39 Fruit an aggregate of follicles; leaves fleshy in texture; inflorescence; leaves entire of sparsely and coarsely serrate, with < 12 points per leaf; [plants primarily of dry habitats] [*Diamorpha*, *Hylotelephium*, *Rhodiola*, *Sedum*, *Sempervivum*] **CRASSULACEAE**
- 39 Fruit a 5 (-7) locular capsule; leaves membranaceous in texture; leaves serrate, with > 20 points per leaf; [plants of wet habitats] [*Penthorum*] **PENTHORACEAE**
- 38 Pistils many; inflorescence of solitary flowers, or diffuse.
- 40 Leaves cuneate at the base; flowers in a diffuse inflorescence [*Ranunculus*] **RANUNCULACEAE**
- 40 Leaves cordate at the base; flowers solitary, on long pedicels [*Rubus (dalibarda)*] **ROSACEAE**
- 37 Pistil 1, with 1-to many carpels (in many MALVACEAE, the carpels loosely united in a ring [of more than 5] around the single style/stigma); fruit **either** a 1-, 2-, 3-, 5-, 6-, or 10-locular capsule, **or** a silique/silicle, **or** a ring of mericarps.
- 41 Petals 4; sepals 4; stamens 6; fruit a silique/silicle [many] **BRASSICACEAE**
- 41 Petals 5 (rarely 4 or 6); sepals 5 (rarely 4 or 6); stamens 5 (or multiples of 5), 6, or 12; fruit a capsule or ring of mericarps.
- 42 Stamens many, connate into a staminal tube; carpels 5-many; fruit a capsule or ring of mericarps; leaves usually serrate [*Abutilon*, *Hibiscus*, *Malvastrum*, *Malvaviscus*, *Sida*] **MALVACEAE**
- 42 Stamens 5-many, distinct; carpels 2-5; fruit a capsule; leaves entire (serrate in *Croton* in EUPHORBIACEAE).
- 43 Flowers unisexual; leaf vestiture of peltate scales and/or stellate hairs; leaves often > 4 cm long and > 8 mm wide (there are exceptions) [*Croton*] **EUPHORBIACEAE**
- 43 Flowers bisexual; leaf vestiture simple or stellate; leaves small and narrow, < 4 cm long, < 8 mm wide
- 44 Flowers 6-merous, petals and sepals 6, stamens 6 or 12; corolla pink or purplish (rarely white); fruit a septical capsule [*Lythrum*] **LYTHRACEAE**
- 44 Flowers 5-merous, the petals and sepals 5, stamens 5 or various multiples of 5; corolla yellow, reddish, or blue; fruit a loculicidal or septical capsule.
- 45 Stamens 5; corolla yellow or blue; capsule 10-locular, septical [*Linum*] **LINACEAE**
- 45 Stamens (5-) 10, 15, 20, 30 (-many); corolla white, pink, yellow, or reddish; capsule 3-, 5- (-10)-locular, loculicidal.
- 46 Stamens (5-) 10, 15, 20, 30 (-many); corolla yellow or reddish; capsule 3 (-10)-locular, loculicidal [*Crocantemum*, *Lechea*] **CISTACEAE**
- 46 Stamens 10; corolla white or pink; capsule 5-locular [*Chimaphila*] **ERICACEAE**
- 36 Petals fused; stamens (4-) 5 (-7).
- 47 Pistils 2, united only by the style and stigma; fruit a schizocarp of 2 follicles (often single by abortion); plant with milky juice when fresh; leaves entire; inflorescence an umbel [*Amsonia*, *Asclepias (tuberosa)*] **APOCYNACEAE**
- 47 Pistil 1 (of 2 or 3 fused carpels); fruit a capsule; plant lacking milky juice; leaves entire or serrate; inflorescence various (but not an umbel).
- 48 Ovary deeply 4-lobed; fruit a schizocarp of 4 mericarps [*Amsinckia*, *Buglossoides*, *Echium*, *Hackelia*, *Heliotropium*, *Lithospermum*, *Mertensia*, *Myosotis*, *Symphytum*] **BORAGINACEAE**
- 48 Ovary not lobed; fruit a capsule or berry.
- 49 Leaves scale-like, 1-4.5 mm long, appressed to the stem; petals 4; stamens 4 [*Bartonia*] **GENTIANACEAE**
- 49 Leaves larger (or only 2-8 mm long in *Pyxidantha* in DIAPENSIACEAE, but then spreading); petals 5-7; stamens 5-7.
- 50 Leaves 2-8 mm long; plant a creeping subshrub (keyed here as a failsafe) [*Pyxidantha*] **DIAPENSIACEAE**
- 50 Leaves > 15 mm long; plant an herb, erect or sprawling.
- 51 Leaves cordate at the base; plant a twining vine [*Calystegia*, *Convolvulus*, *Ipomoea*, *Jacquemontia*] **CONVOLVULACEAE**
- 51 Leaves cuneate to rounded at the base; plant an erect, sprawling, or reclining herb (twining in *Solanum dulcamara* in SOLANACEAE).
- 52 Inflorescences (solitary or of several flowers) terminal on the stem.
- 53 Corolla lobes longer than the fused corolla cup, blue; styles 2; herbage lacking stipitate glands; fresh plants not aromatic [*Hydrolea*] **HYDROLEACEAE**
- 53 Corolla lobes very short, much shorter than the corolla cup or tube, sometimes barely perceptible and represented only by teeth on the edge of the corolla limb, white or pink; style 1; herbage often with stipitate glands; fresh plants often rankly aromatic [*Datura*, *Hyoscyamus*, *Nicotiana*, *Solanum*] **SOLANACEAE**
- 52 Inflorescences (of solitary or several flowers) axillary or lateral on the stem.

- 54 Flowers sessile or very-short pedicelled, solitary in the leaf axils.
 55 Stamens alternate with the corolla lobes; flower ca. 10 mm in diameter..... [Evolvulus] CONVULVACEAE
 55 Stamens opposite the corolla lobes; flower ca. 1 mm in diameter..... [Lysimachia] PRIMULACEAE
 54 Flowers **either** solitary and obviously pedicelled, **or** several in an axillary or lateral inflorescence.
 56 Corolla lobes longer than the fused corolla cup, blue [Hydrolea] HYDROLEACEAE
 56 Corolla lobes very short, much shorter than the corolla cup or tube, sometimes barely perceptible and represented only by teeth on the edge of the corolla limb, white, yellow, pink, various other colors (rarely including blue).
 57 Fruit a capsule, 4-seeded [Calystegia, Stylisma] CONVULVACEAE
 57 Fruit a berry or capsule, many-seeded [Alkekengi, Atropa, Calibrachoa, Capsicum, Hyoscyamus, Nicandra, Petunia, Physalis, Salpichroa] SOLANACEAE

Key P2 – herbaceous dicots with alternate, simple, and palmately lobed leaves on the stem

- 1 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypselia..... [many] ASTERACEAE
 1 Inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers in a head, e.g. *Eryngium* in APIACEAE, but then with other features differing, such as stamens 4, or green calyx present, or fruit a schizocarp of mericarps, etc.).
 2 Plant a vine, climbing by tendrils or twining.
 3 Vine climbing by twining.
 4 Leaf margins entire; flowers bisexual; plants hermaphroditic; petals connate, large and showy [Merremia, Ipomoea] CONVULVACEAE
 4 Leaf margins serrate; flowers unisexual; plants dioecious; petals absent..... [Humulus] CANNABACEAE
 3 Vine climbing by tendrils.
 5 Ovary inferior; petals connate; flowers unisexual..... [many] CUCURBITACEAE
 5 Ovary superior; petals distinct; flowers bisexual..... [Passiflora] PASSIFLORACEAE
 2 Plant an herb, sometimes sprawling, reclining (e.g. *Cymbalaria* in PLANTAGINACEAE, *Aconitum* in RANUNCULACEAE), but lacking climbing adaptations such as tendrils or twining stems.
 6 Ovary inferior; inflorescence an umbel; fruit a schizocarp of 2 mericarps
 7 Involucre well-developed and obvious [Bowlesia, Eryngium (*prostratum* and others)] APIACEAE
 7 Involucre absent or minute [Hydrocotyle] ARALIACEAE
 6 Ovary superior; inflorescence various, not an umbel; fruit various, a capsule, an aggregate of achenes or follicles, a ring of (>2) mericarps.
 8 Perianth uniseriate, the corolla absent (the calyx petaloid and white in *Cnidocolus*); flowers unisexual; plants **either** with stinging hairs **or** not..... [Cnidocolus, Ricinus] EUPHORBIACEAE
 8 Perianth biseriate (uniserial in *Aphanes* in ROSACEAE and in *Trautvetteria* in RANUNCULACEAE); flowers bisexual; plants lacking stinging hairs.
 9 Pistils many (or 2-3 in *Aphanes* in ROSACEAE), each with 1 carpel, arranged spirally or in a ring (if in a ring, of 2-5); fruit an aggregate of achenes, follicles, or utricles.
 10 Perianth bilaterally symmetrical, either hooded or spurred; fruit an aggregate of follicles [Aconitum, Delphinium] RANUNCULACEAE
 10 Perianth radially symmetrical, not hooded or spurred; fruit an aggregate of utricles or achenes (plumose achenes in *Geum*)
 11 Stamens showy, bright white, dilated towards the tip; pistils ca. 15; fruit an aggregate of utricles [Trautvetteria] RANUNCULACEAE
 11 Stamens not showy, white, or dilated towards the tip; pistils many (> 25); fruit an aggregate of achenes.
 12 Flowers lacking a hypanthium; achenes short-beaked [Ranunculus] RANUNCULACEAE
 12 Flowers with a prominent hypanthium; achenes with an elongate, plumose beak..... [Aphanes, Geum] ROSACEAE
 9 Pistil 1, with 1-to many carpels (in many MALVACEAE, the carpels loosely united in a ring of more than 5 around the style); fruit a capsule, an achene, a follicle, or a ring of 3 or 5-many 1-seeded mericarps.
 13 Perianth uniseriate, the corolla absent..... [Aphanes] ROSACEAE
 13 Perianth biseriate, with well-developed and differentiated calyx and corolla
 14 Corolla bilaterally symmetrical, the petals connate (except distinct in *Consolida* in RANUNCULACEAE); fruit a capsule, a follicle, or a schizocarp of 3 1-seeded mericarps.
 15 Corolla not spurred; fruit an elongate (10-20 cm) capsule with 2 curved beaks..... [Proboscidea] MARTYNIACEAE
 15 Corolla with a nectar spur; fruit < 3 cm long.
 16 Petals distinct; fruit a follicle..... [Consolida] RANUNCULACEAE
 16 Petals connate; fruit a capsule or a schizocarp of 3 1-seeded mericarps.
 17 Carpels 2; fruit a capsule; stamens 4 [Cymbalaria] PLANTAGINACEAE
 17 Carpels 3; fruit a schizocarp of 3 1-seeded mericarps; stamens 8 [Tropaeolum] TROPAEOLACEAE
 14 Corolla radially symmetrical, the petals distinct (fused and tubular in *Ipomoea*); fruit a capsule or a schizocarp consisting of a ring of 5-many 1-seeded mericarps.
 18 Stem trailing; petals fused and tubular [Ipomoea] CONVULVACEAE
 18 Stem erect; petals separate.
 19 Stamens many, connate into a stamen tube; carpels 5-many, completely or only loosely fused; fruit a capsule or a schizocarp of 5-many mericarps borne in a ring; calyx often subtended by an epicalyx (an additional calyx-like, green, foliaceous whorl of bracts) [many] MALVACEAE
 19 Stamens 5 or 10, distinct; carpels 2 or 5, fused; fruit a capsule or a schizocarp of 5 1-seeded mericarps.
 20 Fruit a schizocarp of 5 1-seeded mericarps; carpels 5; stamens 10..... [Geranium] GERANIACEAE
 20 Fruit a capsule with 2 locules, loculicidal; carpels 2; stamens 5..... [Hydrophyllum] HYDROPHYLLACEAE

Key P3 – herbaceous dicots with alternate, simple, and pinnately lobed leaves on the stem

- 1 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [many] **ASTERACEAE**
- 1 Inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers in a head, e.g. *Eryngium* in APIACEAE, but then with other features differing, such as stamens 4, or green calyx present, or fruit a schizocarp of mericarps, etc.).
 - 2 Perianth uniseriate, with only undifferentiated tepals; flowers many and small, greenish or brownish, inconspicuous individually; inflorescence of glomerules that are usually further aggregated into racemes or panicles; fruit an achene or utricle [Atriplex, Chenopodium, Dysphania] **AMARANTHACEAE**
 - 2 Perianth biseriate, both sepals and petals present and differentiated (except uniseriate and of 2 white to cream-colored sepals 5-10 mm long in *Macleaya* in PAPAVERACEAE); flowers larger, usually with the petals prominently colored; inflorescence various, but not as above; fruit a capsule, silique/silicle, or a schizocarp of 2 mericarps.
 - 3 Corolla bilaterally symmetrical and the petals connate into a tube (or the corolla 2-lipped but the corolla lobes twisted so as to make the flower asymmetrical); stamens 4; fruit a 2-locular and loculicidal capsule opening by 2 valves [Castilleja, Macranthera, Pedicularis, Striga] **OROBANCHACEAE**
 - 3 Corolla radially symmetrical and either connate into a tube or distinct (except *Reseda* in RESEDACEAE, with bilateral symmetry but separate petals); stamens 5 or more; fruit a silique/silicle, a schizocarp of 4 mericarps, or a 1-, 3-, or 4-locular capsule (2-locular in *Ipomoea* in CONVOLVULACEAE and *Glaucium* in PAPAVERACEAE), opening variously.
 - 4 Ovary inferior; fruit **either** a schizocarp of 2 mericarps **or** a 4-locular capsule.
 - 5 Flowers 5-merous, aggregated into a head; fruit a schizocarp of 2 mericarps [Eryngium] **APIACEAE**
 - 5 Flowers 4-merous, in a diffuse inflorescence; fruit a 4-locular capsule..... [Oenothera] **ONAGRACEAE**
 - 4 Ovary superior; fruit **either** a silique/silicle, **or** a 1-, 2-, or 3-locular capsule, **or** a berry.
 - 6 Sepals and petals of different numbers, the sepals 2-3, the petals 0, 4, or 6; stamens many [Argemone, Chelidonium, Eschscholzia, Glaucium, Macleaya, Papaver, Stylophorum] **PAPAVERACEAE**
 - 6 Sepals and petals the same number, 4-8 each; stamens 5 or 6 (10-25 in *Reseda* in RESEDACEAE).
 - 7 Corolla bilaterally symmetrical; stamens 10-25..... [Reseda] **RESEDACEAE**
 - 7 Corolla radially symmetrical; stamens 5 or 6.
 - 8 Petals 4, distinct; stamens 6; fruit a silique/silicle [many] **BRASSICACEAE**
 - 8 Petals 5, connate into a tube; stamens 5; fruit **either** a capsule **or** a berry.
 - 9 Plant a twining vine.
 - 10 Corolla with a long tube, much longer than the lobes, scarlet, white, pink, or blue; leaves shallowly to deeply pinnately parted into 3-many lobes [Ipomoea] **CONVOLVULACEAE**
 - 10 Corolla with a short tube, the lobes longer than the tube, purplish; leaves with a single large terminal lobe, and 2 small basal lobes (these almost separate as leaflets) [Solanum (dulcamara)] **SOLANACEAE**
 - 9 Plant an erect or sprawling herb.
 - 11 Fruit a capsule, 1-locular; corolla white, pink, lavender, or blue, the tube short (< 4 mm long), the lobes flaring, the corolla < 15 mm long or wide [Ellisia, Hydrophyllum, Nemophila, Phacelia] **BORAGINACEAE**
 - 11 Fruit **either** a capsule, 2- or 3-locular, **or** a berry; corolla scarlet, blue, white, yellow, greenish-yellow, or purple, the tube long (>10 mm long) and cylindrical, the corolla > 10 mm long or wide.
 - 12 Stigmas 3; fruit a capsule with 3 valves; XXXX [Gilia, Ipomopsis, Navarretia] **POLEMONIACEAE**
 - 12 Stigmas 2; fruit **either** a capsule with 2 valves **or** a berry; YYYY [Datura, Hyoscyamus, Nicandra, Physalis, Solanum] **SOLANACEAE**

Key Q – herbaceous dicots with whorled leaves on the stem

- 1 Cauline leaves palmately compound.
 - 2 Cauline leaves essentially sessile, and also palmately cleft to the base, and further lacerately divided into linear or oblanceolate segments..... [Anemone] **RANUNCULACEAE**
 - 2 Cauline leaves petiolate, with 3-5, sessile or petiolulate, ovate, elliptic, or obovate leaflets (these serrate and sometimes with additional lobes).
 - 3 Inflorescence a spherical umbel of many flowers; fruit a drupe with 2-3 seeds; stem leaves 3-5..... [Panax] **ARALIACEAE**
 - 3 Inflorescence of single terminal flowers on the 1-several branches; fruit an aggregate of achenes; stem leaves 3..... [Anemone] **RANUNCULACEAE**
- 1 Cauline leaves simple.
 - 4 Inflorescence an involucre head subtended by phyllaries, heads solitary or many, variously arrayed in secondary inflorescences; fruit a cypsela **ASTERACEAE**
 - 4 Inflorescence various, but not as above; fruit various, not as above (sometimes the flowers tightly grouped, but then with other features differing, such as stamens 4, or green calyx present, or fruit a schizocarp of mericarps, etc.).
 - 5 Fruit a 3-lobed, 3-locular capsule; inflorescence a cyathium, consisting of a single pistillate flower (reduced to a single 3-carpellate pistil) and 2 or more staminate flowers (each reduced to 1 stamen), borne in a cup-like involucre, the involucre bearing pointed or rounded glands, these sometimes brightly colored and petaloid, mimicking an individual flower (the cyathia then secondarily arranged in terminal cymes, or solitary and axillary, etc.); fresh plants with milky juice [Euphorbia] **EUPHORBIACEAE**
 - 5 Fruit various, not as above; inflorescence not a cyathium (and staminate or bisexual flowers almost always with > 1 stamen); fresh plants lacking milky juice.
 - 6 Leaves succulent, the terminal whorls closely juxtaposed; pistils 4-5; fruit an aggregate of follicles..... [Sedum] **CRASSULACEAE**
 - 6 Leaves herbaceous, thin in texture, whorls separated; pistil 1, of 2-5 fused carpels; fruit a capsule or achene.
 - 7 Larger whorled leaves on a plant < 10 mm wide [some taxa keyed here and under the second lead].
 - 8 Inflorescence a cymule, either axillary, or axillary and terminal; ovary inferior.
 - 9 Leaves markedly variable in shape or size in each whorl; fruit a capsule; petals 5..... [Mollugo] **MOLLUGINACEAE**
 - 9 Leaves similar in size and shape in each whorl; fruit dry or fleshy, indehiscent; petals (3-) 4 [Galium] **RUBIACEAE**
 - 8 Inflorescence a terminal raceme, panicle, spike, cyme, corymb, or umbel; ovary superior.
 - 10 Corolla bilaterally symmetrical, the petals connate; carpels 2; stamens 4, 6, or 8.

- 11 Stamens 4; corolla blue or almost white[*Collinsia, Nuttallanthus*] **PLANTAGINACEAE**
 11 Stamens 6 or 8; corolla pink or yellow [Polygala] **POLYGALACEAE**
 10 Corolla radially symmetrical, the petals separate; carpels 2, 3, or 5; stamens 5, 10, or many.
 12 Inflorescence an axillary umbel; leaves narrowly linear and more than 10× as long as wide, > 20 mm long and < 2 mm wide; whorls of 3-6 leaves [Asclepias (*verticillata*)] **APOCYNACEAE**.
 12 Inflorescence a terminal cyme, raceme, panicle, or umbel; leaves as above, or broader in shape, narrower, or shorter; whorls of 3-16 leaves.
 13 Inflorescence a terminal cyme or umbel; corolla white; carpels 5.
 14 Leaves narrowly linear, 12-16 in each whorl; stamens 5.....[*Spergula*] **CARYOPHYLLACEAE**
 14 Leaves ovate or obovate, 3 (-4) in each whorl.....[*Chimaphila*] **ERICACEAE**
 13 Inflorescence a terminal raceme or panicle; corolla reddish, maroon, or yellow.
 15 Corolla reddish or maroon [Lechea] **CISTACEAE**
 15 Corolla yellow[*Lysimachia (asperulifolia, loomisii)*] **PRIMULACEAE**
 7 Larger whorled leaves on a plant >10 mm wide.
 16 Inflorescence of terminal involucre clusters; perianth of 6 tepals; fruit an achene; stamens 9; [plants of very dry habitats]..... [Eriogonum] **POLYGONACEAE**
 16 Inflorescence various, but not as above; perianth of 2 whorls (the calyx often obsolete in *Galium* in RUBIACEAE), 3-, 4-, 5-, 6-, or 7-merous; stamens 2-7; [plants of dry-mesic to very wet habitats].
 17 Fruit dry or fleshy, indehiscent; petals (3-) 4; ovary inferior [Galium] **RUBIACEAE**
 17 Fruit a capsule or follicle, dehiscent; petals 4-7; ovary superior.
 18 Inflorescence an umbel; fresh plants with milky juice[*Asclepias (quadrifolia)*] **APOCYNACEAE**
 18 Inflorescence not an umbel; fresh plants with clear juice.
 19 Corolla pink-purple, 6-merous, the petals separate and borne on the edge of a hypanthium; stamens 8, 10, or 12; [plants of wetlands].....[*Decodon, Lythrum*] **LYTHRACEAE**
 19 Corolla white, yellow, or greenish, 4-, 5-, or 7-merous, the petals fused at least basally into a tube (falling as a unit), not on a hypanthium; stamens 2, 4, 5, or 7; [plants of mesic habitats].
 20 Stamens 2; corolla bilaterally symmetrical [Veronicastrum] **PLANTAGINACEAE**
 20 Stamens 4, 5, or 7; corolla radially symmetrical.
 21 Petals yellowish-white, with prominent green streaks; biennial or monocarpic plant, 10-30 dm tall when fertile; leaves 15-35 cm long.....[*Frasera*] **GENTIANACEAE**
 21 Petals white or yellow; perennial plants, 1-15 dm tall; leaves 1-15 cm long.....[*Lysimachia*] **PRIMULACEAE**
 {add [*Platycodon*] **CAMPANULACEAE**}

Key R – herbaceous dicots with opposite, compound leaves on the stem

- 1 Inflorescence an involucre head subtended by phyllaries, heads solitary or many, variously arrayed in secondary inflorescences; fruit a cypsela..... **ASTERACEAE**
 1 Inflorescence various, but not as above; fruit various, not as above.
 2 Leaves pinnately compound.
 3 Leaves even-pinnate [Kallstroemia, Tribulus] **ZYGOPHYLLACEAE**
 3 Leaves odd-pinnate..... [Valeriana] **VALERIANACEAE**
 2 Leaves palmately compound.
 4 Cauline leaves essentially sessile, and also palmately cleft to the base, and further lacerately divided into linear or oblanceolate segments [Anemone] **RANUNCULACEAE**
 4 Cauline leaves petiolate, with 3-5, sessile or petiolulate, ovate, elliptic, or obovate leaflets (these serrate and sometimes with additional lobes).
 5 YYYYY [Cannabis] **CANNABACEAE**
 5 XXXX [Anemone] **RANUNCULACEAE**

Key S – herbaceous dicots with opposite, simple leaves on the stem

- 1 Leaves unlobed (though sometimes serrate or crenate).....
 **Key S1 – herbaceous dicots with opposite, simple, and unlobed leaves on the stem**
 1 Leaves palmately or pinnately lobed (leaves with cordate, sagittate, or hastate leaf bases and otherwise unlobed are treated as unlobed).
 2 Leaves palmately lobed..... **Key S2 – herbaceous dicots with opposite, simple, and palmately lobed leaves on the stem**
 2 Leaves pinnately lobed..... **Key S3 – herbaceous dicots with opposite, simple, and pinnately lobed leaves on the stem**

Key S1 – herbaceous dicots with opposite, simple, and unlobed leaves on the stem

- 1 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [many] **ASTERACEAE**
 1 Inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers in a head, e.g. *Pycnanthemum* in LAMIACEAE, but then with other features differing, such as stamens 4, or green calyx present, or fruit a schizocarp of mericarps, etc.).
 2 Leaves scale-like, stems fleshy; flowers embedded in the fleshy stem, no perianth present; [of saline environments (coastal or rarely inland).].....[*Salicornia, Sarcocornia*] **AMARANTHACEAE**
 2 Leaves small to large; stems not fleshy; flowers sessile or on pedicels; [collectively of many habitats, saline and not].
 3 Ovary inferior or partially inferior.
 4 Perianth of a single whorl (petals absent) (note that in *Mirabilis* in NYCTAGINACEAE the petaloid calyx is subtended by a 5-lobed fused set of involucre bracts).
 5 Leaves herbaceous, suborbicular, about as long as wide or wider than long; calyx 3- or 4-merous; stamens 4, 8, or 12.

- 6 Plant ascending, with a single node (2 leaves); leaves > 6 cm long and wide; calyx 3-merous, brown to yellowish; stamens 12...
.....[*Asarum*] **ARISTOLOCHACEAE**
- 6 Plant creeping, with many nodes; leaves 3-15 mm long and wide; calyx 4-merous, yellow to greenish; stamens 4 or 8.....
.....[*Chrysosplenium*] **SAXIFRAGACEAE**
- 5 Leaves fleshy, linear, lanceolate, to broadly ovate, at least slightly longer than broad; calyx 5-merous; stamens 3, 5, or 10.
- 7 Flowers axillary, sessile or nearly so, solitary or a few; petaloid sepals widely spreading, separate; leaves linear to oblanceolate;
stamens 5 or 10.....[*Sesuvium*] **AIZOACEAE**
- 7 Flowers in terminal cymose panicles; petaloid sepals connate into a narrow tube (reminiscent of the corolla of *Ipomoea*); leaves
lanceolate, elliptic, ovate, or broadly ovate; stamens 3 or 5.....[*Boerhavia, Mirabilis*] **NYCTAGINACEAE**
- 4 Perianth in 2 whorls (sepals and petals both present).
- 8 Petals distinct; inflorescence diffuse.
- 9 Leaves distinctly 3-veined from the base, the 3 veins converging again at the leaf apex..... [*Rhexia*] **MELASTOMATAACEAE**
- 9 Leaves with prominently pinnate venation[*Circaea, Epilobium, Ludwigia*] **ONAGRACEAE**
- 8 Petals connate into a tube (at least basally); inflorescence often a head or dense terminal cyme (also axillary, or solitary on long
peduncles).
- 10 Petals 5; stamens 3, 4, or 5.
- 11 Inflorescence axillary, of 1-several flowers; stamens 5.....[*Triosteum*] **CAPRIFOLIACEAE**
- 11 Inflorescence terminal, **either** of compact cymes **or** of a pair of flowers on a long peduncle; stamens 3 or 4.
- 12 Inflorescence a pedunculate pair of flowers; stamens 4.....[*Linnaea*] **LINNAEACEAE**
- 12 Inflorescence of compact cymes; stamens 3.....[*Valeriana (scandens), Valerianella*] **VALERIANACEAE**
- 10 Petals 4 (or 6 or 8 in *Richardia* in RUBIACEAE); stamens 4, 6, or 8.
- 13 Inflorescence a head, subtended by 4 large bright white bracts.....[*Cornus (canadensis)*] **CORNACEAE**
- 13 Inflorescence a head or more diffuse (see below); sometimes subtended by green bracts.
- 14 Leaves serrate; corolla bilaterally symmetrical (especially the flowers near the outer edge of the head); inflorescence a
head.....[*Dipsacus, Knautia*] **DIPSACACEAE**
- 14 Leaves entire; corolla radially symmetrical; inflorescence a head or more diffuse (see below).
- 15 Petals acute; flowers in terminal panicles, cymes, or panicles, or axillary; plant habit various, not simultaneously with
all the characters below..... [*Diodia, Houstonia, Mitchella; Oldenlandia, Richardia, Spermaceae*] **RUBIACEAE**
- 15 Petals broadly rounded; flowers axillary, solitary; plant a diffusely branched herb with linear leaves.....
.....[*Polypremum*] **TETRACHONDRAEAE**
- 3 Ovary superior.
- 16 Perianth of a single whorl (petals absent) or missing entirely (petals and sepals both absent).
- 17 Inflorescence a cyathium, consisting of a single pistillate flower (reduced to a single 3-carpellate pistil) and 2 or more staminate
flowers (each reduced to 1 stamen), borne in a cup-like involucre, the involucre bearing pointed or rounded glands, these
sometimes brightly colored and petaloid, mimicking an individual flower (the cyathia then secondarily arranged in terminal
cymes, or solitary and axillary, etc.); fresh plants with milky juice; fruit a 3-lobed, 3-locular capsule.....
.....[*Euphorbia*] **EUPHORBIACEAE**
- 17 Inflorescence not a cyathium (and staminate or bisexual flowers with > 1 stamen, except *Callitriche* in PLANTAGINACEAE);
fresh plants lacking milky juice; fruit various, not as above.
- 18 Flowers 1 (or 2) in leaf axils; leaves entire.
- 19 Flowers unisexual; sepals 0; flowers (staminate) with 1 stamen..... [*Callitriche*] **PLANTAGINACEAE**
- 19 Flowers bisexual; sepals 4; flowers with 2, 4, or 6 stamens.
- 20 XXXX..... [*Trianthes*] **AIZOACEAE**
- 20 YYYY.....[*Didiplis, Rotala*] **LYTHRACEAE**
- 18 Flowers many, in axillary spikes, cymes, or glomerules, or in terminal spikes, heads, cymes, or panicles; leaves entire or
serrate.
- 21 Fruit a 2-locular capsule; XXXX..... [*Mercurialis*] **EUPHORBIACEAE**
- 21 Fruit single-seeded, an achene or utricle; YYYY.
- 22 Leaves serrate, regularly and sharply so; plants with stinging hairs (or not).....[*Boehmeria, Pilea, Urtica*] **URTICACEAE**
- 22 Leaves entire, or with a few very obscure crenations (*Iresine*) or basally disposed rounded lobe-like teeth (*Atriplex*);
plants without stinging hairs.
- 23 Style 1; leaves generally either longer than 30 mm, or wider than 8 mm (if linear and smaller than those dimensions,
then fleshy).....
[*Achyranthes, Alternanthera, Atriplex, Froelichia, Gomphrena, Guilleminea, Iresine, Salsola, Suaeda*] **AMARANTHACEAE**
- 23 Styles 2-30 mm long, 0.5-8 mm wide, linear or narrowly elliptic.....
.....[*Herniaria, Paronychia, Scleranthus*] **CARYOPHYLLACEAE**
- 16 Perianth in 2 whorls (sepals and petals both present).
- 24 Gynoecium of 4-many pistils, each 1-carpellate.
- 25 Pistils 4-5, in a single whorl; stamens 4, 5, 8, or 10; fruit an aggregate of follicles.....
.....[*Crassula, Hylotelephium, Bryophyllum, Sedum*] **CRASSULACEAE**
- 25 Pistils many, spiral; stamens many; fruit an aggregate of plumose achenes.....[*Clematis*] **RANUNCULACEAE**
- 24 Gynoecium **either** of 1 pistil (with 1 or more carpels), **or** of 2 pistils, united only by the style and stigma (APOCYNACEAE).
- 26 Petals not at all connate, not even at their bases.
- 27 Leaves with pellucid punctate glands (most easily visible with transmitted light); stamens often fascicled into 3, 4, or 5
fascicles; petals yellow or pinkish..... [*Hypericum*] **HYPERICACEAE**
- 27 Leaves lacking pellucid punctate glands; stamens not fascicled; petals variously colored.
- 28 Sepals 2; stamens opposite the petals..... [*Claytonia, Montia*] **PORTULACACEAE**
- 28 Sepals 3-7; stamens opposite the sepals.
- 29 Petals 3; sepals 5, dimorphic, the 2 outer sepals narrower than the 3 inner and concave sepals; stamens (3-) 5-15 (-25)..
..... [*Lechea*] **CISTACEAE**
- 29 Petals 4-7; sepals 4-7, normally monomorphic; stamens 4, 5, 6, 8, 10, or 12 (or sometimes rarely 2 or 3).
- 30 Capsule 2-5 (-6) locular; style 1; perianth 4-7-merous; stamens 4, 6, 8, 10, or 12.....
.....[*Ammannia, Cuphea, Decodon, Lythrum, Rotala*] **LYTHRACEAE**
- 30 Capsule either 1-locular of 10-locular; styles 2-5; perianth 4-5-merous; stamens 4, 5, 8, or 10 (or rarely 2 or 3).

- 31 Capsule 1-locular, dehiscent apically by teeth or valves; sepals connate into a tube or separate; styles 2-5; perianth 4-5-merous; stamens 4, 5, 8, or 10 (or rarely 2 or 3)..... [most] **CARYOPHYLLACEAE**
- 31 Capsule 10-locular (each of the 5 carpels divided at maturity), septical; sepals distinct or nearly so; styles 5, perianth 5-merous; stamens 5 [*Linum*] **LINACEAE**
- 26 Petals connate at least for a short distance at their bases.
- 32 Corolla radially symmetrical (or so slightly bilaterally symmetrical as to be mistakable as radially symmetrical); stamens as many as the corolla lobes (or 1 less in *Ruellia* in ACANTHACEAE, *Buchnera* in OROBANCHACEAE, *Trichostema* in LAMIACEAE, and *Verbena* in VERBENACEAE); carpels 2 or 3.
- 33 Pistils 2, united only by the style and stigma; fruit a schizocarp of 2 1-carpellate follicles (often single by abortion); plant with milky juice when fresh (except *Catharanthus*); leaves entire..... [*Apocynum*, *Asclepias*, *Catharanthus*, *Cynanchum*, *Gonolobus*, *Matelea*, *Seutera*] **APOCYNACEAE**
- 33 Pistil 1 (of 2-5 fused carpels); fruit **either** a 2-5-carpellate capsule **or** of 4 1-seeded nutlets derived from 2 carpels; plant lacking milky juice; leaves entire or serrate.
- 34 Ovary and capsule 3-5-carpellate; capsule 3- or 1-locular.
- 35 Sepals 2..... [*Montia*] **MONTIACEAE**
- 35 Sepals 5.
- 36 Inflorescence a terminal cyme; corolla salverform, with an elongated and very narrow tube, pink or white; capsule 3-locular..... [*Phlox*] **POLEMONIACEAE**
- 36 Inflorescence various but not cymose, of terminal or axillary racemes or panicles, or of solitary axillary flowers; corolla connate only at the base, the petals appearing nearly separate (not salverform); capsule 1-locular [*Lysimachia*] **PRIMULACEAE**
- 34 Ovary and capsule 2-carpellate; fruit **either** a 2-locular capsule **or** of 4 1-seeded nutlets derived from 2 carpels.
- 37 Stamens 4-12, the same number as the corolla lobes; corolla (and the flower as a whole) strictly radially symmetrical.
- 38 Capsule septical; corolla white, pink, blue, yellowish white, or greenish white; inflorescence **either** a terminal or axillary cyme, **or** a terminal panicle or raceme, or a terminal or axillary cyme reduced to 1 or a few flowers [*Bartonia*, *Centaurium*, *Eustoma*, *Gentiana*, *Gentianella*, *Gentianopsis*, *Obolaria*, *Sabatia*, *Schenkia*] **GENTIANACEAE**
- 38 Capsule loculicidal and also deeply 2-lobed; corolla white, pink, or scarlet with a yellow interior; inflorescence of cymosely arranged spikes [*Mitreola*, *Spigelia*] **LOGANIACEAE**
- 37 Stamens 4, 1 fewer than the 5 corolla lobes; corolla usually slightly bilaterally symmetrical (the flower as a whole made bilaterally symmetrical by the 4 stamens).
- 39 Leaves entire; corolla tube flaring for all of its length
- 40 Fruit a schizocarp of 4 1-seeded nutlets; inflorescence terminal, of cymes; corolla ca. 5 mm long; leaves prominently 3-veined [*Trichostema*] **LAMIACEAE**
- 40 Fruit a capsule; inflorescence axillary, of cymes or clusters (often reduced to a solitary flower); corolla > 12 mm long; leaves with single primary vein [*Dyschoriste*, *Ruellia*] **ACANTHACEAE**
- 39 Leaves serrate; corolla salverform, the tube narrow and nearly the same diameter for most of its length; inflorescence a terminal spike or raceme, or raceme of racemes.
- 40 Fruit a 2-locular capsule; stamens inserted near the base of the corolla tube..... [*Buchnera*] **OROBANCHACEAE**
- 40 Fruit a schizocarp of 4 mericarps; stamens inserted near the middle of the corolla tube [*Verbena*] **VERBENACEAE**
- 32 Corolla bilaterally symmetrical (or the corolla 2-lipped but the corolla lobes twisted so as to make the flower asymmetrical); fertile stamens fewer than the corolla lobes (except *Plantago* in PLANTAGINACEAE, which is equal, with 4 each; a few genera have a 5th, sterile, stamen which is obviously different in form than the 4 fertile stamens) (note that many corollas are bilabiate and the number of corolla lobes, 4 or 5, may be difficult to interpret); carpels 2.
- 41 Carpels 2, each carpel slightly to deeply lobed, separating at maturity into 4 half-carpellate units (not separating in *Phyla* in VERBENACEAE); fruit a schizocarp of 4 mericarps (or 2 nutlets in *Phyla* in VERBENACEAE).
- 42 Inflorescence a thyrs, verticillaster, or terminal cyme, the flowers borne in cymose lateral branches; corolla strongly bilaterally symmetrical (rarely nearly radially symmetrical); stems square in \times -section (or sometimes rounded, especially on older growth); fresh plants often (but not always) aromatic [most] **LAMIACEAE**
- 42 Inflorescence of spikes or racemes, the flowers or fruits single at nodes; corolla often nearly radially symmetrical; stems rounded in X-section (rarely square); fresh plants usually not aromatic [*Phyla*, *Verbena*] **VERBENACEAE**
- 41 Carpels 2, unlobed; fruit a capsule (or an achene in *Phryma*).
- 43 Stamens 2.
- 44 Corolla 4 lobed, almost radially symmetrical; corolla scarious, white, or bluish [*Plantago*, *Veronica*] **PLANTAGINACEAE**
- 44 Corolla 4-5-lobed, **either** strongly bilabiate **or** salverform (*Pseuderanthemum* in ACANTHACEAE); white, blue, or yellow.
- 45 Inflorescence an axillary cluster or spike..... [*Dicliptera*, *Justicia*, *Pseuderanthemum*] **ACANTHACEAE**
- 45 Inflorescence of solitary (rarely 2) axillary flower.
- 46 Sepals 4 [*Hemianthus*, *Micranthemum*] **LINDERNIACEAE**
- 46 Sepals 5, distinct or nearly so.
- 47 Corolla barely bilaterally symmetrical, the lobes about as long as the tube; outer sepals ovate, much wider than the inner sepals..... [*Bacopa*] **PLANTAGINACEAE**
- 47 Corolla distinctly bilabiate, the lobes shorter than the tube; sepals of nearly the same width.
- 48 Sterile stamens (the lower pair) consisting of slender filaments [*Lindernia*] **LINDERNIACEAE**
- 48 Sterile stamens minute or completely absent..... [*Gratiola*] **PLANTAGINACEAE**
- 43 Stamens 4.
- 49 Corolla 4 lobed, nearly radially symmetrical; corolla scarious..... [*Plantago*] **PLANTAGINACEAE**
- 49 Corolla 5-lobed, distinctly bilabiate or in some nearly radially symmetrical; corolla colored.
- 50 Flowers in terminal racemes, panicles, or spikes, the inflorescence not interspersed with large, leaf-like bracts.
- 51 Sepals separate to the base or nearly so, not forming a tube..... [*Antirrhinum*, *Chelone*, *Linaria*, *Nuttallanthus*, *Penstemon*] **PLANTAGINACEAE**

- 51 Sepals connate for at least 0.3× their length to form a tube (this cup-like and flaring in *Scrophularia* in SCROPHULARIACEAE).
- 52 Inflorescence a diffuse panicle; corolla 5-11 mm long, reddish-brown (sometimes with some yellow); fruit a septical capsule..... [*Scrophularia*] SCROPHULARIACEAE
- 52 Inflorescence of 1 or more terminal (and sometimes upper axillary) spikes or racemes; corolla 10-50 mm long (6-8 mm long in *Phryma* in PHRYMACEAE), white, pink, blue, purple, or yellow; fruit either a loculicidal capsule (OROBANCHACEAE) or a single seeded achene (*Phryma* in PHRYMACEAE).
- 53 Corolla 10-50 mm long, pink, blue, purple, or yellow; fruit a loculicidal capsule..... [*Agalinis, Aureolaria, Buchnera, Pedicularis*] OROBANCHACEAE
- 53 Corolla 6-8 mm long, white to pale pink; fruit a 1-seeded achene contained in the accrescent calyx, this “lopping down” against the inflorescence axis..... [*Phryma*] PHRYMACEAE
- 50 Flowers axillary and solitary, borne in the axils of normally-sized leaves or somewhat reduced but still large and leaf-like bracts [some taxa keyed here and below].
- 54 Sepals separate to the base or nearly so, not forming a tube.
- 55 Corolla distinctly bilabiate..... [*Lindernia*] LINDERNIACEAE
- 55 Corolla not bilabiate, only slightly bilaterally symmetrical.
- 56 Leaves serrate, 2.0-4.5 cm long; plant usually blackening on drying..... [*Mecardonia*] PLANTAGINACEAE
- 56 Leaves entire, either mostly larger or smaller [see below]; plant not blackening on drying
- 57 Leaves 0.6-2.8 cm long, round, obovate, or broadly elliptic, < 1.8× as long as wide; plants creeping, ascending to 3 dm tall; [plants of wet places]..... [*Bacopa*] PLANTAGINACEAE
- 57 Leaves 3-30 cm long, narrowly elliptic to lanceolate, > 2× as long as wide; plants erect or the stems sprawling; [plants mostly of uplands]..... [*Dyschoriste, Ruellia*] ACANTHACEAE
- 54 Sepals connate for at least 0.3× their length to form a tube.
- 58 Corolla yellow, orange, or red.
- 59 Calyx lobes longer than the tube, or as long as the tube, corolla 25-50 mm long; plants usually blackening on drying..... [*Aureolaria*] OROBANCHACEAE
- 59 Calyx lobes shorter than the tube; corolla 14-22 mm long; plants not blackening on drying.
- 60 Corolla red or orange, with a very narrow, cylindrical tube, the lobes then flaring into a limb about 1 cm across; plants blackening on drying; [rare alien, in crop fields, a noxious hemiparasitic weed under quarantine]..... [*Striga*] OROBANCHACEAE
- 60 Corolla yellow, not narrowly cylindrical, the lower lip arched; plants not blackening on drying; [rare, in seepage wetlands]..... [*Erythranthe*] PHRYMACEAE
- 58 Corolla white, pale blue, lavender, or pink (sometimes with some yellow).
- 61 Corolla pink (sometimes almost white), often lined with yellow inside; leaves narrowly linear, often filiform (except lanceolate in *A. auriculata*); plants usually blackening on drying (some species do not); corolla not strongly bilabiate..... [*Agalinis*] OROBANCHACEAE
- 61 Corolla white, blue, or combinations of blue and white (sometimes with some yellow markings); leaves broader, mostly lanceolate; plants not blackening on drying; corolla strongly bilabiate.
- 62 Upper lip of the corolla hooded, enfolding the anthers..... [*Melampyrum*] OROBANCHACEAE
- 62 Upper lip of the corolla not hooded and enclosing the anthers; plants not blackening on drying.
- 63 Corolla blue; lower lip of the corolla arched upwards into the throat; plants perennial from rhizomes or crowns, 3-13 dm tall..... [*Mimulus*] PHRYMACEAE
- 63 Corolla bicolored, the upper lip white or very pale blue, the lower lip bright blue; the lower lip of the corolla folded downward into a pouch enfolding the anthers; plants annuals, 0.5-4 dm tall..... [*Collinsia*] PLANTAGINACEAE

Key S2 – herbaceous dicots with opposite, simple, and palmately lobed leaves on the stem

- 1 Leaf lobes very narrow, < 3 mm wide; inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [e.g., *Coreopsis (verticillata)*] ASTERACEAE
- 1 Leaf lobes broad, >20 mm wide; inflorescence, flower, and fruit structure various, but not with the combination of features as above.
- 2 Leaves >4 per above-ground stem; perianth 5-merous; flowers bilaterally symmetrical, the corolla with connate petals, lavender-white with yellow markings in the throat; fruit a large curved capsule..... [*Proboscidea*] MARTYNIACEAE
- 2 Leaves 1-2 per above-ground stem; perianth 3-merous; flowers radially symmetrical, the corolla absent or with distinct petals, white; fruit a berry or aggregate of berries.
- 3 Leaves with peltate petiole attachment; carpel 1; petals present, white..... [*Diphylleia, Podophyllum*] BERBERIDACEAE
- 3 Leaves with petiole attached marginally; carpels many, as separate pistils; petals absent..... [*Hydrastis*] HYDRASTIDACEAE

Key S3 – herbaceous dicots with opposite, simple, and pinnately lobed leaves on the stem

- 1 Inflorescence an involucre head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla connate and tubular at least basally, the calyx absent, the stamens 5, the fruit a cypsela..... [many] ASTERACEAE
- 1 Inflorescence, flower, and fruit structure various, but not with the combination of features as above (sometimes the flowers tightly grouped, but then with other features differing, such as stamens 4, or green calyx present, or fruit a schizocarp of mericarps, etc.).
- 2 Flowers tiny, individually inconspicuous; perianth absent or vestigial; fruit a utricle..... [*Atriplex*] AMARANTHACEAE
- 2 Flowers larger, individually conspicuous; perianth present, the petals or sepals brightly colored; fruit a capsule (or aggregate of achenes in *Clematis* in RANUNCULACEAE or schizocarp of 4 mericarps in *Glandularia* in VERBENACEAE).
- 3 Flowers radially symmetrical; stamens 5 or many; fruit a capsule or aggregate of achenes.
- 4 Stamens 5; fruit a capsule..... [*Ellisia*] BORAGINACEAE
- 4 Stamens many; fruit an aggregate of plumose achenes..... [*Clematis*] RANUNCULACEAE

- 3 Flowers bilaterally symmetrical (sometimes only slightly so); stamens 4 (or 2 in *Veronica* in PLANTAGINACEAE); fruit a capsule or schizocarp of mericarps.
 - 5 Inflorescence of cymosely arranged spikes or heads; fruit a schizocarp of 4 nutlets [*Glandularia*] **VERBENACEAE**
 - 5 Inflorescence of solitary axillary flowers or terminal racemes.
 - 6 Corolla yellow, orange, or red; plants often drying black (but not *Striga*); sepals connate into a tube at least 1/3 as long as the corolla lobes; calyx 5-merous [*Aureolaria*, *Dasistoma*, *Macranthera*, *Seymeria*, *Striga*] **OROBANCHACEAE**
 - 6 Corolla white, pink, lavender, or blue; plants not drying black; sepals distinct or only shortly connate into a short tube, the calyx lobes much longer than the tube; calyx 5- or 4-merous [*Leucospora*, *Penstemon*, *Veronica*] **PLANTAGINACEAE**

THE FLORA

SECTION 1: LYCOPODIOPHYTA (CLUBMOSES)

LI. LYCOPODIACEAE Palisot de Beauvois 1802 (Clubmoss Family) [in LYCOPODIALES]

A family of 10-15 genera and about 400 species. Lycopodiaceae, along with Selaginellaceae and Isoetaceae, have now been shown 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 (1992) divide *Lycopodium* (*sensu latissimo*) 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* (*sensu lato*) into three genera: *Dendrolycopodium*, *Spinulum*, and *Lycopodium* (*sensu stricto*). 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 three 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. Based on this deep division between *Huperzia* and the other genera, some authors additionally advocate the recognition of *Huperzia* in a separate family, Huperziaceae, a suggestion which is by no means outlandish (though not followed here). References: Lellinger (1985); Mickel (1979); Wagner and 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*] **1. *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.
 - 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 southward] **4. *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) **2. *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) **3. *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 perennial, elongate, surficial or subterranean; spores reticulate; [of uplands, mostly in moist to dry soils]; [subfamily *Lycopodioidae*].
 - 5 Branches 1-5 mm wide (including the leaves), compressed to quadrangular, with 4 ranks of leaves; branching of strobilus stalks dichotomous **6. *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 **8. *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 **5. *Dendrolycopodium***
 - 7 Erect leafy stems 10 mm or more in diameter (including the leaves), branched 1-4 × sub-dichotomously; leaves with a 0.4-1.0 mm long stiff spinule; horizontal shoots at or near the ground surface, with winter bud constrictions **7. *Spinulum***

1. *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. In addition, *Huperzia selago* (Linnaeus) Bernhardt 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.

- 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 10×, or preferably 20-40×, magnification); 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 10×, or preferably 20-40×, magnification); 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, not toothed (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; gemma-bearing 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; gemma-bearing 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. 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). June-August. N. QC and NL (Newfoundland) west to ON, 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 × *bartleyi* (Cusick) Kartesz & Gandhi [*H. lucidula* × *porophila*]. Rock outcrops. 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 lucidula (Michaux) Trevisan, Shining Firmoss, Shining Clubmoss. Moist forests and ravines. June-August. NL (Newfoundland) to MB, south to nw. SC, n. GA, n. AL, s. IL, and nw. AR (Peck 2011). [= FNA, K, Pa, Z; = *Lycopodium lucidulum* Michaux – C, F, G, Md, Pa, RAB, S, W, WV]

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

Huperzia × *protoporophila* A. Haines [*H. appressa* × *lucidula*]. Rock outcrops and cliff bases. Known from Chimney Rock Park, Rutherford County, NC (the lowest elevation occurrence of *H. appressa* in NC) and from Roan Mountain, Mitchell County, NC, and Grandfather Mountain, Avery County, NC. Expected at other cliff bases where the two parents are in proximity. 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 gemma-bearing 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 gemma-bearing branches). [= Z]



2. *Lycopodiella* Holub 1964 (Bog Clubmoss)

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 (2002a, 2003a, 2003b)=Z. [also see *Pseudolycopodiella*]

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 to identify. 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 < 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 toward 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. Savannas, seepages, and other wet, sandy sites. July-September. Primarily Southeastern Coastal Plain: se. MA south to FL and west to e. 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 (Haines 2001); s. Mexico south through Central America to n. South America; Cuba. [= FNA, K, Pa, WH3, Z; < *Lycopodium alopecuroides* Linnaeus – RAB; = *Lycopodium alopecuroides* Linnaeus – C, F, G, Md, S, W]

Lycopodiella appressa (Chapman) Cranfill, Southern Bog Clubmoss. Savannas, seepages, bogs. July-September. Primarily Southeastern Coastal Plain: se. NL (Newfoundland) and MA, south to FL, west to OK, AR, and TX, and disjunct in the mountains of KY, TN, NC, WV, and in sw. MI. [= FNA, K, WH3, 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. Gravelly or sandy seepage areas, bogs. July-September. A circumboreal species, ranging south in the Appalachians to NC, where it was first found in 1986 (Weakley, *in prep.*). [= FNA, K, Pa, Z; = *Lycopodium inundatum* Linnaeus – C, Md, W, WV; = *Lycopodium inundatum* var. *inundatum* – F, G]

Lycopodiella prostrata (R.M. Harper) Cranfill, Featherstem Clubmoss, Prostrate Bog Clubmoss. Savannas, seepages. July-September. A Southeastern Coastal Plain endemic: se. NC south to FL and west to TX, with scattered occurrences disjunct inland (as in n. GA and n. AL). [= FNA, K, WH3; < *Lycopodium alopecuroides* – RAB; = *Lycopodium prostratum* R.M. 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.

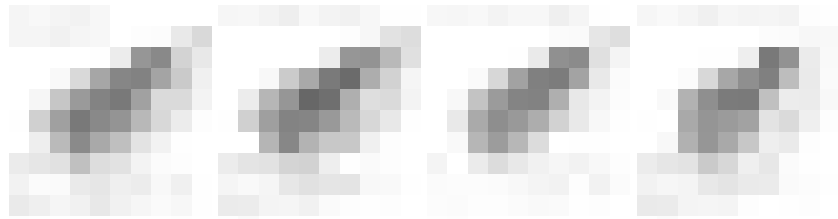
Lycopodiella alopecuroides × *appressa*. [= *Lycopodiella* × *copelandii* (Eiger) Cranfill – K, WH3, Z; *Lycopodium* × *copelandii* Eiger]

Lycopodiella alopecuroides × *inundata*. [= *Lycopodiella* × *robusta* (R.J. Eaton) A. Haines – Z]. See Haines (2002a) for additional information.

Lycopodiella alopecuroides × *prostrata*. [= *Lycopodiella* × *brucei* Cranfill – K, WH3; = *Lycopodium* × *brucei* (Cranfill) Lellinger]

Lycopodiella appressa × *inundata*. [*Lycopodiella* × *gilmanii* A. Haines – Z]. Earlier tentative reports of *Lycopodiella margueritiae* J.G. Bruce, W.H. Wagner, & Beitel for the Mountains of Virginia are apparently based on this hybrid. See Haines (2003a, 2003b) for additional information. [= *Lycopodiella margueritiae* J.G. Bruce, W.H. Wagner, & Beitel – K, misapplied; = *Lycopodiella* × *gilmanii* A. Haines – Z]

Lycopodiella appressa × *prostrata*.



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

A genus of about 12 species, sub-cosmopolitan. 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. Savannas, seepages. 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 s. FL and west to e. TX. [= FNA, Z; = *Lycopodium carolinianum* Linnaeus – C, F, G, Md, RAB, S; > *Lycopodiella caroliniana* (Linnaeus) Pichi Sermolli var. *caroliniana* – K; = *Lycopodiella caroliniana* (Linnaeus) Pichi Sermolli – WH3]

4. ***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. Wet savannas, ditches and other disturbed moist areas. This species is pantropical, occurring in the both the Neotropics and the Paleotropics. Some of its occurrences in our area may be adventive. [= FNA; > *Lycopodiella cernua* (Linnaeus) Pichi Sermolli var. *cernua* – K; = *Lycopodium cernuum* Linnaeus – S; = *Lycopodiella cernua* (Linnaeus) Pichi Sermolli – WH3]

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

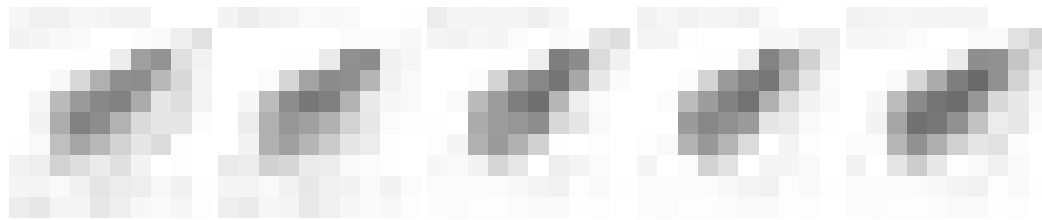
A genus of 4 species, temperate and subarctic. Haines (2003a) makes the case for this genus as distinct from *Lycopodium* s.s. and other relatives. References: Wagner & Beitel in FNA (1993b); Wagner, Beitel, & Moran (1989); Hickey (1977); Øllgaard in Kramer & Green (1990); Haines (2003a)=Z.

- 1 Leaves of the main vertical axis spreading (30-90° 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° 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 the same length as the lateral leaves; leaves of all the ranks spreading at a (21°-) ca. 27° (-36°) angle from the branchlet, thus the branchlet and leaves together 3.5-6 (-7) mm wide..... ***D. hickeyi***
- 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°) angle from the branchlet, thus the branchlet and leaves together ca. 6-9 mm wide ***D. obscurum***

Dendrolycopodium dendroideum (Michaux) A. Haines, Tree Ground-pine, Round-branch Clubmoss, Prickly Tree-clubmoss. Openings, grassy balds, high elevation spruce-fir and northern hardwood forests. July-September. The northernmost of the *L. obscurum* complex, ranging from n. QC and NL (Newfoundland) west to AK, south to s. NJ, 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, Md, WV; = *Lycopodium dendroideum* Michaux – FNA, K, Pa, W; < *L. obscurum* – C]

Dendrolycopodium hickeyi (W.H. Wagner, Beitel, & R.C. Moran) A. Haines, Pennsylvania Ground-pine, Hickey's Tree-clubmoss. Grassy balds, bog margins, forest openings. July-September. N. QC and NL (Newfoundland) west to MN, south to NJ, sw. NC, and n. IN. [= Z; < *Lycopodium obscurum* var. *dendroideum* (Michaux) D.C. Eaton – RAB, F, G, Md, WV; = *Lycopodium hickeyi* W.H. Wagner, Beitel, & R.C. Moran – FNA, K, Pa; = *Lycopodium obscurum* var. *isophyllum* Hickey – W; < *L. obscurum* – C]

Dendrolycopodium obscurum (Linnaeus) A. Haines, Common Ground-pine, Flat-branched Tree-clubmoss. Acidic forests;. July-September. NS and NB west to MI and WI, south to n. GA, ne. AL, s. IN, n. IL, and c. MN. [= Z; = *Lycopodium obscurum* Linnaeus – FNA, K, Pa; = *Lycopodium obscurum* var. *obscurum* – F, G, Md, RAB, W, WV; < *L. obscurum* – C, S]



6. ***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. Dry to mesic, usually acid forests and openings, especially common in disturbed sites, such as successional pine forests. July-September. NL (Newfoundland) west to MN, south to SC, GA, AL, MS, and AR. Hickey & Beitel (1979) and Holub (1975a & 1975b) explain the nomenclatural decision to accept the epithet '*digitatum*' over the recently more familiar '*flabelliforme*.' [= FNA, Pa, Z; = *Lycopodium flabelliforme* (Fernald) Blanch – Md, RAB, S, WV; = *Lycopodium digitatum* Dillenius ex A. Braun – C, K, W; = *Lycopodium complanatum* Linnaeus var. *flabelliforme* Fernald – F, G]

Diphasiastrum × *haberi* (House) Holub [*D. digitatum* × *tristachyum*]. Mt (KY, NC, VA, WV), Pd (VA): dry forests; rare. Known from widely scattered localities in our area; not always in close proximity to its parents. [= FNA, Z; = *Lycopodium* × *haberi* House – K; = *L. haberi* – WV, orthographic error] {not keyed; not mapped}

Diphasiastrum tristachyum (Pursh) Holub, Blue Running-cedar, Ground-cedar. Dry forests, glades, balds, barrens, forest openings. July-September. NL (Labrador) west to AB, south to nw. SC, ne. GA, ne. AL, MO, MN, and e. ND. [= FNA, Pa, Z; = *Lycopodium tristachyum* Pursh – C, F, G, K, Md, RAB, S, W, WV]

7. *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. High elevation hardwood or coniferous forests. August-October. A circumboreal species, south in North America to n. NJ, MN, SD, NM, AZ, and OR, 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. [= Z; = *Lycopodium annotinum* Linnaeus – C, FNA, K, Pa, W; > *L. annotinum* var. *acrifolium* Fernald – F, G, WV; > *L. annotinum* var. *annotinum* – F, G, Md, WV; > *L. annotinum* var. *pungens* (La Pylaie) Desvaux – WV]

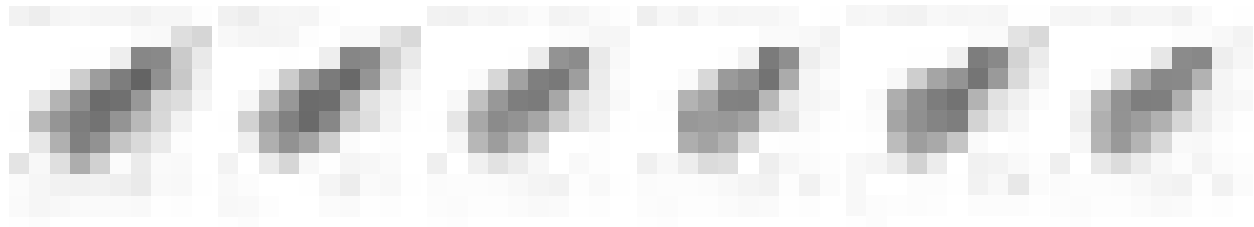
8. *Lycopodium* Linnaeus 1753 (Running Clubmoss)

A genus of 5-10 species, mainly temperate and subarctic. The 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 (2002b, 2003a)=Z. [also see *Dendrolycopodium*, *Diphasiastrum*, *Huperzia*, *Lycopodiella*, *Palhinhaea*, *Pseudolycopodiella*, and *Spinulum*]

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

Lycopodium clavatum Linnaeus, Running Clubmoss. Openings, balds, roadbanks, open forests. July-September. Circumboreal, south in e. North America along the Appalachians to NC and n. GA; also c. Mexico south through Central America to n. South America; West Indies. [= RAB, FNA, K, Md, Pa, W, Z; < *L. clavatum* – C, WV]; = *L. clavatum* var. *clavatum* – F, G, S]

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



L2. ISOETACEAE Reichenbach 1828 (Quillwort Family, Merlin's-grass Family) [in ISOETALES]

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).

Identification notes: Hybrids are possible between many combinations of species.

Key fragment to eastern granite outcrop species by Heafner et al (in prep.)

- 1 Megaspores black or gray, leaves usually no more than 5.0 cm long.
 - 2 Corms transversely oblong to oblong, roots dichotomously branched, phyllotaxy spiraled*I. melanospora*
 - 2 Corms horizontally elongate, roots fibrous and not dichotomously branched, phyllotaxy distichous.....*I. tegetiformans*
- 1 Megaspores white, leaves to 18.7 cm long or longer.
 - 3 Plants diploid (2n = 22); [widespread from VA to AL in the Piedmont]*I. piedmontana*
 - 3 Plants tetraploid (2n = 44); [narrow endemics (as far as is known) to a few counties in the Piedmont of AL and NC].
 - 4 Velum covering 0-10% of the sporangium; leaves (7.9-) avg. 11.5 (-14.9) cm long; [endemic to Franklin County, NC].....*I. species 5 "analogous"*
 - 4 Velum covering approximately 10-20% of the sporangium; [endemic to Randolph County, AL, or Wake County, NC].
 - 5 Leaves (5.9-) avg. 11.9 (-18.9) cm long; [endemic to Randolph County, AL].....*I. species 6 "alabamensis"*
 - 5 Leaves (4.2-) avg. 9.3 (-14.2) cm long; [endemic to Wake County, NC]*I. species 4 "carolinae-septentrionalis"*

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

Isoetes appalachiana D.F. Brunton & D.M. Britton, Appalachian Quillwort. Seepages, small woodland streams, ephemeral wetlands, backwaters. 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, WH3, Z; < *I. engelmannii* – RAB, C, FNA, Pa, W, WV; < *I. engelmannii* var. *engelmannii* – F, S; > *I. engelmannii* var. *georgiana* Engelm.]

Isoetes boomii N. Luebke, Boom's Quillwort. Shallow water of slow-moving streams. Known from Laurens County, GA, AL, and FL. A hexaploid species (2n=66). [= FNA, K, WH3; < *I. boomii* – Z (also see *I. georgiana*)]

Isoetes butleri Engelm., Butler's Quillwort. Seepage areas on calcareous glades. 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. Usually in permanent water bodies with active current. A diploid species (2n=22). Apparently there are 2 cryptic taxa currently combined under the name *I. engelmannii* (Hoot, Napier, & Taylor 2004), genotype NN and genotype SS. [= K, Z; < *I. engelmannii* – RAB, C, G, FNA, Pa, W, WV (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. Springs, stream bottoms, river bottoms, ditches. S. GA south to s. FL. A diploid species (2n=22). [= K, S; < *I. flaccida* FNA, WH3, Z]

Isoetes flaccida A. Braun var. *chapmanii* Engelm., Chapman's Florida Quillwort. Springs, stream bottoms, river bottoms, ditches. FL Panhandle. A diploid species (2n=22). [= K, S; < *I. flaccida* FNA, WH3, Z]

Isoetes flaccida A. Braun var. *flaccida*, Winged Florida Quillwort. Springs, stream bottoms, river bottoms, ditches. S. GA and se. AL south to s. FL. A diploid species (2n=22). [= K, S; < *I. flaccida* FNA, WH3, Z]

Isoetes georgiana N. Luebke, Georgia Quillwort. Streams. Known only from GA (Colquitt, Dodge, Irwin, Tift, 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 D.F. Brunton, Wintergreen Quillwort. Blackwater streams and sandy streambanks. 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, WH3, Z; < *I. engelmannii* – RAB, C, G; < *I. engelmannii* var. *engelmannii* – F, S]



Isoetes junciformis D.F. Brunton & D.M. Britton, Rush Quillwort. Ephemeral wetland swales in bottomland hardwood swamps. 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. {habitat}. July-September. A decaploid species (2n=110). [= FNA, C, K; > *I. macrospora* Durieu – F, G, W]

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

Isoetes mattaponica L.J. Musselman & W.C. Taylor, Mattaponi River Quillwort. Tidal rivers. Apparently endemic to rivers flowing into the 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 ssp. *melanopoda*, Blackfoot Quillwort. Floodplains. S. IN, IL, and MO south to ne. LA; probably represented eastward to c. TN and s. MS (the available material ambiguous) (Brunton & Britton 2006). [< *I. melanopoda* – FNA, K, C, G, Z]

Isoetes melanopoda Gay & Durieu ex Durieu ssp. *sylvatica* D.F. Brunton & D.M. Britton, Eastern Blackfoot Quillwort. Clay soils in low woods, seeps on sandstone or granitic rocks, in NJ in clay-based depressions on Cape May. VA south (in the Piedmont and Coastal Plain) to sw. GA, s. and n. AL, and s. MS; disjunct in s. NJ. A diploid species (2n=22), genotype= PP. [< *I. melanopoda* – FNA, K, C, G, Z; < *I. melanopoda* – RAB (also see *I. melanospora*, *I. virginica*, *I. piedmontana*)]



Isoetes melanospora Engelmann, Black-spored Quillwort. In pools on granite flatrocks. A diploid species (2n=22). [= Z, S; < *I. melanospora* – FNA, K; < *I. melanopoda* – RAB]

Isoetes microvela D.F. Brunton. Banks of rivers in the outer Coastal Plain. May-July (-September). See Brunton & Britton (1998) for additional information. [= K]

Isoetes piedmontana (N.E. Pfeiffer) C.F. Reed, Piedmont Quillwort. In seepage on granitic flatrocks and on Altamaha grit. [= K, Z; < *I. melanopoda* – RAB; < *I. virginica* – C, F, FNA, G]

Isoetes riparia Engelmann ex A. Braun, Shore Quillwort. Tidal waters, lakes. 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, Pa (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 Engelmann. Tidal waters, lakes. {disentangle from *I. riparia*} [= K; < *I. riparia* – C, FNA; = *I. riparia* var. *palmeri* (A.A. Eaton) Proctor – G]



Isoetes species 1. Pools on granite flatrocks. Forty Acre Rock, Lancaster County, SC. Being worked on by W.C. Taylor.

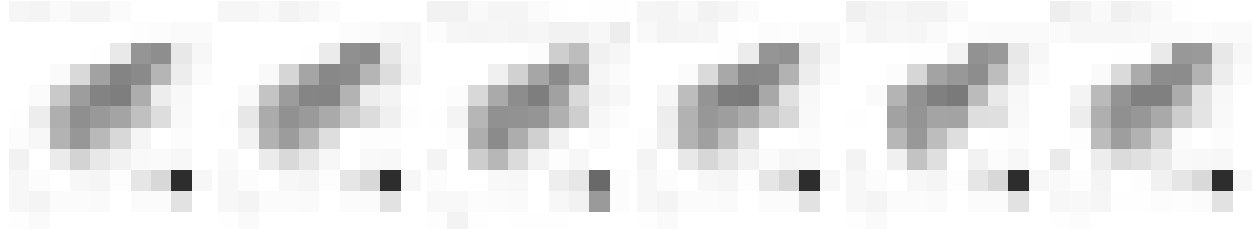
Isoetes species 3. Tidal marshes. A diploid relative of *I. melanopoda*. Being worked on by C. Caplen. A diploid species (2n=22).

Isoetes species 4 “*carolinae-septentrionalis*”. Granite flatrocks

Isoetes species 5 “*analogous*”. Granite flatrocks.

Isoetes species 6 “*alabamensis*”. Granite flatrocks.

Isoetes species 7 “**Broxton Rocks**”. Pools on sandstone outcrops; rare. Under study.



Isoetes tegetiformans Rury, Merlin's-grass. In shallow pools on granite flatrocks. Endemic to a few granite flatrocks in ec. GA (notably Heggies Rock), near the SC line. A diploid species (2n=22), genotype=TT. [= FNA, K, Z]

Isoetes tenella L eman, Spiny-spore Quillwort. In acid lakes, ponds, and rivers (submerged to emerged), tidal mud flats. Circumboreal, in North America from Greenland, NL (Labrador), and AK south to DE, n. OH, MI, WI, CO, and CA. South to PA and NJ (Kartesz 1999). [= K; = *I. echinospora* Durieu – FNA, Pa; > *I. echinospora* var. *echinospora* – F, G; > *I. echinospora* var. *muricata* (Durieu) Engelm. – C, F, G; > *I. echinospora* var. *braunii* (Durieu) Engelm. – G; > *I. muricata* Durieu] {synonymy incomplete}

Isoetes tennesseensis N.T. Luebke & J.M. Budke. Rocky river shoals. Endemic to Polk County, TN, near the North Carolina-Georgia state line, in the Hiwassee River. An octoploid species. See Luebke & 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]

Isoetes valida (Engelm.) Clute, Mountain Quillwort, Carolina Quillwort. Bogs (growing in *Sphagnum*), pools, ponds. A diploid species (2n=22). Genotype=VV. [= K, Z; = *I. caroliniana* (A.A. Eaton) N. Luebke – FNA; < *I. engelmannii* – RAB, C, W, WV; = *I. engelmannii* A. Braun var. *caroliniana* A.A. Eaton – F, S]

Isoetes virginica N.E. Pfeiffer, Virginia Quillwort. In woodland streams. 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*)]



L3. SELAGINELLACEAE Willkomm 1854 (Spikemoss Family) [in SELAGINELLALES]

A family of 1-several genera (the generic circumscriptions still unclear, and about 700-750 species. Selaginellaceae, along with Lycopodiaceae and Isoetaceae, now appear to be only distantly related to other extant pteridophytes and seed plants (Pryer et al. 2001). There has been a recent tendency to split *Selaginella* based on groups that represent very old clades (comparable to the recognition of multiple genera in Lycopodiaceae) (Soj ak 1992;  skoda 1997; Korall, Kenrick, & Therrien 1999; Korall & Kenrick 2002). We have 2 genera, by a moderate approach to generic segregation. *Selaginella* itself is restricted to the type species and a close relative. 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 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.....*Bryodesma*
- 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.....*Lycopodioides*

Bryodesma Soj ak 1992 (Spikemoss)

A genus of about 50 species, widespread in distribution. 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 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.....

-*B. tortipila*
- 1 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.
- 2 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 *B. rupestris*
- 2 Stems mostly erect or ascending, forming compact clumps usually > 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.
- 3 Leaves of the underground (rhizomatous) stems not scalelike; rhizophores mostly aerial; sporophyll base pubescent; leaf and sporophyll apices often pubescent *B. acanthonota*
- 3 Leaves of the underground (rhizomatous) stems scalelike; rhizophores mostly subterranean; sporophyll base glabrous; leaf and sporophyll apices glabrous.
- 4 Leaves mostly tightly appressed; base conspicuously pubescent; strobili distinctly larger in diameter than the subtending stem; sporophyll apex often recurved *B. arenicola* ssp. *arenicola*
- 4 Leaves mostly loosely appressed; base usually glabrescent; strobili not distinctly larger in diameter than the subtending stem; sporophyll apex usually straight *B. arenicola* ssp. *riddellii*

Bryodesma acanthonota (Underwood) Škoda, Spiny Spikemoss, Sand Spikemoss. Sandhills, Altamaha Grit glades. June-August. *S. acanthonota* ranges from se. NC south to s. FL, west to w. Panhandle FL. The complex comprising *S. acanthonota*, *S. arenicola*, and *S. riddellii* has been treated variably. The complex ranges from se. NC south to s. FL and west to c. TX; see Tryon (1955) and Valdespino in FNA (1993b) for additional information on the complex. [= *Selaginella acanthonota* Underwood – FNA, K, S; < *S. arenicola* – RAB, WH3; = *S. arenicola* Underwood ssp. *acanthonota* (Underwood) R. Tryon]

Bryodesma arenicola (Underwood) Soják ssp. *arenicola*, Sand Spikemoss. Dry sands. E. GA south to s. FL, se. GA, and e. Panhandle FL. [= *Selaginella arenicola* Underwood – S; = *S. arenicola* Underwood ssp. *arenicola* – FNA, K; < *S. arenicola* – WH3; =]

Bryodesma arenicola (Underwood) Soják ssp. *riddellii* (Van Eseltine) Škoda, Riddell's Spikemoss. Dry sands, granite outcrops, sandstone outcrops. E. and c. GA west to c. TX and s. OK. See Wilbur & Whitson (2005) for an explanation of the nomenclatural change. [= *S. arenicola* Underwood ssp. *riddellii* (Van Eseltine) R.M. Tryon – FNA, K; = *Selaginella corallina* (Riddell) Wilbur & Whitson; =]

Bryodesma rupestre (Linnaeus) Soják, Rock Spikemoss. Granite flatrocks, other, mostly acidic, rock outcrops, occasionally on greenstone or calcareous shales. June-September. S. Greenland and NS west to BC, south to GA, AL, AR, OK, and WY. 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. [= *Selaginella rupestris* (Linnaeus) Spring – C, F, FNA, G, K, Md, Pa, RAB, S, W, WV]

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



Lycopodioides Boehmer 1760 (Spikemoss)

A genus of ca. 650 species, primarily tropical and subtropical. 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 Main stems erect, the plants to 5 dm tall.....*L. species 1*
- 1 Main stems creeping or ascending.
- 2 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 *L. species 2*
- 2 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.
- 3 Margins of lateral leaves entire; lateral branches of the stems further branching 2-3 times *L. species 3*
- 3 Margins of lateral leaves dentate-serrate; lateral branches of the stems further branching 1-2 times.
- 4 Leaves with margins undifferentiated or with 1-2 rows of slightly paler cells stomates distributed over entire upper surface *L. apodum*
- 4 Leaves with margins of 3-5 rows of transparent (hyaline) cells; stomates of lateral leaves confined to near the midrib on the upper surface *L. ludovicianum*

Lycopodioides apodum (Linnaeus) Kuntze, Meadow Spikemoss. Seepages, bogs, spray cliffs, stream margins, wet meadows, marsh edges, wet spots in lawns, other moist habitats. June-October. S. ME, NY, OH, s. IN, AR, and e. OK south to FL, GA, AL, MS, LA, and e. TX; c. Mexico south to Guatemala. Often overlooked by vascular plant botanists as a moss or liverwort. *L. ludovicianum* of the Gulf Coast east to GA, and *S. eclipes* W.R. Buck, more northern, are superficially very similar. [= *Selaginella apoda* (Linnaeus) Fernald – C, F, FNA, G, K, Md, Pa, RAB, W, WV; = *Diplostachyum apodum* (Linnaeus) Beauvois – S; = *S. apoda* var. *apoda* – WH3]

Lycopodioides ludovicianum (A. Braun) Kuntze, Gulf Spikemoss, Louisiana Spikemoss. Swamp margins, wet meadows. Gulf Coastal Plain from ne. FL and sw. GA west to e. LA. [= *Selaginella ludoviciana* (A. Braun) A. Braun – FNA, K; = *Diplostachyon ludovicianum* (A. Braun) Small – S; = *S. apoda* var. *ludoviciana* (A. Braun) B.F. Hansen & Wunderlin – WH3]

* ***Lycopodioides species 1***, Treelet Spikemoss, Braun's Spikemoss. Naturalized around graveyards or gardens; rare, introduced, native of China. [= *Selaginella braunii* Baker – FNA, K]

* ***Lycopodioides species 2***, Krauss's Spikemoss, Mat Spikemoss. Naturalized around gardens or lawns; native of s. Africa. [= *Selaginella kraussiana* (Kunze) A. Braun – FNA, K]

* ***Lycopodioides species 3***, Blue Spikemoss. Moist forests; native of China. Introduced in sw. GA and other places in the Southeastern United States. [= *Selaginella uncinata* (Desvaux ex Poirlet) Baker – FNA, K, WH3]



SECTION 2: MONILOPHYTA (FERNS)

Family circumscriptions and sequence follow Christenhusz, Zhang, & Schneider (2011), with relatively minor modifications from Smith et al. (2006). References: Smith et al. (2006); Christenhusz, Zhang, & Schneider (2011).

F4. EQUISETACEAE Michaux ex de Candolle 1804 (Horsetail Family) [in EQUISETALES]

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 (or annual in *E. laevigatum*), 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 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*
- 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.
- 3 Cone apex rounded; aerial stems annual*E. laevigatum*
- 3 Cone apex pointed; aerial stems perennial.
- 4 Spores not produced, or white and misshapen; most stem sheaths lacking a blackish band well below the teeth*E. ×ferrissii*
- 4 Spores green, spherical; most stem sheaths with a narrow to broad blackish band well below the teeth*E. hyemale* ssp. *affine*
- 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 branched; [subgenus *Equisetum*].
- 5 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*
- 5 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 < 3/4's of the stem diameter.
- 6 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*
- 6 Sheaths of the sterile stems 3-10 mm long, the teeth dark brown with white margins; sterile stems regularly whorled with simple branches.
- 7 Lowest whorl of branches with 1st internode longer than sheath; spores green, spherical*E. arvense*
- 7 Lowest whorl of branches with 1st internode nearly equal to sheath; spores white, misshapen*E. ×litorale*

Equisetum arvense Linnaeus, Field Horsetail. Moist streambanks, bottomlands, moist disturbed sites, road banks, railroad banks. March-April. A circumboreal species, in North America south to c. GA, c. AL, c. MS, n. AR, n. TX, NM, AZ, and south into Mexico. [= RAB, C, FNA, G, K, Md, Pa, S, W, WV; > *E. arvense* var. *arvense* – F]

Equisetum ×ferrissii Clute (pro sp.) [= *E. hyemale* × *laevigatum*]. Riverbanks, wet forests. There are old reports, repeated in RAB, S, and FNA, of the occurrence of *E. ×ferrissii* in NC and SC; documentation of these reports is not known; it is reported for Prince George's County, MD (Shetler & Orli 2000), for KY (Campbell & Medley 2007), and for all 75 counties of AR (Peck 2011). [= C, FNA, K, Pa; = *E. ferrissii* Clute – G; = *Hippochaete ×ferrissii* (Clute) Škoda & Holub]

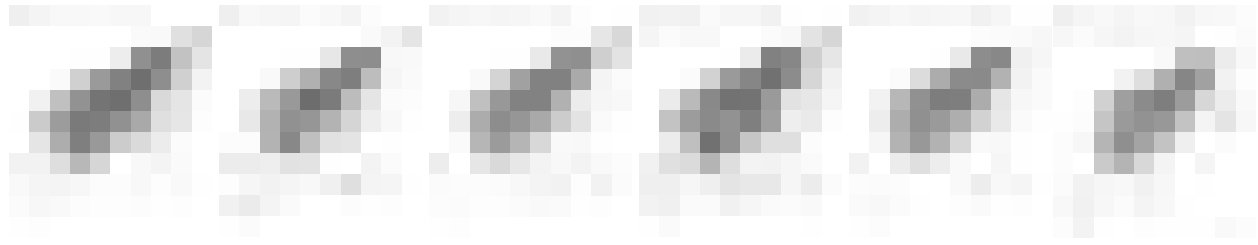
Equisetum fluviatile Linnaeus, Water Horsetail, Pipes. Open calcareous wetlands, wet meadows, river and lake margins. June-August. Circumboreal, south in North America to n. VA, n. WV, PA, OH, IN, IL, IA, and WA. [= C, F, FNA, G, K, Md, Pa, W, WV]

Equisetum hyemale Linnaeus ssp. *affine* (Engelmann) Calder & R.L. Taylor, Tall Scouring Rush, River Scouring Rush. Riverbanks, alluvial floodplains. May-September. Ssp. *affine* occurs nearly throughout North America and in Mexico and Guatemala, and in ne. Asia; ssp. *hyemale* is Eurasian. [= FNA; = *E. hyemale* var. *affine* (Engelmann) A.A. Eaton – C, K, Md, Pa, RAB, W, WH3; > *E. hyemale* var. *affine* – F, WV; > *E. hyemale* var. *robustum* (A. Braun) A.A. Eaton – F; > *E. hyemale* var. *pseudohyemale* (Farwell) Morton – G; > *E. hyemale* var. *elatum* (Engelmann) Morton – G, WV; ? *E. praealtum* Rafinesque – S; = *Hippochaete hyemalis* (Linnaeus) Bruhin ssp. *affinis* (Engelmann) W.A. Weber]

Equisetum laevigatum A. Braun. {habitats}. QC and BC south to NY, w. PA, s. OH, s. IN, s. IL, AR (Peck 2011), e. TX, NM, AZ, CA, and n. Mexico. There are old reports, repeated in RAB, and S, of this species farther south; 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). [= C, FNA, G, K; > *E. hyemale* Linnaeus var. *intermedium* A.A. Eaton – F; > *E. kansanum* Schaffner – F; = *Hippochaete laevigata* (A. Braun) Farwell]

Equisetum ×litorale Kühlewein ex Ruprecht (pro sp.) [*arvense* × *fluviatile*]. Reported by FNA for VA. [= C, F, FNA, K, Pa; = *E. litorale* Kühlewein ex Ruprecht – G] {not mapped}

* *Equisetum ramosissimum* Desfontaines ssp. *ramosissimum*, Branched Scouring Rush. Disturbed areas; native of the Old World, where it is widespread in Europe, Asia, and Africa. This species was apparently introduced long ago on ship's ballast to various old ports, such as Wilmington (New Hanover County, NC), Pensacola (Escambia County, 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, WH3; = *Hippochaete ramosissima* (Desfontaines) Farwell ssp. *ramosissima*]



Equisetum sylvaticum Linnaeus, Woodland Horsetail. Seepage swamps. Circumboreal, south in North America to MD, n. VA, ec. WV, OH, MI, WI, IA, WY, MT, and WA. [= C, FNA, K, Pa; > *E. sylvaticum* var. *sylvaticum* – F, G; > *E. sylvaticum* var. *pauciramosum* Milde – F, G; > *E. sylvaticum* var. *multiramosum* Wherry – Md, WV]

F5. OPHIOGLOSSACEAE (R. Brown) Agardh 1822 (Adder's-tongue Family) [in OPHIOGLOSSALES]

A family of 7-8 genera and about 75-115 species. The Ophioglossaceae is only distantly related to the leptosporangiate ferns; Kuo et al. (2011) and 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 **1. 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 **3. 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 < 20 cm tall; sterile blade fleshy in texture, 1-8 cm long..... **4. 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 **2. Botrypus**

1. 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 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 < ¼ of the way from the base to the apex; primary areoles mostly > 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 < 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 µ 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 µ in diameter **O. pycnostichum**

Ophioglossum crotalophoroides Walter, Bulbous Adder's-tongue. Moist ditch banks and grassy roadside flats. March-September. 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, WH3; > *O. crotalophoroides* var. *crotalophoroides* – K; > *O. crotalophoroides* var. *nanum* Osten ex de Lichtenstein – K]

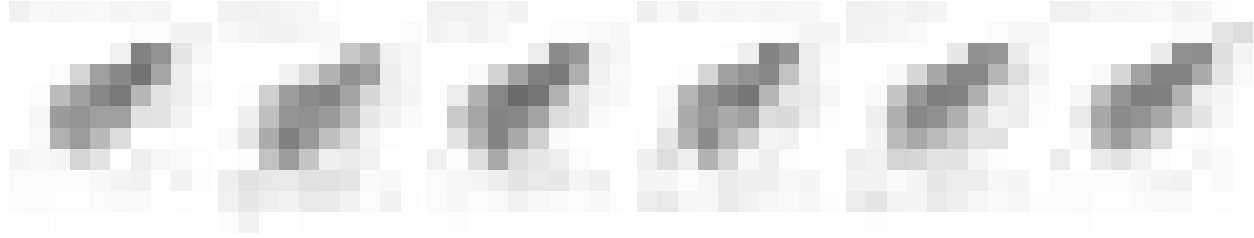
Ophioglossum engelmannii Prantl, Engelmann's Adder's-tongue, Limestone Adder's-tongue. Dry barrens and glades over calcareous rocks, very rarely on granite. March-June. W. VA, IN, IL, KS, and AZ south to Panhandle FL and TX; also in Mexico and Central America. Ascribed to NC by Wagner & Wagner in FNA (1993b), the documentation unknown. [= C, F, FNA, G, K, Pa, S, W, WH3]

Ophioglossum nudicaule Linnaeus f., Slender Adder's-tongue. Lawns and other moist, grassy areas. 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, WH3; > *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. Maritime wet grasslands, moist ditch banks, and grassy roadside flats. March-November. 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) and Peck (2011)

suggest that this species is likely introduced in North America (from a native distribution in Asia). [= RAB, FNA, K, WH3; > *O. floridanum* E. St. John – S]

Ophioglossum pusillum Rafinesque, Northern Adder's-tongue. Wet meadows, swamp edges. March-July. NS west to ND and BC, south to w. VA, n. IN, n. IL, and w. NE, w. WY, w. MT, and CA. [= FNA, K, Pa; = *O. vulgatum* Linnaeus var. *pseudopodium* (Blake) Farwell – C, F, WV; < *O. vulgatum* – G]



Ophioglossum pycnostichum (Fernald) A. & D. Löve, Southern Adder's-tongue. Bottomland forests, moist loamy soils of successional forests and old fields. March-July. S. NJ, IN, IL, and s. MI south to GA, MS, and e. TX; s. Mexico. *O. vulgatum* (defined narrowly) is Eurasian. The best treatment of this complex remains uncertain. [= W; = *O. vulgatum* Linnaeus var. *pycnostichum* Fernald – RAB, C, F, Pa, WV; < *O. vulgatum* Linnaeus – FNA, G, K, S]

2. *Botrypus* Richard 1801 (Rattlesnake Fern)

A genus of 1-2 species, semicosmopolitan. References: Hauk, Parks, & Chase (2003).

Botrypus virginianus (Linnaeus) Michaux, Rattlesnake Fern, Sang-find. In a wide range of fairly dry, mesic, and wet forests, cove forests, especially in nutrient-rich, moist bottomlands and slopes. April-June. NL (Newfoundland) and BC south to n. peninsular FL and CA, and Mexico south through Central America and n. South America; West Indies; Asia; Australia; scattered in Europe. [= *Botrychium virginianum* (Linnaeus) Swartz – RAB, C, FNA, G, K, Pa, W, WH3, WV; = *B. virginianum* var. *virginianum* – F; = *Osmundopteris virginiana* (Linnaeus) Small – S]

3. *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, < 3 mm wide..... *S. dissectum*
- 1 Sterile leaf 2-pinnate to 4-pinnate, not finely divided, the ultimate segments ovate or oblong, > 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 2× 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 > 2× 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. Moist forests, clearings, old fields. August-October. MD, PA, s. IN, s. IL, and c. OK south to s. FL and e. TX. [= *Botrychium biternatum* (Savigny) Underwood – RAB, C, FNA, K, S, W, WH3; = *B. dissectum* var. *tenuifolium* (Underwood) Farwell – F, G; < *B. dissectum* (Sprengel) Lyon – WH]

Sceptridium dissectum (Sprengel) Lyon, Cut-leaf Grape Fern, Dissected Grapefern. Moist forests, clearings, old fields. August-October. NS and QC west to ON and MI, south to Panhandle FL and e. 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 GA, 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, FNA, K, Pa, W, WV; < *B. dissectum* var. *dissectum* – F (also see *S. oneidense*); > *B. dissectum* var. *obliquum* (Muhlenberg ex Willdenow) Clute – G; > *B. dissectum* var. *dissectum* – G; > *B. dissectum* – S; > *B. obliquum* Muhlenberg ex Willdenow – S; < *B. dissectum* (Sprengel) Lyon – WH]

Sceptridium jenmanii (Underwood) Lyon, Alabama Grapefern. Moist to dryish forests and disturbed areas. August-October. C. and sw. VA and w. KY south to Panhandle FL, s. 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, WH3; = *B. alabamense* Maxon – RAB, S]

Sceptridium lunarioides (Michaux) Holub, Winter Grapefern. Old fields, pastures, young forests, granitic flatrocks, juniper-oak-blue ash woodlands over limestone. January-April. W. NC, c. TN, 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, WH3; = *Holubiella lunarioides* (Michaux) Škoda; = *Botrypus lunarioides* Michaux]



Sceptridium multifidum (S.G. Gmelin) M. Nishida, Leather Grapefern. Grassy balds and high elevation meadows; moist forests. August-September. NL (Labrador) and AK south NJ, 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, Pa, W; > *B. multifidum* var. *multifidum* – F, G; > *B. multifidum* var. *intermedium* (D.C. Eaton) Farwell – F, G]

Sceptridium oneidense (Gilbert) Holub, Bluntlobe Grapefern. Moist or boggy forests, foodplain forests, bogs. July-October. Local in occurrence from NB, QC, and ON 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, Pa, W, WV; < *B. dissectum* var. *dissectum* – F ("forma *oneidense* (Gilbert) Clute – embarrassingly transitional"); = *B. multifidum* var. *oneidense* (Gilbert) Farwell – G]

4. *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). [also see *Botrypus* and *Sceptridium*]

- 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. Forests and grassy balds. July-August. Var. *angustisegmentum* ranges from NL (Newfoundland) and ON 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, WV; = *B. lanceolatum* ssp. *angustisegmentum* (Pease & A.H. Moore) R.T. Clausen – FNA, Pa]

Botrychium matricariifolium (A. Braun ex Duwell) A. Braun ex W.D.J. Koch, Daisyleaf Moonwort. Dry to moist forests (often successional), old fields, grassy balds, northern hardwood forests. June-August. NL (Newfoundland) and AB south to w. NC, TN, KY, WV, OH, IL, WI, MN, and ND. [= FNA, K, Pa, W; = *B. matricariaefolium* – F, G, WV (orthographic variant); > *B. matricariaefolium* var. *matricariaefolium* – C]

Botrychium simplex E. Hitchcock var. *simplex*, Least Moonwort. Disturbed gravelly areas in spruce-fir forests, northern hardwoods forests, grassy balds. May-June. NL (Newfoundland) and BC 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, Pa, W, WV]



F6. PSILOACEAE Kanitz 1887 (Whiskfern Family) [in PSILOTALES]

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. In moist bottomland forests, wet hammocks, on soil, stumps, and tree bases, along building foundations (where introduced). 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, WH3]

F8. OSMUNDACEAE Martinov 1820 (Royal Fern Family) [in OSMUNDALES]

A family of 4 genera and about 15-25 species. References: Metzgar et al. (2008)=Z; Lellinger (1985); Whetstone & Atkinson in FNA (1993b); Kramer in Kramer & Green (1990); Yatabe, Nishida, & Murakami (1999).

- 1 Leaves hemidimorphic (juvenile leaves with only sterile pinnae, leaves bearing sporangia with sterile and fertile pinnae, the fertile pinnae either borne medially or terminally); photosynthetic (sterile) pinnae lacking tufts of hairs2. *Osmunda*
 1 Leaves dimorphic (each leaf normally either completely photosynthetic or completely fertile); photosynthetic (sterile) pinnae with tufts of reddish hairs near the junction with the rachis1. *Osmundastrum*

1. *Osmundastrum* C. Presl (Cinnamon Fern)

A monotypic genus, of the Americas and e. Asia. “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); Metzgar et al. (2008) confirmed the opinion that cinnamon fern is an outlier and warrants generic status. References: Metzgar et al. (2008)=Z; McAvoy (2011)=Y; Lellinger (1985); Whetstone & Atkinson in FNA (1993b); Kramer in Kramer & Green (1990); Yatabe, Nishida, & Murakami (1999).

Identification notes: Sterile plants of *Osmundastrum cinnamomeum* are sometimes confused with *Woodwardia virginica*, which also has rather coarse, pinnate-pinnatifid leaves and grows in similar wet, acid places. *Osmundastrum* is coarser (to 2 m tall, vs. to 1 m tall), 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).

Osmundastrum cinnamomeum (Linnaeus) C. Presl, Cinnamon Fern. Bogs, peatlands, pocosins, wet savannas, floodplains, blackwater stream swamps, and other wetlands. March-May. NL (Labrador) west to MN, south to s. FL, c. TX; Mexico south through Central America to n. South America; West Indies; e. Asia. The species also occurs in e. Asia, where sometimes treated as a separate variety (but the combination is not available in *Osmundastrum*). The taxonomic significance of the densely glandular pubescent *Osmundastrum cinnamomeum* var. *glandulosum* (Waters) McAvoy needs additional evaluation; it is reported from scattered locations in e. North America, including SC and VA. Because of its geographic incoherence it is here regarded as a form. [= Z; = *Osmunda cinnamomea* Linnaeus – RAB, FNA, G, Pa, S, W, WH3, WV; > *Osmunda cinnamomea* var. *cinnamomea* – C, F, K; > *Osmunda cinnamomea* Linnaeus var. *glandulosa* Waters – F, K; > *Osmundastrum cinnamomeum* var. *cinnamomeum* – Y; > *Osmundastrum cinnamomeum* var. *glandulosum* (Waters) McAvoy – Y]

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

A genus of 3-7 species, if circumscribed (as here) to exclude *Todea*, *Leptopteris*, and *Osmundastrum*, following Metzgar et al. (2008). References: Metzgar et al. (2008)=Z; Tsutsumi et al. (2011); Lellinger (1985); Whetstone & Atkinson in FNA (1993b); Kramer in Kramer & Green (1990); Yatabe, Nishida, & Murakami (1999).

- 1 Leaves pinnate-pinnatifid, each pinna pinnatifid but not divided into distinct pinnules; spores borne on modified pinnae in the middle of the leaf blade; veins mostly 1-forked; [subgenus *Claytosmunda*]..... *O. claytoniana* var. *claytoniana*
- 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. spectabilis*

Osmunda claytoniana Linnaeus var. *claytoniana*, Interrupted Fern. Upland forests, woodlands, and balds, moist to rather dry. March-June. NL (Newfoundland) west to MN, south to n. GA, TN, and AR; another variety occurs in e. and sc. Asia. A fossil from the Triassic is seemingly indistinguishable from this species and suggests “that *O. claytoniana* has perhaps been in morphological stasis for at least 200 million years and also that the genus *Osmunda* is at least this old” (Metzgar et al. 2008). [= C, F; < *O. claytoniana* – RAB, FNA, G, K, Pa, S, W, WV; = *Osmundastrum claytoniana* (Linnaeus) Tagawa]

Osmunda spectabilis Willdenow, American Royal Fern. Bogs, marshes (including tidal), moist forests, floodplains, swamp forests, and other wetlands. March-June. NL (Newfoundland) west to MB, south to s. FL, e. TX; Mexico south through Central America to s. South America; West Indies. The taxonomy of *O. regalis* and relatives needs additional reassessment (Metzgar et al. 2008); preliminary results suggest that e. North American *O. spectabilis* is more closely related to Asian *O. japonica* (= *O. regalis* var. *japonica*) and *O. lancea* than to European, African, and sw. Asian (typic) *O. regalis*. This conclusion is corroborated by Tsutsumi et al. (2011); specific rank appears warranted for American royal ferns. [= *O. regalis* Linnaeus var. *spectabilis* (Willdenow) A. Gray – RAB, C, F, FNA, G, K, Pa, W, WH3, WV; < *O. regalis* – S]

F9. HYMENOPHYLLACEAE Link 1833 (Filmy Fern Family) [in HYMENOPHYLLALES]

A family of 6-10 (or many more) genera and about 600 species. This treatment follows the generic interpretation of Ebihara et al. (2006), which splits *Trichomanes* (as both polyphyletic and morphologically diverse) and retains a broad and monophyletic *Hymenophyllum*. See Moran (1998) for an interesting discussion and overview of independent fern gametophytes in e. North America. References: Farrar in FNA (1993b); Ebihara et al. (2006, 2007); Iwatsuki in Kramer & Green (1990); Morton (1968).

- 1 Gametophytes only present, not in association with or in close proximity to filmy-fern sporophytes.
 - 2 Gametophytes filamentous, no portion flattened and planar, forming felt-like mats **4. *Crepidomanes***
 - 2 Gametophytes thalloid, flattened **1. *Hymenophyllum***
- 1 Sporophytes present.
 - 3 Leaves simple to slightly lobed, < 2 cm long; rhizomes filiform, <0.5 mm in diameter.
 - 4 Leaves glabrous or with simple hairs; rhizomes densely covered with dark-colored hairs **2. *Didymoglossum***
 - 4 Leaves stellate pubescent; rhizomes glabrous or with sparse light-colored hairs **1. *Hymenophyllum***
 - 3 Leaves pinnate-pinnatifid, > 5 cm long; rhizomes filiform or moderately stout.
 - 5 Rhizomes filiform, <0.5 mm in diameter, glabrous or with sparse light-colored hairs; indusium (“involucre”) bivalvate (deeply divided into 2 flaps); receptacle not exerted from between the deeply bilobed indusium **1. *Hymenophyllum***
 - 5 Rhizomes moderately stout, 0.8-1.5 mm in diameter, densely clad with dark-colored hairs; indusium (“involucre”) tubular or funnelliform, sometimes slightly 2-lobed; receptacle long and whiplike, exerted from the mouth of the tubular (slightly bilobed) indusium **3. *Vandenboschia***

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

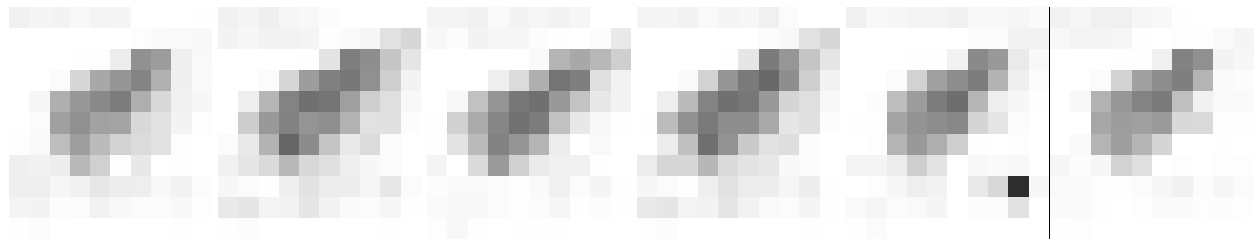
As here broadly circumscribed, a genus of about 250-330 species, almost strictly tropical in distribution, but very rarely extending into humid north temperate regions. *Sphaerocionium* C. Presl and other segregates are often recognized; these segregates may well be warranted. Iwatsuki in Kramer & Green (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: Ebihara et al. (2006)=Z; Davison (1997); Raine, Farrar, & Sheffield (1991); Iwatsuki in Kramer & Green (1990); Morton (1968).

- 1 Sporophytes present.
 - 2 Leaf blade with stellate hairs; [subgenus *Sphaerocionium*] ***H. tayloriae***
 - 2 Leaf blade glabrous; [subgenus *Hymenophyllum*] ***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; [subgenus *Sphaerocionium*] ***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; [subgenus *Hymenophyllum*] ***H. tunbrigense***

Hymenophyllum tayloriae Farrar & Raine, Gorge Filmy Fern. Spray cliffs near waterfalls, permanently moist ceilings of grottoes in escarpment gorges with high rainfall. 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, Fentress, Scott, and

Sevier counties, TN, and Lawrence, Franklin, and Lamar counties, 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, Z; = "a branching ribbon-like gametophyte with marginal rhizoids and small, ovate, plate-like gemmae several cells wide, of the genus *Hymenophyllum*" – RAB; = *Sphaerocionium species 1*]

Hymenophyllum tunbrigense (Linnaeus) J.E. Smith, Tunbridge Filmy Fern. Moist rock faces in an escarpment gorge with high rainfall. June-September. N. Mexico south through Central America to n. South America; SC; West Indies (Jamaica and Hispaniola); w. Europe; Africa; Australia and New Zealand. The occurrence of this filmy fern in the escarpment gorge of Eastatoe Creek and its tributaries (Pickens County, SC) 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 *Vandenboschia boschiana*. This species may yet be found in NC in similarly rugged and humid escarpment gorges. It differs from *V. boschiana* 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, Z]



2. *Didymoglossum* Desvaux 1827

A genus of 30-40 species, primarily tropical. References: Ebihara, Farrar, & Ito (2008)=Y; Ebihara et al. (2006)=Z; Ebihara et al. (2007); Iwatsuki in Kramer & Green (1990); Morton (1968); Dubuisson et al. (2003).

Didymoglossum petersii (A. Gray) Copeland, Dwarf Filmy Fern. 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, and on tree bark in swamps (in LA and MS). June-August. W. NC, nw. SC, sw and sc. TN, south to n. peninsular FL, c. AL, s. MS, and e. LA; disjunct in the Ozarks and Ouachitas of AR; Mexico (Chiapas, Veracruz, and Puebla) and Guatemala. This diminutive species is often overlooked, except by bryologists and hepaticologists; superficially, it does resemble a moss or liverwort more than a fern. It occurs on tree bark in some parts of its range. [= Z; = *Trichomanes petersii* A. Gray – RAB, FNA, K, S, W, WH3]

3. *Vandenboschia* Copeland 1938

A genus of 15-20 species, of the tropics and extending to north temperate areas of high humidity. References: Ebihara, Farrar, & Ito (2008)=Y; Ebihara et al. (2006)=Z; Ebihara et al. (2007); Iwatsuki in Kramer & Green (1990); Morton (1968); Dubuisson et al. (2003).

Vandenboschia boschiana (Sturm) Ebihara & K. Iwatsuki, Appalachian Filmy Fern. On rock outcrops, usually vertical or overhanging, usually in deeply shaded grottoes receiving seepage or spray from waterfalls. June-September. W. VA, s. OH, s. IN, s. IL south to w. NC and nw. SC, n. GA, n. AL, and ne. MS (Menapace, Davison, & Webb 1998); disjunct in the Ozarks of nw. AR; disjunct in Chihuahua, Mexico. See Belden et al. (2004) for more details on the first documented Virginia occurrence. [= Z; = *Trichomanes boschianum* Sturm – RAB, C, F, FNA, G, K, S, W, WV]

4. *Crepidomanes* C. Presl 1851

A genus of 30-40 species, tropical and extending to north temperate areas of high humidity; strictly Old World, except for our species. References: Ebihara, Farrar, & Ito (2008)=Y; Ebihara et al. (2006)=Z; Weakley et al. (2011)=X; Ebihara et al. (2007); Iwatsuki in Kramer & Green (1990); Morton (1968); Dubuisson et al. (2003).

Crepidomanes intricatum (Farrar) Ebihara & Weakley, Grotto-felt, Appalachian Trichomanes, Weft Fern. On ceilings or back walls of grottoes, especially in humid gorges or near or behind waterfalls. Rather widespread in e. North America, from NH, VT, w. NY, OH, IN, and IL south to NC, nw. SC, n. GA, and n. AL. *Crepidomanes intricatum* cannot be morphologically distinguished from gametophytes of *Vandenboschia boschiana* or *Didymoglossum 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* (*s.l.*) 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 absence of 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 *Vandenboschia boschiana* and *Didymoglossum 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 *Crepidomanes 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 known eastern North America species of Hymenophyllaceae should be investigated carefully. *Vittaria appalachiana* and *Hymenophyllum tayloriae* gametophytes differ from *Crepidomanes intricatum* in being thallose rather than filamentous. Ebihara, Farrar, & Ito (2008) have recently reported that *Crepidomanes intricatum* shares its chloroplast genome with the Asian triploid *Crepidomanes schmidtianum* (Zenker ex Tasch.) K. Iwatsuki var. *schmidtianum*; further studies are underway to determine the relationship of the two. [= X; = *Trichomanes intricatum* Farrar – 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; = *Vandenboschia species 1 – Z*]

F10. GLEICHENIACEAE C. Presl 1825 (Forking-fern Family) [in GLEICHENIALES]

A family of about 6 genera and 125-140 species, pan-tropical and -subtropical. References: Nauman in FNA (1993b).

***Dicranopteris* Bernhardt 1805 (Forking-fern)**

A genus of 8-12 species, pan-tropical and -subtropical. References: Nauman in FNA (1993b).

* ***Dicranopteris flexuosa* (Schrader) Underwood**, Drooping Forked-fern. Wet pine flatwoods, moist disturbed areas; native in New World tropics. FL Panhandle (Bay and Franklin counties) and FL peninsula, s. AL (Mon Louis Island, Mobile County); West Indies; Mexico, Central America, and South America. [= FNA, K, S, WH3]

F13. LYGODIACEAE M. Roemer 1840 (Climbing Fern Family) [in SCHIZAEALES]

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).

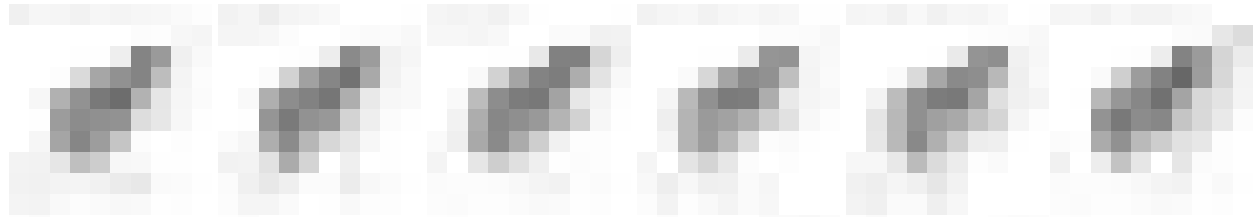
***Lygodium* Swartz 1800 (Climbing Fern)**

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

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

* ***Lygodium japonicum* (Thunberg) Swartz**, Japanese Climbing Fern. Disturbed areas; native of Asia. June-September. 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* (Bernhardt) Swartz**, American Climbing Fern, Hartford Fern. Bogs, moist thickets, swamp forests, sandstone outcrops, roadside ditches and roadbanks, in strongly acid soils. July-September. NH, VT, NY and MI south to SC, n. GA, and n. AL, widely scattered except in the Cumberland Plateau of KY, TN, and AL, where it is most common. 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, Pa, S, W, WV]



F14. SCHIZAEACEAE Kaulfuss 1827 (Curly-grass Family) [in SCHIZAEALES]

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. Moist, peaty oil in Coastal Plain bogs, often associated with *Pseudolycopodiella caroliniana*, *Drosera filiformis*, and *Chamaecyparis thuyoides* (though not in dense *Chamaecyparis* stands). May-July. In acid, boggy sites in DE, NJ, NY, NL (Newfoundland), NS, and NB; 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. [= C, F, FNA, G, K]

F16. MARSILEACEAE Mirbel 1802 (Water-clover Family) [in SALVINIALES]

A family of 3 genera and about 55-75 species, nearly cosmopolitan. References: Nagalingum, Nowak, & Pryer (2008); Johnson in FNA (1993b); Kramer in Kramer & Green (1990).

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

Marsilea Linnaeus 1753 (Waterclover)

A genus of 50-70 species, nearly cosmopolitan. References: Jacono & Johnson (2006)=Z; Johnson in FNA (1993b); Kramer in Kramer & Green (1990); Knepper, Johnson, & Musselman (2002); Schaefer et al. (2011). Key based in part on Z and FNA.

Identification notes: The **raphe** is the portion of the peduncle adnate to the sporocarp. The peduncle ends in a blunt tooth, the **proximal tooth**. Further up on the sporocarp is a second tooth, the **distal tooth**.

- 1 Leaves strongly bicolored (pale green toward the base of each of the 4 leaflets, darker green toward the tip); aquatic forms with a swollen air bladder just below the leaf.....*M. mutica*
 1 Leaves unicolored.
 2 Roots present (1-3) between the nodes, as well as at the nodes.
 3 Distal tooth 0.3-0.8 mm long; sporocarps 3.5-5.0 mm long.....*M. minuta*
 3 Distal tooth absent or < 0.2 mm long; sporocarps 4.5-6.0 mm long.....*M. quadrifolia*
 2 Roots present only at the nodes
 4 Distal tooth absent or a very low bump.....*M. macropoda*
 4 Distal tooth 0.4-1.2 mm long, sharply acute to pointed, often hooked.....*M. vestita*

* *Marsilea macropoda* Engelman ex A. Braun, Golden Waterclover, Big-footed Waterclover. {habitat}; native of s. TX and Mexico. Reported as introduced eastward in AL and c. and s. peninsular FL. [= FNA, K, WH3, Z]

* *Marsilea minuta* Linnaeus, Small Waterclover. Lakes and streams; native of the Old World. Known in North America from AL, FL, GA, and TN. [= FNA, WH3, Z; ? *M. crenulata* Desvaux; ? *M. crenulata* Presl]

* *Marsilea mutica* Mettenius, Nardoo, Australian Waterclover. Ditches, ponds; native of Australasia. Apparently spreading rapidly in VA. [= WH3, Z]

* *Marsilea quadrifolia* Linnaeus, European Waterclover. Shallow water of artificial impoundment; native of Europe. Not seen fertile in NC. 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, Pa]

* *Marsilea vestita* Hooker & Greville, Hairy Waterclover. Wet ditches, old fields; native of w. North America. [= FNA, K, WH3, Z]

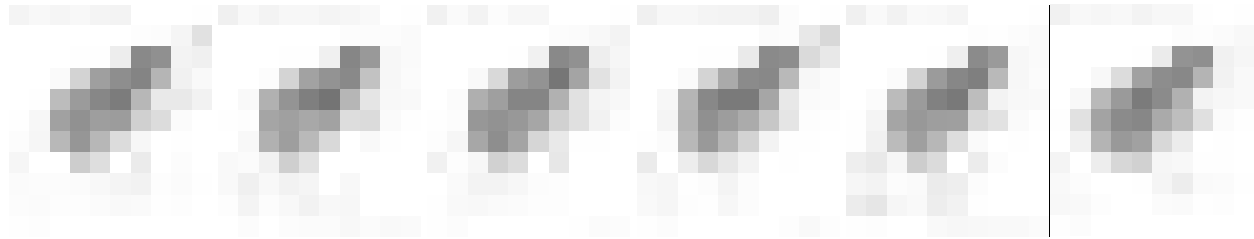
Pilularia Linnaeus 1753 (Pillwort)

A genus of 2-6 species, nearly cosmopolitan. References: Nagalingum, Nowak, & Pryer (2008); Dennis & Webb (1981); Kramer in Kramer & Green (1990).

Identification notes: *Pilularia* lacks a leaf-blade, the 1-8 cm long petiole is narrowly winged, and looks a bit 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."

Pilularia americana A. Braun, American Pillwort. Vernal pools and seepage areas on granitic flatrocks, other ponds, drawdown shores of lakes. This peculiar plant has a puzzling distribution, being known from several disjunct regions: WA to s. CA; NE and MO south to c. TX; SC, GA, TN, AL, and Mexico (Durango and Baja California Norte); similar plants, perhaps

conspecific, occur in South America and Africa. The fragmented distribution may be at least partly explainable by the inconspicuous nature of the plant. First reported for SC in 1993 (J. Allison, pers. comm.). [= FNA, K, S]



F17. SALVINIACEAE Martinov 1820 (Floating Fern Family) [in SALVINIALES]

A family of 2 genera and about 16 species, all floating aquatics. *Azolla* is sometimes separated as a separate family, Azollaceae. References: Nagalingum, Nowak, & Pryer (2008); Nauman in FNA (1993b); Lumpkin in FNA (1993b); Schneller in Kramer & Green (1990).

- 1 Leaves < 1 mm long, reddish or green, without hairs on the upper surface *Azolla*
 1 Leaves 5-50 mm long, bright green, with obvious hairs on the upper surface *Salvinia*

***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* (through its symbiont) 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: Evrard & Van Hove (2004)=Z; 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. Stagnant waters of interdune ponds, limesink ponds, old millponds, beaver ponds, floodplain sloughs, often locally abundant. 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, Pa, S; < *A. filiculoides* – WH3, Z]

* ***Azolla filiculoides*** Lamarck. Freshwater lake; native of w. North America, south into Mexico, Central America, South America, e. Asia. 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; < *A. filiculoides* – WH3, Z]

***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 10× 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 10× magnification)..... *S. molesta*

* ***Salvinia minima*** Baker, Water Spangles. Quiet waters; probably introduced in our area from farther south. [= FNA, K, Z; *S. auriculata* – S, misapplied]

* ***Salvinia molesta*** D.S. Mitchell. Still waters of farm ponds, calcareous seepage ponds, and other situations; native of Brazil. *S. molesta* has been found at scattered sites in GA (Gwinnett and Lamar counties) (Carter, Baker, & Morris 2009), 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, WH, Z; ? *S. adnata* Desvaux]

F30. DENNSTAEDTIACEAE Lotsy 1909 (Bracken Family) [in POLYPODIALES]

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 (1990).

- 1 Leaf blades broadly triangular in outline, about as broad as long, subcoriaceous; sori linear, confluent *Pteridium*
- 1 Leaf blades elongate in outline, at least 2× as long as broad, membranaceous; sori globular, separate
- 2 Leaves 2-pinnate-pinnatifid; indusium tubular or cuplike; leaves generally < 1 m long..... *Dennstaedtia*
- 2 Leaves 3-4-pinnate-pinnatifid; indusium flap-like; leaves generally > 1 m long..... *Hypolepis*

Dennstaedtia Bernhardt 1801 (Cuplet Fern)

A genus of about 45 species, of tropical to temperate distribution; *Dennstaedtia* is poorly known and of uncertain circumscription. Only *D. punctilobula* is temperate in distribution; anatomical evidence suggests that it is not closely related to tropical *Dennstaedtia*, and its separation from that genus may be warranted. References: Nauman & Evans in FNA (1993b); Kramer in Kramer & Green (1990).

Identification notes: *Dennstaedtia punctilobula* 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 (< 0.5 mm in diameter).

* *Dennstaedtia cicutaria* (Sw.) T. Moore. Reported for AL by Kartesz (1999) on the basis of Dean's (1969) mention of an individual plant of *D. rubiginosa* having been planted in Mobile. This report is rejected, as there is no evidence of naturalization. The species is native of tropical America. [= K; ? *D. rubiginosa* (Kaulfuss) T. Moore] {rejected; not keyed}

Dennstaedtia punctilobula (Michaux) T. Moore, Hay-scented Fern, Pasture Fern, Boulder Fern. Rocky or dry woodlands and forests, rock outcrops, pastures, clearings, roadbanks. June-September. NS and QC west to MI, south to NC, n. GA, n. AL, and AR, progressively more montane southward. [= RAB, C, F, FNA, G, K, Pa, S, W, WV]



Hypolepis Bernhardt 1806 (Bramble Fern)

A genus of about 45 species, pantropical. References: Nauman in FNA (1993b).

- 1 Stipe and rachis bearing numerous small prickles; [native, restricted to FL] *H. repens*
- 1 Stipe and rachis smooth, lacking prickles; [alien]..... *H. tenuifolia*

Hypolepis repens (Linnaeus) C. Presl, Creeping Bramble Fern. Swamps, wet hammocks. N. FL (Clay County) south to c. FL; West Indies; Mexico, Central America, South America. [= FNA, K, S, WH3]

* *Hypolepis tenuifolia* (G. Forster) Bernhardt, Spineless Bramble Fern, Soft Ground-fern. Moist disturbed areas, native of tropical e. Asia and South Pacific islands. Rather commonly cultivated, and escaping and establishing vegetatively by rhizome.

Pteridium Gleditsch ex Scopoli 1760 (Bracken)

A genus of 2-11 species, cosmopolitan in distribution. Bracken taxonomy remains provisional; the molecular work of Der et al. (2009) outlines a probable taxonomic structure for the genus. *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: Thomson, Mickel, & Mehlreter (2008)=Z; Der et al. (2009); Jacobs & Peck in FNA (1993b); Tryon (1941).

- 1 Leaf segment margins slightly to moderately pubescent; terminal (caudate) tip of the basalmost pinnule of the basal pinna (3-) avg. 12 (-28)% as long as the entire pinna; lower surface of rachis and costae shaggy pubescent; terminal segments of well-developed pinnules generally 2-4× as long as broad, about 3-8 mm wide *P. aquilinum* ssp. *latiusculum*
- 1 Leaf segment margins glabrous or sparsely pilose; terminal (caudate) tip of the basalmost pinnule of the basal pinna (16-) avg. 25 (-45)% as long as the entire pinna; lower surface of rachis and costae glabrous or sparsely pilose; terminal segments of well-developed pinnules generally 6-15× as long as broad, about 2-5 mm wide..... *P. aquilinum* ssp. *pseudocaudatum*

Pteridium aquilinum (Linnaeus) Kuhn ssp. *latiusculum* (Desvaux) Hultén, Eastern Bracken. Mainly in dry woodlands, forests, and heath balds, up to 1600 m in elevation. July-September. The species is nearly worldwide in distribution. NL (Newfoundland) west to MB, south to Panhandle FL, TX, and n. Mexico. The circumscription of ssp. *latiusculum* follows

Thomson, Mickel, & Mehlreter (2008) in excluding Old World material included by many earlier authors. The relationship of the '*latiusculum*' and '*pseudocaudatum*' entities is discussed in detail by Speer & Hilu (1999) and Speer, Werth, & Hilu (1999). [= Z; < *Pteridium aquilinum* (Linnaeus) Kuhn var. *latiusculum* (Desvaux) Underwood ex Heller – RAB, C, F, FNA, G, K, W, WH3, WV; = *P. latiusculum* (Desvaux) Hieronymus var. *latiusculum* – S; = ***Pteridium latiusculum*** (Desvaux) Hieronymus]

Pteridium aquilinum (Linnaeus) Kuhn ssp. ***pseudocaudatum*** (Clute) Hultén, Tailed Bracken, Southern Bracken. Mainly in dry sandy woodlands, often locally abundant in sandhills and flatwoods. July-September. Ssp. *pseudocaudatum* is primarily distributed in the Southeastern Coastal Plain (where it is ubiquitous and abundant), but is reported north to MA, OH, IN, s. MI, and MO. [= Z; = *Pteridium aquilinum* (Linnaeus) Kuhn var. *pseudocaudatum* (Clute) Heller – RAB, C, F, FNA, G, K, W, WH3, WV; = *P. latiusculum* (Desvaux) Hieronymus var. *pseudocaudatum* (Clute) Maxon – S]

F31. PTERIDACEAE E.D.M. Kirchner 1831 (Maidenhair Fern Family) [in POLYPODIALES]

A family of about 40 genera and about 1000 species. Here circumscribed to include Vittariaceae (see Smith et al. 2006). This family may be further subdivided, into families Adiantaceae (*Adiantum*, *Vittaria*), Sinopteridaceae (*Cheilanthes*, *Notholaena*, *Astrolepis*, *Pellaea*), Cryptogrammeae (*Cryptogramma*), Pteridaceae (*Pteris*), and Parkeriaceae (*Acrostichum*, *Ceratopteris*). References: Lellinger (1985); Windham in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990); Kramer in Kramer & Green (1990); Crane (1997).

- 1 Gametophytes only present; [subfamily *Vittarioideae*].....**10. Vittaria**
- 1 Sporophytes present.
 - 2 Leaves linear, 10-60 cm long and 1-3 mm wide; [subfamily *Vittarioideae*].....**10. Vittaria**
 - 2 Leaves dissected, not linear, > 20 mm wide.
 - 3 Sori round or oblong, distinct and separate along the pinnule margins; leaves bright-green, glabrous, herbaceous, delicate, and flexible; [subfamily *Vittarioideae*].....**9. Adiantum**
 - 3 Sori continuous along the pinnule margins (or across the blade in *Acrostichum*); leaves mostly dark-green or glaucous, often pubescent, coriaceous, tough, and stiff (except *Ceratopteris*).
 - 4 Plant aquatic or subaquatic, pale green, delicate.....**3. Ceratopteris**
 - 4 Plant epipetric or terrestrial (except *Acrostichum*), usually dark green and coriaceous.
 - 5 Fertile pinnae with entire lower surface covered by sporangia; leaves 1.5-5 m long; [of wetlands, n. FL southward]; [subfamily *Ceratopteridoideae*].....**2. Acrostichum**
 - 5 Fertile pinnae with sori marginal; leaves < 0.5 m long; [of rocky sites, collectively widespread].
 - 6 Leaves strongly dimorphic, the fertile leaves obviously longer than the sterile and with narrow elongate ultimate segments; [subfamily *Cryptogrammoideae*].....**1. Cryptogramma**
 - 6 Leaves essentially monomorphic.
 - 7 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 *Cheilanθοideae*].
 - 8 Lower leaf surfaces covered with whitish powder, otherwise glabrous or sparsely pubescent.....**5. Argyrochosma**
 - 8 Lower leaf surfaces pubescent (or glabrous in *Cheilanthes alabamensis*), never with conspicuous whitish powder**6. Cheilanthes**
 - 7 Leaves 1-2-pinnate, the ultimate leaf-segments 8-100 mm long, glabrous or sparsely and inconspicuously hairy.
 - 9 Leaf undersurface densely covered with stellate and ciliate scales; [subfamily *Cheilanθοideae*].....**7. Astrolepis**
 - 9 Leaf undersurface glabrous or with non-stellate scales.
 - 10 Rachis dark-brown or purple; [subfamily *Cheilanθοideae*].....**8. Pellaea**
 - 10 Rachis green or tan; [subfamily *Pteridoideae*].....**4. Pteris**

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

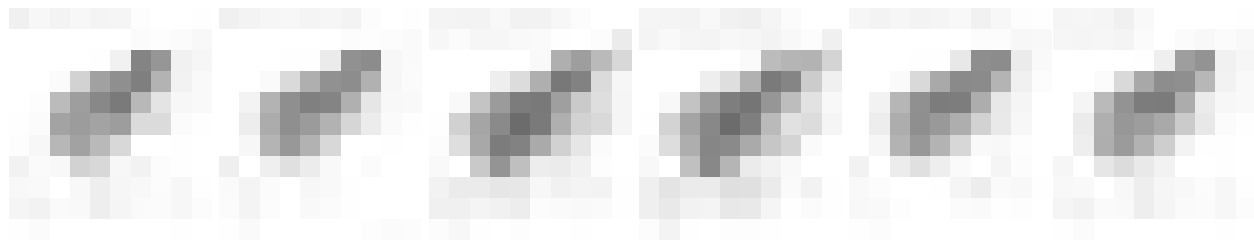
A genus of about 10 species, of temperate Eurasia, North America, and South America. References: Alverson in FNA (1993b); Tryon, Tryon, & Kramer in Kramer & Green (1990).

Cryptogramma stelleri (S.G. Gmelin) Prantl in Engler, Slender Rock-brake. Limestone cliffs. NL (Newfoundland) and AK, south to c. PA, WV (Pendleton and Randolph counties), IL, IA, CO, UT, NV, and OR. [= FNA, C, F, G, K, Pa, WV]

2. *Acrostichum* Linnaeus 1753 (Leather Fern)

A genus of 3 species, pantropical. References: Lloyd in FNA (1993b).

Acrostichum danaeifolium Langsdorff & Fischer, Giant Leather Fern. Freshwater and brackish swamps and marshes. N. peninsular FL (Dixie County) south to s. FL; West Indies; Mexico, Central America and South America. [= FNA, K, WH3; = *A. danaeaeifolium* – S, orthographic variant]



3. *Ceratopteris* Brongniart 1821 (Antler fern)

A genus of 3 species, widespread in tropical, subtropical, and warm temperate areas. References: Lloyd in FNA (1993b). Key based on FNA.

- 1 Sterile leaves simple, or palmately to pinnately lobed, or 1-4-pinnately divided, the pinnae (or veins) toward the base of the leaf opposite; petioles often inflated; sporangia with or without an annulus, the annulus with 0-10 (-40) indurated cells *C. pteridoides*
- 1 Sterile leaves (1-) 2-3-pinnately divided, the pinnae toward the base of the leaf alternate; petioles usually not inflated; sporangia with an annulus, the annulus with 13-71 indurated cells.
 - 2 Sporangia with 16 spores *C. richardii*
 - 2 Sporangia with 32 spores *C. thalictroides*

Ceratopteris pteridoides (Hooker) Hieronymus. Ponds and lakes (natural and artificial). S. GA, FL, LA (including Florida parishes); West Indies; Central and South America; se. Asia. [= FNA, K, S, WH3]
 *? *Ceratopteris richardii* Brongniart. Lakes and ponds. Probably only introduced in the southeastern United States. West Indies; Central and South America; Africa. [= FNA, K]
 *? *Ceratopteris thalictroides* (Linnaeus) Brongniart. Canals, swamps, ditches. Widespread in tropical and subtropical areas of America and Asia. Regarded by some authors as introduced in the se. United States. [= FNA, K, WH3; = *C. deltoidea* Benedict -S]



4. *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 Pinnae strictly simple, without lobes or pinnules; outline of leaf blade lanceolate, typically > 3x as long as wide *P. vittata*
- 1 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
 - 2 Pinnae of mature leaves not decurrent or only the terminal pinnae decurrent..... *P. cretica*
 - 2 Pinnae of mature leaves decurrent in the upper half of the leaf onto the rachis *P. multifida*

* *Pteris cretica* Linnaeus, Common Cretan Brake. Limey rocks and soils. Pantropical, the original range unclear. Var. *albolineata* Hooker is sometimes recognized, seemingly differing only in the broad white central stripe on the pinnae (as opposed to solid green pinnae in var. *cretica*). [= WH3; = *Pycnodoria cretica* - S; > *Pteris cretica* Linnaeus var. *cretica* - FNA, K; <]
 * *Pteris multifida* Poiret, Spider Brake. Old walls with lime mortar; native of the Tropics. [= RAB, FNA, K, WH3; = *Pycnodoria multifida* (Poiret) Small - S]
 * *Pteris vittata* Linnaeus, Ladder Brake. Old walls with lime mortar; native of e. Asia. [= RAB, FNA, K, WH3; = *Pycnodoria vittata* (Linnaeus) Small - S]

5. *Argyrochosma* (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); Sigel et al. (2011); Windham (1987); Tryon, Tryon, & Kramer in Kramer & Green (1990); Gastony & Rollo (1998).

Argyrochosma dealbata (Pursh) Windham, Powdery Cloak Fern. Limestone cliffs. IL, MO, and KS south to AR and TX; disjunct in sc. KY. [= FNA, K; = *Notholaena dealbata* (Pursh) Kunze - C, F, G; = *Cheilanthes dealbata* Pursh; = *Pellaea dealbata* (Pursh) Prantl]

6. *Cheilanthes* Swartz 1806 (Lipfern)

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). [also see *Argyrochosma* and *Astrolepis*]

- 1 Leaf surfaces glabrescent; ["*Cheilanthes alabamensis* group"].
 - 2 Rhizomes short-creeping, usually 4-7 mm in diameter; pinnule midveins green on the upper surface for most of their length; spores 32 per sporangium.....*C. alabamensis*
 - 2 Rhizomes long-creeping, usually 1-3 mm in diameter; pinnule midveins black on the upper surface for most of their length; spores 64 per sporangium.....*C. microphylla*
- 1 Leaf surfaces pubescent (tomentose, villous, or lanose).
 - 3 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 10× magnification); 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*].
 - 4 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).....*C. castanea*
 - 4 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.....*C. tomentosa*
 - 3 Petiole and rachis with hairs only (as seen at 10× magnification); 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*].
 - 5 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.....*C. feei*
 - 5 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.....*C. lanosa*

Cheilanthes alabamensis (Buckley) Kunze, Alabama Lipfern. Dry outcrops of limestone. June-September. VA, w. NC, s. MO, and OK south and west to n. GA, AL, TX, NM, se. AZ, and Mexico (south to Oaxaca). 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 *C. 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 *C. 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 *C. 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, WH3, Z; = *Myriopteris species 1*]



Cheilanthes castanea Maxon, Chestnut Lipfern. Dry outcrops of sedimentary or metamorphic rocks (including calcareous shales and siltstones). June-September. Sw. TX to s. AZ and south into Mexico, 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 are 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 *C. castanea* is distinct from or merely a form of *C. eatonii* is controversial. The complex of the 2 taxa includes apogamous triploids and sexual tetraploids. [= W, WV, Z; < *C. eatonii* Baker – C, FNA, K; = *Myriopteris species 2*]

Cheilanthes feei T. Moore, Slender Lipfern. Dry outcrops of calcareous sedimentary rocks (dolostone), other rock outcrops. June-September. WI, MN SD, MT, AB, and BC south to AR, TX, NM, AZ, s. CA, and n. Mexico (Chihuahua and Coahuila); disjunct eastward in KY and w. VA. Known from 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); an additional eastern collection from 1930 has recently come to light, from Durham Co. in nc. NC (Rothfels, Sigel, & Windham 2012). The species is an apogamous triploid of unknown parentage. [= C, FNA, G, K, W, Z; = *Myriopteris species 3*]

Cheilanthes lanosa (Michaux) D.C. Eaton, Hairy Lipfern. Dry outcrops of felsic or intermediate metamorphic and igneous rocks. 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, Pa, S, W, WH3, WV, Z; = *C. vestita* (Sprengel) Swartz – F; = *Myriopteris species 4*]

Cheilanthes microphylla (Swartz) Swartz, Southern Lipfern. Shell hammocks, limestone outcrops. Ne. FL south through FL; West Indies; Mexico through Central America to n. South America; West Indies. [= FNA, K, S, WH3, Z; = *Myriopteris species 5*]

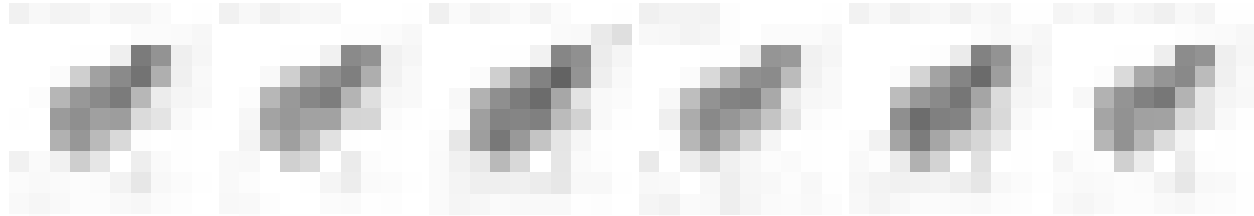
Cheilanthes tomentosa Link, Woolly Lipfern. Dry outcrops of intermediate or calcareous metamorphic, igneous, or sedimentary rocks (including sandstone outcrops in the Coastal Plain of GA and SC). June-September. Primarily Appalachian, from PA south to KY, GA, and AL, also at scattered localities from AR, OK, and KS south and west to NM, AZ, and Mexico (south to Veracruz). The species is an apogamous triploid. [= RAB, C, FNA, G, K, W, S, Z; = *C. lanosa* – F, misapplied; = *Myriopteris species 6*]

7. *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 *Argyrochosma*, *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 integerrima (Hooker) D.M. Benham & Windham. Outcrops of Ketona dolostone. OK, NM, AZ, and NV south into Mexico; disjunct to c. AL (Bibb County); also disjunct in Hispaniola. This taxon is apparently an apogamous triploid derived from *Astrolepis cochisensis* (Goodding) D.M. Benham & Windham and an unknown taxon. [= FNA; = *Astrolepis* ×*integerrima* – K; = *Cheilanthes integerrima* (Hooker) Mickel; = *Notholaena integerrima* (Hooker) Hevly; = *Pellaea* sp.]



Astrolepis sinuata (Lagasca ex Swartz) D.M. Benham & Windham ssp. *sinuata*, Wavy Cloak-fern. Granitic outcrops and boulders. OK, TX, NM, and AZ, south into Central and South America; West Indies; 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; = *Pellaea* sp.]

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

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). [also see *Argyrochosma*, *Astrolepis*, *Cheilanthes*]

- 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 toward 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 toward 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 mucro or cusp*P. viridis*
 - 3 Ultimate segments leathery, strongly rolled, mucronate at the apex.
 - 4 Leaves oblong to elliptic in outline; pinnae either ternate toward the base of the leaf and simple toward 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 toward the base, becoming ternate to simple toward the tip; [known from outcrops in Piedmont of NC].....*P. wrightiana*

Pellaea atropurpurea (Linnaeus) Link, Purple Cliff-brake. Outcrops of limestone and other rocks (usually either calcareous or mafic), rarely on masonry walls (Wieboldt 1995). 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, SK, and AB south to FL, AL, TN, AR, TX, NM, AZ, Mexico, and Guatemala. [= RAB, C, F, FNA, K, Pa, S, W, WH3, WV; = *P. atropurpurea* var. *atropurpurea* – G; = *P. ×atropurpurea*]

Pellaea glabella Mettenius ex Kuhn ssp. *glabella*, Smooth Cliff-brake. Dry, exposed outcrops of calcareous rocks (limestone, dolostone), rarely on masonry walls (Wieboldt 1995). 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, Pa; = *P. atropurpurea* var. *bushii* Mackenzie – G; < *P. glabella* – F, S, W, WV]

Pellaea ternifolia (Cavanilles) Link ssp. ***arizonica*** Windham, Arizona Cliff-brake. On granitic outcrops. A remarkable disjunct from sw. United States and Mexico (south to Oaxaca) 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. Outcrop of Altamaha Grit; native of 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, WH3; = *Cheilanthes viridis* (Forsskål) Swartz]

Pellaea wrightiana Hooker, Wright's Cliff-brake. South-facing outcrops of Carolina slate or granitic rock with infrequent nutrient-rich seepage. May-September. OK west to se. CO and sw. UT, south to TX, AZ, and n. Mexico (Coahuila, Chihuahua, Sonora, Baja California Norte, and Baja California Sur), 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* Gooding. [= RAB, FNA, K]



9. *Adiantum* Linnaeus 1753 (Maidenhair Fern)

A genus of 150-200 species, nearly cosmopolitan. References: Paris in FNA (1993b); Lu et al. (2011)=Z; 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, > 2× as long as broad.
 - 3 Ultimate segments at middle of penultimate divisions usually > 3.2× 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 n. MD and se. PA on serpentine, from a generally more northern and western distribution] ***A. aleuticum***
 - 3 Ultimate segments at middle of penultimate divisions usually < 3.2× 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 aleuticum (Ruprecht) Paris, Aleutian Maidenhair. Serpentine barrens. NL and QC south at scattered sites to se. PA and MD (Paris in FNA 1993b); also in scattered locations in w. North America, from s. AK south to s. CA, AZ, and Mexico (Chihuahua). [= FNA, K, Pa, Z; = *A. pedatum* Linnaeus ssp. *calderi* Cody – C; = *A. pedatum* Linnaeus var. *aleuticum* Ruprecht – F]

Adiantum capillus-veneris Linnaeus, Venus'-hair Fern, Southern Maidenhair. Moist calcareous substrates, in the Coastal Plain on "marl" (coquina limestone) (NC and SC), on calcareous clay bluffs (GA), and adventive on lime mortar of old buildings and walls (as in Wilmington and Fayetteville, NC); in the Mountains and Interior Low Plateau on limestone or other calcareous sedimentary rocks. 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 BC, 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, WH3]

* ***Adiantum hispidulum*** Swartz, Rough Maidenhair, Garden Maidenhair. Stone walls, old wells; native of Asia. Reported for GA (Harper 1903). [= FNA, K, S]

Adiantum pedatum Linnaeus, Northern Maidenhair. Moist forests and cliffs, especially over calcareous or mafic rocks, sometimes in seasonal seepage. June-August. NS and NB west to ON and MN, south to GA, AL, MS, LA, and OK. [= RAB, FNA, G, K, Pa, S, W, WV, Z; = *A. pedatum* ssp. *pedatum* – C; = *A. pedatum* var. *pedatum* – F]

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

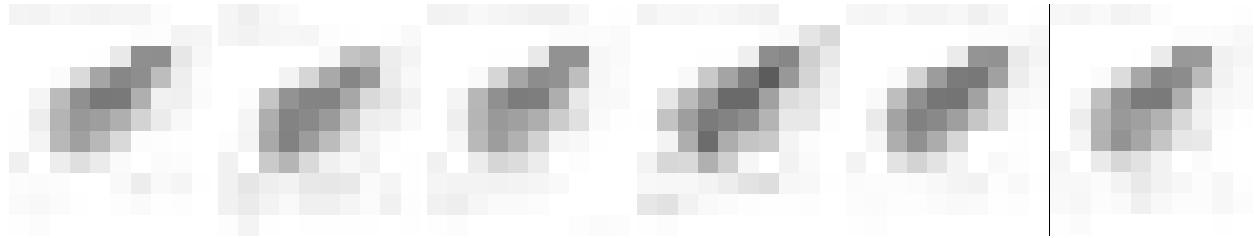
A genus of about 50 species, tropics and subtropics. References: Farrar in FNA (1993b); Farrar & Mickel (1991); Kramer in Kramer & Green (1990). Key adapted from Farrar in FNA.

- 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." 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, or on sandstone. 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; < *V. lineata* (Linnaeus) Smith – WV]

Vittaria lineata (Linnaeus) Smith, Shoestring Fern. Epiphyte on the bark of *Sabal palmetto*, but the northernmost native site (in Lincoln County, GA) was on rock. Se. GA and formerly ec. GA south to s. FL; c. Mexico south through Central America to n. South America; West Indies; introduced in e. SC (Beaufort and Jasper counties) on landscaping plants. Sporophytic plants have pendant linear leaves, 1-3 mm wide and up to 60 cm long, hence the common name. [= FNA, K, S, WH3]



F32. CYSTOPTERIDACEAE Schmakov 2001 (Brittle Fern Family) [in POLYPODIALES]

A family of 4 genera. References: Christenhusz, Zhang, & Schneider (2011).

Cystopteris Bernhardt 1806 (Bladder Fern, Brittle Fern)

A genus of about 20 species, sub-cosmopolitan 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 (1990).

Identification notes: See *Woodsia* for suggestions on distinguishing between *Cystopteris* and *Woodsia*, similar ferns often confused. Hybrids frequently occur where two or more species of *Cystopteris* grow in proximity. The following hybrids may be anticipated in our area: *Cystopteris bulbifera* × *tennesseensis*, *Cystopteris bulbifera* × *tenuis* [= *C. ×illinoensis* R.C. Moran], *Cystopteris fragilis* × *tenuis*, *Cystopteris protrusa* × *tennesseensis*, *Cystopteris protrusa* × *tenuis*, *Cystopteris tennesseensis* × *tenuis* [= *C. ×wagneri* R.C. Moran].

- 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 2-3× as long as the reddish to tan petiole; bulblets usually present, smooth, green, 2-3 mm in diameter, usually on the rachis and the midrib; spores 20-27 μ long.....*C. bulbifera*
- 2 Leaf blade 6-25 cm long, usually about 1× as long as the dark brown petiole; bulblets present or absent, deformed and scaly, dark, < 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-) 3-4× 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)× 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. protrusa*
- 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 μ 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. Moist outcrops and talus of calcareous rocks, rarely up to 1500 m elevation. May-August. NL (Newfoundland) west to MN, south to NC, nw. SC (Oconee County), nw. GA, 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, Pa, S, W, WV]

Cystopteris fragilis (Linnaeus) Bernhardt, Fragile Fern, Brittle Fern. Cliffs, ascending in our area to 1650 m. June-September. Circumboreal, in North America ranging from NL (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, Pa, W; = *C. fragilis* var. *fragilis* – C, F, G, S; < *C. fragilis* (also see *C. tenuis*) – WV]

Cystopteris protrusa (Weatherby) Blasdell, Lowland Bladder Fern. Rich woods or on moss- and soil-covered talus in boulderfields, occasionally on ledges of rock outcrops. April-June. NY and ON west to MN, south to GA, Panhandle FL (Washington County) (Wunderlin & Hansen 2006), 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, Pa, W, WH3, WV; = *C. fragilis* var. *protrusa* Weatherby – F, G, S]

Cystopteris tennesseensis Shaver, Tennessee Bladder Fern. Moist to dry outcrops of calcareous rocks, including coquina limestone ("marl") in the outer Coastal Plain. April-June. PA, KY, IL, WI, and IA south to NC, nw. GA, 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, Pa, W; = *C. ×tennesseensis* – WV]

Cystopteris tenuis (Michaux) Desvaux, Mackay's Bladder Fern. Moist outcrops and cliffs of metamorphic and sedimentary rocks, occasionally in moist soils near rock outcrops or moist soil banks. May-August. NL (Newfoundland) west to MN and NE, south to VA, IL, MO, and AR (Peck 2011), 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, Pa, W; = *C. fragilis* var. *mackayi* Lawson – C, F, G; < *C. fragilis* – WV]



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 basisopic pinnule of the proximal pinnae with basal basisopic pinnulet shorter than the adjacent pinnulet; pinnae of second pair sessile, with basal pinnules shorter than the adjacent pinnule (or second basal pinnae rarely stalked); spores 27-31 μ m in diameter *G. appalachianum*
- 1 Sessile basal basisopic pinnule of the proximal pinnae with basal basisopic 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 μ m in diameter *G. dryopteris*

Gymnocarpium appalachianum Pryer & Haufler, Appalachian Oak Fern. Moist, rocky forests, at medium to high elevations. 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. Karyotype = AA. [= FNA, K, Pa, Z; < *G. dryopteris* (Linnaeus) Newman – C, G, W, WV; < *Dryopteris disjuncta* (Ledebour) C.V. Morton – F]

Gymnocarpium dryopteris (Linnaeus) Newman, Northern Oak Fern. Moist, rocky forests, at medium to high elevations. Circumboreal, occurring throughout northern and central Eurasia, Greenland, south in North America to MD (?), e. WV, s. PA, OH, MI, WI, IA, w. SD, CO, n. NM, and c. AZ. See Pryer & Haufler (1993) for a detailed analysis of the distinguishing features

of *G. appalachianum* and *G. dryopteris*. Karyotype = AAJJ. [= FNA, K, Pa, Z; < *G. dryopteris* (Linnaeus) Newman – C, G, W, WV; < *Dryopteris disjuncta* (Ledebour) C.V. Morton – F]

Triploids are known from the mountains of VA. Their identity is uncertain; based on geography they are presumably *G. appalachianum* × *dryopteris* [AAJ], but could be *G. ×brittonii* (Sarvela) Pryer & Haufler [= *G. disjunctum* × *dryopteris* = AJJ]. Triploids can be distinguished 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. ×brittonii* (Sarvela) Pryer & Haufler – K]



F33. ASPLENIACEAE Frank 1877 (Spleenwort Family) [in POLYPODIALES]

A family of a 2 genera 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. 2004a), a conclusion followed here. References: Kramer & Viane in Kramer & Green (1990); Schneider et al. (2004a).

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)=Z; Murakami et al. (1999); Kramer & Viane in Kramer & Green (1990).

Identification notes: Several of the more frequently encountered sterile hybrids are included in the key and treated fully below. Others may be recognized by intermediate morphology and usual co-occurrence with both parents.

- 1 Leaves simple, unlobed (or with a few, irregular forkings in *A. septentrionale*); 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 toward the tip; leaves pinnatifid to tripinnate, the outline of the leaf blade narrowly to broadly triangular, widest at the base (or slightly above the base in *A. abscissum*).
 - 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 (or normal in *A. tutwilerae*, known only from Hale County, AL).
 - 8 Spores abortive*A. xebenoides*
 - 8 Spores normal; [endemic (as far as known) to Hale County, AL]*A. tutwilerae*
 - 6 Petiole partially or entirely green (darkened or not at its base).
 - 9 Leaves pinnatifid or pinnate through most or all of their lengths.
 - 10 Leaves pinnatifid, sometimes fully pinnate at the base; spores normal*A. pinnatifidum*
 - 10 Leaves pinnate (sometimes pinnate-pinnatifid at the base in *A. xtrudellii*); spores abortive (*A. xtrudellii*) or normal (*A. abscissum*)
 - 11 Spores normal*A. abscissum*
 - 11 Spores abortive*A. xtrudellii*
 - 9 Leaves bipinnate to tripinnate.
 - 12 Petiole darkened toward 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*
 - 12 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.
 - 13 Pinnae orbicular to obovate-oblong, 1-2× as long as wide, the base more-or-less symmetrical (if auriculate, only slightly so and on the side of the pinna toward the base of the leaf); old leaf rachises often with persistent projections left from the disarticulation of the pinnae.
 - 14 Main pinnae deeply lobed into 3-many segments (the leaves therefore pinnate-pinnatifid); [of FL]*A. verecundum*

- 14 Main pinnae merely toothed (the leaves therefore pinnate); [widespread in our area].
- 15 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 toward 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*
- 15 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*
- 13 Pinnae oblong-rectangular, 2 \times or more as long as wide, the base asymmetrical or auricled (more prominently auricled on the side of the pinna toward the tip of the leaf); old leaf rachises lacking persistent projections left from the disarticulation of the pinnae.
- 16 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*
- 16 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].
- 17 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 toward the leaf tip..... *A. monanthes*
- 17 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 toward the pinna tip.
- 18 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*
- 18 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
- 19 Pinna margins crenate to serrate; pinna base lacking an auricle, or the auricle rudimentary; veins evident; spores 64 per sporangium *A. heterochroum*
- 19 Pinna margins shallowly crenate; pinna base with auricle; veins obscure; spores 32 per sporangium
..... *A. heteroresiliens*

Asplenium abscissum Willdenow, Cutleaf Spleenwort. Limestone sinkhole. Mexico, Central America, and n. South America; West Indies; nc. and c. FL peninsula; s. FL; n. AL. This species is a diploid, with chromosome complement AA. Found in Jackson County, AL in 2009 (Barger et al. 2010). [= FNA, K, S, WH3]

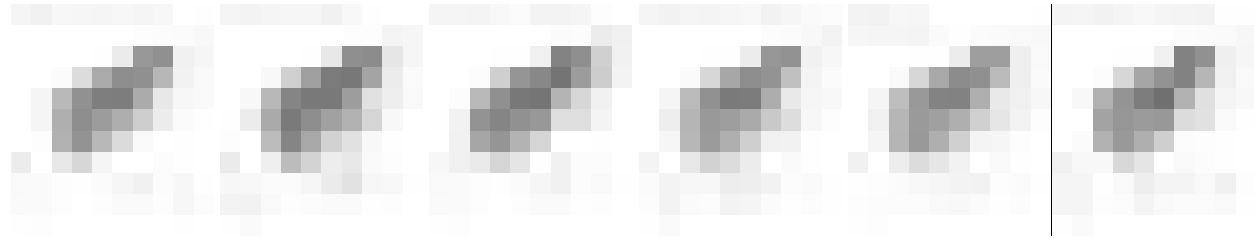
Asplenium bradleyi D.C. Eaton, Bradley's Spleenwort. Dry outcrops of felsic sedimentary or metasedimentary rocks, such as sandstone, quartzite, or metaquartzite, at low to moderate elevations. April-October. PA, MD, OH, KY, s. IL, and MO south to c. NC, c. GA, AL, TN, and AR, reaching its greatest abundance 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, Pa, S, W, WV; = *A. xbradleyi*]

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

Asplenium heterochroum Kunze, Bicolored Spleenwort. Fairly moist outcrops of calcareous sedimentary rocks, such as coquina limestone ("marl"). Se. and sc. GA (Jones & Coile 1988) south to n. FL; West Indies; s. Mexico (Chiapas, Veracruz), Belize. Its chromosome complement can be symbolized HHHH. [= FNA, K, WH3; < *A. heterochroum* Kunze - S]

Asplenium heteroresiliens W.H. Wagner, Marl Spleenwort, Carolina Spleenwort, Wagner's Spleenwort, Morzenti's Spleenwort. 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). 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) allopolyploid 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, WH3; < *A. heterochroum* Kunze - S]

Asplenium monanthes Linnaeus, Single-sorus Spleenwort. Moist calcareous situations, in the mountains in moist grottoes of calcareous to semi-calcareous metamorphic rocks (such as mylonite or marble) near waterfalls in humid escarpment gorges with high rainfall, on limestone talus in collapsed sinkhole mouth, or on moist Coastal Plain limestone outcrops. 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 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); limestone talus in the collapsed mouth of a sinkhole in Jackson County, AL; and the Huachuca Mountains, Cochise County, AZ. Given the variability of *A. monanthes* throughout is wide and scattered distribution, and its complex of related and closely similar species, our material deserves additional study to verify its true identity. [= RAB, FNA, K, W, WH3]



Asplenium montanum Willdenow, Mountain Spleenwort. 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 2000 m), but in the Piedmont to as low as 150 m. May-October. Primarily Appalachian: s. VT, MA, NY, OH, and KY south to c. NC, n. GA and AL; disjunct in Ozarkian highlands (Peck 2011). *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. ×trudellii* (and of other sterile hybrids). [= RAB, C, F, FNA, G, K, Pa, S, W, WV]

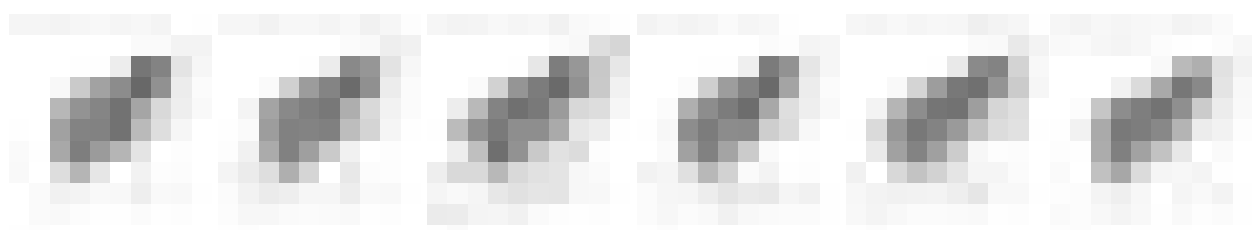
Asplenium pinnatifidum Nuttall, Lobed Spleenwort. Fairly moist to very dry outcrops of felsic sedimentary or (mostly low-grade) metamorphic rocks, such as sandstone, phyllite, and schist, at low to moderate elevations. May-October. NJ, se. PA, wc. PA, s. OH, IN, IL, and MO south to w. NC, c. GA (Jones & 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, Pa, S, W, WV; = *A. pinnatifidum* var. *pinnatifidum* – G; = *A. ×pinnatifidum* – K]

Asplenium platyneuron (Linnaeus) Britton, Sterns, & Poggenburg, Ebony Spleenwort. Moist to dry soils of forests, woodlands, old fields; also on outcrops, especially of calcareous rocks and in masonry crevices, at low to moderate elevations; common. April-October. QC, ON, 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. ×ebenoides* (as well as other sterile hybrids). *A. platyneuron* in general, and var. *platyneuron* specifically, is by far the most common of our *Asplenium* species, 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 > 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 < 3.5 cm long, pinnae subtire to pinnatifid, larger leaves to 20-45 (-50) cm tall, with 25-50 pairs of pinnae). [= RAB, C, FNA, Pa, S, W, WH3, WV; > *A. platyneuron* var. *platyneuron* – F, G, K, Z; > *A. platyneuron* var. *bacculum-rubrum* (Featherman) Fernald – F, G, K, Z; > *A. platyneuron* var. *incisum* (Howe ex Peck) B.L. Robinson – F, Z]

Asplenium resiliens Kunze, Blackstem Spleenwort. Moist to dry outcrops of calcareous sedimentary or metamorphic rocks, such as limestone, dolostone, coquina, or marble, sometimes on narrow seams of calcareous materials in otherwise acidic rocks, rarely on mortar or concrete, mostly at low to moderate elevations, but remarkably on Grandfather Mountain at over 1800 m. April-October. Sc. PA, KY, s. IL, MO, se. KS, OK, TX, CO, and s. NV south to FL, TX, AZ, and Mexico; 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*. [= C, F, FNA, G, K, Pa, RAB, S, W, WH3, WV]

Asplenium rhizophyllum Linnaeus, Walking Fern. 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. May-October. S. QC, ON 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. ×ebenoides* (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. [= C, FNA, K, Pa, RAB, W; = *Camptosorus rhizophyllum* (Linnaeus) Link – F, G, S, WV]

Asplenium ruta-muraria Linnaeus var. *cryptolepis* (Fernald) Wherry, American Wall-rue. Moist to dry outcrops of calcareous sedimentary or metamorphic rocks, such as limestone, dolostone, or marble, at low to moderate elevations. 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. ON and n. MI south to n. NJ, w. NC, nw. GA (Jones & Coile 1988), n. AL, TN, and AR (Peck 2011). 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. [= WV; < *A. ruta-muraria* – C, FNA, Pa, RAB, 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, K; > *A. ruta-muraria* var. *lanceolum* Christ – K]



Asplenium scolopendrium Linnaeus var. *americanum* (Fernald) Kartesz & Gandhi, American Hart's-tongue Fern. Humid sinkholes. E. TN and n. AL, and in other habitats farther north in c. NY, n. MI, and ON; also in the West Indies (Haiti) and s. Mexico (Chiapas, Nuevo León, Oaxaca). It is also reported as naturalized in MD by Reed (1953). [= FNA, K; = *Phyllitis scolopendrium* (Linnaeus) Newman var. *americana* Fernald – C, F, G; < *Phyllitis scolopendrium* – S]

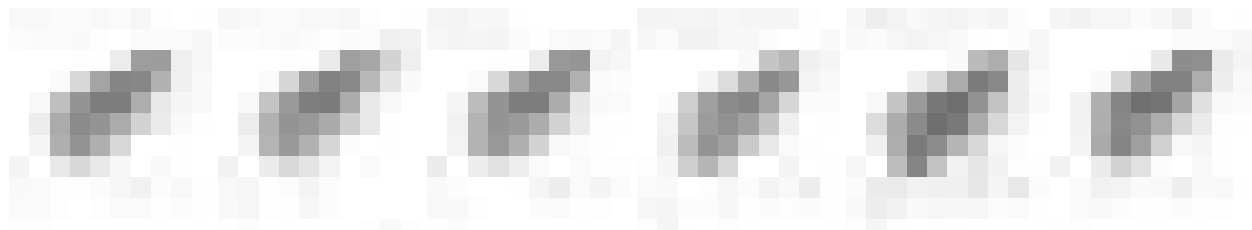
* *Asplenium scolopendrium* Linnaeus var. *scolopendrium*, European Hart's-tongue Fern. Sparsely naturalized from cultivation; reported as naturalized in a well in MD by Reed (1953). [= FNA, K; = *Phyllitis scolopendrium* (Linnaeus) Newman var. *scolopendrium* – C, F, G]

Asplenium septentrionale (Linnaeus) Hoffmann, Forked Spleenwort. Acidic rocks. Western North America south into nw. Mexico (Baja California), Asia, Europe; disjunct in WV (Hardy and Monroe counties) and the AR Ozarks (Peck 2011). This very inconspicuous species is likely to be found at additional locations. Its chromosome formula is SSSS. [= C, FNA, K]

Asplenium trichomanes Linnaeus ssp. *quadrivalens* D.E. Meyer emend. Lovis, Maidenhair Spleenwort. Moist outcrops of calcareous sedimentary rocks, such as limestone or dolostone. 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. ON south to w. VA, OH, and s. IL, and in BC, WA, and OR. Ssp. *quadrivalens* is a tetraploid of uncertain origin, presumably autotetraploid, but perhaps the result of the hybridization of two ecologically differentiated diploid races of *A. trichomanes*. [= FNA, K, Pa, W; < *A. trichomanes* – C, F, G, S]

Asplenium trichomanes Linnaeus ssp. *trichomanes*, Maidenhair Spleenwort. 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. 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 NL (Newfoundland) to AK, south to NC, c. GA (Jones & Coile 1988), c. AL, AR, OK, w. TX, Chihuahua, se. AZ, and w. OR. Ssp. *trichomanes* is a diploid, probably involved in the origin of ssp. *quadrivalens*. [= FNA, K, Pa, W; < *A. trichomanes* – C, F, G, RAB, S, WH3, WV]

Asplenium ×trudellii Wherry (pro species) [*montanum* × *pinnatifidum*], Trudell's Spleenwort. Moist outcrops of felsic sedimentary or metamorphic rocks, such as sandstone, phyllite, schist, at low elevations. 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. Recently located west of the Mississippi River in Baxter County, AR (Peck 2011). There are some reports that it can sometimes produce fertile spores. [= F, FNA, K, WV; = *Asplenium pinnatifidum* Nuttall var. *trudellii* (Wherry) Clute – G; = *Asplenium trudellii* Wherry – S; = ×*Asplenosorus trudellii* (Wherry) Mickel]



Asplenium tutwilerae B.R. Keener & L.J. Davenport, Tutwiler's Spleenwort. Crevices of calcareous conglomerate. So far as is known, *A. tutwilerae*, the fertile allotetraploid of *A. ×ebenoides*, is limited to a single population in Hale County, AL; however Peck (2011) reports a population from Garland County, AR, which produces viable spores, and may prove to be a second station of the fertile tetraploid. The chromosome formula of *A. tutwilerae* is PPRR. See Keener & Davenport (2007). [< *A. ×ebenoides* – K; < *Asplenium ebenoides* R.R. Scott – FNA, S]

Asplenium verecundum Chapman ex Underwood, Modest Spleenwort, Delicate Spleenwort. Moist limestone outcrops, grottoes, and sinkholes. Endemic to FL, from n. FL (Columbia, Jackson, Liberty, Taylor counties) southward (Wunderlin & Hansen 2004); or perhaps better treated as the northern component of the West Indian *A. myriophyllum*. Its chromosome formula is VVVV. [= FNA, WH3; < *A. myriophyllum* (Swartz) K. Presl – K; > *A. verecundum* – S; > *A. scalifolium* E.P. St. John – S; > *A. suave* E.P. St. John – S; > *A. subtile* E.P. St. John – S]

F34. DIPLAZIOPSIDACEAE X.C. Zhang & Christenhusz 2011 (Glade Fern Family) [in POLYPODIALES]

A family of 2 genera. References: Christenhusz & Schneider (2011); Christenhusz, Zhang, & Schneider (2011).

Homalosorus Small ex Pichi-Sermolli 1977 (Glade Fern)

A monotypic genus, perennial, of e. North America. References: Christenhusz, Zhang, & Schneider (2011)=Z; Kato in FNA (1993b); Kramer et al. in Kramer & Green (1990).

Homalosorus pycnocarpus (Sprengel) Pichi-Sermolli, Glade Fern. 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). July-September. QC, ON, and MN south to GA and LA (much more common in sedimentary rock areas of the Appalachians than in the primarily acid-soil Blue Ridge and Piedmont). [= S, W, Z; = *Diplazium pycnocarpon* (Sprengel) M. Broun – FNA, K, Pa; = *Athyrium pycnocarpon* Sprengel – RAB, C, F, G, WV; = *Diplaziopsis pycnocarpa* (Sprengel) M.G. Price]

F35. THELYPTERIDACEAE Pichi Sermolli 1970 (Marsh Fern Family) [in POLYPODIALES]

A family of 6-30 genera (generic circumscription especially controversial and problematic) and 900-1200 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, < 2× 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, > 2× 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 FNA (1993b); Smith in Kramer & Green (1990).

* *Macrothelypteris torresiana* (Gaudichaud-Beaupré) Ching, Mariana Maiden Fern. Disturbed areas, and increasingly invasive in natural habitats (especially in the southern parts of our area); native of the Asian and African tropics. Leonard (1972) discusses the history of this species in the southeastern United States. It continues to spread northward, and is reported for Kentucky by Gorman, Bruton, & Estes (2011). [= FNA, K, WH3; = *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 FNA (1993b); 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*P. 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*P. hexagonoptera*

Phegopteris connectilis (Michaux) Watt, Northern Beech Fern. Moist cliffs where wet by spray from waterfalls (at medium elevations), also on high elevation cliffs wet by seepage and in spruce-fir forests, northward in cool ravines and on swamp borders. April-August. A circumboreal species, at its southern limit in North America in MD, WV, OH, IL, IA, MT, and OR; disjunct southward in w. NC and e. TN, and in CO. Most of the occurrences in NC are at waterfalls in the escarpment gorges of Transylvania, Macon, and Jackson counties, near Highlands. The species is a triploid, reproducing apogamously. [= FNA, K, Pa, WV; = *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. Mesic to submesic forests. April-August. QC west to ON, WI, and MN, south to Panhandle FL and e. TX. [= FNA, K, Pa, S, WH3, WV; = *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* (*T. palustris* var. *pubescens*), subgenus or genus *Parathelypteris* (*T. noveboracensis*, *T. simulata*), subgenus *Cyclosorus* or genus *Christella* (*T. dentata*, *T. hispidula* var. *versicolor*, *T. interrupta*, *T.*

kunthii, *T. ovata* var. *ovata*), and subgenus or genus *Stegnogramma* (*T. burksiorum*). The appropriate names, should the additional segregate genera be adopted, are listed in synonymy. References: Smith in FNA (1993b); Smith (1981); Smith in Kramer & Green (1990). [also see *Macrothelypteris* and *Phegopteris*]

- 1 Sori elongate; sporangia with hairs 0.1-0.2 mm long; [endemic to nc. AL]; [subgenus or genus *Stegnogramma*]..... *T. burksiorum*
- 1 Sori round or slightly longer than wide; sporangia glabrous; [collectively widespread]
- 2 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.
 - 3 Leaf blade broadest near the middle, gradually reduced to the base, the petiole < 1/3 the length of the blade; [of upland and wetland habitats]; [subgenus or genus *Parathelypteris*] *T. noveboracensis*
 - 3 Leaf blade broadest near the base, the pinnae stopping abruptly, the petiole 2/3 to fully as long as the blade; [of wetland habitats].
 - 4 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*] *T. palustris* var. *pubescens*
 - 4 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*]..... *T. simulata*
- 2 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*].
- 5 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.
 - 6 Lower surface of costae with tan scales; upper surface of costae glabrous or sparsely pubescent with hairs < 0.2 mm long; rhizomes long-creeping..... *T. interrupta*
 - 6 Lower surface of costae lacking scales; upper surface of costae moderately to densely hairy with hairs > 0.3 mm long; rhizomes short-creeping.
 - 7 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 *T. dentata*
 - 7 Rachises and petioles usually tan; costae sparsely hairy on the lower surface, the hairs variable in length, most of them > 0.3 mm long and at least some > 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 *T. hispidula* var. *versicolor*
- 5 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.
 - 8 Upper surface of the costae and costules glabrous above (rarely minutely hairy, the hairs never > 0.2 mm long), eglandular *T. ovata* var. *ovata*
 - 8 Upper surface of the costae and costules with at least a few stout hairs > 0.3 mm long; upper leaf surface pubescent to nearly glabrous, also glandular with stipitate glands.
 - 9 Lowermost 1-2 pairs of pinnae distinctly shorter than the pair above (ca. ¾ as long); basal veins from adjacent lobes of the pinna always meeting *T. hispidula* var. *versicolor*
 - 9 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 *T. kunthii*

Thelypteris burksiorum J.E. Watkins & D.R. Farrar. Moist sandstone grottoes. A narrow endemic of nc. AL. Watkins & Farrar (2002, 2005) present evidence for its recognition as a species distinct from *Thelypteris pilosa* and discuss its likely evolution as an ancient relictual taxon. 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, K; = *Stegnogramma pilosa* (M. Martens & Galeotti) K. Iwatsuki var. *alabamensis* (Crawford) K. Iwatsuki; = *Stegnogramma burksiorum* (J.E. Watkins & D.R. Farrar) Weakley]

* *Thelypteris dentata* (Forsskål) E. P. St. John, Downy Maiden Fern, Soft Fern. Disturbed areas; native of tropical and subtropical Asia and Africa. [= FNA, K, WH3; > *T. dentata* – S; > *T. reducta* Small ex R.P. St. John – S; = *Christella dentata* (Forsskål) Brownsey & Jermy]

Thelypteris hispidula (Decaisne) C.F. Reed var. *versicolor* (R. St. John) Lellinger, Hairy Maiden Fern. Moist forests, limesinks, and on soil in disturbed areas. E. SC south to s. FL < west to e. TX. Other varieties occur in the West Indies, in tropical New and Old World. [= FNA, K, WH3; = *T. versicolor* R. St. John – S; < *Christella hispidula* (Decaisne) Holttum; = *T. quadrangularis* (Fee) Schelpe var. *versicolor* (R. St. John) A.R. Smith]

Thelypteris interrupta (Willdenow) K. Iwatsuki, Hottentot Fern. Marshes, swamps, ditches. Pantropical. [= FNA, K, WH; ? *T. gongyloides* (Schkuhr) Small – S; > *T. totta* (Thunberg) Schelpe; = *Cyclosorus interruptus* (Willdenow) H. Itô; *Christella*]

Thelypteris kunthii (Desvaux) C.V. Morton, Kunth's Maiden Fern, Southern Shield Fern. Coquina limestone ('marl') outcrops, calcareous bluffs and sinkhole slopes, also adventive on and around coquina limestone (marl) riprap around small bridges and ditches and in suburban forests. May-August. Se. NC south to s. FL and west to c. TX; Mexico south through Central America into n. South America; West Indies. [= RAB, FNA, K, WH3; < *T. normalis* (C. Christensen) Moxley – S; < *Christella normalis* (C. Christensen) Holttum]

Thelypteris noveboracensis (Linnaeus) Nieuwland, New York Fern. Mesic forests, bottomland forests, bogs, submesic forests. May-August. NL (Newfoundland) and WI south to GA, AL, and AR. Distinctive in the leaves tapering about equally to both tip and base. [= RAB, C, FNA, G, K, Pa, S, W, WV; = *Dryopteris noveboracensis* (Linnaeus) A. Gray – F; = *Parathelypteris noveboracensis* (Linnaeus) Ching]

Thelypteris ovata R. P. St. John var. *ovata*, Ovate Maiden Fern. On coquina limestone ("marl") or in disturbed, calcareous areas. S. SC south to s. FL, west to s. AL; and in the Bahamas. Var. *lindheimeri* (C. Christensen) A.R. Smith occurs in TX, Mexico, Belize, Guatemala, and Jamaica. [= FNA, K; > *T. ovata* var. *ovata* – S, in a narrower sense; > *T. ovata* var. *harperi* (C. Christensen) R. P. St. John – S; < *T. ovata* – WH3; = *Christella ovata* (R.P. St. John) Löve & Löve]

Thelypteris palustris Schott var. *pubescens* (Lawson) Fernald, Marsh Fern. Bogs, marshes (including freshwater tidal marshes), and bottomland forests. June-September. The species is circumboreal, occurring in n. Europe, n. Asia, and n. North America. Var. *pubescens* is the American variety, ranging from NL (Newfoundland) and MB south to s. FL and c. TX; c. Mexico (Michoacán, Distrito Federal); Bermuda, Cuba. [= C, FNA, G, K, Pa, W, WH3, WV; < *T. palustris* – RAB; = *Dryopteris thelypteris* (Linnaeus) Swartz var. *pubescens* (Lawson) A.R. Prince ex Weatherby – F; < *T. thelypteris* (Linnaeus) Nieuwland – S]

Thelypteris simulata (Davenport) Nieuwland, Bog Fern, Massachusetts Fern. In NC and WV in acid peat bogs at about 1000 meters in elevation, in DE, NJ, and VA in acid seepage swamps in the Coastal Plain. July-September. Northeastern, ranging from NS 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, Pa, S, W, WV; = *Dryopteris simulata* Davenport – F; = *Parathelypteris simulata* (Davenport) Holttum]

F36. WOODSIACEAE Herter 1949 (Woodsia Family) [in POLYPODIALES]

A family of about 15 genera and 700 species, cosmopolitan in distribution, but concentrated in temperate and montane areas. References: Smith in FNA (1993b); Smith et al. (2006); Lellinger (1985); Kramer et al. in Kramer & Green (1990).

- 1 Sori elongate, indusia present and flaplike, attached along a long side.
 - 2 Leaves 2-pinnate to 3-pinnate (the pinnae at least 1-pinnate); sori elongate, 2-3× as long as wide, the larger sori generally curved and extending across the veins (except *Diplazium esculentum*).
 - 3 Veins free, simple or forked..... [see *Athyrium* in ATHYRIACEAE]
 - 3 Veins anastomosing [see *Diplazium* in ATHYRIACEAE]
 - 2 Leaves 1-pinnate to 1-pinnate-pinnatifid (the pinnae entire or pinnatifid); sori elongate, 2.5-6× as long as wide, even the larger sori generally straight and not extending across the veins.
 - 3 Leaves 1-pinnate-pinnatifid, the pinnae pinnatifid [see *Deparia* in ATHYRIACEAE]
 - 3 Leaves 1-pinnate, the pinnae entire [see *Homalosorus* in DIPLAZIOPSIDACEAE]
- 1 Sori round, indusia present or absent, if present cuplike or lateral (but not attached along a long side).
 - 4 Leaf blades broadly triangular in outline, ca. 1× as long as wide; rhizome ca. 1 mm in diameter; indusia absent; [native species of mountain peaks of n. NC and VA] [see *Gymnocarpium* in CYSTOPTERIDACEAE]
 - 4 Leaf blades lanceolate, oblong, or ovate in outline, 2× or more as long as wide; rhizome more than 2 mm in diameter.
 - 5 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..... [see *Cystopteris* in CYSTOPTERIDACEAE]
 - 5 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*

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 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; leaf blade 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. On cliffs of sandstone, shale, granite, granitic gneiss, and hornblende gneiss. June-September. Endemic to the Southern and Central Appalachians of VA, WV, NC, nw. GA, TN, and the Ozarks of AR (Peck 2011). 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 eastward in ON and QC). 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, WV; = *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. Cliffs of amphibolite, greenstone, other rocks. June-September. Circumboreal, ranging in North America from NL (Newfoundland) and AK south to VA, nw. NC, OH, n. IL, nw. IA, SK, and BC. [= RAB, C, F, FNA, G, K, Pa, S, W, WV]

Woodsia obtusa (Sprengel) Torrey ssp. *obtusa*, Common Woodsia, Blunt-lobed Cliff Fern. Rock outcrops of various sorts, moist talus, terrestrial near rock outcrops. June-September. ME, QC, MN, and e. NE, south to Panhandle FL and TX. [= FNA, K; < *W. obtusa* – RAB, C, F, G, Pa, S, W, WH3, WV]



F38. ONOCLEACEAE Pichi Sermolli 1970 (Sensitive Fern Family) [in POLYPODIALES]

A family of 4 genera and 5 species (but see below), of north temperate regions. The family as here circumscribed is monophyletic and sister to Blechnaceae (Smith et al. 2006). Christenhusz, Zhang, & Schneider (2011) prefer to combine the 5 species in the family into a single genus (*Onoclea*). References: Christenhusz, Zhang, & Schneider (2011); Smith et al. (2006)

- 1 Sterile leaves pinnate-pinnatifid, 6-25 dm tall, broadest toward 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..... ***Matteuccia***
 1 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***

Matteuccia Todaro 1866 (Ostrich Fern)

A monotypic genus, north temperate in distribution. Two other species formerly included in *Matteuccia* (or sometimes in *Onoclea*) are either better treated in the genus *Pentarhizidium* Hayata (Gastony & Ungerer 1997), or else the genera *Pentarhizidium*, *Matteucia*, and *Onocleopsis* should be united into *Onoclea* (Christenhusz, Zhang, & Schneider 2011). The members of the family store starch in their expanded and persistent petiole bases. References: Johnson in FNA (1993b); Kramer et al. in Kramer & Green (1990).

Matteuccia struthiopteris (Linnaeus) Todaro var. ***pensylvanica*** (Willdenow) C.V. Morton, Ostrich Fern. Alluvial forests and calcareous wetlands. The species is circumboreal; the North American var. *pensylvanica* ranges from NL (Newfoundland) west to AK, south to VA (Smyth and Craig cos.), MO, SD, and BC. 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. [= FNA, G; < *M. struthiopteris* – C, K, Pa; = *Pteretis pensylvanica* (Willdenow) Fernald – F; = *M. pensylvanica* (Willdenow) Raymond – WV; = ***Onoclea struthiopteris*** (Linnaeus) Roth var. ***pensylvanica*** (Willdenow) B. Boivin]

Onoclea Linnaeus 1753 (Sensitive Fern)

A genus of 1 species, of temperate e. North America and e. Asia. References: Gastony & Ungerer (1997)=Z; Johnson in FNA (1993b); Kramer et al. in Kramer & Green (1990).

Onoclea sensibilis Linnaeus var. ***sensibilis***, Sensitive Fern, Bead Fern. Marshes, swamps, wet disturbed places. May-June. The species ranges from NL (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. Alternatively, species status is sometimes given (Gastony & Ungerer 1997). 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. [*O. sensibilis* – RAB, C, F, FNA, G, K, Pa, S, W, WH3, WV; = *O. sensibilis* – Z]

F39. BLECHNACEAE (C. Presl) Copeland 1947 (Deer Fern Family) [in POLYPODIALES]

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 (1990).

- 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: Mickel & Smith (2004)=Z; Kramer, Chambers, & Hennipman in Kramer & Green (1990).

- 1 Leaf blades usually < 5 dm long; leaves pinnate-pinnatifid in all or part; margins entire (to sparingly and irregularly serrulate) *B. appendiculatum*
- 1 Leaf blades usually > 5 dm long; leaves pinnate throughout; margins serrulate *B. serrulatum*

Blechnum appendiculatum Willdenow, Hammock Fern. Moist forests. S. GA south to s. FL; West Indies; Central America, South America. Collected once in LA, on the west bank of the Mississippi River in bottomland hardwoods in Iberville Parish, LA. [= Z; = *B. occidentale* Linnaeus var. *minor* Hooker – FNA, WH3; < *B. occidentale* – K1, K2, S]

Blechnum serrulatum L.C. Richard, Swamp Fern, Marsh Fern. Vacant lots, bottomlands. Ne. FL south to FL peninsula; Mexico, Central America, South America; West Indies; Malesia and Australia. Introduced and established in e. SC (Beaufort and Jasper counties) via landscaping plants brought in from FL (P. McMillan, pers. comm. 2005); similarly introduced in s. AL (H. Horne, pers. comm. 2012, W. Barger, pers. comm. 2012). [= FNA, K1, K2, S, WH3, Z]

Woodwardia J.E. Smith 1793 (Chain Fern)

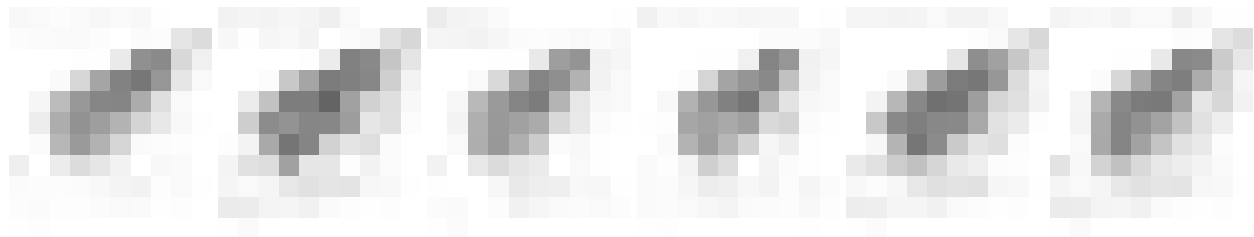
A genus of about 13 species of temperate and tropical portions of the Northern Hemisphere, especially e. and se. Asia. References: Kramer, Chambers, & Hennipman in Kramer & Green (1990).

Identification notes: In sterile leaf, *Woodwardia areolata* is sometimes confused with *Onoclea*, but *W. areolata* has the pinnae generally alternate (vs. tending to be opposite), the pinnae generally acute or acuminate (vs. obtuse), and the pinna margin finely serrulate (vs. entire).

- 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. Moist to wet, acid, organic soils, such as bogs, blackwater bottomlands, pocosins. May-September. NS west to MI and MO, south to s. FL and e. TX, primarily on the Coastal Plain. See Cranfill (1983) for a discussion of the geography and ecology of *W. areolata*. [= RAB, C, F, FNA, G, K, Pa, W, WH3; = *Lorinseria areolata* (Linnaeus) K. Presl – S, WV]

Woodwardia virginica (Linnaeus) J.E. Smith, Virginia Chain Fern. Moist to wet, acid, organic soils, such as bogs, blackwater bottomlands, pocosins, sometimes in standing water, as in periodically flooded coastal plain depression ponds. June-September. NS west to MI and IL, south to s. FL and TX, and in Bermuda, primarily on the Coastal Plain. Sometimes confused when sterile with *Osmundastrum cinnamomeum* (which see for discussion). [= RAB, C, F, FNA, G, K, Pa, W, WH3; = *Anchistea virginica* (Linnaeus) K. Presl – S]



F40. ATHYRIACEAE Alston 1956 (Lady Fern Family) [in POLYPODIALES]

References: Christenhusz, Zhang, & Schneider (2011).

- 1 Leaves 2-pinnate to 3-pinnate (the pinnae at least 1-pinnate); sori elongate, 2-3× as long as wide, the larger sori generally curved and extending across the veins (except *Diplazium esculentum*).
 - 2 Veins free, simple or forked *Athyrium*
 - 2 Veins anastomosing *Diplazium*
- 1 Leaves 1-pinnate to 1-pinnate-pinnatifid (the pinnae entire or pinnatifid); sori elongate, 2.5-6× as long as wide, even the larger sori generally straight and not extending across the veins.
 - 3 Leaves 1-pinnate-pinnatifid, the pinnae pinnatifid *Deparia*
 - 3 Leaves 1-pinnate, the pinnae entire [see *Homalosorus* in DIPLAZIOPSIDACEAE]

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 (1990); Kelloff et al. (2002). [also see *Deparia* and *Homalosorus*]

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, but flattened, strands); *Athyrium* and *Deparia* have 2, *Dryopteris* has 4-7.

- 1 Leaves variegated, silvery gray and gray-green; [alien]..... *A. niponicum*
- 1 Leaves not variegated, bright green; [native, sometimes cultivated]
 - 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. Moist forests, rock outcrops on grassy balds at high elevations. 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. NL (Newfoundland) and n. QC west to SK, south to VA (Kartesz 1999), w. NC, e. TN, OH, MO, AR (Peck 2011), and NE. [= S, WV; = *A. filix-femina* (Linnaeus) Roth ex Mertens var. *michauxii* (Sprengel) Farwell – C, F, G; = *A. filix-femina* var. *angustum* (Willdenow) G. Lawson – FNA, Pa; = *A. filix-femina* ssp. *angustum* (Willdenow) Clausen – K, W]

Athyrium asplenioides (Michaux) A.A. Eaton, Southern Lady Fern. Moist forests. May-September. MA, WV, IL, and KS south to n. FL and e. TX. [= RAB, S, WV; = *A. filix-femina* (Linnaeus) Roth ex Mertens var. *asplenioides* (Michaux) Farwell – C, F, FNA, G, Pa; = *A. filix-femina* ssp. *asplenioides* (Michaux) Hultén – K, W, WH3]

* *Athyrium niponicum* (Mettenius) Hance, Japanese Painted Fern. Suburban woodlands, lawns; commonly planted as an ornamental, rarely naturalizing, native of Japan. This common suburban ornamental (forma *picta*) spreads locally from plantings; it seems only a matter of time before it begins to naturalize more widely. Reported as naturalizing sparingly in AR (Peck 2011).

Deparia Hooker & Greville 1829

A genus of about 40-50 species, primarily in tropical to warm temperate Asia and Africa. References: Kato in FNA (1993b); Kramer et al. in Kramer & Green (1990).

Identification notes: Unlike *Athyrium*, *Deparia* has the costal groove not continuous with the rachis groove. In addition, *Deparia* has multicellular hairs on the leaf blades.

- 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. acrostichoides*
- 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 acrostichoides (Swartz) M. Kato, Silvery Spleenwort. Moist forests, cove forests. June-September. NS west to MN, south to NC, SC, n. GA, n. AL, and AR. *D. acrostichoides* is the only species native to the New World; it has several very closely related species in e. Asia (in section *Lunathyrium*). It stores starch in the swollen, persistent petiole bases. [= FNA, K, Pa, W; = *Athyrium thelypteroides* (Michaux) Desvaux – RAB, C, F, G, WV; = *Diplazium acrostichoides* (Swartz) Butters – S]

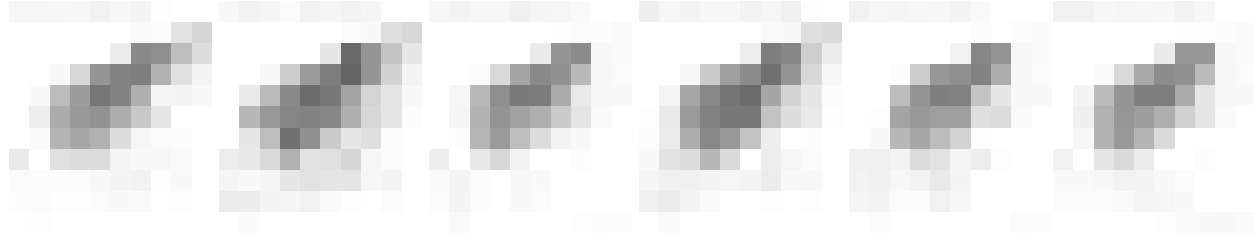
* *Deparia petersenii* (Kunze) M. Kato. Swamp forests, disturbed areas; native to se. Asia. Introduced and naturalized in the Southeast, including in c. and s. GA, AL, s. MS, and FL. [= FNA, WH3; = *Deparia petersonii* – K, orthographic variant; = *Deparia japonica* (Thunberg) M. Kato, misapplied; = *Diplazium japonicum* (Thunberg) Beddome, misapplied]

Diplazium Swartz 1800 (Twin-sorus 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 (1990).

- 1 Leaves 2-pinnate; veins anastomosing *D. esculentum*
- 1 Leaves 1-pinnate; veins free [see *Homalosorus pycnocarpus* in DIPLAZIOPSIDACEAE]

* *Diplazium esculentum* (Retzius) Swartz, Vegetable Fern. Moist disturbed areas; native of the Old World tropics. [= FNA, K, WH3]



F42. DRYOPTERIDACEAE Ching 1965 (Wood-fern Family) [in POLYPODIALES]

A family of about 40-45 genera and 1700 species, cosmopolitan in distribution, but concentrated in temperate and montane areas. Here circumscribed (following Smith et al. 2006) to exclude Onocleaceae and Woodsiaceae. References: Smith in FNA (1993b); Smith et al. (2006); Lellinger (1985); Kramer et al. in Kramer & Green (1990).

- 1 Leaf blades pentagonal in outline, ca. 1× as long as wide, the terminal pinna by far the largest; [introduced species, naturalized in moist ravines in SC] *Arachniodes*
- 1 Leaf blades lanceolate, oblong, or ovate in outline, 1.5× or more as long as wide.
 - 2 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 (*Dryopteris*) or peltate (*Rumohra*).
 - 3 Indusia reniform; leaf blade (at least of larger leaves on mature plants) usually > 40 cm long *Dryopteris*
 - 3 Indusia peltate; leaf blade < 40 cm long *Rumohra*
 - 2 Leaves 1-pinnate, the pinnae toothed and each with a slight to prominent lobe near the base on the side toward the leaf tip, dark green, subcoriaceous to coriaceous; indusia peltate.
 - 4 Veins anastomosing, rejoining to form a netlike pattern; pinnae 4-25 pairs per leaf; [non-native, rarely naturalized] *Cyrtomium*
 - 4 Veins branching dichotomously, free, not rejoining to form a netlike pattern; pinnae 25-50 pairs on larger leaves; [plant a common native species] *Polystichum*

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 (1990).

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

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 (1990).

- 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. Ditches, disturbed swamps, moist ravines, old mortar of brick walls; native of e. Asia. [= FNA, K, S, WH3; = *Polystichum falcatum* Linnaeus f.]

* *Cyrtomium fortunei* J. Smith var. *fortunei*, Fortune's Net-veined Holly Fern. Roadside banks, old mortar of brick walls; native of se. China. Two other varieties are recognized; neither appears to be naturalized in North America. Reported for Polk County, TN (D. Estes, pers. comm., 2010). [= FNA; < *C. fortunei* – K]

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 (1990); 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.

- 1 Leaves bipinnate-pinnatifid to tripinnate-pinnatifid (or to quadripinnate in the lower pinnae).
 - 2 Leaves evergreen, the blades appearing more-or-less parallel-sided and 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 < 2× as long as the first tip-pointed pinnule of the basal pinna.....*D. intermedia*
 - 2 Leaves deciduous, the blades appearing more or less triangular and 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 > 2× as long as the first tip-pointed pinnule of the basal pinna.
 - 3 Leaf blade ca. 1× as long as the petiole; indusium occasionally glandular; first basal-pointed pinnule of the basal pinna 2.5-5× as long as the first tip-pointed pinnule of the basal pinna.....*D. campyloptera*
 - 3 Leaf blade 2× as long as the petiole; indusium glabrous; first basal-pointed pinnule of the basal pinna ca. 2× 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, 2-3× as long as the spreading, evergreen, sterile leaves, which form a winter "rosette"; fertile leaves linear-lanceolate in outline, generally 4-8× as long as wide; pinnae mostly 1.5-3× 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° (like an open Venetian blind); fertile leaves 8-12 cm wide.....*D. cristata*
 - 5 Leaves not dimorphic, or only slightly so, deciduous (*D. goldiana*), evergreen (*D. ludoviciana*), or else with usually deciduous fertile and semi-evergreen sterile fronds (*D. celsa*); fertile leaves lanceolate to ovate in outline, generally 1.5-4× as long as wide; pinnae mostly 3-5× as long as wide; scales at base of petiole dark brown with tan margins.
 - 7 Leaves evergreen, fertile only toward 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 or semi-evergreen, 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 Costa with bullate (blistered-appearing) scales abundant, usually dark; [rarely naturalized alien].....*D. erythrosora*
 - 8 Costa lacking bullate scales; [native, sometimes also cultivated].
 - 9 Sterile leaves semi-evergreen; fertile leaves deciduous with sori submedial, not touching the costule at maturity; leaf blade lanceolate, usually 2-4× 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*
 - 9 Leaves deciduous with sori medial, touching the costule at maturity; leaf blade ovate to narrowly ovate, usually 1.5-3× 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. Spruce-fir forests, northern hardwood forests. July-September. NL (Newfoundland) and n. QC 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, Pa, S, W, WV; = *D. spinulosa* (O.F. Mueller) Watt var. *americana* (Fischer ex Kunze) Fernald - F; = *D. austriaca* (Jacquin) Woyнар ex Schinz & Thellung var. *austriaca* - G]

Dryopteris carthusiana (Villars) H.P. Fuchs, Spinulose Wood-fern, Toothed Wood-fern. Acidic, organic-rich bogs, swamps, less frequently in moist rocky ravines, rich forests, and sloping rock outcrops. June-September. Irregularly circumboreal, in North America ranging from n. QC west to YT, south to NC, SC, ne. GA, 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, Pa, W; = *D. spinulosa* (O.F. Mueller) Watt - RAB, S, WV; = *D. spinulosa* var. *spinulosa* - F; = *D. austriaca* (Jacquin) Woyнар ex Schinz & Thellung var. *spinulosa* (O.F. Mueller) Fiori - G]



Dryopteris celsa (W. Palmer) Knowlton, W. Palmer, & Pollard ex Small, Log Fern. Swamps, seepage bogs, and calcareous floodplains, typically associated with calcareous substrates. June-September. Ne. NJ and ne. NY west to s. IL, e. MO, and AR, south to SC, GA, n. AL, TN, e. and n. LA, and e. TX (Mink, Singhurst, & Holmes 2011a); disjunct in w. NY and w. MI; overall very scattered in its distribution. 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, Pa, S, W, WV; = *D. goldiana* (Hooker ex Goldie) ssp. *celsa* W. Palmer – G]

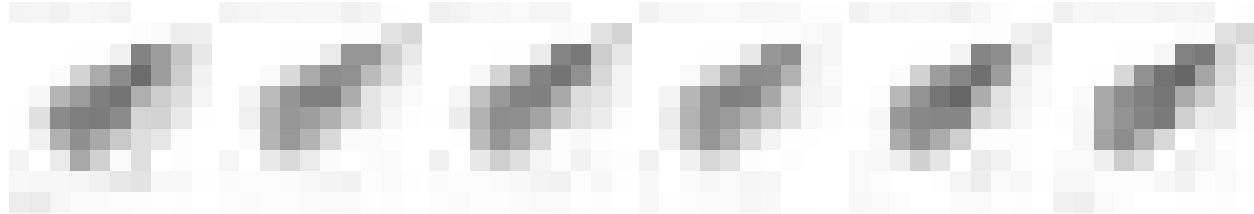
Dryopteris clintoniana (D.C. Eaton) Dowell, Clinton's Wood-fern, Broad Swamp Fern. Acid seepages, swampy forests, red maple swamps. NB, QC, and ON, south to DE, DC, MD (Somerset Co.), n. VA (Arlington and Fairfax counties), PA, OH, IN, and IL. This species is a fertile allohexaploid derived from hybridization of *D. cristata* and *D. goldiana*; its chromosome complement is symbolized GGLLSS. [= FNA, C, G, K, Pa; = *D. cristata* (Linnaeus) A. Gray var. *clintoniana* (D.C. Eaton) Underwood – F]

Dryopteris cristata (Linnaeus) A. Gray, Crested Wood-fern. Bogs, swamp forests. July-September. Circumboreal, in North America from NL (Newfoundland) to s. SK and se. BC, south to NC, TN, OH, IN, n. IL, IA, NE, and ID; disjunct in c. GA, AL, and LA. 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, Pa, S, W, WV; = *D. cristata* var. *cristata* – F]

* ***Dryopteris erythrosora*** (D.C. Eaton) Kuntze, Autumn Fern, Japanese Red Shield-fern. Suburban woodlands; native of Japan, Korea, and China. Also recently reported as naturalizing in AR (Simpson, Crank, Witsell, & Peck 2008; Peck 2011) and nc. NC (Rothfels, Sigel, & Windham 2012).

Dryopteris goldiana (Hooker ex Goldie) A. Gray, Goldie's Wood-fern. Boulderfield forests, rich cove forests, seepage swamps, especially over calcareous sedimentary or mafic metamorphic or igneous rocks. June-September. NB west to s. ON and MN, south to nw. SC, n. GA, n. AL, TN, KY, R (Peck 2011), 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*. [= RAB, C, F, FNA, K, Pa, S, W, WV; = *D. goldiana* ssp. *goldiana* – G]

Dryopteris intermedia (Muhlenberg ex Willdenow) A. Gray, Fancy Fern, Evergreen Wood-fern. Cove forests, other moist, rocky forests, over a variety of substrates. June-September. NL (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, Pa, S, W, WV; = *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. Blackwater swamp forests. June-September. A Southeastern Coastal Plain species: e. NC south to s. FL, west to s. AL, s. MS (Sorrie & Leonard 1999), and e. LA; disjunct in the West Gulf Coastal Plain of LA and AR (Peck 2011), and possibly disjunct in sc. KY, the report old and somewhat uncertain. 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, WH3]

Dryopteris marginalis (Linnaeus) A. Gray, Marginal Wood-fern. Rock outcrops, boulderfield forests, other rocky forests. June-September. NL (Newfoundland) west to s. ON 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, Pa, S, W, WV]

***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).

- 1 Leaves 1-pinnate; [common, native].....*P. acrostichoides*
- 1 Leaves 2-pinnate; [rare, alien] *P. polyblepharum*

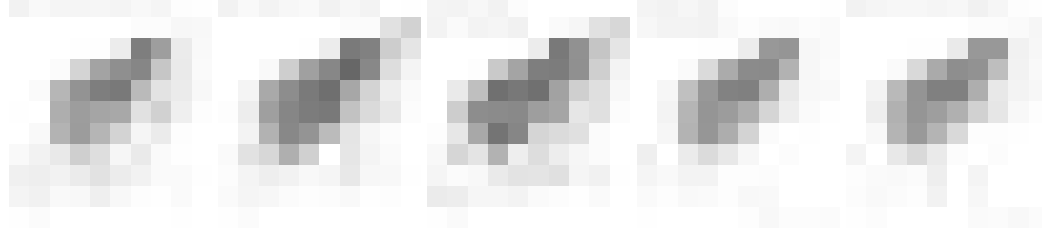
Polystichum acrostichoides (Michaux) Schott, Christmas Fern. Moist to dry forests and woodlands, especially slopes, ravines, and small stream bottomlands. June-September. NS west to MN, south to s. FL and e. TX; also in ne. Mexico (Nuevo León and Tamaulipas). One of the most familiar ferns in e. North America. Var. *lonchitoides* Brooks, allegedly endemic to WV, is of dubious taxonomic value. [= RAB, C, F, FNA, G, Pa, S, W, WH3, WV; > *P. acrostichoides* var. *acrostichoides* – K; > *P. acrostichoides* var. *lonchitoides* Brook – K]

* ***Polystichum polyblepharum*** (Roemer ex Kunze) K. Presl, Japanese Tassel-fern. Moist ravines; native of e. Asia. Reported for AL as *P. braunii* (Spenner) Fée. {not yet keyed}

***Rumohra* Raddi 1819 (Leatherleaf Fern)**

A genus of about 7 species, perennials, mainly tropical and Southern Hemisphere. References: Kramer et al. in Kramer & Green (1990).

* *Rumohra adiantiformis* (G. Forster) Ching, Leatherleaf Fern. Suburban woodlands, roadsides, disturbed areas; native of Old World and New World tropics. June-September. Reported for Franklin County in the FL Panhandle by Kunzer et al. (2009). [= K, WH3]



F44. NEPHROLEPIDACEAE Pichi Sermolli 1975 (Sword Fern Family) [in POLYPODIALES]

A family of 1 genus and about 15-30 species. Sometimes united, as by Smith et al. (2006), into the Lomariopsidaceae. References: Christenhusz, Zhang, & Schneider (2011).

Nephrolepis Schott 1834 (Sword Fern)

A genus of about 15-30 species, widespread in tropical and subtropical areas.

- 1 Pinnae 2.5-23 cm long; midleaf pinnae with veins densely pubescent on the upper surface; pinnae not distinctly auricled at base *N. biserrata*
- 1 Pinnae 1-7.3 cm long; midleaf pinnae with veins glabrous on the upper surface; pinnae auricled at base on the side toward the leaf tip.
 - 2 Scales on the upper surface of the rachis bicolored (pale but distinctly darker at the base); pinnae attachments spaced 5-12 mm apart; rhizomes bearing spherical tubers (not always present)..... *N. cordifolia*
 - 2 Scales on the upper surface of the rachis concolored (pale to reddish brown throughout); pinnae attachments spaced 7-21 mm apart; rhizomes not bearing tubers..... *N. exaltata*

* *Nephrolepis biserrata* (Swartz) Schott, Giant Sword Fern. Disturbed suburban areas; native of the tropics and subtropics of both hemispheres. [= FNA, K, WH3; ? *N. falcata* (Cavanilles) C. Christensen]

* *Nephrolepis cordifolia* (Linnaeus) K. Presl, Narrow Sword Fern. Moist places; probably not native in FL. Pantropical, the original distribution obscure. [= FNA, K, S, WH3]

Nephrolepis exaltata (Linnaeus) Schott, Boston Fern. Epiphytic or terrestrial in a range of open to shaded moist habitats; in our area perhaps only introduced. Panhandle and ne. FL south to s. FL; West Indies; Central and South Americ; widely introduced elsewhere. [= FNA, S, WH3; > *N. exaltata* ssp. *exaltata* – K]

F48. POLYPODIACEAE J. Presl & C. Presl 1822 (Polypody Family) [in POLYPODIALES]

A family of about 35-40 genera and 500-700 species, cosmopolitan, especially tropical. Here circumscribed to include Grammitidaceae (including *Micropolypodium*). References: Smith in FNA (1993b); Smith et al. (2006); Hennipman, Veldhoen, & Kramer in Kramer & Green (1990); Parris in Kramer & Green (1990).

- 1 Plants dwarf, the leaf blades <5 cm long; [occurring only in habitats where the air is constantly humid and the substrate saturated, as in grottoes behind waterfalls]..... **1. *Micropolypodium***
- 1 Plants larger, the leaf blades 7-90 cm long; [occurring in moist to dry habitats].
 - 2 Leaf blade densely scaly on the lower surface; rhizome 1-2 mm in diameter; leaf segment margins entire **5. *Pleopeltis***
 - 2 Leaf blade scaleless on the lower surface; rhizome 3-15 (-30) mm in diameter; leaf segment margins denticulate (*Polypodium*) or entire (*Phlebodium*, *Pecluma*).
 - 3 Leaves pectinate, at least the larger with >25 pairs of segments, each 1.5-5 (-8) mm wide; [of ne. FL southward]..... **4. *Pecluma***
 - 3 Leaves pinnatifid, even the larger with < 25 pairs of segments, (3-) 5-40 mm wide; [collectively widespread in our area.
 - 4 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 **3. *Phlebodium***
 - 4 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..... **2. *Polypodium***

1. *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 re-circumscribed 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. On ceiling of grotto in spray cliff of waterfall in humid gorge. 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]

2. *Polypodium* Linnaeus 1753 (Polypody)

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). [also see *Pecluma*, *Phlebodium* and *Pleopeltis*]

Identification notes: 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."

[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 > 40 per sorus (range of 25-120); leaves mostly lobed to apex, without an attenuate, unlobed tip | <i>P. appalachianum</i> |
| 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 < 40 per sorus (range of 7-69); leaves mostly with an attenuate, unlobed tip | <i>P. virginianum</i> |
| 1 | Characters intermediate; spores abortive | <i>P. xincognitum</i> |

Polypodium appalachianum Haufler & Windham [*P. virginianum* complex], Appalachian Rockcap Fern. Moist rocks at low to high elevations, especially in ravines, on north-facing outcrops, and in other moist sites. June-October. NL (Newfoundland) west to e. ON, 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, Pa, Z; < *P. virginianum* – RAB, C, F, S, W, WV; < *P. vulgare* Linnaeus var. *virginianum* (Linnaeus) Eaton – G]

Polypodium xincognitum Cusick is the triploid hybrid [*P. appalachianum* × *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. {not mapped}

Polypodium virginianum Linnaeus [*P. virginianum* complex], Common Rockcap Fern. Moist rocks. 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, Pa, Z; < *P. virginianum* – RAB, C, F, S, W, WV (also see *P. appalachianum*); < *P. vulgare* Linnaeus var. *virginianum* (Linnaeus) Eaton – G (also see *P. appalachianum*)]



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

A genus of 2-4 species, of tropical and subtropical regions of the Western Hemisphere. References: Nauman in FNA (1993b); Hennipman, Veldhoen, & Kramer in Kramer & Green (1990).

Phlebodium aureum (Linnaeus) J. Smith, Goldfoot Fern, Golden Polypody. Epiphytic on the old leaf bases of *Sabal palmetto* and in crotches and crevices of other trees, particularly *Quercus virginiana*, and rarely terrestrial on calcareous soils or masonry. E. SC (Beaufort, Jasper, and Charleston counties), e. GA (Camden, Chatham, and Glynn counties), south to s. FL, west to Panhandle FL (Wakulla County) (Kunzer et al. 2009). Found in Cape Romain National Wildlife Refuge (Charleston County, SC) in the late 1970s by Steve Bowling, where apparently native (S. Bowling, pers. comm. 2007); also introduced and apparently established in SC (Beaufort, Jasper, Charleston counties) via planting of palmettos from farther south (P. McMillan, pers. comm. 2005). [= FNA, K, S, WH3; = *Polypodium aureum* Linnaeus]

4. *Peculum* M.G. Price (Rockcap Fern)

A genus of about 30 species, of tropical and subtropical America. References: Mickel & Smith (2004)=Z; Evans in FNA (1993b).

- 1 Veins 1-forked; segments at base of blade abruptly reduced in size; [usually epiphytic].....*P. plumula*
 1 Veins 2-4 forked; segments at base of blade gradually reduced to auricles; [usually terrestrial].....*P. ptilodon* var. *caespitosa*

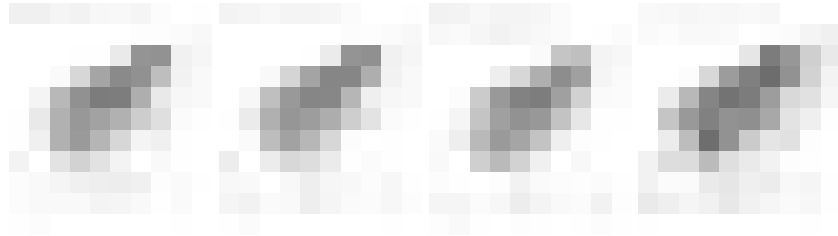
Peculum plumula (Humboldt & Bonpland ex Willdenow) M.G. Price. Epiphytic on tree branches, less commonly on limestone, in hammocks and swamps. Ne. FL (Duval County) south to s. FL; West Indies, Mexico, Central America, and n. South America. [= FNA, K, WH3, Z; = *Polypodium plumula* Humboldt & Bonpland ex Willdenow – S]

Peculum ptilodon (Kunze) M.G. Price var. *bourgeauana* (E. Fournier) A.R. Smith. Terrestrial or on logs or tree bases in hammocks and swamps. Ne. FL (Duval County) south to s. FL; West Indies; Mexico and Central America. [= WH3, Z; = *Peculum ptilodon* (Kunze) M.G. Price var. *caespitosa* (Jenman) Lellinger – FNA; = *Peculum ptilodon* (Kunze) M.G. Price ssp. *caespitosum* (Jenman) Windham – K; = *Polypodium pectinatum* Linnaeus – S]

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

A genus of about 50 species, primarily tropical. Windham (1993) and later authors, such as Otto et al. (2009), make a compelling case, based on morphological, chemical, and molecular data, that the "scaly polypodies" should be placed in *Pleopeltis*, rather than in *Polypodium*. The exact limits of the genus are still under active research and are not yet stable. References: Otto et al. (2009); 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. On tree limbs and trunks (especially when leaning) and on rocks. June-October. Ssp. *michauxiana* ranges from se. MD, IL, MO, and se. KS, south to s. FL and TX; also in Mexico and Guatemala; recent studies suggest that it warrants specific status (Sprunt et al. 2011). Ssp. *polypodioides* ranges in the West Indies, Central America and South America. Four additional subspecies 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, WV; < *Marginaria polypodioides* (Linnaeus) Tidestrom – S; = *Pleopeltis polypodioides* var. *michauxiana* – WH3, nomen nudum]



GYMNOSPERMS

SECTION 3: ACROGYMNOSPERMAE (EXTANT GYMNASPERMS)

The gymnosperms are a possibly artificial grouping of about 16 families, about 86 genera, and about 850 species. The folk taxonomy of conifers in our area is an interesting, 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." References: Kramer & Green (1990).

G1. CYCADACEAE Persoon 1807 (Cycad Family, Sago-palm Family) [in CYCADALES]

A family of 1 genus and about 107 species, trees and shrubs, of the Old World tropics and warm temperate areas. References: Johnson & Wilson in Kramer & Green (1990); Jones (1993).

Cycas Linnaeus 1753 (Cycad, Sago-palm)

A genus of about 107 species, trees and shrubs, of the Old World tropics and warm temperate areas. References: Johnson & Wilson in Kramer & Green (1990); Jones (1993).

* ***Cycas revoluta*** Thunberg, Sago-palm. Suburban woodlands; native of Japan. Reported as naturalized in the Tallahassee area (Leon County) of the Florida Panhandle (Clewell & Tobe 2011). [=WH]

G2. ZAMIACEAE Reichenbach 1837 (Zamia Family) [in CYCADALES]

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 1753 (Coontie, Zamia)

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, Florida Coontie. Maritime forests, pinelands. Se. GA (Camden and Glynn counties) 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, 2009) 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, Z; < *Z. pumila* Linnaeus – K, WH3, misapplied; = *Z. umbrosa* Small – S; < *Z. floridana* Alphonse de Candolle]

G3. GINKGOACEAE Engler in Engler & Prantl 1897 (Ginkgo Family) [in GINKGOALES]

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. Frequently planted, rarely escaped to suburban woodlands and yards; native to se. China. *Ginkgo* is only weakly naturalized in our area (FNA). [= C, FNA, K, Pa]

G7. PINACEAE Sprengel ex F. Rudolphi 1830 (Pine Family) [in PINALES]

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 borne in fascicles of 2-5 (basally bound by a scarious sheath) or on short shoots in clusters of many leaves in apparent whorls.
- 2 Leaves borne in fascicles of 2-5 (basally bound by a scarious sheath); [subfamily *Pinoideae*].....***Pinus***
- 2 Leaves borne on short shoots in clusters of many (>10) leaves in apparent whorls; [subfamily *Laricoideae*].
- 3 Leaves evergreen; cones 6-12 cm long***Cedrus***
- 3 Leaves deciduous; cones 1-2 cm long***Larix***
- 1 Leaves alternate; [subfamily *Abietoideae*].

- 4 Leaves 4-angled in cross-section.....*Picea*
- 4 Leaves distinctly flattened (2-sided) in cross-section.
- 5 Leaves attached directly to twig; cones 4-15 cm long, erect.....*Abies*
- 5 Leaves jointed, on short, persistent base; cones 1-3.8 cm long, pendant.....*Tsuga*

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

(by Alan S. Weakley and Derick B. Poindexter)

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 3.5-8 cm long; [native, also planted]; [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 10× magnification); [plant of the Central Appalachians and north, native from Page and Madison counties, VA, northward].....*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 10× magnification); [plant of the Southern Appalachians, native from Grayson and Smyth counties, VA, southward].....*A. fraseri*
- 1 Cones 10-15 cm long; [alien, persistent from horticultural use and sparingly naturalized].
 - 3 Juvenile-form leaves of young plants with rounded-retuse apices; leaf resin canals 2, marginal; cone bracts exerted and reflexed with elongate apical cusps; [section *Abies*].....*A. alba*
 - 3 Juvenile-form leaves of young plants with spinose-bifid apices; leaf resin canals 2, median (and usually with up to 2 additional marginal canals); cone bracts exerted and erect with abrupt, short apical cusps; [section *Momi*].....*A. firma*

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

Abies balsamea (Linnaeus) P. Miller, Balsam Fir, Northern Balsam. High elevation forests and cliffs. April-May. NL (Newfoundland) and NL (Labrador) west to n. AB, 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 toward *A. fraseri*, and have been variously treated as *A. intermedia* Fulling, *A. balsamea* var. *phanerolepis* Fernald, or *A. ×phanerolepis* (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 (which includes the clinal var. *phanerolepis*). The balsam woolly adelgid, an alien pest, is afflicting this species in Shenandoah National Park. [= C, FNA, K, Pa, W, Y, Z; > *A. balsamea* var. *balsamea* – F, G; > *A. balsamea* var. *phanerolepis* Fernald – F, G, WV; > *A. ×phanerolepis* (Fernald) Liu – Y; > *A. intermedia* Fulling]

* *Abies firma* Siebold & Zuccarini, Momi Fir. Naturalized from horticultural plantings near homesites. See Poindexter (2010b) for detailed information on the naturalization of this fir in our area and its recognition.

Abies fraseri (Pursh) Poiret, Fraser Fir, She Balsam, Southern Balsam. High elevation forests, from about 1500-2037 m. May-June; September-November. Southern Appalachian endemic, from Grayson and Smyth counties, VA (notably, Mount Rogers) south to e. TN and sw. NC; naturalizing on Brasstown Bald in GA, where planted. 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 (especially Alleghany, Ashe, Avery, Mitchell, and Watauga counties). Most Christmas tree plantations are at 1000-1500 m in elevation; below 1000 m, Fraser Fir is very susceptible to a fungal root rot (*Phytophthora*), above 1500 m 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, WV, 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. Frequently planted, rarely escaped to suburban woodlands. [= 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, with > 30 pubescent scales; twigs pubescent; [alien species rarely planted] *L. decidua*
 1 Leaves 1-2.5 cm long; cones 1.2-2 cm long, with 10-20 glabrous scales; twigs glabrous; [native species rarely south to MD and WV]
 *L. laricina*

- * *Larix decidua* P. Miller, European Larch. Forests; native of Europe. Planted as an ornamental and experimentally as a forest tree, persisting and sometimes escaping in the high mountains of NC. [= F, K, Pa]

Larix laricina (Du Roi) K. Koch, Eastern Larch, Eastern Tamarack. Bogs and swamps. NL (Newfoundland), NL (Labrador), Keewatin, and AK, south to MD (Garrett County, WV (Preston County and Randolph counties), OH, IN, IL, MN, and British Columbia. [= FNA, C, F, G, K, Pa, WV]

Picea A. Dietrich 1824 (Spruce)

A genus of about 35-40 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 2.5-4.5 cm long; upper branches ascending, the lower spreading; outer bud scales prolonged into minute hairlike projections; [plant native]..... *P. rubens*

- * *Picea abies* (Linnaeus) H. Karsten, Norway Spruce. Persisting and escaping from forestry plantations at moderate or high elevations, notably in e. WV, Great Smoky Mountains National Park (Kephart Prong), Mount Mitchell State Park, and the Biltmore Estate; native of n. Europe. [= FNA, K, Pa, WV]

Picea rubens Sargent, Red Spruce, He Balsam. 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 1000 m), ranging in moisture tolerance from dry ridges (though these are often fog-bathed) to saturated peats, and sometimes planted and naturalized. May-June; October. NS and NB south (interruptedly) to w. NC and e. TN. *Picea mariana* (P. Miller) Britton, Sterns, & Poggenburg, Black Spruce, ranges south to s. PA and n. NJ, and 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*. Hardin (1971b) discusses the existence of these 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 is warranted. [= RAB, C, F, FNA, G, K, Pa, W, WV, Z; > *P. rubens* - S; > *P. australis* Small - S]

Pinus Linnaeus 1753 (Pine)

A genus of about 110 species, trees, of the Northern Hemisphere, south to Central America. The State Tree of North Carolina is the "Pine," the species left artfully and politically ambiguous. References: Kral in FNA (1993b); Silba (2011)=Z; 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. Seedlings have needles single, rather than fascicled.

- 1 Needles 5 in each bundle; each needle with 1 vascular bundle; [subgenus *Strobos*, section *Strobos*]..... *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 > 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 *Australes*]..... *P. palustris*
 2 Bracts and bud scales entire or edged with hairs, but not fimbriate; sheath < 1.5 cm long; needles (2-) 3-30 cm long, in bundles of 2-4; twigs < 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 *Australes*].
 4 Needles in bundles of 2 and 3.
 5 Needles 3-7 cm long; prickles on cones 3-8 mm long, stout (> 1 mm wide at base of prickle)..... *P. pungens*

- 5 Needles 5-30 cm long; prickles on cones 1-3 mm long, slender (< 1 mm wide at base of prickle).
 - 6 Needles 17-30 cm long; cones (6) 12-15 cm long.....*P. elliottii* var. *elliottii*
 - 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 slender to somewhat stout, 0.5-1.2 mm wide.
 - 10 Needles 10-17 cm long; branches brittle; spring shoots with a single node, with 1 whorl of branches; [subgenus *Pinus*, section *Pinus*, subsection *Pinus*]*P. resinosa*
 - 10 Needles 2-13 cm long; branches flexible; spring shoots usually with several nodes (several whorls of branches).
 - 11 Needles 2-8 cm long, generally twisted; cones **either** opening at maturity, not serotinous, the scales bearing prominent, slender prickles 2-5 mm long, **or** serotinous and unarmed; [subgenus *Pinus*, section *Trifoliae*, subsection *Contortae*].
 - 12 Needles 2-3.5 cm long, not twisted, curved; cones serotinous, unarmed; leaf sheaths < 2.5 mm long*P. banksiana*
 - 12 Needles 2-8 cm long, generally twisted, straight; cones opening at maturity, not serotinous, the scales bearing prominent, slender prickles 2-5 mm long; leaf sheaths > 2.5 mm long.....*P. virginiana*
 - 11 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.
 - 13 Anthers dark orange; bark flaky, the laminated layers sloughing off in a manner typical of a pine; [native trees of xeric sands, also sometimes planted in pine tree farms]; [subgenus *Pinus*, section *Trifoliae*, subsection *Contortae*]*P. clausa*
 - 13 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 *Australes*].....*P. glabra*
 - 9 Needles stout, 1.3-2.5 mm wide.
 - 14 Needles 15-25 cm long; cones 8-22 cm long; needles 1.5-2.5 mm wide; [trees naturalized on barrier islands]; [subgenus *Pinus*, section *Pinus*, subsection *Pinaster*].....*P. pinaster*
 - 14 Needles 3-16 cm long; cones 3-9 cm long; needles 1.3-2 mm wide; [collectively widespread.
 - 15 Needles 7-16 cm long; cones 4-6 cm long, each scale bearing a small depressed mucro; [introduced tree].
 - 16 Buds light brown, resinous; [introduced tree, often planted inland]*P. nigra*
 - 16 Buds white, not resinous; [introduced tree, usually planted only on Coastal Plain barrier islands]; [subgenus *Pinus*, section *Pinus*, subsection *Pinus*]*P. thunbergiana*
 - 15 Needles 3-6 (-8) cm long; cones **either** 6-9 cm long with each scale bearing a stout, woody spine, **or** 3-6 cm long and unarmed; [native tree of the Mountains and upper Piedmont **or** introduced trees south to MD and WV].
 - 17 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 *Australes*].....*P. pungens*
 - 17 Cones 3-6 cm long, unarmed; [introduced trees south to MD and WV].
 - 18 Needles 2-3.5 cm long; cone appressed upward against the stem, strongly asymmetrical; leaf sheaths < 2.5 mm long; [subgenus *Pinus*, section *Trifoliae*, subsection *Contortae*]*P. banksiana*
 - 18 Needles 3-7 cm long; cone reflexed downward against the stem; leaf sheaths > 2.5 mm long; [subgenus *Pinus*, section *Pinus*, subsection *Pinus*]*P. sylvestris* var. *sylvestris*

Auxiliary Key to common pines of the Piedmont

- 1 Needles 12-25 cm long, predominantly in bundles of 3; winter buds > 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 < 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, < 1.0 mm wide; bark plates mostly > 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 banksiana* Lambert, Jack Pine. Dry forests. Reported as possibly naturalized in WV (Harmon, Ford-Werntz, & Grafton 2006). [= C, F, FNA, G, K, Pa]



Pinus clausa (Chapman ex Engelmann) Vasey ex Sargent, Sand Pine. Dry sands, widely planted in pulp plantations in FL and s. GA, experimentally planted as far north as NC. *P. clausa* is closely related to *P. virginiana*, the n. North American *P. banksiana*, and the nw. North American *P. contorta* complex. [= FNA, K, S, WH3, Z; > *P. clausa* var. *clausa*; > *P. clausa* var. *immuginata* D.B. Ward]

Pinus echinata P. Miller, Shortleaf Pine, Rosemary Pine, Yellow Pine. Dry rocky ridges and slopes, sandhills, old fields, forests, generally in rather xeric sites, but also occurring in mesic to even wet sites. 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, pa, S, W, WH3, WV, Z]

Pinus elliotii Engelmann var. *elliottii*, Slash Pine. Native in wet pine flatwoods and maritime forests in GA and SC, extensively planted in GA, SC, and NC in silvicultural plantations on a wide variety of soils, many of them unsuitable for its successful growth. January-February; October-November. *P. elliotii* var. *elliottii* 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. *elliottii* has been extensively planted throughout the Coastal Plain of Ga, 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. *elliottii* 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 not revealing reddish patches). [= FNA, K, Z; < *P. elliotii* – RAB, WH3; > *P. caribaea* Morelet – S, misapplied; > *P. palustris* P. Miller – S, misapplied; ? *P. heterophylla* – S]

Pinus glabra Walter, Spruce Pine, Walter's Pine. Bottomland forests, rich, moist soils. 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, WH3, Z]

* ***Pinus nigra*** Arnold, Austrian Pine. Disturbed areas; native of Europe. [= C, F, FNA, G, K, Pa]

Pinus palustris P. Miller, Longleaf Pine, Southern Pine. 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. 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 featured in the official NC State Toast ("Here's to the land of the longleaf Pine...") and the highest honor that the Governor of North Carolina can bestow on an individual for service to the state is to appoint him or her to the honorary Order of the Longleaf Pine. A hybrid with *P. taeda*, *P. ×sondereggeri* H.H. Chapman, occurs. [= RAB, C, FNA, K, WH3; = *P. australis* Michaux f. – F, G, S]



* ***Pinus pinaster*** Aiton, Maritime Pine, Cluster Pine. Planted and naturalized on barrier islands; native of Mediterranean Europe. *P. pinaster* is reported by Brown (1959) to be "introduced from Mediterranean region and planted on sand-flats 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 Highway 12 (Dare County, NC), farther south at Bodie Island Lighthouse (Dare County, NC), on Ocracoke Island (Hyde County, NC), and elsewhere. [= K]

Pinus pungens Lambert, Table Mountain Pine, Bur Pine, Hickory Pine. Dry ridges, cliffs, shale barrens, usually requiring fire for its reproduction, occurring at least up to 1550 m. 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, C, F, FNA, G, K, Pa, S, W, WV, Z]

Pinus resinosa Aiton, Red Pine. High elevation forests, in pine plantations, and persisting after silvicultural planting. This species is native as far south as WV (Pendleton and Hardy counties) and PA (Luzerne, Wyoming, Tioga, and Centre counties). In WV, it is much more common as a plantation tree than as a native. [= C, F, FNA, G, K, Pa, WV]

Pinus rigida P. Miller, Pitch Pine. Southward 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), northward (as in NJ) in acidic sandy and

peaty soils near sea level, and also scattered through a variety of forest types. 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, Pa, S, W, WV, Z; = *P. rigida* ssp. *rigida*]

Pinus serotina Michaux, Pocosin Pine, Pond Pine, Marsh Pine. Peaty soils of pocosins, swamps of small blackwater streams. 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 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, G, K, S, WH3, Z; = *P. rigida* P. Miller ssp. *serotina* (Michaux) Clausen]

Pinus strobus Linnaeus, Eastern White Pine. Moist to dry forests, bottomlands, dry, rocky ridges in humid gorges. 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, Pa, W, WV, Z; = *Strobus strobus* (Linnaeus) Small – S; > *Pinus strobus* ssp. *cumberlandensis* J. Silba – Z; > *P. strobus* ssp. *strobus* – Z]



* ***Pinus sylvestris*** Linnaeus var. *sylvestris*, Scots Pine. Cultivated and sometimes escaped; native of Europe. 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, Pa]

Pinus taeda Linnaeus, Loblolly Pine, Old Field Pine. Forests, fields, pine plantations, much more abundant and widespread than formerly, occurring farther west than as a native. March-April; October-November. Native from s. NJ, DE, and e. MD south to n. peninsular FL, west to e. TX and se. OK, primarily on the Coastal Plain, but inland to s. TN; this distribution now expanded by forestry plantation northward. See *P. elliotii* for additional characters to distinguish these two species. [= RAB, C, F, FNA, G, K, S, W, WH3, Z]

* ***Pinus thunbergiana*** Franco, Japanese Black Pine. Planted and persisting, sometimes appearing native, on barrier islands, 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. 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. 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, Pa, S, W, WV, Z]

Tsuga Carrière 1847 (Hemlock)

A genus of about 14 species, trees, of e. Asia (China, Japan, and Taiwan), e. North America, and w. North America. 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, the ovuliferous scales ascending, even at maturity *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, mostly 3/4 to fully 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, the ovuliferous scales spreading at a right angle to the axis at maturity *T. caroliniana*

Tsuga canadensis (Linnaeus) Carrière, Eastern Hemlock, Canada Hemlock. 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). 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 was often left by loggers. The hemlock woolly adelgid is severely affecting this species. [= RAB, C, F, FNA, G, K, Pa, S, W, WV, Z]

Tsuga caroliniana Engelm., Carolina Hemlock. 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. 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 ne. 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]



G9. PODOCARPACEAE Endlicher 1847 (Podocarp Family) [in ARAUCARIALES]

A family of 19 genera and ca. 130 species, trees and shrubs, mainly tropical and subtropical and mainly southern hemisphere. References: Page in Kramer & Green (1990).

Podocarpus L'Héritier ex Persoon 1807 (Podocarp, Plum Pine)

A genus of ca. 100 species, trees (rarely shrubs), mainly tropical, subtropical, and south temperate of both hemispheres, but extending north to warm temperate Asia. References: Page in Kramer & Green (1990).

* ***Podocarpus macrophyllus*** (Thunberg) D. Don. Forests; native of China and Japan. [= WH3; > *P. macrophyllus* var. *maki* Endlicher – K2]

G11. CUPRESSACEAE Bartlett 1830 (Cypress Family) [in CUPRESSALES]

A family of about 29 genera and about 130 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: Farjon (2005); Hart & Price (1990); Hardin (1971b); Watson & Eckenwalder in FNA (1993b); Page in Kramer & Green (1990).

- 1 Leaves alternate.
 - 2 Leaves evergreen, rigid, > 2 cm long, tapering from near the base to a long-acuminate apex; [subfamily *Cunninghamioideae*].....**1. *Cunninghamia***
 - 2 Leaves deciduous, flexible, < 2 cm long, parallel-sided, the apex short-acute; [subfamily *Taxodioideae*].....**2. *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; leaves opposite (decussate) or in whorls of 3**5. *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; leaves opposite (decussate).
 - 4 Leaves acute; female cones globose and woody, the hard scales peltate, not imbricate; ultimate branchlets (including the scale leaves) about 1 mm broad **4. *Chamaecyparis***

- 4 Leaves obtuse; 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]6. *Platykladus*
- 5 Branchlets flattened in horizontal planes; seeds winged; [native tree, but also sometimes planted]3. *Thuja*

1. *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. Suburban woodlands; commonly planted horticulturally, rarely naturalizing, native of China. A variety of forms are seen, some with dark-green, others with glaucous-blue foliage. [= K, Z; *C. sinensis* R. Brown]

2. *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." 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); a few recognizable intermediates can be seen. See Lickey & Walker (2002) for a contrary argument supporting varietal status. 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); Lickey & Walker (2002)=Y; Watson in FNA (1993b); Page in Kramer & Green (1990); Tsumura et al. (1999). Key adapted from Z.

- 1 Larger knees short, rarely > 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 > 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 sometimes mimic *T. ascendens*); leaves linear, flat, spirally arranged but by twisting of their basal portions spreading laterally and featherlike (pseudo-distichous), appressed only on drooping branches of the crown, if at all; leaves mostly 8-20 mm long (sometimes less on crown branches); bark thin (< 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. Limesink ponds (dolines), clay-based Carolina bays, wet savannas, pocosins and other wet, peaty habitats, shores of natural blackwater lakes, swamps of blackwater streams. March-April; October. Se. VA (recently confirmed, J. Townsend, pers. comm. 2009) south to s. FL, west to e. LA; it is surely one of the most scenic trees of eastern North America. [= RAB, G, K, S, WH3, Z; < *T. distichum* – F; = *T. distichum* var. *imbricarium* (Nuttall) Croom – FNA, Y; = *T. distichum* var. *nutans* (Aiton) Sweet]

Taxodium distichum (Linnaeus) L.C. Richard, Bald-cypress. Brownwater and blackwater swamps, usually in riverine situations. March-April; October. DE and e. MD south to s. 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, Pa, S, WH3, WV, Z; = *T. distichum* var. *distichum* – C, FNA, Y; < *T. distichum* – F (also see *T. ascendens*)]

3. *Thuja* Linnaeus 1753 (Arborvitae)

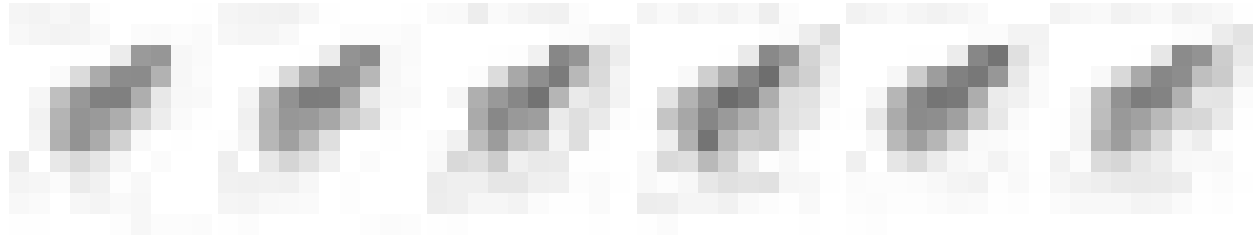
A genus of 5 species, trees, of e. North America, w. North America, and e. Asia. References: Chambers in FNA (1993b); Page in Kramer & Green (1990).

Thuja occidentalis Linnaeus, American Arborvitae, Northern White Cedar, Flat Cedar. 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). March-April. NS, Hudson Bay, and MB south to PA (where considered strictly introduced by Rhoads & Block 2007), 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, Pa, S, W, WV]

4. *Chamaecyparis* Spach 1841 (White Cedar)

A genus of about 6 species, trees, of warm temperate to cool temperate North America and Asia. The genus consists of 6 species – ours, 1 in w. North America, and 3 in Japan & Taiwan. References: Michener in FNA (1993b); Farjon (2005)=Y; Farjon (1998)=Z; Page in Kramer & Green (1990).

Chamaecyparis thuyoides (Linnaeus) Britton, Sterns, & Poggenburg, Atlantic White Cedar, Juniper. Peat dome and streamhead pocosins, blackwater stream swamps, hillside seepages, in highly acidic, peaty or sandy soils. 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; northward it is often found in kettle-hole bogs. In SC and GA, *C. 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. [= RAB, C, F, FNA, G, K, Pa, S, WH3; > *C. thuyoides* var. *henryae* (H.L. Li) Little – Y, Z; > *C. thuyoides* var. *thuyoides* – Y, Z; = *Cupressus thuyoides* Linnaeus]



5. *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 (2008b, 2008c)=Z; Adams in FNA (1993b); Adams (1986); Adams & Demeke (1993); Adams (1995, 2008a); Page in Kramer & Green (1990).

- 1 Leaves flat-acicular, 8-25 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*]
 - 2 Leaves 8-18 mm long; female cone ("berry") 6-10 mm in diameter ***J. communis* var. *depressa***
 - 2 Leaves 15-25 mm long; female cone ("berry") 8-12 mm in diameter ***J. conferta***
- 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*].
 - 3 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 or flattened crowns, the lower branches often drooping ***J. virginiana* var. *silicicola***
 - 3 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***

Leaf and cone size. While in *J. communis* var. *depressa* leaves are 0.8-1.8 cm long and cones are only 0.6-1.0 cm in diameter (Fernald 1950), in *J. conferta*, both leaves and cones are larger: leaves are 1.5-2.5 cm long (Voroshilov 1982), cones to 1.2 cm in diameter (Rehder 1940, Voroshilov 1982).

Leaf cross-section. While in *J. communis* var. *depressa* leaves are only slightly concave above and bluntly keeled underneath, in *J. conferta* they are deeply grooved above (becoming folded on drying), their keels more pronounced below.

Juniperus communis Linnaeus var. *depressa* Pursh, Ground Juniper, Mountain Juniper, Common Juniper. 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). March-April; fleshy cone maturing in second or third year. This species is circumpolar, widespread in n. North America, n. Europe, and n. Asia. Adams (2008a, 2008b, 2008c) recognizes 5 varieties in North America, all eastern North American plants belonging to var. *depressa*. In North America *J. communis* 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, in our area notably known from Mount Satulah (Macon County, SC), King's Pinnacle (Gaston County, NC), and in sandy soils at Hitchcock Woods (Aiken County, SC). 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, Pa, W, Z; < *J. sibirica* Burgsdorff – S; < *J. communis* – WV]

* *Juniperus conferta* Parlatore, Japanese Shore Juniper. Roadsides; native of Japan. Reported as naturalizing in AL (Barger, pers. comm. 2012). Also reported for MA.

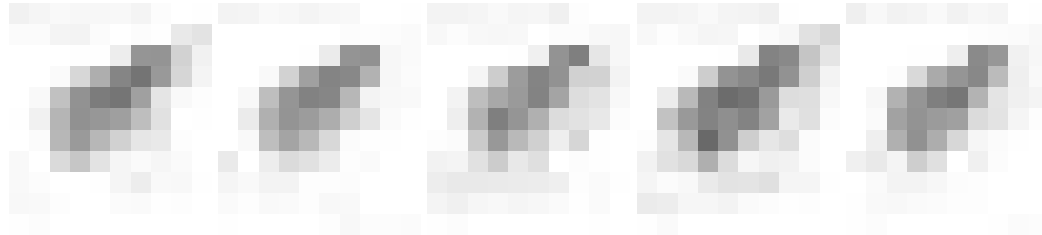
Juniperus virginiana Linnaeus var. *silicicola* (Small) E. Murray, Southern Red Cedar, Coastal Red Cedar. Maritime forests and scrub, hammocks, coastal shell middens and natural shell deposits, brackish marshes, and other sandy or peaty, circumneutral situations. January-February; October-November. Se. VA south to c. peninsular FL, west to e. LA (Florida Parishes). 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, and in other areas the characters used to separate them seem variable or imperfectly correlated. Large individuals can be as much as a meter in diameter. [= FNA, K, Z; = *J. silicicola* (Small) L.H. Bailey – RAB; = *Sabina silicicola* Small – S; = *J. virginiana* ssp. *silicicola* (Small) J. Silba; < *J. virginiana* – WH3]

Juniperus virginiana Linnaeus var. *virginiana*, Eastern Red Cedar. 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. January-March; October-November. S. ME west to e. ND, south to n. FL, s. AL, s. MS, s. LA, and c. TX; disjunct in Coahuila, Mexico (Adams 2011). Var. *virginiana* ranges throughout e. United States. The wood is much used for fence posts and the traditional southern cedar chest (which takes advantage of the aromatic and moth-deterrent properties of cedar wood). [= C, F, FNA, G, K, Z; = *J. virginiana* – Pa, RAB, W, WV; = *Sabina virginiana* (Linnaeus) Antoine – S; < *J. virginiana* – WH3; = *J. virginiana* ssp. *virginiana*]

6. *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. Commonly planted, especially in graveyards, and rarely persisting and spreading to pastures, fields, and roadsides; native of Asia. [= FNA, K, WH3; = *Biota orientalis* (Linnaeus) Endlicher – S; = *Thuja orientalis* Linnaeus]



G12a. CEPHALOTAXACEAE Neger 1907 (Plum-yew Family) [in CUPRESSALES]

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. Suburban woodlands; uncommonly grown horticulturally, rarely naturalizing in the vicinity of plantings (as in Chapel Hill, Orange County, NC, and Grottoes, Augusta County, VA), native of Asia. [= Z]

G12b. TAXACEAE S.F. Gray 1822 (Yew Family) [in CUPRESSALES]

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..... | <i>Taxus</i> |
| 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..... | <i>Torreya</i> |

Taxus Linnaeus 1753 (Yew)

The genus consists of about 8 (or more) 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 BC and AB 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); Spjut (2007a, 2007b)=Y; Farjon (1998)=Z; Page in Kramer & Green (1990).

- 1 Bud scales blunt, only slightly keeled..... *T. baccata*
- 1 Bud scales often acute, keeled.
 - 2 Leaf undersurfaces with cuticular papillae along the stomatal bands; shrubs or small trees to 10 m tall; [of Panhandle FL] *T. floridana*
 - 2 Leaf undersurfaces usually lacking cuticular papillae along the stomatal bands; shrubs to 2 m tall (or trees in *T. cuspidata*); [of w. NC and VA northward, or naturalized from plantings].
 - 3 Stomata in (4-) 5-9 (-11) rows on each side of midvein; [native of ne. N. America, south to w. NC and VA] *T. canadensis*
 - 3 Stomata in (7-) 9-14 (-17) rows on each side of midvein; [alien]..... *T. cuspidata*

* *Taxus baccata* Linnaeus, English Yew. Suburban woodlands, planted as hedges and ornamentals, escaping locally, as in Rock Creek Park, Washington, DC (Shetler & Orli 2000); native of Europe. [= C, G, K, Pa, Z; = *T. baccata* ssp. *baccata*]

Taxus canadensis Marshall, Canada Yew, American Yew. Cliffs, bluffs, and rocky slopes over calcareous or mafic rocks, red spruce and hemlock swamps and bogs. April-May. NL (Newfoundland), NL (Labrador), MN, and s. MB 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 common. Deer have a devastating effect on populations of this species in our area. [= C, F, FNA, G, K, Pa, W, WV, Z; > *T. canadensis* var. *canadensis* - Y; > *T. canadensis* var. *minor* (Michaux) Spjut - Y; > *T. canadensis* var. *adpressa* (Hort. ex Carrière) Spjut - Y; = *T. baccata* Linnaeus ssp. *canadensis* (Marshall) Pilger]

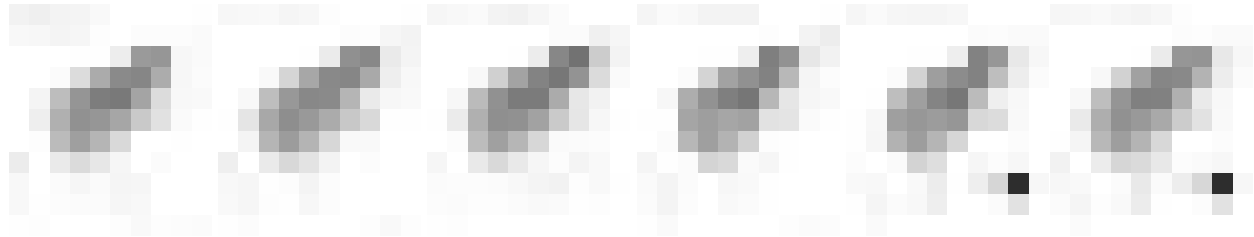
* *Taxus cuspidata* Siebold & Zuccarini, Japanese Yew. Suburban woodlands, planted as hedges and ornamentals, escaping locally (Shetler & Orli 2000); native of Japan. [= C, G, K, Pa, Y; > *T. cuspidata* var. *cuspidata* - Z; = *T. baccata* Linnaeus ssp. *cuspidata* (Siebold & Zuccarini) Pilger]

Taxus floridana Nuttall ex Chapman, Florida Yew. Mesic bluffs and ravines. Endemic to Panhandle FL. [= FNA, K, S, WH3, Z; = *T. globosa* Schlechtendal var. *floridana* (Nuttall ex Chapman) Spjut - Y = *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. Moist ravines and bluffs, and also rarely established near plantings. 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, WH3; = *Tumion taxifolium* (Arnott) Greene - S]



SECTION 4: MAGNOLIIDS AND PRIMITIVE ANGIOSPERMS

3. CABOMBACEAE A. Richard 1828 (Water-shield Family) [in NYMPHAEALES]

A family of 2 genera and about 6 species, aquatic herbs, nearly cosmopolitan. This family is closely related to the Nymphaeaceae and may be best combined with it (Angiosperm Phylogeny Group 2003). References: Wiersema in FNA (1997); Williamson & Schneider in Kubitzki, Rohwer, & Bittrich (1993); Les et al. (1999).

- 1 Plants with all leaves floating and peltate; plants coated with a layer of transparent, mucilaginous jelly; floating peltate leaves 3.5-11 cm long, 2-6.5 cm wide; [subfamily *Hydropeltoideae*] **Brasenia**
 1 Plants with submersed leaves dichotomously divided into linear segments; plants not coated with mucilaginous material; floating peltate leaves (when present) 0.6-3.0 cm long, 0.1-0.4 wide; [subfamily *Cabomboideae*] **Cabomba**

Brasenia Schreber 1789 (Water-shield)

A monotypic genus, an aquatic herb, widely distributed in tropical and temperate regions of the Old and New World. References: Williamson & Schneider in Kubitzki, Rohwer, & Bittrich (1993).

Identification notes: The elliptic, peltate, floating leaves and mucilaginous petioles make *Brasenia* unmistakable.

Brasenia schreberi J.F. Gmelin, Water-shield, Purple Wen-dock. Lakes, ponds, sluggish streams, floodplain oxbow ponds. June-October. NS west to MN, south to s. FL and TX; also from BC south to CA; also in tropical America and the Old World. [= RAB, C, F, FNA, G, GW, K, Pa, S, W]

Cabomba Aublet 1775 (Fanwort)

A genus of about 5 species, aquatic herbs, tropical and temperate regions of America. References: Williamson & Schneider in Kubitzki, Rohwer, & Bittrich (1993).

Identification notes: *Cabomba* is sometimes mistaken for other, superficially somewhat similar aquatics, such as *Ceratophyllum* (Ceratophyllaceae), *Utricularia* (Lentibulariaceae), and *Myriophyllum* (Haloragaceae). *Cabomba* has the leaves opposite (rather than whorled), dichotomously divided (like *Ceratophyllum*), but the divisions lacking the marginal denticles of *Ceratophyllum*, and on a 1-3 cm long petiole (vs. sessile or on a petiole 0-2 mm long). *Utricularia* has the leaves sometimes dichotomously divided, but the divisions are usually irregular, the leaves are alternate (in most species), and bladder traps are present. *Myriophyllum* has the leaves pectinately rather than dichotomously divided.

Cabomba caroliniana A. Gray, Fanwort. Millponds, lakes, slow-moving streams. May-September. NJ west to OH, s. MI, and MO, south to FL and TX; sporadically introduced elsewhere from aquarium "throw-outs." *C. caroliniana* var. *pulcherrima* R.M. Harper, with purplish flowers and vegetative parts, occurs in the southeastern Coastal Plain; it needs further evaluation. GW imply that the purple pigmentation may be merely an environmental response to warm waters, and is not correlated with morphologic characters. [= RAB, C, F, FNA, G, GW, Pa, S; > *C. caroliniana* var. *caroliniana* – K; > *C. caroliniana* var. *pulcherrima* R.M. Harper – K; > *C. pulcherrima* (R.M. Harper) Fassett]

4. NYMPHAEACEAE R.A. Salisbury 1805 (Water-lily Family) [in NYMPHAEALES]

A family of 6 genera and about 75 species, aquatic herbs, cosmopolitan. References: Wiersema & Hellquist in FNA (1997); Schneider & Williamson in Kubitzki, Rohwer, & Bittrich (1993); Les et al. (1999).

- 1 Flowers nearly spherical, 2-5 cm in diameter; sepals 6 (in our species), petaloid, green to yellow, incurved; petals many, inconspicuous, scalelike or staminodial; leaves often of 2 types, the submersed leaves (when present) thinner in texture than the floating or emersed leaves; floating or emersed leaves having 60-90% of their surface area with vasculature derived from the midrib; rhizome with triangular or winged leaf scars; [subfamily *Nupharoideae*] **Nuphar**
 1 Flowers hemispheric, 4-20 cm across; sepals 4, greenish, inconspicuous; petals spreading and ascending, white or yellow, showy; leaves of 1 type, floating; floating leaves having 25-40 % of their surface area with vasculature derived from the midrib; rhizome with circular leaf scars; [subfamily *Nymphaeoidae*] **Nymphaea**

Nuphar J.E. Smith 1809 (Spatterdock, Yellow Pondlily)

A genus of about 16 species, aquatic herbs, of north temperate areas. Beal (1956) recognized 8 taxa of *Nuphar* in North America, which he treated as subspecies of the European *N. lutea*. Voss's (1985) statement (about the genus in Michigan) "our plants are quite easily distinguished ... and they are treated here as closely related species" applies equally (or better!) in our area. Recent treatments (see references) recognize multiple species. References: Beal (1956)=Z; Wiersema & Hellquist in FNA (1997); Padgett (1999)=Y; Padgett (2007)=X; Schneider & Williamson in Kubitzki, Rohwer, & Bittrich (1993). Key based in large part on FNA.

- 1 Sepals 5 (or 5-6 in *N. rubrodiscalis*); stigmatic disc red; fruit deeply constricted below the stigmatic disc; leaf blades 3.5-25 cm long; [section *Nuphar*].

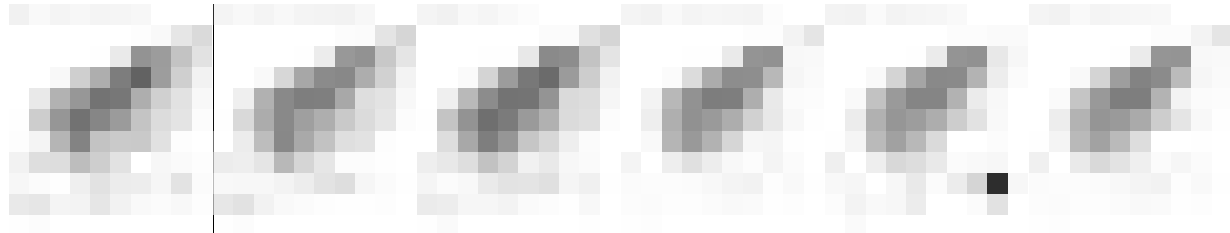
- 2 Anthers 1-3 mm long; stigmatic disc with 6-10 deep crenations; stigmatic rays terminating 0-0.2 mm from the margin of the disc; constriction below disc 1.5-5 mm in diameter; leaf sinus 2/3 or more the length of the midrib; leaf blades 3.5-10 (-13) cm long *N. microphylla*
- 2 Anthers (2-) 3-6 mm long; stigmatic disc with 8-15 shallow crenations; stigmatic rays terminating 0-1.6 mm from the margin of the disc; constriction below disc 5-10 mm in diameter; leaf sinus ca. 1/2 the length of the midrib; leaf blades 5-25 cm long..... *N. rubrodisca*
- 1 Sepals 6-9 (-12); stigmatic disc yellow, green, or sometimes reddish; fruit slightly or not at all constricted below the stigmatic disc; leaf blades 7-50 cm long; [section *Astylus*].
- 3 Floating leaf blades 2-6× as long as wide, the sinus < ¼ as long as the midrib; thin-textured submersed leaves often more abundant than the floating leaves; [of blackwater or tidal streams, rivers, and lakes of the Coastal Plain, se. VA, e. NC, e. SC, Panhandle FL, s. AL].
- 4 Floating leaf blades 3-6× as long as wide; stigmatic rays elliptic, terminating < 1 mm from the edge of the disk; [of blackwater or tidal streams, rivers, and lakes of the Coastal Plain of se. VA to e. SC] *N. sagittifolia*
- 4 Floating leaf blades 2-3× as long as wide; stigmatic rays linear, mostly terminating 1-2 mm from the edge of the disk; [of blackwater streams and rivers, Panhandle FL and s. AL]..... *N. ulvacea*
- 3 Floating leaf blades 1-2× as long as wide, the sinus > ¼ as long as the midrib; thin-textured submersed leaves absent or at least fewer than floating or emersed leaves; [collectively of various habitats and distributions, but not as above].
- 5 Leaf petiole flattened on the upper (adaxial) surface and winged along the margins; fruit usually purplish; sepals red or maroon at the base adaxially *N. variegata*
- 5 Leaf petiole terete or slightly flattened, not winged; fruit usually greenish or yellowish; sepals yellow or red at the base adaxially.
- 6 Lower leaf surface glabrous to sparsely pubescent; leaves 7-30 cm wide, (1-) 1.5 (-2)× as long as wide, the lobes acute to broadly rounded; leaves mostly emersed; [widespread in our area]..... *N. advena*
- 6 Lower leaf surface densely silvery-pubescent; leaves 20-45 cm wide, ca. 1× as long as wide the lobes, broadly rounded; leaves mostly floating; [of AL, FL, and GA Coastal Plain]..... *N. orbiculata*

Nuphar advena (Aiton) R. Brown ex Aiton f., Broadleaf Pondlily. Lakes, ponds, natural depression ponds, old millponds, slow-flowing rivers (blackwater and brownwater). April-October. The most widespread and common *Nuphar* in e. North America, ranging from ME west to WI, south to s. FL, Cuba, TX, and n. Mexico. See *N. sagittifolia* for discussion of the two taxa. [= C, FNA, Pa, WV; = *Nuphar luteum* (Linnaeus) Sibthorp & J.E. Smith ssp. *macrophyllum* (Small) E.O. Beal – RAB, GW, W, Z; > *Nuphar advena* – F, G; > *Nuphar fluviatile* (R.M. Harper) Standley – F, G; > *Nuphar puteorum* Fernald – F; = *Nuphar lutea* J.E. Smith ssp. *advena* (Aiton) Kartesz & Gandhi – K; > *Nymphaea advena* Aiton – S; > *Nymphaea chartacea* Miller & Standley – S; > *Nymphaea fluviatilis* R.M. Harper – S; = *Nuphar advena* ssp. *advena* – X, Y]

Nuphar microphylla (Persoon) Fernald. Lakes and ponds. June-September. NS, QC, and MB south to s. NJ, se. PA, MI, IL, and MN. [= C, FNA, Pa, X, Y; = *Nuphar microphyllum* – F, G; < *Nuphar lutea* ssp. *pumila* (Timm) E.O. Beal – K; < *Nuphar pumila* Timm; < *Nuphar luteum* ssp. *pumilum* (Timm) E.O. Beal – Z]

Nuphar orbiculata (Small) Standley. Quiet waters in blackwater swamps. May-October. A Southeastern Coastal Plain endemic: e. GA south to Panhandle FL and s. AL. [= FNA; = *Nuphar lutea* ssp. *orbiculata* (Small) E.O. Beal – K; > *Nymphaea orbiculata* Small – S; > *Nymphaea bombycina* (Miller & Standley) Standley – S; = *Nuphar advena* (Aiton) Aiton f. ssp. *orbiculata* (Small) D. Padgett – X, Y; = *Nuphar luteum* ssp. *orbiculatum* (Small) E.O. Beal – Z]

Nuphar rubrodisca Morong. Lakes and ponds. June-September. NB, QC, and ON south to NJ, PA, MI, and MN. [= FNA; = *Nuphar ×rubrodisca* Morong – C, X; = *Nuphar ×rubrodiscum* Morong – F; = *Nuphar rubrodiscum* – G; = *Nuphar lutea* J.E. Smith ssp. *rubrodisca* (Morong) Hellquist & Wiersema – K]



Nuphar sagittifolia (Walter) Pursh, Narrowleaf Pondlily, Bonnets. Blackwater streams, rivers, and lakes, in swift, sluggish, or stagnant water, extending downriver into freshwater tidal areas. April-October. Endemic to our area: e. VA south to ne. SC, very conspicuous and locally abundant on shallow bars along rivers such as the Northeast Cape Fear, Black, and Waccamaw, and forming dense colonies in Lake Waccamaw. Apparent hybrids with *N. advena* have been named *Nuphar ×interfluitans* Fernald. The submersed leaves have somewhat the texture and appearance of a thin leaf lettuce or the marine alga *Ulva*. This species appears to be closely related to *N. ulvacea* (Miller & Standley) Standley of blackwater rivers of Panhandle FL, another phylogeographic connection between se. NC and Panhandle FL. DePoe & Beal (1969) and Beal & Southall (1977) argue that this taxon and *N. advena* intergrade clinally, with *N. advena* inland and *N. sagittifolia* in the outer Coastal Plain, and that the two taxa are maintained by water temperatures. This ignores the fact that the two taxa often occur in close proximity to one another in both the inner and outer Coastal Plain. The frequency of so-called intermediates has also been exaggerated; few populations will present any difficulties in identification. I prefer to treat these taxa as species, with rare hybridization or introgression. Molecular data suggest that *N. sagittifolia* is more closely related to the boreal *N. variegata* than to *N. advena* (Padgett (2007)). [= C, FNA, X; = *Nuphar luteum* (Linnaeus) Sibthorp & J.E. Smith ssp. *sagittifolium* (Walter) E.O. Beal – RAB, GW, Z; = *Nuphar sagittifolium* – F, G, orthographic variant; = *Nuphar lutea* J.E. Smith ssp. *sagittifolia* (Walter) E.O. Beal – K; = *Nymphaea sagittifolia* Walter – S]

Nuphar ulvacea (G.S. Miller & Standley) Standley, Sea-lettuce Pondlily. Blackwater streams. Endemic to Panhandle FL and s. AL. April-September. [= FNA; = *Nuphar luteum* (Linnaeus) Sibthorp & J.E. Smith ssp. *ulvaceum* (G.S. Miller & Standley) E.O. Beal – GW, K; = *Nymphaea ulvacea* G.S. Miller & Standley – S; = *Nuphar advena* (Aiton) R. Brown ssp. *Ulvacea* (G.S. Miller & Standley) D. Padgett – X]

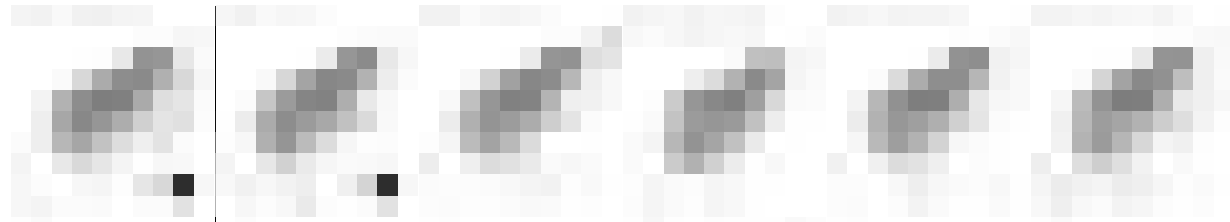
Nuphar variegata Durand in G.W. Clinton. Lakes and ponds. Widespread in ne. North America, south to DE, NJ, PA, OH, IN, IL, IA, and NE. May-September. [= C, FNA, Pa, X; = *Nuphar variegatum* – F, G; = *Nuphar lutea* ssp. *variegata* (Durand) E.O. Beal – K; = *Nuphar luteum* ssp. *variegatum* (Durand) E.O. Beal – Z]

Nymphaea Linnaeus 1753 (Waterlily)

A genus of about 50 species, aquatic herbs, cosmopolitan. References: Wiersema in FNA (1997); Woods et al. (2005a, 2005b)=Z; Schneider & Williamson in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Leaf margins sinuate-dentate*N. capensis* var. *zanzibariensis*
- 1 Leaf margins entire.
 - 2 Petals blue*N. elegans*
 - 2 Petals yellow or white (to pink).
 - 3 Petals yellow; plants producing stolons*N. mexicana*
 - 3 Petals white (to pink); plants not producing stolons.
 - 4 Petiole solid-colored; leaf length/width ratio (length measured from petiole attachment to tip of leaf, along midvein) (0.44-) avg. 0.56 (-0.71); two leaf lobes with rounded lobe tips; lower leaf surface reddish-purple*N. odorata* ssp. *odorata*
 - 4 Petiole striped; leaf length/width ratio (-.55-) 0.63 (-0.73); leaf lobes with pointed tips; lower leaf surface green*N. odorata* ssp. *tuberosa*

* *Nymphaea capensis* Thunberg var. *zanzibariensis* (Caspary) Conard, Cape Blue Waterlily. Ponds and canals; native of Africa. April-August. [= K, WH]
Nymphaea elegans Hooker, Tropical Blue Waterlily. Ponds, ditches, cypress swamps. April-August. FL west to TX, south into Mexico; Bahamas. [= K, WH]
Nymphaea mexicana Zuccarini, Banana Waterlily, Yellow Waterlily. Sluggish or stagnant waters; scattered in occurrence and possibly introduced from farther south, but the introduction agents may well be wild ducks, such as canvasbacks. June-September. Ne. NC south to s. FL, west to TX, also in sw. United States and Mexico. [= RAB, FNA, K, Z; = *Castalia flava* (Leitner) Greene – S]



Nymphaea odorata W.T. Aiton ssp. *odorata*, White Waterlily. Ponds, sluggish waters. June-September. NL (Newfoundland) west to MB, south to FL and TX; also scattered in the w. United States. *N. odorata* is polymorphic, leading to the naming of numerous species, subspecies, and varieties (see synonymy for a few of the named entities). Wiersema in FNA (1997) recognize ssp. *odorata* (all of our plants) and ssp. *tuberosa* (Paine) Wiersema & Hellquist, more western and northern, but approaching our area (see below). Other named entities warrant further evaluation. *N. odorata* var. *gigantea* [= *Castalia lekophylla* Small] occurs on the Coastal Plain, and is considered to differ from var. *odorata* in its larger leaves (1.5-6 dm in diameter vs. 0.5-2.5 dm), larger flowers (mostly > 15 cm wide vs. mostly < 10 cm), and leaves upturned at the margins (vs. flat). *N. odorata* var. *minor* [= *Castalia minor* (Sims) Nyar] is considered to differ from var. *odorata* in its generally smaller size, leaves 5-11 cm in diameter, flowers mostly < 8 cm wide (vs. mostly > 9 cm wide); it may be merely a dwarfed form of extremely nutrient-limited waters of the Coastal Plain. [= FNA, K, Z; < *N. odorata* – Pa, RAB, WV; >> *N. odorata* var. *odorata* – C; > *N. odorata* var. *odorata* – F, G; > *N. odorata* var. *gigantea* Tricker – C, F, G; > *N. odorata* Schivar. *stenopetala* Fernald – F; > *Castalia odorata* (W.T. Aiton) Wood – S; > *Castalia minor* (Sims) Nyar – S; > *Castalia lekophylla* Small – S]
Nymphaea odorata W.T. Aiton ssp. *tuberosa* (Paine) Wiersema & Hellquist, White Water-lily. Ponds and lakes. QC and MB south to MD, NJ, PA, OH, IN, IL, AR, and OK. [= FNA, K, Z; < *N. odorata* var. *odorata* – C; = *N. tuberosa* Paine – F, G; < *N. odorata* – Pa]

7a. ILLICIACEAE A.C. Smith 1947 (Star-anise Family) [in AUSTROBAILEYALES]

A family of 1 genus and about 42 species, shrubs and trees, of temperate and subtropical se. Asia and se. North America (se. United States, Cuba, Haiti, and e. Mexico). The family is most closely related to the Schisandraceae, Austrobaileyaceae, and Trimeniaceae. References: Keng in Kubitzki, Rohwer, & Bittrich (1993).

Illicium Linnaeus 1759 (Star-anise)

A genus of about 42 species, shrubs and trees, of temperate and subtropical se. Asia and se. North America (se. United States, Cuba, Haiti, and e. Mexico). Morris et al. (2007) studied the evolution of the genus and revised its sectional taxonomy; New World and Old World taxa form separate clades, treated as separate sections, our species being in section *Cymbostemon*. References: Vincent in FNA (1997); Morris et al. (2007); Keng in Kubitzki, Rohwer, & Bittrich (1993); Stone & Freeman (1968).

- 1 Flowers 2-5-5 cm across; tepals 21-33, red-maroon (rarely white or pinkish); leaf tips acute to acuminate *I. floridanum*
- 1 Flowers 0.8-1.2 cm across; tepals 11-16, yellowish green; leaf tips obtuse or rounded *I. parviflorum*

Illicium floridanum Ellis, Florida Star-anise. Acid ravines and small stream swamps. Sw. GA west to e. LA. Sparingly naturalized north of its native range from plantings, as along Black Creek, at Kalmia Gardens, Hartsville, Darlington County, SC (D. Hope, pers.comm. 2008). [= FNA, GW, K, S, WH]

* *Illicium parviflorum* Michaux ex Ventenat, Swamp Star-anise, Yellow Anise-tree, Ocala Anise-tree. Cultivated and persistent; native of central peninsular FL. April-June. This species occurs in swampy forests, evergreen hammocks, and bayheads and is endemic to scattered localities in central FL; it is in the horticultural trade and has been introduced in various places, including sw. and se. GA and sc. SC (Aiken County) (H. Shealy and R. McCartney, pers.comm. 2008). [= FNA, K, S, WH]

7b. SCHISANDRACEAE Blume 1830 (Star-vine Family) [in AUSTROBAILEYALES]

A family of 2 genera and about 40-60 species, woody vines, of e. Asia and e. North America (only our single species). The family is most closely related to the Illiciaceae, Austrobaileyaceae, and Trimeniaceae. In APG III (2009), Schisandraceae is included in Illiciaceae, but the differences seem sufficient to keep them separate. References: Saunders (2001); Keng in Kubitzki, Rohwer, & Bittrich (1993).

Schisandra Michaux 1803 (Star-vine)

A genus of about 26 species, woody vines, of e. Asia (about 25 species) and e. North America (1 species). References: Vincent in FNA (1997); Lin, Shui, & Yang (2011); Godfrey (1988)=Z; Saunders (2001)=Y; Stone (1968); Keng in Kubitzki, Rohwer, & Bittrich (1993).

Schisandra glabra (Brickell) Rehder, Star-vine, Climbing-magnolia, Magnolia-vine. Rich slopes adjacent to bottomland forests, mesic "islands" surrounded by bottomlands, moist hammocks. May-June; July-August. Ne. NC (Martin County), sc. NC (Gaston County), n. GA, w. TN, e. and se. KY, and e. AR south to the FL Panhandle and LA; Mexico (Sierra Madre Oriental, Hidalgo). [= RAB, K, WH, Y, Z; = *Schizandra coccinea* Michaux – S, orthographic variant; = *S. coccinea* Michaux – W]



11. SAURURACEAE E. Meyer 1827 (Lizard's-tail Family) [in PIPERALES]

A family of 4 genera and 6 species, perennial herbs, of temperate e. and se. Asia (*Saururus*, *Gymnotheca*, *Houttuynia*), w. North America (*Anemopsis*), and e. North America (*Saururus*). One other member of the family occurs in North America: *Anemopsis californica* Hooker & Arnott, primarily of the sw. United States. References: Buddell & Thieret in FNA (1997); Wood (1971); Cheng-Yih & Kubitzki in Kubitzki, Rohwer, & Bittrich (1993); Meng et al. (2003).

- 1 Ovary of 3 (-4) carpels, these fully fused and forming a single locule; stamens 3 *Houttuynia*
- 1 Ovary of (3-) 4 carpels fused only at the base; stamens 6 *Saururus*

Houttuynia Thunberg

A monotypic genus, a perennial herb, native of e. and se. Asia. References: Cheng-Yih & Kubitzki in Kubitzki, Rohwer, & Bittrich (1993)

* *Houttuynia cordata* Thunberg. Disturbed areas; moist suburban forests; native of e. Asia.

Saururus Linnaeus 1753 (Lizard's-tail, Water-dragon)

A genus of 2 species, perennial herbs, our species in temperate e. North America, the other in e. Asia. References: Buddell & Thieret in FNA (1997); Cheng-Yih & Kubitzki in Kubitzki, Rohwer, & Bittrich (1993).

Saururus cernuus Linnaeus, Lizard's-tail, Water-dragon. Swamps, overwash pools in stream floodplains, ditches, usually where water ponds seasonally or periodically. May-July; August-September. CT, s. QC, s. ON, and MI south to s. FL and e. TX. In swamps of the Coastal Plain, *Saururus* often is dominant in large patches. The elongate inflorescence, drooping at the tip, is distinctive, attractive, and the fanciful inspiration for the genus name, the specific epithet, and the common names. Thien et al. (1994) studied the reproductive biology of *Saururus cernuus*, and found that pollination was both by wind and by insects. [= RAB, C, F, FNA, G, GW, K, Pa, S, W, WH, WV]

12. PIPERACEAE C.A. Agardh 1824 (Pepper Family) [in PIPERALES]

A family of about 5-8 genera and 3000 species, shrubs, herbs, trees, and vines, of tropical and subtropical areas. References: Tebbs in Kubitzki, Rohwer, & Bittrich (1993).

Peperomia Ruiz & Pavón 1794 (Peperomia)

A genus of about 1000 species, of tropical and subtropical regions, especially America. References: Boufford in FNA (1997); Boufford (1982)=Z; Tebbs in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Leaves opposite or whorled; stems pubescent ***P. humilis***
 1 Leaves alternate; stems glabrous..... ***P. pellucida***

* ***Peperomia humilis*** A. Dietrich. Calcareous hammocks; native of Jamaica. Coast of FL, north to vicinity of Jacksonville, FL. [= FNA, K, Z; > *Micropiper humilis* (Vahl) Small – S; > *Micropiper leptostachyon* (Nuttall) Small – S]

* ***Peperomia pellucida*** (Linnaeus) Kunth, Pepper-elder, Man-to-man. Disturbed areas; introduced. *P. pellucida* has been collected escaped from cultivation in FL, LA, and GA (in the vicinity of Savannah). Boufford (1982) describes the species as showing "weedy tendencies" in the southeastern United States, where "first collected in 1957," and states that "it will be interesting to see if this plant will continue to expand its range". [= FNA, K, Z]

15. ARISTOLOCHIACEAE A. L. de Jussieu 1789 (Birthwort Family) [in PIPERALES]

A family of about 6-12 genera and 600 species, vines, shrubs, and herbs, of tropical, subtropical, and warm temperate regions. References: Barringer & Whittemore in FNA (1997); Ohi-Toma et al. (2006); Neinhuis et al. (2005); Huber in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Acaulescent herb; calyx tube straight, radially symmetrical; stamens 12; [subfamily *Asaroideae*].
 2 Leaves deciduous, pubescent, paired ***Asarum***
 2 Leaves evergreen, glabrous, not paired ***Hexastylis***
 1 Twining vine or caulescent herb; calyx tube bent, bilaterally symmetrical; stamens 6; [subfamily *Aristolochioideae*, tribe *Aristolochieae*].
 3 Woody, twining vine; leaves 8-35 cm wide; [subtribe *Isotrematinae*] ***Isotrema***
 3 Low, erect or ascending herb; leaves 0.7-6.5 cm wide.
 4 Leaf blade as wide as long, or wider than long; leaf venation palmate; [subtribe *Aristolochiinae*]..... ***Aristolochia***
 4 Leaf blade narrower than long; leaf venation pinnate; [subtribe *Isotrematinae*] ***Endodeca***

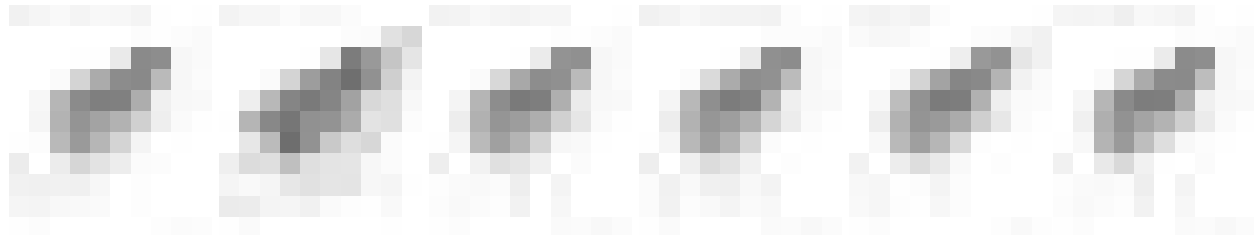
Aristolochia Linnaeus 1753 (Birthwort)

A genus of about 300 species, herbs and vines, once *Endodeca*, *Isotrema*, and *Pararistolochia* are excluded (Huber in Kubitzki 1993). Recent work has clarified that *Aristolochia* s.l. comprises 4 main clades, each of which is distinctive molecularly, morphologically, and in karyotype. These can be (as here) recognized as genera, or alternatively as four subgenera, grouped into two genera (*Aristolochia* including *Pararistolochia*, and *Isotrema* including *Endodeca*), as suggested by Ohi-Toma et al. (2006). References: Barringer in FNA (1997); Ohi-Toma et al. (2006); Kelly & González (2003); Huber in Kubitzki, Rohwer, & Bittrich (1993). [also see *Endodeca* and *Isotrema*]

- 1 Plant an herb; flowers yellowish, < 2 cm across ***A. clematitis***
 1 Plant a woody vine; flowers brownish-purple and white, ca. 10 cm across ***A. elegans***

* ***Aristolochia clematitis*** Linnaeus, Birthwort. Disturbed areas; native of Europe. June-August. Naturalized in se. PA (Rhoads & Block 2007) and MD (Barringer in FNA 1997). [= C, FNA, K, Pa]

* ***Aristolochia elegans*** Mast., Elegant Dutchman's-pipe, Calico Flower. Disturbed areas; native of Brazil. [? *A. littoralis* Parodi – WH]



Asarum Linnaeus 1753 (Wild Ginger)

See *Hexastylis* for discussion of generic limits. References: Whittemore, Mesler, & Lu in FNA (1997); Huber in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Calyx lobes 5-10 (-12) mm long, strongly reflexed, often more-or-less appressed back against the calyx tube, acute or acuminate, the tubular tips 0-4 mm long.....*A. reflexum*
- 1 Calyx lobes 10-35 mm long, spreading to ascending from the base, acuminate to caudate, the tubular tips 4-20 mm long.
 - 2 Calyx tube 10-20 mm long; calyx lobes long-caudate, 15-35 mm long, erect.....*A. acuminatum*
 - 2 Calyx tube 4-10 mm long; calyx lobes acuminate to short-caudate, 10-25 mm long, spreading.....*A. canadense*

Asarum acuminatum (Ashe) Bicknell. Mt (NC, VA): rich deciduous forests; rare. Mainly west of the Blue Ridge; distribution unclear at this time. [*A. canadense* var. *canadense* – C, G; *A. canadense* – RAB, FNA, K, Pa, W; = *A. canadense* Linnaeus var. *acuminatum* Ashe – F; > *A. acuminatum* (Ashe) Bicknell – S; > *A. rubrocinctum* Peattie – S] {not yet mapped}

Asarum canadense Linnaeus, Common Wild Ginger. Mt (GA, NC, SC, VA), Pd (DE, GA, NC, SC, VA), Cp (DE, NC, SC, VA, WV): rich deciduous forests in circumneutral soils; common (uncommon in Piedmont of NC and SC, uncommon in VA Coastal Plain, rare in Coastal Plain in DE, NC, and SC). April-May. NB and QC west to MN, south to NC, AL, and n. LA. Taxa recognized at varietal or specific level in the past have recently often been ignored, but have some merit; they deserve further attention. [= S; < *A. canadense* var. *canadense* – C, G; < *A. canadense* – RAB, FNA, K, Pa, W; > *A. canadense* var. *ambiguum* (Bicknell) Farwell – F; > *A. canadense* var. *canadense* – F] {not yet mapped}

Asarum reflexum Bicknell. Mt (NC, VA?, WV?): rich deciduous forests in circumneutral soils; rare? April-May. CT west to s. MB, south to w. NC, KY, and MO. [= S = *A. canadense* Linnaeus var. *reflexum* (Bicknell) B.L. Robinson – C, F, G; < *A. canadense* – RAB, FNA, K, Pa, W; = *A. reflexum* Bicknell – S] {not yet mapped}

Endodeca Rafinesque 1828 (Turpentine-root)

A genus of 2 (or more?) species, of eastern and sc. North America. This genus is morphologically distinctive within *Aristolochia* (in the broad sense), and forms a clade with *Isotrema* distinctive from *Aristolochia* s.s. (Ohi-Toma et al. 2006). References: Barringer in FNA (1997); Ohi-Toma et al. (2006); Kelly & González (2003); Neinhuis et al. (2005); Huber in Kubitzki, Rohwer, & Bittrich (1993).

Endodeca serpentaria (Linnaeus) Rafinesque, Turpentine-root, Virginia Snakeroot, Serpent Birthwort. Dry to mesic forests, perhaps more restricted to mesic situations over acidic substrate, ranging into drier situations over calcareous or mafic substrates. May-June; June-July. CT and NY west to IL, MI, and MO, south to c. peninsular FL and TX. The tremendous variation in this species needs further study. Plants with sparingly pubescent, thin-textured, linear to lanceolate leaves have been called *Aristolochia hastata*. Plants with broadly ovate, densely pubescent leaves have been called *Aristolochia convolvulacea*. These may represent merely morphologic extremes of a polymorphic complex; alternatively, some taxonomic recognition of such plants as distinct from *A. serpentaria* may be warranted. [= *Aristolochia serpentaria* Linnaeus – RAB, C, FNA, G, K, Pa, W, WH; > *A. serpentaria* var. *hastata* (Nuttall) Duchartre – F; > *A. serpentaria* var. *serpentaria* – F; > *A. hastata* Nuttall – S; > *A. convolvulacea* Small – S; > *A. serpentaria* – S]

Hexastylis Rafinesque 1825 (Heartleaf)

A genus of 10 species, herbs, of se. North America, very possibly best expanded to include Asian taxa treated in *Heterotropa* and *Asiasarum*. Barringer (1993) and Kelly (1997, 1998) have recently employed a broad definition of *Asarum*, including *Hexastylis*. Over the last half-century various students of the group (emphasizing a range of fields of evidence) have arrayed themselves for and against the recognition of *Hexastylis* as a genus distinct from *Asarum*. A cladistic analysis (Kelly 1997, 1998) showed distinctive clades which could be interpreted as evidence for the recognition of *Hexastylis* (including the Asian *Heterotropa*), though the author preferred to recognize 2 subgenera. I choose here to follow the more traditional (at least in our area) separation of *Hexastylis* from *Asarum*, until and unless stronger evidence is presented for their combination. Electrophoretic and morphologic studies currently in progress validate the species / varietal level taxonomy presented, insofar as results are available (R. Wyatt, pers. comm.). A difficult genus, *Hexastylis* is made more frustrating by the fact that nearly all diagnostic features relate to the shape and size of the fleshy and brittle calyx – characters which are difficult to describe and are largely lost when specimens are pressed. The difficulty of identifying herbarium specimens has sometimes been (apparently) used as a justification for reducing (often drastically, as in C) the number of taxa recognized. To those familiar with this genus in the field, however, the taxa here recognized form geographically distinctive populations. Size and (to a lesser degree) shape of individual flowers show considerable variation and can be altered by environmental factors; individual flowers or plants can be difficult to identify if taken out of context. Populations, however, are usually readily identifiable. References: Whittemore & Gaddy in FNA (1997); Gaddy (1987a)=Z; Blomquist (1957)=Y; Barringer (1993)=X; Gaddy (1987b); Gaddy (1986); Gaddy in Wofford (1989); Sugawara (1987); Huber in Kubitzki, Rohwer, & Bittrich (1993). Key adapted from FNA, Gaddy in Wofford (1989), and Gaddy (1987a).

Identification notes: The photograph (Figure 1) in Gaddy (1987a) of the flowers of all species other than *H. arifolia* and *H. speciosa* is highly recommended as an aid to identification. The calyx tube orifice is measured on the inside – the diameter of the opening. The width of calyx lobes is measured from sinus tip to sinus tip.

- 1 Style extension bifid to stigma; leaves triangular to ovate-sagittate or subhastate, portions of the sides of nearly all leaves straight or concave; leaves mottled, the paler areas between the veins.
- 2 Calyx abruptly contracted near the middle, the lower portion narrowly cuplike, abruptly expanded into a much broader upper half; calyx tube with internal raised reticulations; calyx lobes spreading; [endemic near Montgomery, AL]*H. speciosa*
- 2 Calyx gradually contracted to a smooth waist just below the calyx lobes; calyx tube smooth internally; calyx lobes spreading or erect; [collectively widespread in our area].

- 3 Calyx lobes erect, 2-4 mm long, 2-4 mm wide at base; [of the Mountains westward] *H. arifolia* var. *ruthii*
- 3 Calyx lobes spreading, 2.5-8 mm long, 3-9 mm wide at base; [of the Coastal Plain, Piedmont, and eastern Mountains].
- 4 Calyx tube 13-18 mm long, 6-10 mm wide; [of the Coastal Plain, Piedmont, and Mountains of s. VA, NC, SC, GA, and westward through AL and MS to se. LA] *H. arifolia* var. *arifolia*
- 4 Calyx tube 20-25 mm long, 10-12 mm wide; [of the lower Gulf Coastal Plain, of sw. GA, FL Panhandle, s. AL, s. MS, and se. LA]...
..... *H. arifolia* var. *callifolia*
- 1 Style extension notched or divided at the apex, not bifid to the stigma; leaves rounded, with cordate base, all portions of the sides of the leaves convex; leaves mottled or unmottled, if mottled, the paler areas along the veins.
- 5 Inner surface of calyx lobes pilose with whitish hairs; plant rhizomatous, the rhizomes long-creeping *H. lewisii*
- 5 Inner surface of calyx lobes puberulent; plant clumped or short-creeping.
- 6 Calyx tube broadly urceolate-campanulate or rhombic-ovate (broadest near the middle).
- 7 Calyx tube urceolate-campanulate; calyx lobes 10-22 mm wide at base.
- 8 Leaves scattered along the length of the rhizome; [of Coastal Plain and lower Piedmont of GA and AL]
..... *H. shuttleworthii* var. *harperi*
- 8 Leaves clustered at the tip of the rhizome; [of the Mountains and upper Piedmont of NC, SC, and GA]
..... *H. shuttleworthii* var. *shuttleworthii*
- 7 Calyx tube rhombic-ovate (broadest near the middle); calyx lobes 3-8 mm wide at base.
- 9 Internal ridged reticulation an open network raised < 1 mm or absent *H. contracta*
- 9 Internal ridged reticulation a close network raised 1.5-2 mm *H. rhombiformis*
- 6 Calyx tube cylindrical to narrowly cylindro-urceolate.
- 10 Calyx tube cylindrical to narrowly cylindro-urceolate; calyx lobes 2-4 mm long, erect to slightly spreading *H. virginica*
- 10 Calyx tube cylindrical, calyx lobes 4-15 mm long, moderately spreading to reflexed.
- 12 Calyx tube longer than wide.
- 13 Calyx tube orifice 8-12 mm wide, > ½ the length of the calyx lobes; calyx lobes 6-17 mm wide; ovary superior; leaves usually solid green (sometimes variegated) *H. heterophylla*
- 13 Calyx tube orifice 4-8 mm wide, < ½ the length of the calyx lobes; calyx lobes 4-7 mm wide; ovary half-inferior; leaves usually variegated *H. naniflora*
- 12 Calyx tube about as wide as long (at widest point) or wider than long, flared.
- 14 Calyx tube about as wide as long; calyx tube orifice width < the length of the calyx lobes *H. heterophylla*
- 14 Calyx tube wider at flare than long; calyx tube orifice width > the length of the calyx lobes.
- 15 Calyx tube 12-25 mm long; leaves always strongly variegated; [widespread in dry to moist upland forests of the Piedmont (and rarely Coastal Plain and low Mountains) of VA, NC, and SC] *H. minor*
- 15 Calyx tube 8-18 mm long; leaves solid green or faintly variegated; [of pocosins and pocosin ecotones in the NC and SC sandhills, usually growing in or near *Sphagnum*] *H. sorriei*

Hexastylis arifolia (Michaux) Small var. *arifolia*, Little Brown Jug, Arrowleaf Heartleaf. Dry to mesic deciduous forests. March-May. Se. VA, sw. VA, se. TN, and n. AL south to se. GA (Carter, Baker, & Morris 2009), Panhandle FL, s. MS, and se. LA, primarily on the Coastal Plain and Piedmont. [= C, FNA, K, W, Y, Z; < *H. arifolia* – RAB; = *Asarum arifolium* Michaux – F; = *H. arifolia* – G, S; < *Asarum arifolium* Michaux – WH; = *Asarum arifolium* Michaux var. *arifolium* – X]

Hexastylis arifolia (Michaux) Small var. *callifolia* (Small) Blomquist. Mesic forests. March-May. Sw. GA and Panhandle FL (?) west to se. LA, in the lower East Gulf Coastal Plain. [= FNA, K, Y, Z; = *H. callifolia* (Small) Small – S; = *Asarum callifolium* Small; < *Asarum arifolium* Michaux – WH; = *Asarum arifolium* Michaux var. *callifolium* (Small) Barringer – X]

Hexastylis arifolia (Michaux) Small var. *ruthii* (Ashe) Blomquist, Appalachian Little Brown Jug. Upland forests, ultramafic outcrop barrens, calcareous forests. March-June. A Southern Appalachian endemic: sw. VA, se. KY, w. NC, e. TN, n. AL, and n. GA. Perhaps warranting species status. At the Buck Creek olivine barren (Clay County, NC) this species carpets several hundred hectares, in association with *Packeria paupercula* var. *appalachiana*, *Thalictrum macrostylum*, *Sporobolus heterolepis*, and *Symphotrichum rhiannon*; various morphological differences of this population, especially the rhizomatous habit, suggest that it may represent an additional undescribed taxon. [= C, FNA, K, W, Y, Z; < *H. arifolia* – RAB; = *Asarum ruthii* Ashe – F; = *H. ruthii* (Ashe) Small – G, S; = *Asarum arifolium* Michaux var. *ruthii* (Ashe) Barringer – X]



Hexastylis contracta Blomquist, Mountain Heartleaf. On acidic soils in deciduous forests with *Kalmia latifolia* and *Rhododendron maximum*. May-June. Endemic to the Cumberland Plateau of TN (Chester, Wofford, & Kral 1997) and KY, with a few disjunct populations in the Blue Ridge of NC and in the Ridge and Valley of sw. VA (Washington County) (J. Townsend, pers.comm. 2006). [= RAB, FNA, K, W, Y, Z; < *H. virginica* – C; < *Asarum contractum* (Blomquist) Barringer – X (also see *H. rhombiformis*); = *Asarum contractum* (Blomquist) Barringer]

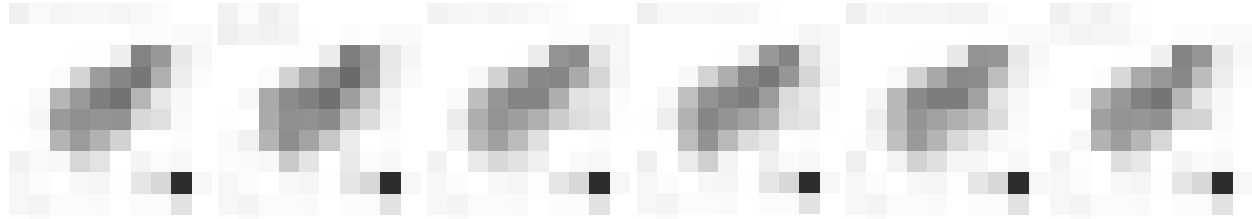
Hexastylis heterophylla (Ashe) Small, Variable-leaf Heartleaf. Slopes and bluffs in xeric to mesic forests, usually associated with *Kalmia latifolia*. March-late May. A broad Southern Appalachian endemic: w. VA and WV south through e. KY, ne. TN, and w. NC to nw. SC, n. GA, and n. AL. [= RAB, FNA, K, S, W, Y, Z; < *H. virginicum* – C; < *Asarum virginicum* Linnaeus – F, G; = *Asarum heterophyllum* Ashe – WV]

Hexastylis lewisii (Fernald) Blomquist & Oosting, Lewis's Heartleaf. Upland forests (pine or oak), pocosin ecotones. April-May. Endemic to the Piedmont of VA and the Piedmont and Coastal Plain of NC. [= RAB, FNA, K, Y, Z; < *H. shuttleworthii* – C; = *Asarum lewisii* Fernald – F]

Hexastylis minor (Ashe) Blomquist, Little Heartleaf. Upland or moist forests. February-May. Endemic to the Piedmont and adjacent Coastal Plain and Mountains of nc. VA, NC, and nc. SC. [= RAB, FNA, K, W, Z; < *Asarum virginicum* Linnaeus – F; < *H. virginica* – C, G, S; = *Asarum minus* Ashe; = *Hexastylis minus* – Y, a grammatical error]

Hexastylis naniflora Blomquist, Dwarf-flower Heartleaf. Acidic, sandy loam on bluffs and ravines in deciduous forests, frequently associated with *Kalmia latifolia*. March-June. Endemic to the upper Piedmont of s. NC and n. SC. [= RAB, FNA, K, W, Y, Z; < *H. virginica* – S; = *Asarum species 2*]

Hexastylis rhombiformis Gaddy, French Broad Heartleaf. In deciduous forests on sandy river bluffs or in ravines with *Kalmia latifolia* and *Rhododendron maximum*. Late March-June. Endemic to the southern Blue Ridge of NC and SC, known only from Henderson, Polk, Buncombe, and Transylvania counties. Following Gaddy's (1986) naming of this species, Barringer (1993) considered the species merely a form of *Asarum contractum*, but electrophoretic and morphologic studies indicate that it is distinct from *H. contracta*, and more closely related to *H. virginica* (Murrell et al. 1998; R. Wyatt, pers. comm.). [= FNA, K, W, Z; < *Asarum contractum* (Blomquist) Barringer – X; = *Asarum species 3*]



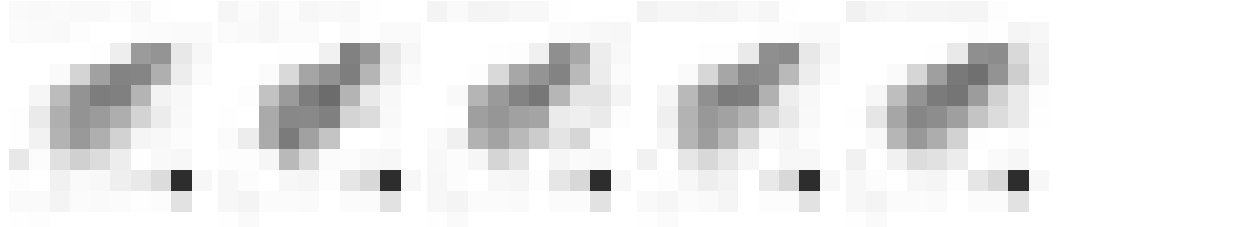
Hexastylis shuttleworthii (Britten & Baker f.) Small var. ***harperi*** Gaddy, Harper's Heartleaf. Bogs, acid hammocks. C. GA, c. AL, and ne. MS, south and west of (and allopatric from) var. *shuttleworthii* (Gaddy 1987b); it approaches SC and should be sought there. [= FNA, K, Z; < *H. shuttleworthii* – S; = *Asarum shuttleworthii* Britten & Baker f. var. *harperi* (Gaddy) Barringer – X]

Hexastylis shuttleworthii (Britten & Baker f.) Small var. ***shuttleworthii***, Large-flower Heartleaf. Acidic soils in deciduous and deciduous-coniferous forests, often along creeks under *Rhododendron maximum*. May-July. Endemic to the Southern Appalachians: W. NC and e. TN to nw. SC, n. GA, and ne. AL; previous reports of *H. shuttleworthii* for VA and WV are apparently based on large-flowered individuals of *H. heterophylla* (J. Townsend, pers. comm. 2008). [= FNA, K, Z; < *H. shuttleworthii* – RAB, G, S, W, Y; < *H. shuttleworthii* – C (also see *H. lewisii*); < *Asarum shuttleworthii* Britten & Baker – F; = *Asarum shuttleworthii* Britten & Baker f. var. *shuttleworthii* – X]

Hexastylis sorriei L.L. Gaddy, Sandhill Heartleaf. Seepage bogs, pocosins, typically in association with *Osmundastrum cinnamomeum*, *Sarracenia rubra*, and *Sphagnum spp.* March-April. Endemic to Sandhills region of NC and SC. For additional information, see Gaddy (2011). [= *Asarum species 1*]

Hexastylis speciosa R.M. Harper. Shaded forests along streams and bogs. April-May. Endemic to a small area in central AL (Autauga, Chilton, and Elmore counties, north of Montgomery). [= FNA, K, S, Y, Z; = *Asarum speciosum* (R.M. Harper) Barringer – X]

Hexastylis virginica (Linnaeus) Small, Virginia Heartleaf. Upland forests. April-June. A relatively widespread species, occurring throughout NC and VA, extending west into WV, e. KY, and ne. TN (Chester, Wofford, & Kral 1997). *H. memmingeri*, a doubtful taxon close to *H. virginica*, with the calyx very small (< 1.5 cm long), narrowly cylindro-urceolate, and the calyx lobes very short (ca. 2 mm long) will key here. Gaddy does not recognize it, considering it a small form of *H. virginica*, but it may warrant varietal rank. It is known from NC, VA, and WV, in the Piedmont and Mountains. [= RAB, FNA, K, W, Y, Z; < *H. virginica* – C (also see *H. contracta*, *H. heterophylla*, *H. minor*, and *H. naniflora*); >> *Asarum virginicum* Linnaeus – F (also see *H. heterophylla* and *H. minor*); > *Asarum virginicum* – WV; > *Asarum memmingeri* Ashe – F, WV; < *H. virginica* – G; > *H. virginica* – S; > *H. memmingeri* (Ashe) Small – S; = *Asarum virginicum* Linnaeus]



***Isotrema* Rafinesque 1819 (Dutchman's-pipe)**

A genus of about 50 species, of temperate and tropical Asia, se. North America, and Central America. References: Barringer in FNA (1997); Ohi-Toma et al. (2006); Kelly & González (2003); Huber in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Plant nearly glabrous; leaves abruptly pointed (short acuminate); calyx purple or brown; [of the Mountains].....***I. macrophyllum***
 1 Plant soft pubescent; leaves blunt; calyx yellow, with a purple mouth; [largely of west or south of the Appalachians, also locally spread from cultivation].....***I. tomentosum***

Isotrema macrophyllum (Lamarck) C.F. Reed, Pipevine, Dutchman's-pipe. Cove forests and other mesic mountain forests. May-June; August-September. A southern-central Appalachian endemic: sw. PA to c. TN and n. GA. [= *Aristolochia macrophylla* Lamarck – RAB, C, FNA, K, Pa, S, W; = *A. durior* Hill – F, G]

Isotrema tomentosum (Sims) H. Huber, Woolly Dutchman's-pipe, Pipevine. Floodplain forests, disturbed areas. S. IN, s. MO, and se. OK, south to sw. GA, Panhandle FL, and TX. FNA also reports that it is escaped in VA. [= *Aristolochia tomentosa* Sims – RAB, C, F, FNA, G, GW, K, S, WH]

17. MAGNOLIACEAE A.L. de Jussieu 1789 (Magnolia Family) [in MAGNOLIALES]

A family of about 7 genera and 223 species, trees and shrubs, tropical and warm temperate, of e. and se. Asia, and from e. North America south through West Indies and Central America to Brazil. References: Hardin (1972); Hardin & Jones (1989)=Z; Meyer in FNA (1997); Figlar & Nootboom (2004); Frodin & Govaerts (1996); Nootboom in Kubitzki, Rohwer, & Bittrich (1993); Kim et al. (2001).

- 1 Leaves about as broad as long, (0-) 4 (-8)-lobed; fruit a lanceoloid aggregate of samaras, each samara 2-seeded, tan, and indehiscent; [subfamily *Liriodendroideae*].....*Liriodendron*
- 1 Leaves longer than broad, not lobed (in some species the leaves auriculate-cordate basally); fruit an ovoid, cone-like aggregate of follicles, each follicle dehiscent to reveal a scarlet seed, at first connected to the follicle by a thread-like strand; [subfamily *Magnolioideae*].....*Magnolia*

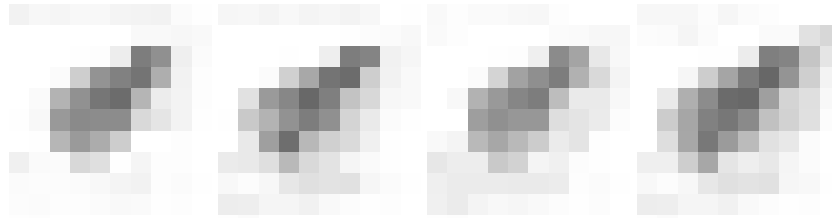
Liriodendron Linnaeus (Tulip-tree)

A genus of 2 species, trees, relictually distributed, with *L. tulipifera* in e. North America and *L. chinense* (Hemsley) Sargent in c. China and n. Vietnam. References: Nootboom in Kubitzki, Rohwer, & Bittrich (1993); Fetter, Weakley, & Parks (in prep.)=Z.

- 1 Leaves large, 4-8-lobed, the terminal lobes acute; [of the Mountains, Piedmont, and Coastal Plain (especially brownwater rivers and mesic bluffs and slopes)]*L. tulipifera* var. *tulipifera*
- 1 Leaves small, 0-4-lobed, the terminal lobes obtuse to broadly rounded; [of the Coastal Plain, especially fire-maintained, wetland, acidic, and peaty sites].....*L. tulipifera* var. *1*

Liriodendron tulipifera Linnaeus var. *tulipifera*, Tulip-tree, Yellow Poplar, Whitewood. Mesic forests, cove forests in the Mountains to at least 1500m in elevation, bottomland forests and swamps. April-June; September-October. Widespread in e. North America, south to Panhandle FL. An important timber tree in the Southern Appalachians. [= Z; < *L. tulipifera* – RAB, C, F, FNA, G, GW, K, Pa, S, W, WH, WV, Z]

Liriodendron tulipifera Linnaeus var. *1*, Coastal Plain Tulip-tree, Southern Yellow Poplar. Blackwater swamps, streamhead pocosins in the fall-line sandhills. April-June; September-October. Its occurrence in fire-maintained, acid soil habitats in the Coastal Plain is surprising to people used to *Liriodendron* as a tree of mesic, rich soil forests. It is, however, a typical species of streamhead pocosins in the fall-line sandhills, growing with *Pinus serotina*, *Nyssa biflora*, and *Acer rubrum*, and often with scorch marks twenty feet up the trunk. [= Z; < *L. tulipifera* – RAB, C, F, FNA, G, GW, K, S, W, WH, Z]



Magnolia Linnaeus 1753 (Magnolia, Cucumber-tree)

A genus of about 130 species, trees and shrubs, of e. Asia (Himalayas and Sri Lanka to Japan and w. Malaysia) and America (e. North America to West Indies, Central America, and South America). Molecular phylogenetics show *Magnolia virginiana* and *M. grandiflora* as closely related in a New World primarily subtropical clade, *M. macrophylla* in a clade with its close relatives, *M. fraseri* and *M. pyramidata* together, *M. acuminata* as basal in a clade that is otherwise Asian (equivalent to subgenus *Yulania*), and *M. tripetala* grouped in another clade that is otherwise Asian (Azuma et al. 2001). The sections used follow Figlar & Nootboom (2004). References: Tobe (1998)=Y; Spongberg (1998)=X; Frodin & Govaerts (1996)=V; Palmarola-Bejerano, Romanov, & Bobrov (2008)=U; Azuma, Thien, & Kawano (1999); Azuma et al. (2001); Figlar & Nootboom (2004); Nootboom in Kubitzki, Rohwer, & Bittrich (1993); Kim et al. (2001); Hunt (1998).

- 1 Leaves cordate-auriculate at base; [subgenus *Magnolia*].
 - 2 Leaves glaucous and finely appressed-pubescent beneath; buds and twigs pubescent; [subgenus *Magnolia*, section *Macrophylla*].
 - 3 Conelike aggregate fruit (follicetum) 2.5-6.5 cm long, 1.5-4 cm in diameter; leaf blade 17-56 cm long; stamens 170-350; pistils 20-50; small tree (to 12 m tall); [of Panhandle FL]*M. ashei*
 - 3 Conelike aggregate fruit (follicetum) 5-8 cm long, 5-7 cm in diameter; leaf blade 50-110 cm long; stamens (300-) 350-580; pistils 50-80; medium to large tree (to 32 m tall); [widespread, but not of Panhandle FL]*M. macrophylla*
 - 2 Leaves green and glabrous beneath; buds and twigs glabrous; [subgenus *Magnolia*, section *Auriculata*].
 - 4 Stamens 8-15 mm long; leaves (most of them) over 25 cm long; conelike aggregate fruit (follicetum) 6.5-11 (-14) cm long; [of the Mountains and Piedmont]*M. fraseri*
 - 4 Stamens 4-8 (-10.5) mm long; leaves (most of them) < 25 cm long; conelike aggregate fruit (follicetum) 3.5-5.5 (-6) cm long; [of the Coastal Plain].....*M. pyramidata*

- 1 Leaves cuneate to rounded (subcordate) at base.
- 5 Leaves evergreen, coriaceous in texture, glossy dark green above as if varnished, rusty tomentose or green beneath; [subgenus *Magnolia*, section *Magnolia*].....*M. grandiflora*
- 5 Leaves variably evergreen to deciduous, herbaceous or subcoriaceous in texture, medium green above with a slightly glossy or dull finish; glaucous or green beneath.
- 6 Leaves evergreen to deciduous, aromatic when fresh, 8-20 cm long, elliptic, strongly glaucous beneath; [subgenus *Magnolia*, section *Magnolia*].
- 7 Leaves evergreen; previous year's stems densely pubescent; mature leaves with pubescent midveins; flowers opening near sundown (2-5 hours later than var. *virginiana*); medium to large tree, to >20 m tall; [of the Gulf Coast and inland, north and east to s. SC (e. NC?)]......*M. virginiana* var. *australis*
- 7 Leaves evergreen to deciduous (at least tardily); previous year's stems glabrous; mature leaves with few hairs along the midvein below; flowers opening mid-afternoon; shrub to multi-stemmed small tree, to 10 m (rarely to 15 m) tall; [of the Atlantic Coastal Plain and inland, south and west to s. SC and w. NC]*M. virginiana* var. *virginiana*
- 6 Leaves deciduous, non-aromatic, 4-50 cm long, either ovate, obovate, or oblanceolate, green beneath.
- 8 Leaf base cuneate-attenuate; leaf blade obovate or oblanceolate (broader toward the tip); buds either glabrous or sericeous.
- 9 Leaf blades 3-16 cm long; buds densely sericeous; [alien]; [classification]*M. kobus*
- 9 Leaf blades 15-50 cm long; buds glabrous; [native]; [subgenus *Magnolia*, section *Rhytidospermum*, subsection *Rhytidospermum*] .
.....*M. tripetala*
- 8 Leaf base rounded to subcordate (often cuneate to widely cuneate in *M. acuminata* var. *subcordata*); leaves 10-30 cm long, broader near the middle or toward the base, borne scattered along the twig; buds pubescent; [subgenus *Yulania*, section *Yulania*, subsection *Tulipastrum*].
- 10 Twigs of the current year glabrous; petals greenish or greenish-yellow; medium to large tree*M. acuminata* var. *acuminata*
- 10 Twigs of the current year pubescent, or at least with persistent hair-bases, petals golden-yellow above, light-yellow below; small tree (rarely larger)*M. acuminata* var. *subcordata*

Magnolia acuminata (Linnaeus) Linnaeus var. *acuminata*, Cucumber-tree, Cucumber Magnolia. Mesic to subxeric forests, especially (but by no means strictly) over mafic or calcareous rocks, up to at least 1550m (where growing with *Betula alleghaniensis*, *Abies fraseri*, *Picea rubens*, and *Sorbus americana*), ultramafic outcrop barrens (where codominant with *Pinus rigida* and *Quercus alba*). April-June; July-August. S. ME, MY, c. IN, s. MO, and e. OK, south to c. GA, Panhandle FL, s. AL, s. MS, and w. LA. The recognition of two varieties is uncertain (see discussion below). [= C, F, G, V, W, X, Y; < *M. acuminata* - RAB, FNA, K, Pa, WV, Z; = *Tulipastrum acuminatum* (Linnaeus) Small - S; = *Yulania acuminata* (Linnaeus) D.L. Fu var. 1]

Magnolia acuminata (Linnaeus) Linnaeus var. *subcordata* (Spach) Dandy, Yellow Cucumber-tree, Showy Cucumber Magnolia. Moist to dry slopes and bottomlands over mafic or calcareous rocks. Var. *subcordata* ranges from sc. NC south to AL. It has been treated variously as a variety, a species, or merged with *M. acuminata*. Coker (1943) discusses its history, distribution, and taxonomic status. Additional study is needed. [= V, X, Y; < *M. acuminata* - RAB, FNA, K, W, Z; = *Tulipastrum cordatum* (Michaux) Small - S; = *Magnolia cordata* Michaux; = *Yulania acuminata* (Linnaeus) D.L. Fu var. 2]

Magnolia ashei Weatherby, Ashe's Magnolia. Moist to wet hammocks. Endemic to FL Panhandle. [= FNA, K, Z; = *M. macrophylla* Michaux var. *ashei* (Weatherby) D.L. Johnson - WH; = *M. macrophylla* ssp. *ashei* (Weatherby) Spongberg - V, X, Y]

Magnolia fraseri Walter, Fraser Magnolia, Earleaf Umbrella-tree. Mt (GA, NC, SC, VA, WV), Pd (GA, NC, SC, VA): mesic forests; common (uncommon in upper Piedmont only, uncommon in WV). April-May; July-August. A Southern Appalachian endemic: KY and w. VA south through w. NC and e. TN to nw. SC, n. GA, and ne. AL. [= RAB, C, F, FNA, G, K, S, W, Z; = *M. fraseri* var. *fraseri* - V, X; = *M. fraseri* ssp. *fraseri* - Y]

Magnolia grandiflora Linnaeus, Southern Magnolia, Bull Bay. Maritime forests, mesic Coastal Plain bluffs and flats, bottomlands, now also widely naturalized, spreading from cultivation into wet to mesic forests. April-June; September-October. The pre-Columbian range was apparently from se. NC south to c. peninsular FL, west to e. TX, largely on the Coastal Plain, now somewhat expanded northward and inland by naturalization from centuries of horticultural planting. Curtis (1860) states that "the northern limit of this tree is in Brunswick County, south of the Cape Fear; but it flourishes in cultivation through all the lower part of the State." This is, of course, the classic "southern magnolia," along with live oak (*Quercus virginiana*), and baldcypress (*Taxodium distichum*), one of the totem trees of the Deep South. [= RAB, C, FNA, GW, K, S, V, Y, Z; *Magnolia* s.s.]

Magnolia kobus DC., Kobus Magnolia, Kobushi Magnolia. Suburban woodlands; native of Japan. [= Pa] {add to synonymy}

Magnolia macrophylla Michaux, Bigleaf Magnolia. Mesic forests, primarily over limestone, other calcareous sedimentary rocks (calcareous shales, sandstones, etc.), or mafic rocks (east of the Blue Ridge), mesic hammocks in the Coastal Plain. May-June; July-August. The range of this species is often stated in such a way as to imply that it is a tree of the southern mountains. Actually, it avoids the Southern Blue Ridge, reaching its greatest abundance in the sedimentary rock Appalachians west of the Blue Ridge, particularly the Cumberland Plateau, and occurs east of the Blue Ridge only as a rare disjunct. *M. macrophylla* ranges from s. OH and sw. VA south through e. TN to w. GA, west to AL, MS, n. LA, and se. AR (Sundell et al. 1999); disjunct on Crowleys Ridge in ne. AR (population now extirpated), c. and nc. SC, and e. SC (where probably not native). The leaves are up to 1.1 meter long and 3.5 dm wide. See Williams (1999) for additional information about the discovery and nomenclature of

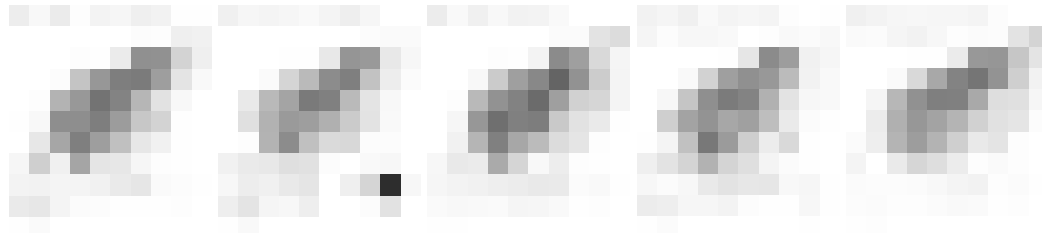
this species. The Gulf Coast endemic *Magnolia ashei* Weatherby is related and is sometimes treated as a variety or subspecies of *M. macrophylla*. [= RAB, C, F, FNA, G, K, S, W, Z; = *M. macrophylla* ssp. *macrophylla* – V, X, Y]

Magnolia pyramidata Bartram, Pyramid Magnolia. Mesic hammocks, mesic forests, especially of bluffs and ravines. April-May; August. A Southeastern Coastal Plain endemic: c. SC south to Panhandle FL, west to e. TX. Sometimes treated as a variety or subspecies of *M. fraseri*, to which it is clearly closely related, but the distributional and morphological differences are discrete and specific status seems warranted. [= RAB, FNA, K, S, WH, Z; = *M. fraseri* Walter var. *pyramidata* (Bartram) Pamplinini – V, X; = *M. fraseri* Walter ssp. *pyramidata* (Bartram) E. Murray – Y]

Magnolia tripetala (Linnaeus) Linnaeus, Umbrella Magnolia, Umbrella-tree. Mesic forests, ravines. April-May; July-October. Centered in the Southern Appalachians, but avoiding higher elevations, and therefore occurring primarily "around" the Blue Ridge; ranging from sc. and sw. PA, s. OH, s. IN south to SC, GA, Panhandle FL (Tobe 2007), AL, and MS; also disjunct in the Ouachita Mountains of c. AR and e. OK. [= RAB, C, F, FNA, G, K, Pa, S, V, W, WH, WV, X, Y, Z; *Houpoëa* sp. 1]

Magnolia virginiana Linnaeus var. *australis* Sargent, Southern Sweet Bay. Pocosins, bay forests, and swamps in the Coastal Plain, streamhead pocosins, swamps, and sandhill seeps in the Sandhills, bogs and peaty swamps in the Piedmont and Mountains. April-July; July-October. S. SC (se. NC?) south to s. FL, and west to e. TX, rarely extending into adjacent, more interior provinces; disjunct in nw. Cuba. *Magnolia virginiana* was recently discovered in Cuba, the single population named as ssp. *oviedoae* A. Palmarola, M.S. Romanov, & A.V. Bobrov (Palmarola-Bejerano, Romanov, & Bobrov 2008), but based on molecular results of Azuma et al. (2011), it seems better to consider this population as part of *M. virginiana* var. *australis*. Morphological, molecular, and chemical studies have shown strong variation in *M. virginiana* in North America, but the patterns are not clear based on the limited current studies (Azuma, Thien, & Kawano 1999). Based on the studies of Azuma et al. (2011), Azuma, Thien, & Kawano (1999), Tobe (1998), and McDaniel (1966), the recognition of two varieties seems clearly warranted, with a strong genetic break occurring in SC (a secondary and less strong genetic break separates West Gulf Coastal Plain populations from more eastern populations) (Azuma et al. 2011). Additional study is needed to understand the exact distributions of the two taxa in the area of contact (SC and adjacent GA and NC), whether species status is warranted, as suggested by Azuma et al. (2011), and the correlation between morphological traits and genetic variation. [= F, Y; < *M. virginiana* – RAB, C, FNA, G, GW, K, S, V, W, WH, X, Z; = *M. virginiana* ssp. *australis* (Sargent) A.E. Murray – U]

Magnolia virginiana Linnaeus var. *virginiana*, Northern Sweet Bay. Pocosins, bay forests, and swamps in the Coastal Plain, streamhead pocosins, swamps, and sandhill seeps in the Sandhills, bogs and peaty swamps in the Piedmont. April-July; July-October. Se. MA south to w. NC, s. SC, and e. GA. [= F, Y; < *M. virginiana* – RAB, C, FNA, G, GW, K, Pa, S, V, W, X, Z; = *M. virginiana* ssp. *virginiana* – U]



21. ANNONACEAE A.L. de Jussieu 1789 (Custard-apple Family) [in MAGNOLIALES]

A family of about 128-130 genera and about 2200-2300 species, trees, shrubs, and lianas, mostly tropical. References: Kessler in Kubitzki, Rohwer, & Bittrich (1993).

Asimina Adanson 1763 (Pawpaw)

A genus of about 12 species of shrubs and small trees, endemic to e. North America. Here circumscribed to include *Deeringothamnus* of peninsular FL. Four additional species occur south of our area in the FL peninsula: *A. manasota* DeLaney, *A. pulchella* (Small) Rehder & Dayton, *A. rugelii* B.L. Robinson, and *A. tetramera* Small. It is likely that additional taxa will be named. References: DeLaney (2010)=V; Kral (1960)=Z; Wilbur (1970a)=Y; Godfrey (1988)=X; Kral in FNA (1997); Ward (2001); Kessler in Kubitzki, Rohwer, & Bittrich (1993).

Identification notes: Hybrids are known between some of the pineland species, notably *A. angustifolia* × *incana* [= *A. ×nashii* Kral], and should be expected where two species are present. These hybrids are named as binomials and further discussed in DeLaney (2010)

- 1 Leaves herbaceous in texture, obovate, >6 cm wide, acute-acuminate at the apex; peduncles with bracts; flowers reddish-maroon; shrubs and trees, 1-15 m tall; [collectively widespread in our area].
- 2 Flowering peduncles 3-8 mm long, the hairs tan to rusty; leaves 6-15 (-20) cm long; sepals 4-7 mm long; outer petals 10-13 mm long; fruit 1-3 (-6) cm long; plant a shrub 1-2 m (rarely to 5 m) tall; [primarily of the Coastal Plain in our area, extending into the Piedmont in NC and SC, and into the Mountains in SC] *A. parviflora*
- 2 Flowering peduncles (10-) 15-20 (-25) mm long, the hairs dark reddish-brown; leaves 15-35 cm long; sepals 8-12 mm long; outer petals 15-25 mm long; fruit (3-) 7-15 cm long; plant a tree to 15 m tall; [widespread in our area]..... *A. triloba*
- 1 Leaves coriaceous in texture, linear to oval, blunt at the tip (or acute-acuminate); peduncles lacking bracts; flowers maroon, pale pink, yellow, cream, or white; shrubs to 2 m tall; [of e. GA, very rarely e. SC, and southward].
- 3 Flowers borne on growth of the previous year, appearing before or with leaf expansion; leaves 1.5-4× as long as broad, 4-10 cm long, 1-6 cm long; flowers with a sweet odor.

- 4 Newly emergent leaf blades densely tomentose on both surfaces with pale blonde or tan pubescence; mature leaves medium green, the margins flat or nearly so; outer petals white to yellowish, inner petals yellowish with a deep yellow corrugated zone; [of dry pinelands].
.....*A. incana*
- 4 Newly emergent leaf blades densely tomentose on the lower surface with the hairs near the midrib reddish, the upper surface sparsely pubescent; mature leaves pale green or blue-green, glaucous, the margins revolute; outer petals white, inner petals white, yellowish, or pink, with a maroon or purple corrugated zone; [of wet pinelands]*A. reticulata*
- 3 Flowers borne on growth of the current year, appearing after leaf expansion; leaves 3-15× as long as wide, 4-20 cm long, 0.5-4 cm wide; flowers with a sweet or fetid odor.
- 5 Flowers terminal on short lateral branchlets; pubescence of new growth, petiole, lower leaf surface and peduncle dense, tomentose, and bright red*A. obovata*
- 5 Flowers axillary along primary stems and/or branches; pubescence sparser and/or tan to rusty red.
- 6 Outer petals maroon or red, 1.5-3 cm long; leaves erect and secund, 4-11 cm long, 1-4 cm wide, averaging 3-5× as long as wide; leaf tips obtuse, rounded, or rounded-emarginate (rarely somewhat acute); shrubs to 3 (-5) dm tall*A. pygmaea*
- 6 Outer petals yellowish white or pale pink, 3-10 cm long; leaves erect and secund, or not, 5-15 (-20) cm long, 0.5-3 cm wide, averaging 6-15× as long as wide; leaf tips acute or obtuse; shrubs 10-17.5 dm tall.
- 7 Leaves widest at or shortly above the middle, mostly 8-15× as long as wide, widest at the mid-point of the blade or just above; leaf margins revolute; outer petals white; new growth pubescent, becoming glabrous with age; primary stems erect to ascending, the leaves oriented in many directions*A. angustifolia*
- 7 Leaves widest near the tip, mostly 6-10× as long as wide, widest well beyond the midpoint of the blade; leaf margins slightly revolute; outer petals white or pink; new growth glabrous or very sparsely pubescent, becoming glabrous with age; primary stems weakly to strongly arching, the leaves upwardly secund*A. spatulata*

Asimina angustifolia Rafinesque, Slimleaf Pawpaw. Dry pinelands. Se. GA south to c. peninsular FL, west to about the Suwannee River in the e. Panhandle of FL. [= V; = *A. longifolia* var. *longifolia* – FNA, X, Z; < *Asimina angustifolia* – K, WH, Y; < *Ptyothamnus angustifolius* (Rafinesque) Small – S]

Asimina incana (W. Bartram) Exell, Flag Pawpaw, Polecat Bush, Woolly Pawpaw. Dry pinelands. E. GA south to c. peninsular FL, occurring in dry pinelands. [= FNA, K, V, WH, Y; = *Ptyothamnus incanus* (W. Bartram) Small – S; = *A. speciosa* Nash – Z; = *A. incana* – X, orthographic variant]

Asimina obovata (Willdenow) Nash. Scrub, sandhills, open dry hammocks. FL peninsula, north to Clay County. [= FNA, K, V, WH, X, Y, Z; = *Ptyothamnus obovatus* (Willdenow) Small – S]

Asimina parviflora (Michaux) Dunal, Small-flowered Pawpaw, Small-fruited Pawpaw. Sandy or rocky, dry to fairly moist forests. April-May; July-September. Se. VA south to c. peninsular FL, west to se. TX, primarily on the Coastal Plain, but inland to sw. SC, n. GA, sc. TN, and n. MS. [= RAB, C, F, G, FNA, K, S, V, W, WH, X, Y, Z]

Asimina pygmaea (W. Bartram) Dunal, Dwarf Pawpaw. Pine flatwoods, wet savannas. Se. GA south to c. peninsular FL. It is a dwarf shrub 2-3 dm tall of pine flatwoods, occupying wetter sites than the other "pineland pawpaws." [= FNA, GW, X, Z; = *A. pygmaea* – K, V, WH, Y, orthographic variant; = *Ptyothamnus pygmaeus* (W. Bartram) Small – S]

Asimina reticulata Chapman, Netleaf Pawpaw. Wet flatwoods, savannas. S. GA south to s. peninsular FL. Reported for GA by GAHP (2003) and Kartesz (1999). [= FNA, K, V, WH, X, Y, Z; = *Ptyothamnus reticulatus* (Shuttleworth ex Chapman) Small – S; = *A. cuneata* Shuttleworth ex A. Gray] {synonymy incomplete}



Asimina spatulata (Kral) D.B. Ward, Slimleaf Pawpaw. Dry pinelands, dry maritime forests. S. SC south to n. FL (west of the Suwannee River), west to Panhandle FL and s. AL; disjunct in Charleston County, SC (Gramling 2010, as *A. angustifolia*; P. McMillan, pers.comm. 2004). DeLaney (2010) discusses that *A. spatulata* includes a variety of geographically somewhat coherent forms, and for now may be considered a "species of convenience" needing additional study. [= V; = *Asimina longifolia* Kral var. *spatulata* Kral – FNA, X, Z; < *Ptyothamnus angustifolius* (Rafinesque) Small – S; < *A. angustifolia* Rafinesque – K, WH, Y]

Asimina triloba (Linnaeus) Dunal, Common Pawpaw, Indian-banana. Alluvial forests, other moist, nutrient-rich forests. March-May; August-October. NJ, w. NY, and s. ON west to s. MI and e. NE, south to Panhandle FL, s. LA, and ne. TX. [= RAB, C, F, FNA, G, K, Pa, S, V, W, WH, X, Y, Z]

22. CALYCANTHACEAE Lindley 1819 (Sweet-shrub Family) [in LAURALES]

A family of 4 genera and about 8 species, shrubs and trees, of temperate e. China, temperate e. North America, temperate w. North America, and tropical ne. Australia. References: Nicely (1965); Wood (1958); Li et al. (2004); Kubitzki in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Stamens 10-20; winter buds naked; tepals linear, reddish brown to yellowish-green*Calycanthus*
- 1 Stamens 5-6; winter buds with imbricate scales; tepals obovate to orbicular (at least the outer), pale to dark yellow*Chimonanthus*

Calycanthus Linnaeus 1759 (Sweet-shrub)

A genus of 2-4 species, 1 (or 2) of e. North America, 1 of w. North America, and 1 of China (the latter sometimes segregated as a separate genus, *Sinocalycanthus*). References: Johnson in FNA (1997); Kubitzki in Kubitzki, Rohwer, & Bittrich (1993); Nicely (1965)=Z; Ferry & Ferry (1987)=Y.

- 1 Tepals pale yellowish-green; seeds ca. 6 mm in diameter, with short, curved hairs.....*C. brockianus*
 1 Tepals reddish brown; seeds ca. 10 mm in diameter, with long, straighter hairs.....*C. floridus*

Calycanthus brockianus Ferry & Ferry, Brock's Sweet-shrub. Moist slopes. Endemic to mesic hardwood forests in GA. Its taxonomic validity is uncertain and controversial. [= *C. brockiana* – K, Y, orthographic variant; < *C. floridus* Linnaeus var. *floridus* – FNA]

Calycanthus floridus Linnaeus, Sweet-shrub, Strawberry-shrub, Carolina Allspice, Sweet Bubby-bush. Forested slopes and streambanks. April-May; August-September. PA, WV, and KY, south to GA, nw. FL, AL, and s. MS. Two varieties have traditionally been recognized, var. *floridus* with pubescent twigs, petioles, and leaf undersurfaces, and var. *glaucus* with glabrous (or sparsely pubescent) twigs, petioles, and leaf undersurfaces. They have broadly overlapping distributions and variable characters and seem best considered as taxonomically uninformative variation. The outer edges of the natural original distribution are somewhat unclear, because of extensive cultivation for centuries. [> *C. floridus* Linnaeus var. *floridus* – FNA, GW, K, Pa, RAB, Y, Z; > *C. floridus* Linnaeus var. *glaucus* (Willdenow) Torrey & A. Gray – C, FNA, K, Y; < *C. floridus* Linnaeus var. *floridus* – FNA; > *C. floridus* var. *laevigatus* (Willdenow) Torrey & A. Gray – GW, Pa, RAB, Z; > *C. floridus* – F; > *C. floridus* – S; > *C. mohrii* Small – S; > *C. fertilis* Walter – F, G; > *C. fertilis* – S; > *C. nanus* Loiseleur – S; > *C. floridus* var. *oblongifolius* (Nuttall) Boufford & Spongberg]

Chimonanthus Lindley (Wintersweet)

A genus of ca. 6 species, shrubs, of e. Asia. References: Kubitzki in Kubitzki, Rohwer, & Bittrich (1993).

- * *Chimonanthus praecox* (Linnaeus) Link, Wintersweet. Reported as at least persistent in City of Alexandria, VA (Steury 2011).



28. LAURACEAE A.L. de Jussieu 1789 (Laurel Family) [in LAURALES]

A family of about 50 genera and 2500-3500 species, trees and shrubs, of tropical, subtropical, and (rarely) warm temperate regions. *Laurus nobilis* Linnaeus, Laurel, Bay, native to the Mediterranean region of Europe and the bay leaf of commerce; planted as an ornamental and spice, especially in warmer parts of our area, but is not known to escape in our area. References: van der Werff in FNA (1997); van der Werff & Richter (1996); Rohwer in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Leaves evergreen; flowers bisexual; [tribe *Perseeae*].
 2 Leaves glabrous, bright green, with yellow callosities in the principal vein axils; crushed leaves with the odor of camphor.....*Cinnamomum*
 2 Leaves pubescent to glabrate, dark green, without yellow callosities in the principal vein axils; crushed leaves with the odor of bay.....*Persea*
 1 Leaves deciduous; flowers unisexual; [tribe *Laureae*].
 3 Some of the leaves with 1-2 (-5) rounded lobes; small to medium trees*Sassafras*
 3 None of the leaves lobed; medium to large shrubs.
 4 Leaves 4-16 cm long, 2-6 cm wide, obovate, ovate, or broadly elliptic*Lindera*
 4 Leaves 1.2-4 cm long, 0.5-1.5 (-1.9) cm wide, narrowly elliptic.....*Litsea*

Cinnamomum Schaeff 1760 (Cinnamon)

A genus of about 350 species, trees and shrubs, of e. and se. Asia, Oceania, and tropical America. References: Rohwer in Kubitzki, Rohwer, & Bittrich (1993); van der Werff in FNA (1997).

- * *Cinnamomum camphora* (Linnaeus) J. Presl, Camphortree. Disturbed areas, suburban woodlands, increasingly in natural forests; native of e. Asia. April-May. A serious invasive, especially southward. Reported as escaped and apparently naturalized in South Carolina by Hill & Horn (1997). In NC, reported for Moore County. [= FNA, K, WH; = *Camphora camphora* (Linnaeus) Karsten – S]

Lindera Thunberg 1783 (Spicebush, Benzoin)

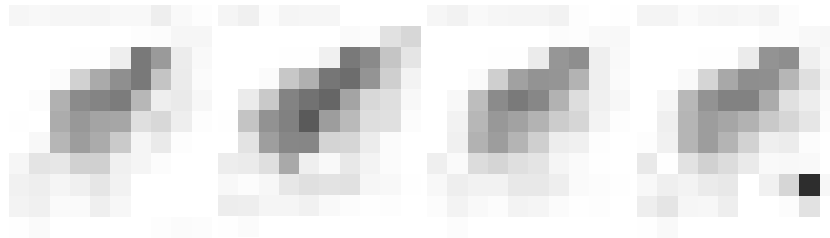
A genus of about 100 species, trees and shrubs, of tropical and temperate Asia, Australia, and e. North America. References: Wofford (1983)=Z; Wofford in FNA (1997); Steyermark (1949); McCartney, Wurdack, & Moore (1989); Rohwer in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Leaves typically with a thick, subcoriaceous texture (though sometimes thinner in texture if growing in shade), 4-8 cm long, 2-3.5 cm wide, narrowly obovate to oblanceolate, pubescent and strongly whitened below; leaves and bark aromatic, the odor lemony *L. subcoriacea*
- 1 Leaves with a thin, membranous texture, 6-16 cm long, 2-6 cm wide, obovate, elliptic, or ovate, glabrous to pubescent below, but not strongly whitened; leaves and bark strongly aromatic, the odor spicy or like sassafras.
 - 2 Leaf base cuneate; leaves widely obovate, plane (not rugose), with a short-acuminate apex, glabrous above, borne horizontally, spicy-fragrant when crushed; shrubs not colonial, often multi-stemmed from base, short to tall (to 5 m tall) *L. benzoin*
 - 2 Leaf base widely cuneate to rounded; leaves narrowly ovate, reticulate-rugose, with an acute apex, pubescent above, drooping, fragrant when crushed with an odor like sassafras; shrubs colonial, short (to 2 m tall)..... *L. melissifolia*

Lindera benzoin (Linnaeus) Blume, Northern Spicebush. Rich alluvial forests, mesic forests on slopes with circumneutral soils, bottomlands, swamps. March-April; August-September. ME, s. ON, and MI, south to Panhandle FL and e. TX; disjunct in Edwards Plateau of c. TX. Where occurring on upland slopes, *L. benzoin* is an excellent indicator of base-rich soils, generally derived from calcareous sedimentary rocks or mafic metamorphic or igneous rocks. Some floristic treatments recognize two varieties based on whether the leaves and young twigs are pubescent (var. *pubescens*) or not (var. *benzoin*) but the varieties so recognized overlap broadly in distribution; it seems best to regard this as mere variation within the species. [= FNA, GW, Pa, RAB, W, WV, Z; > *L. benzoin* var. *benzoin* – C, F, G, K; > *L. benzoin* (Linnaeus) Blume var. *pubescens* (Palmer & Steyermark) Rehder = C, F, G, K; = *Benzoin aestivale* (Linnaeus) Nees – S]

Lindera melissifolia (Walter) Blume, Southern Spicebush, Pondberry. Wet flats and depressions, generally with pocosin shrubs. March-April; August-September. This species is southern in range, with a very scattered distribution in se. and c. NC, e. SC, e. & sw. GA, nw. FL, sw. AL (?), nw. MS, se. MO-AR, and se. AR-LA (recent collections unknown from FL and LA). It is nearly extirpated in NC, currently known only from three populations, in Sampson, Bladen, and Cumberland counties. A historic record from Orange County, NC (in the lower Piedmont), collected by Elisha Mitchell in 1820 and 1822, appears to be bonafide (McVaugh, McVaugh, & Ayers 1996). [= FNA, K, WH, Z; = *L. melissaefolia* – RAB, F, GW, orthographic variant; = *Benzoin melissaefolium* (Walter) Nees – S]

Lindera subcoriacea B.E. Wofford, Bog Spicebush. Peaty seepage bogs in headwaters of blackwater streams, in the sandhills and immediately adjacent Piedmont, with other pocosin shrubs. March-April; July-August. The overall range of this newly described species is still poorly known; it appears to be a Southeastern Coastal Plain endemic, ranging from se. VA (perhaps s. NJ) south to FL and west to LA. Occurring in our area primarily in a scattering of small populations in the fall line Sandhills of NC and SC, with an outlier or two in "Piedmont pocosins" just west of the Sandhills. Distinctive characteristics of sun-grown plants include the rounded apex of the leaf, the leaf strongly whitened beneath and borne in an ascending to even appressed position in relation to the twigs, and a typically fastigiate or virgate branching pattern, with multiple stems or branches ascending vertically and nearly parallel to one another. Shade plants have a different form. [= FNA, K, Z; < *L. benzoin* – WH]



Litsea Lamarck 1792 (Pondspice)

A genus of about 400 species, trees and shrubs, of warm temperate and tropical areas, especially se. Asia and Australia. The genus is very heterogeneous and probably needs division into more natural groups. References: van der Werff in FNA (1997); Rohwer in Kubitzki, Rohwer, & Bittrich (1993).

Litsea aestivalis (Linnaeus) Fernald, Pondspice. Margins of limesink ponds and Carolina bays, less commonly in wet depressions and wet stringers dominated by shrubs. March-April; May-June. A Southeastern Coastal Plain endemic: e. MD (Wicomico County) and se. VA (York and Isle of Wight counties) south to n. FL (and allegedly also in LA, based on an old and poorly labeled specimen). The fine, zigzag twigs are distinctive. It grows to 6 m tall, characteristically forming a rounded bush. [= RAB, F, FNA, GW, K, WH]

Persea P. Miller 1754 (Bay)

A genus of about 150-200 species, trees and shrubs, of Asia and America. The avocado is a member of this genus, *Persea americana* P. Miller. References: Wofford in FNA (1997); Godfrey (1988); Clewell (1985); Rohwer in Kubitzki, Rohwer, & Bittrich (1993).

- 1 Twigs glabrous or glabrate; lower surfaces of leaves with minute, silvery to shining-golden hairs (the color depending on age), appressed to the surface; peduncles 1-3 cm long; leaves tending to be smaller and blunter *P. borbonica*
- 1 Twigs densely rusty-pubescent; lower surfaces of leaves with longer, rusty, often crooked hairs, not appressed, especially evident along the midrib and principal veins; peduncles 4-7 cm long; leaves tending to be larger and more acute *P. palustris*

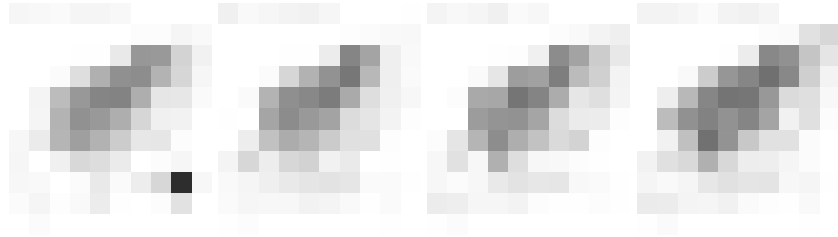
Persea borbonia (Linnaeus) Sprengel, Red Bay. Dunes, maritime forests, in dry sandy soils on barrier islands, known only north to Carteret County, NC. May-June; September-October. E. NC (Carteret County) south to FL and west to se. TX; reports of the species north of NC are based on the inclusion of *P. palustris* in a broadly defined *P. borbonia*, or are simply in error, based on less hairy plants of *P. palustris*. This species is rare north of Florida and becoming rarer with the destruction of most maritime and near coastal upland forests for the construction of vacation homes and tourist accommodations. [= FNA, G, GW, K, WH; < *P. borbonia* – RAB, F (also see *P. palustris*); = *Tamala borbonia* (Linnaeus) Rafinesque – S; = *P. borbonia* var. *borbonia*]

Persea palustris (Rafinesque) Sargent, Swamp Bay. Swamps, pocosins, bay forests, maritime forests, generally in wet peaty soils, but also in fairly dry, sandy soils in maritime forests. May-June; September-October. A Southeastern Coastal Plain endemic: DE, e. MD, and se. VA south to FL and west to se. TX; also in the Bahamas. Though variable in amount of hairs on the leaves, the hairs of *P. palustris* are always of a distinctly different character than those of *P. borbonia*. [= C, FNA, G, GW, K, WH; < *P. borbonia* – RAB, F; = *Tamala pubescens* (Pursh) Small – S; = *P. borbonia* var. *pubescens* (Pursh) Little]

Sassafras Presl 1825 (Sassafras)

A genus of 3 species, trees, of temperate e. Asia (2 species) and e. North America (1 species). References: van der Werff in FNA (1997); Rohwer in Kubitzki, Rohwer, & Bittrich (1993).

Sassafras albidum (Nuttall) Nees, Sassafras. A wide variety of forests, old fields, disturbed areas, fencerows. March-April; June-July. S. ME, s. ON, MI, and s. WI, south to c. peninsular FL, s. AL, s. MS, and se. TX. The original source of "root beer." [= RAB, C, FNA, G, K, Pa, W, WH; > *S. albidum* var. *molle* (Rafinesque) Fernald – F, WV; > *S. albidum* var. *albidum* – F, WV]



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