Flora of the Southern and Mid-Atlantic States

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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 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.
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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.
INTRODUCTION

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/fru肩tng 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:
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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 -- 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 Mb; 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 2007a, 2009, 2010) as FNA; Brown & Brown (1984) as Mb; 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.

Acknowledgments

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 regularly throughout the seasons, leaf duration can be difficult, especially on herbarium specimens. Meanwhile, 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 stock, with specialized structures for climbing and other deviations in growth form, such as 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 corrs) or from the very base (ground level) of an aerial stem. Stem leaves (cauleine 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 stalks (petioles, rachis, rachillae) that lack leaf tissue. Simple 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. Palamately compound leaves have all leaflets attached at a single point, at the end of the petiole. Palamately 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). Palamately compound leaves have leaflets attached to one or more axes (rachises, rachillae) that extend beyond the end of the petiole, and many taxa have 2 or more orders of division. Bibifoliate (2-foliolate) leaves are very rare in our flora. Trifoliate leaves (3-foliolate, and sometimes called “ternate”) are very common in our flora and can be either palamately 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 palamately 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 rachilla, 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, decompound, biernate, or other terms, but these have largely been avoided in the keys in this work because the “complexness” is often complex, mixed between pinnate and ternate, and therefore difficult to accurately distinguish. 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
KEYS TO FAMILIES AND GENERA

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 (biserate), or everted. 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 1/10th to 9/10th 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 3/10th 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 < 1/10th of the way to the midrib, and the tooth itself (measured on its shorter side if it is 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.

**Sleuthing 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 fruit. 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×). The number of carpels and locules can usually be determined from either the ovary or the immature or mature fruit, by making a careful ×-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 axes. The bulbus 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 deciduous 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 leaf keys available in print and online for the winter identification of trees and shrubs. Herbaceous plants with winter rosettes or otherwise green 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 leaf keys available in print and online for the winter identification of trees and shrubs.

**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).
### KEYS TO FAMILIES AND GENERA

<table>
<thead>
<tr>
<th>Leaf size</th>
<th>Lycophytes</th>
<th>Pteridophytes</th>
<th>Gymnosperms</th>
<th>Basal Angiosperms</th>
<th>Eudicots</th>
<th>Monocots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very small (&lt; 20 mm long), or linear quill leaves in Isoetes</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Typicaly many-merous, the segments borne spirally or in whorls</td>
<td>Typically 3-merous, the segments in whorls</td>
<td>Typically 3-merous, the segments in whorls</td>
</tr>
<tr>
<td>Typicaly 1-5× compound (1-5× compound), but also simple or variously less complicatedly compound</td>
<td>Usually Complexity compound (1-5× compound), but also simple or variously less complicatedly compound</td>
<td>Simple and scale-like or needle-like (or 1-pinnately compound in Zamia and Cycadaceae, and fan-shaped and dichotomously veined in Ginkgo)</td>
<td>Simple (or dichotomously compound in Cabomba)</td>
<td>Simple to complexity compound</td>
<td>Simple with few exceptions (except palmately or pinnately compound in Arisaema and palmately or pinnately compound in the giant leaves of Areaceae)</td>
<td></td>
</tr>
<tr>
<td>Leaves or leaflets never present</td>
<td>Leaves not lobed (leaflets never present)</td>
<td>Leaves and/or leaflets often lobed (diversely so)</td>
<td>Leaves or leaflets not lobed</td>
<td>Leaves not lobed (except the base sometimes cordate or auriculate)</td>
<td>Leaves and/or leaflets often lobed (diversely so)</td>
<td>Leaves or leaflets not lobed</td>
</tr>
<tr>
<td>Alternate, opposite, or whorled</td>
<td>Alternate, opposite, or whorled</td>
<td>Alternate, opposite, whorled, or fascicled</td>
<td>Alternate (rarely opposite, in cabomba, Calycanthus, and Asarum)</td>
<td>Alternate, opposite, or whorled</td>
<td>Almost always alternate (rarely opposite or whorled)</td>
<td></td>
</tr>
<tr>
<td>Cauline scale leaves (basal quill leaves in Isoetes)</td>
<td>Basal</td>
<td>Cauline (or basal in Zamia and Cycadaceae)</td>
<td>Cauline (or basal in Nymphaeaceae and Brasenia)</td>
<td>Cauline or basal</td>
<td>Cauline or basal</td>
<td></td>
</tr>
<tr>
<td>A single unbranched vein</td>
<td>Complex and variable, often with some dichotomous portions</td>
<td>Single midvein or several parallel (dichotomous in Ginkgo)</td>
<td>1° and 2° veins pinnate or palmate, ultimate veins netted or free</td>
<td>1° and 2° veins pinnate or palmate, ultimate veins netted or free</td>
<td>1° and 2° veins parallel or penni-parallel, smaller veins cross-veins at right angles</td>
<td></td>
</tr>
<tr>
<td>Spores, borne in sporangia auxiliary to scale leaves (or in Isoetes embedded in the base of quill leaves)</td>
<td>Spores, mostly borne on the undersurface of leaves, but also in a variety of specialized structures (but not as in Lycophytes)</td>
<td>Seeds, borne naked on scales, or in berry- or drupe-like structures</td>
<td>Seeds, borne in fruits</td>
<td>Seeds, borne in fruits</td>
<td>Seeds, borne in fruits</td>
<td></td>
</tr>
<tr>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Typically many-merous, the segments borne spirally or in whorls</td>
<td>Typically 4-5-merous (sometimes many), the segments in whorls</td>
<td>Typically 3-merous, the segments in whorls</td>
<td></td>
</tr>
<tr>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Typically &gt; 6 (rarely 1-6)</td>
<td>Typically 4-5 or 1-2, sometimes many, very rarely 3</td>
<td>Typically 3 (rarely 1, 2, 4, or 6)</td>
<td></td>
</tr>
<tr>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Usually separate (sometimes fused)</td>
<td>Usually fused, sometimes separate</td>
<td>Always fused</td>
<td></td>
</tr>
<tr>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Perianth segments typically separate (fused in Nymphaeaceae or Aristolochiaceae)</td>
<td>Perianth segments often fused, but also often separate</td>
<td>Perianth segments typically separate (fused in Nymphaeaceae or Aristolochiaceae)</td>
<td></td>
</tr>
<tr>
<td>Key</td>
<td>Description</td>
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<tr>
<td>A1</td>
<td>Pteridophytes reduced to thalloid or filamentous, free-living gametophytes</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>A2</td>
<td>Gymnosperms, Monocots, and Eudicots</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>Ferns, pteridophytes, and Cephalodendron</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>A4</td>
<td>Gymnosperms, Monocots, and Eudicots</td>
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<tr>
<td>A5</td>
<td>Gymnosperms, Monocots, and Eudicots</td>
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<tr>
<td>A6</td>
<td>Gymnosperms, Monocots, and Eudicots</td>
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</tr>
<tr>
<td>A7</td>
<td>Medium to large terrestrial pteridophytes</td>
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<tr>
<td>B1</td>
<td>Bryophytes</td>
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</tr>
<tr>
<td>B2</td>
<td>Ginkgo</td>
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<tr>
<td>B3</td>
<td>Gymnosperm trees and shrubs with scale or needle leaves</td>
<td></td>
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<tr>
<td>C1</td>
<td>Floating aquatics</td>
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<tr>
<td>C2</td>
<td>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)</td>
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<tr>
<td>D1</td>
<td>Plants rosette shrubs or shrubs, the leaves strongly basally disposed and few to many, the above-ground stem stout (&gt; 1 cm in diameter), usually &lt; 1 dm tall; leaf arrangement alternate, opposite, or whorled.</td>
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<tr>
<td>D2</td>
<td>Leaves “fern-like”, 1-pinnate-pinnatifid or more divided, deciduous; plants lacking both flowers and seeds, reproducing by spores; [Pteridophytes]</td>
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<tr>
<td>D3</td>
<td>Leaves either simple, 1-pinnate, or palmately compound, evengreen; plants bearing seeds, with or without flowers; [Gymnosperms, Monocots, and Eudicots]</td>
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<tr>
<td>D4</td>
<td>Leaves simple or palmately compound; [Monocots and Eudicots]</td>
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<tr>
<td>E1</td>
<td>Angiosperm shrubs and shrubs with basal leaves</td>
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<tr>
<td>E2</td>
<td>Plants trees, shrubs, or lianas, the leaves usually many and cauline (borne along the stem), the above-ground stem usually &gt; 2 dm long, if shorter, then not stout (&lt; 0.5 cm in diameter); leaf arrangement alternate, opposite, or whorled.</td>
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<tr>
<td>F1</td>
<td>Woody angiosperms with alternate, compound leaves</td>
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<tr>
<td>F2</td>
<td>Leaves compound; [Eudicots and Monocots]</td>
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<tr>
<td>F3</td>
<td>Leaves simple; [Eudicots, Basal Angiosperms, and Monocots]</td>
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<tr>
<td>G1</td>
<td>Woody angiosperms with alternate, simple leaves</td>
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<tr>
<td>G2</td>
<td>Leaves alternate; [Eudicots, Basal Angiosperms, and Monocots]</td>
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<tr>
<td>G3</td>
<td>Leaves compound; [Eudicots and Monocots]</td>
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<tr>
<td>G4</td>
<td>Leaves simple; [Eudicots, Basal Angiosperms, and Monocots]</td>
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<tr>
<td>H1</td>
<td>Woody angiosperms with whorled leaves</td>
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<tr>
<td>H2</td>
<td>Leaves whorled</td>
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<tr>
<td>H3</td>
<td>Leaves opposite</td>
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<tr>
<td>I1</td>
<td>Woody angiosperms with opposite, compound leaves</td>
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<tr>
<td>I2</td>
<td>Leaves compound</td>
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<tr>
<td>I3</td>
<td>Leaves simple</td>
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<tr>
<td>J1</td>
<td>Woody angiosperms with opposite, simple leaves</td>
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<tr>
<td>J2</td>
<td>Leaves compound</td>
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<tr>
<td>J3</td>
<td>Leaves simple</td>
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<tr>
<td>K1</td>
<td>Woody angiosperms with opposite, compound leaves</td>
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<tr>
<td>K2</td>
<td>Leaves compound</td>
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<tr>
<td>K3</td>
<td>Leaves simple</td>
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<tr>
<td>L1</td>
<td>Woody angiosperms with opposite, simple leaves</td>
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<tr>
<td>L2</td>
<td>Leaves compound</td>
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<tr>
<td>L3</td>
<td>Leaves simple</td>
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<tr>
<td>M1</td>
<td>Monocots</td>
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<tr>
<td>M2</td>
<td>Eudicots and Basal Angiosperms</td>
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</tr>
</tbody>
</table>

Additional notes:

- Plants aquatic, 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.
- 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.
- Plants completely lacking chlorophyll (white, pink, orange, tan, red), strictly parasitic or mycotrophic; [Eudicots and Monocots].
- 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).
- Plants reproducing by spores; [Lycophytes and Pteridophytes].
- Plants reproducing by seeds, developing in fruits derived from flowers; [Gymnosperms, Basal Angiosperms, and Monocots].
- 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.
- 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).
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 epipteric on vertical or overhanging bedrock; [Pteridophytes] ]

2 Leaves linear, grass-like, 1-60 cm long, 20× or more as long as wide.

3 Leaves not "fern-like," unlobed, variously awl-shaped, scale-like, or terete; [Lycophytes or Pteridophytes].

4 Leaf blades medium to large, > 30 cm long or wide.

5 Terrestrial, growing in soil, not associated with rock outcrops ...

6 Epipetric or epiphytic, growing on rock, tree bark, walls, or over rock in thin soil mats or in small soil pockets, or on tree trunks ...

7 Leaf blades medium to large, > 30 cm long or wide.

8 Epipetric or epiphytic, growing on rock, tree bark, walls, or over rock in thin soil mats or in small soil pockets, or on tree trunks...

9 Leaf blades (not including the petiole) small, < 30 cm long or wide (some species will key either here or in the next lead).

10 Plants with creeping rhizomes; leaves few, reduced to a winged petiole ... 

11 Plants cormose or with short rhizomes; leaves numerous, undivided leaves .................[Isoetes] ISOETACEAE (L2)

12 Plants with creeping rhizomes; leaves few, reduced to a winged petiole .................[Phylaria] MARSILEACEAE (F16)

13 Leaves opposite.

14 Leaves compound..............

15 Leaves simple..................

16 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).

17 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"])

18 Leaves compound..............

19 Leaves simple..................

20 Leaves alternate.

21 Leaves compound..............

22 Leaves simple..................

24 Leaves opposite.

25 Leaves compound..............

26 Leaves simple..................

27 Leaves opposite.

28 Leaves compound..............

29 Leaves simple..................

30 Leaves opposite.
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 SCHIZACEAE), 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.

4 Leaves either straight and stiff or notably spiral-curlly, 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-curlly; plants terrestrial in peaty substrate, the leaves erect...........[Schizaea] SCHIZACEAE (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 narrow scales (< 1.5 mm long), the internodes much longer than the leaves; sporangia yellowish, 3-locular, < 1 mm in diameter; stems upright, repeatedly branched dichotomously;

6 Leaves either larger or, if scale-like, with nerves and with 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; [Lycopodium].

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

9 Sori on the undersurface of the leaf, marginal and more-or-less hidden beneath either the unmodified revolute leaf margin or

9 Sori on the undersurface of the leaf, located away from the margins

9 Plant with 1 (-2) leaves, 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). [Daidymoglossum] HYMENOPHYLLACEAE (F9)

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

10 Sori on the undersurface of the leaf, marginal and more-or less hidden beneath either the unmodified revolute leaf margin or

10 Sori on the undersurface of the leaf, located away from the margins

Hymenophyllaceae (F9)

11 Leaf blade narrowly triangular in outline, ca. 1× as long as wide.

11 Leaf blade concave in outline, the basal pinnae 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)

12 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

12 Sori not marginal, either exposed, or slightly to strongly hidden by indusia.

Key A4 – small ‘fern-like’ pteridophytes, epiphytic or epiphytic, growing on rock, tree bark, or walls
KEYS TO FAMILIES AND GENERA

13 Leaf blades 3-12 cm long; sori elongate, covered by a flap-like, entire indusium.................. [Asplenium] ASPLENIACEAE (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; pectioles 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 sepalate hairs, which extend out from under the sorus on all sides; pectioles 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, as broad as long.
7 Sporangia borne on normal leaf blades..................................................[Gymnocarpium] CYSTOPTERIDACEAE
7 Sporangia borne on a 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 rachis-like, 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, unifying upwards into 1 ~shaped bundle .............................................................[Asplenium platyneuron] ASPLENIACEAE (F35)
11 Sori round; leaf blades monomorphic (or slightly dimorphic in Cystopteris); the larger leaf blades 5-15 cm wide; petiole with 2 vascular bundles, unifying upwards into 1 U-shaped or V-shaped bundle.
12 Leaf venation nearly lacking (if present, not of unincellular acicular hairs or gland-tipped hairs)...........................................................................................................[Cystopteris] CYSTOPTERIDACEAE
12 Leaf venation of unincellular 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, epiphytic 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 by a reflected 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] ASPLENIACEAE (F35)
4 Sori circular or globular, the indusium peltate, reniform, or cuplike; leaf blades > 5 cm wide when > 30 cm long.
5 Leaves pinnatifid..................................................[Pteris] PTERIDACEAE (F31)
5 Leaves 1-pinnate or 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)
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 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 usually 4-20 mm long and 2-10 mm wide

3 Leaves 2-pinnate-pinnatifid; indusium flap-like, pocket-like, or hood-like, attached at one side of the sorus and arching over it

4 Leaves 4-9 cm wide, the tip acute to acuminate; indusium pocket-like or hood-like

5 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

6 Leaves 5-25 (-30) cm wide, with scales and minute glands (sometimes also with sepalate hairs); [native species].

7 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

8 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

9 Leaves 2-pinnate-pinnatifid; indusium cup-like, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments

10 Leaves 5-25 (-30) cm wide, with scales and minute glands (sometimes also with sepalate hairs); [native species].

11 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

12 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

13 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

14 Vascular bundles 2 in the petiole (or uniting near the leaf blade into 1).

15 Leaves 2-pinnate-pinnatifid; indusium flap-like, pocket-like, or hood-like, attached at one side of the sorus and arching over it.

16 Leaves 1-pinnate-pinnatifid; indusium cup-like, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments

17 Leaves 10-30 cm wide, the tip acute to acuminate; indusium flap-like ............... [Athyrium] ATHYRIACEAE (F40)

18 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

19 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

20 Leaves 2-pinnate-pinnatifid; indusium flap-like, pocket-like, or hood-like, attached at one side of the sorus and arching over it.

21 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

22 Leaves 1-pinnate-pinnatifid; indusium cup-like, attached beneath the sorus and consisting of 3-6 lanceolate to ovate segments

23 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

24 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

25 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

26 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

27 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

28 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

29 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

30 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

31 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

32 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

33 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

34 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

35 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

36 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

37 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

38 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

39 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

40 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

41 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

42 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

43 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

44 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

45 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

46 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

47 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)

48 Leaves 4-9 cm wide, the tip long-attenuate; indusium pocket-like or hood-like

49 Leaves 25-65 cm wide, with whitish, straight, acicular hairs; [species adventive and weedy] ................................................................................................................... [Macrothelypteris] THELYPTERIDACEAE (F35)
KEYS TO FAMILIES AND GENERA

9 Rhizomes short-creeping, the leaves clustered, not forming clonal patches; vascular bundles in the lower petiole 2-7 (sometimes unifying to 1 in the upper petiole); sorus 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 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 (obtusa)] 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)

15 Leaves 1-pinnate-pinnatifid or less divided, the pinnae entire, toothed, lobed or pinnatifid.

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)

17 Rhizomes short-creeping, the leaves clustered, forming clonal patches.

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)

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)

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 Osmunda 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); racines 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 < ½ 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 > ½ 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 tall); 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; racines 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] ASPLENIACEAE (F33)

23 Petiole and rachis green; fertile leaves 10-20 (-30) cm wide.

24 Leaves 1-pinnate-pinnatifid (the pinnae pinnatifid)..........................................................[Homalosorus] DIPLAZIOPSISIDACEAE (F34)

24 Leaves 1-pinnate (the pinnae entire). ..............................................................................[Deparia] ATHYRIACEAE (F40)

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 NPHROLEPIDACEAE); indusium peltate (Polystichum in DRYPOTERIDACEAE) or reniform or crescent-shaped (Nephrolepis in NPHROLEPIDACEAE).

26 Leaves dark-green, subcoriaceous to coriaceous; pinnae neither articulate nor deciduous with age; rhizome not producing stolons; [native, common] ..........................................................[Polystichum] DRYPOTERIDACEAE (F44)

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] DRYPOTERIDACEAE (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]
<table>
<thead>
<tr>
<th>Key B1 – cycads</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pinnae with a single, thick and prominent midrib</td>
</tr>
<tr>
<td>1 Pinnae with many parallel veins</td>
</tr>
</tbody>
</table>

Key B2 – ginkgo

One family and genus: [Ginkgo] GINKGOACEAE (G3)

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

<table>
<thead>
<tr>
<th>Key B3 – gymnosperm trees and shrubs with scale or needle leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Leaves opposite or in whorls of 3.</td>
</tr>
<tr>
<td>2 Leaves needle-like or scale-like, &lt; 5 mm wide, evergreen (seasonally deciduous in Larix and Taxodium)</td>
</tr>
</tbody>
</table>

Key C – aquatics

<table>
<thead>
<tr>
<th>Key C – aquatics</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
</tr>
<tr>
<td>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)</td>
</tr>
<tr>
<td>2 Leaves or leaf-like stems basal, or arising in clusters from along a buried rhizome.</td>
</tr>
<tr>
<td>3 Leaves variously compound or divided</td>
</tr>
<tr>
<td>3 Leaves or leaf-like stems simple.</td>
</tr>
<tr>
<td>4 Leaves broadly, usually long-petiolate, with strong differentiation between petiole and blade, the blade margins not parallel, the blade &lt; 6x as long as wide and &gt; 2.5 cm wide</td>
</tr>
<tr>
<td>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 &gt; 10x as long as wide and &lt; 2 cm wide</td>
</tr>
<tr>
<td>2 Leaves cauline.</td>
</tr>
<tr>
<td>5 Leaves variously compound or divided</td>
</tr>
<tr>
<td>5 Leaves simple.</td>
</tr>
<tr>
<td>6 Leaves alternate</td>
</tr>
<tr>
<td>6 Leaves opposite or whorled</td>
</tr>
</tbody>
</table>

Key C1 – floating aquatics

<table>
<thead>
<tr>
<th>Key C1 – floating aquatics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Individual leaves &gt; 2 cm wide.</td>
</tr>
<tr>
<td>2 Leaves obovate, cuneate at the base, sessile, pale green; plants floating because of “unwettable” leaf surfaces</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>3 Petiole terete, not air-filled; plants floating because of inflated cells centrally located on each leaf (most easily seen on the lower surface)</td>
</tr>
</tbody>
</table>
3 Leaves pinnately compound.
4 Leaves palmately 4-foliolate, with very clear differentiation of the long petiole from the 4 leaflets.

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

1 Leaves peltate.
2 Leaves more or less pinnate or palmate.
3 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.
4 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.).
5 Leaves small, < 8 cm in diameter, at maturity emersed or submersed.
6 Inflorescence diffuse, a raceme or panicle with whitish flowers, or a linear spadix of tightly packed golden-yellow flowers.
7 Inflorescence tight with flowers, an elongate, golden yellow spadix; leaves blue-green, “unwettable”.
8 Inflorescence a spike.
9 Flowers 4-5-merous; stamens 3-4.
10 Flowers 4-5-merous; stamens 3-4.
11 Flowers 3-merous or many (>5) -merous; stamens 3.
12 Flowers 3-merous or many (>5) -merous; stamens 3.

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

1 Leaves palmately 4-foliolate, with very clear differentiation of the long petiole from the 4 leaflets.
2 Leaves pinnately compound.
3 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.
4 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.).
5 Leaves small, < 8 cm in diameter, at maturity emersed or submersed.
6 Inflorescence diffuse, a raceme or panicle with whitish flowers, or a linear spadix of tightly packed golden-yellow flowers.
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8 Inflorescence a spike.
9 Flowers 4-5-merous; stamens 3-4.
10 Flowers 4-5-merous; stamens 3-4.
11 Flowers 3-merous or many (>5) -merous; stamens 3.
12 Flowers 3-merous or many (>5) -merous; stamens 3.

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; plants tufted or with very short rhizomes; [Lycoptera].
3 New leaves unfurling with circinate vernation (a fiddlehead); plants reproducing by spores, from sporocarps on short stalks from the rhizome; [Lycoptera].
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 3; petals 3; stamens 4; [Lycoptera].
6 Sepals 5; petals 5; stamens 4; [Lycoptera].
7 Flowers 3-merous or many (>5) -merous; stamens 3.
8 Flowers 3-merous or many (>5) -merous; stamens 3.
9 Flowers 3-merous or many (>5) -merous; stamens 3.
10 Flowers 3-merous or many (>5) -merous; stamens 3.
11 Flowers 3-merous or many (>5) -merous; stamens 3.
12 Flowers 3-merous or many (>5) -merous; stamens 3.

| Family | Example
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KEYS TO FAMILIES AND GENERA

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).
2 Floating or emersed leaves cuneate to rounded at base.
2 Floating leaves peltate .......................................................................................................................................
3 Floating or emersed leaves elliptic or suborbicular.
4 Leaves emersed, lanceolate to narrowly elliptic; flowers 5-merous; [Eudicots] ...........................................................................................................................................[Trapa] HYDROCHARITACEAE
4 Leaves emersed or floating, suborbicular or elliptic (if emersed, then suborbicular; flowers 3-merous; [Monocots].
5 Leaves emersed, suborbicular ......................................................................................................................[Eichhornia] PONTEDERIACEAE
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 2-3.5 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 stipes); inflorescence various, but not as above.
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 involucrate head; [Eudicots].

3 Leaves along stem at 2-many nodes; plants of fresh to brackish waters; [collectively widespread].

4 Flowers 4- or 5-merous; [Monocots].
5 Leaves (or at least leaf sheaths) serrate or minutely spiny; fruits sessile, entire; leaves 5-15× as long as wide .............. [Najas] HYDROCHARITACEAE
6 Leaves (including sheaths) entire; leaf stalked, dentate on one side; leaves >20× as long as wide .............. [Zannichellia] HYDROCHARITACEAE
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
9 Flowers radially symmetrical, 3-4-merous; petals absent or separate
10 Stems lacking ridges running down from leaf bases .........................................................[Elatine] ELATINACEAE
11 Stems with ridges running down from leaf bases .........................................................[Didiplis, Rotala] LYTHRACEAE

12 Plants pubescent (at least on the upper stem); leaves pinnately veined; [Eudicots] ............. [Hydroclea] HYDROCHARITACEAE
13 Inflorescences of flowers solitary or in 2-4 flowered racemes, axillary; spathe lacking; perianth conspicuous with 3 pink to purple petals ........................................................................... [Murdannia] COMMELINACEAE
14 Inflorescence a spike, terminal or axillary; with or without a spathe; perianth lacking.
15 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]
16 Plants with nodes running down from leaf bases; leaves pinnately veined; [collectively widespread].

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

1 Leaves opposite, no nodes with 3 or more leaves.
2 Leaves in 2-3 pairs, appearing verticillate; plants of marine waters; [of FL, MS, LA and southward] ........................................ 
3 Leaves with a midvein; perianth parts 0 or 4, variously colored (not yellow).

4 Flowers radially symmetrical, 3-4-merous; petals absent or separate
5 Hydrilla; leaves filiform, terete or nearly so; stipules present, adnate to the leaf base and forming a sheath around the stem > 10 mm long.
6 Stipule free at its tip, the sheathing portion not appearing inflated; flowers > 2, in an interrupted spike ..................................................... [Stuckenia] POTAMOGETONACEAE
7 Stipule adnate its entire length to the leaf base, appearing inflated; flowers usually 2, on a flexuous, elongate peduncle .............. [Ruppia] RUPPIACEAE
8 Leaves flat; stipules absent, or if present, either free or adnate to the leaf base and forming a sheath for < 10 mm.
9 Leaves lacking a midvein; perianth parts 6, yellow .................................................................................. [Heterantha] PONTEDERIACEAE
10 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].
11 Leaves tipped by a callus (visible at 10× magnification); leaf margins entire; flowers many, grouped in a terminal involucrate head; [Eudicots].
12 Leaves filiform, terete or nearly so; stipules present, adnate to the leaf base and forming a sheath around the stem > 10 mm long.
13 Inflorescence a cylindrical, interrupted spike, lacking a spathe; leaves either parallel-margined or variously or 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] ........................................ 
16 Leaves with a rounded apex; flowers in a flattened spike sheathed by a spathe-like bract; [from e. NC northward].....

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].
2 Leaves simple or 3-foliolate; leaves < 9 dm long and < 2 dm wide; [Eudicots or Monocots].
KEYS TO FAMILIES AND GENERA

1 Leaves trifoliolate.

2 Plant a liana, climbing by twining, by tendrils, or by adventitious roots.

3 Leaves untoothed and unlobed. .......................................................................................................................... [Lackeya] FABACEAE

4 Leaves coarsely toothed or lobed.

5 Leaves toothed; flowers white (to pale pink) ................................................................................................. [Galax, Shortia] DIAPENSIACEAE

6 Leaves entire; flowers bright pink. .......................................................................................................................... [Phemeranthus] MONTIACEAE

7 Leaves linear, terete in ×-section. ................................................................................................................... [Talipariti] TALIACEAE

8 Leaves elliptic, flat in ×-section. .......................................................................................................................... [Sibbidulium] ROSACEAE

9 Leaves simple.

10 Leaves with 5-many leaflets (poorly developed leaves in some species with only 3 leaflets).

11 Leaves 10-60 mm wide; capsules 25-80 mm long. .......................................................................................... [Yuca] AGAVACEAE

12 Leaves 4-10 mm wide; capsules 4-8 mm long. ............................................................................................... [Nolina] RUSCACEAE

13 Leaves either broader or distinctly fleshy and essentially terete in ×-section, < 2 dm long; flowers 5-merous; rosette subshrubs; [Eudicots].

14 Leaves trifoliolate. .............................................................................................................................................. [Sibbidulium] ROSACEAE

15 Leaves palmately or palmately-pedately compound.

16 Leaves palmately compound (all the leaflets attached at a single point).

17 Terminal leaflet with a petiolule. ................................................................................................................... [Rhus (aromatica), Toxicodendron] ANACARDIACEAE

18 Leaflets with serrate margins. .......................................................................................................................... [Eurythrina, Lespedeza] RUSCACEAE

19 Stems unarmed.

20 XXXX. ............................................................................................................................................................... [Eleutherococcus] ARALIACEAE

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

23 Plant a liana, climbing by tendrils ................................................................................................................... [Ampelopsis] VITACEAE

24 Plant a shrub or tree, not climbing.

25 Plant armed with prickles on the stem, and sometimes also on the axes and main veins of the leaves. .......................................................................................................................... [Aralia] ARALIACEAE

26 Plant unarmed.

27 Leaves oddly 2-pinnately compound, or more complexly compound than 1-pinnate.

28 Leaves pinnately, or palmately, or complexity compound.

29 Leaves pinnately, bipinnately, or complexity compound.

30 Leaves pinnately-trifoliolate, or more complexly pinnately compound than 1-pinnate.
21 Leaves 1-pinnately compound

23 Leaves even-pinnately compound (generally with 2 leaflets at the apex of the rachis, these obviously and symmetrically paired).

24 Leaves odd-pinnately compound (generally with a single leaflet at the terminus of the rachis).

25 Leaflets rounded to obtuse at the apex (or acute to acuminate in Gymnocladus); fruit a drupe; inflorescence a panicle with many, small, radially symmetrical flowers

26 Leaflets acuminate at the apex; fruit a drupe; inflorescence a panicle with many, small, radially symmetrical flowers

27 Leaflets armed with prickles or stipular or nodal spines; leaves often also with prickles.

28 Leaflets unarmed (leaflets with spinose margins in some species, or the stem with dense hispid hairs).

Gymnocladus below ....................................................................... [Pistacia] ANACARDIACEAE

29 Leaflets without stipules; plant a tree or tall shrub; leaves entire or obscurely crenate or serrate; plant a tree or tall shrub;

30 Leaflets serrate.

31 Leaflets crenate, the teeth rounded and often inconspicuous.

32 Leaflets (especially the basal and on the basalscopic side) with 1-5 large rounded teeth, each bearing a prominent dark yellow; fruit a capsule

33 Leaflets serrate.

34 Leaflets lacking 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, with conspicuous pellucid punctate glands...

35 Leaflets not aromatic when fresh, lacking pellucid punctate glands; leaves never with prickles on the rachis; leaflet apices rounded.

36 Leaflets (especially the basal and on the basalscopic side) with 1-5 large rounded teeth, each bearing a prominent dark yellow; fruit a capsule

37 Leaflets serrate.

38 Leaflets crenate, the teeth rounded and often inconspicuous.

39 Leaflets without stipules; flowers radially symmetrical, white, cream, or pink; stamens 10; fruit a legume.

40 Leaf 2-5 cm long, with 5-7 leaflets

41 Flowers radially symmetrical, stamens 4-5; fruit a drupe; leaves without stipules

42 Leaflets serrate.

43 Leaflets entire.

44 Leaflets serrate.

45 Inflorescences axillary.

46 Plant a tree, freely branched; thimble inner bark not brightly colored; flowers bisexual, 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.

47 Inflorescences terminal.

48 Flowers bilaterally symmetrical, papilionaceous (reduced in Amorpha to a single petal); stamens 10; fruit a legume; leaves with stipules.

49 Fruit an inflated capsule, 30-50 mm long; inflorescence a terminal thyrse; corolla yellow.

40 Leaf 2-5 cm long, with 5-7 leaflets

41 Flowers radially symmetrical, stamens 4-5; fruit a drupe; leaves without stipules

42 Leaflets serrate.

43 Leaflets entire.

44 Leaflets serrate.

45 Inflorescences axillary.

46 Plant a tree, freely branched; thimble inner bark not brightly colored; flowers bisexual, 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.

47 Inflorescences terminal.

48 Flowers bilaterally symmetrical, papilionaceous (reduced in Amorpha to a single petal); stamens 10; fruit a legume; leaves with stipules.

49 Fruit an inflated capsule, 30-50 mm long; inflorescence a terminal thyrse; corolla yellow.

40 Leaf 2-5 cm long, with 5-7 leaflets

41 Flowers radially symmetrical, stamens 4-5; fruit a drupe; leaves without stipules

42 Leaflets serrate.

43 Leaflets entire.

44 Leaflets serrate.

45 Inflorescences axillary.

46 Plant a tree, freely branched; thimble inner bark not brightly colored; flowers bisexual, 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.

47 Inflorescences terminal.

48 Flowers bilaterally symmetrical, papilionaceous (reduced in Amorpha to a single petal); stamens 10; fruit a legume; leaves with stipules.

49 Fruit an inflated capsule, 30-50 mm long; inflorescence a terminal thyrse; corolla yellow.

40 Leaf 2-5 cm long, with 5-7 leaflets

41 Flowers radially symmetrical, stamens 4-5; fruit a drupe; leaves without stipules

42 Leaflets serrate.

43 Leaflets entire.

44 Leaflets serrate.

45 Inflorescences axillary.

46 Plant a tree, freely branched; thimble inner bark not brightly colored; flowers bisexual, 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.

47 Inflorescences terminal.

48 Flowers bilaterally symmetrical, papilionaceous (reduced in Amorpha to a single petal); stamens 10; fruit a legume; leaves with stipules.

49 Fruit an inflated capsule, 30-50 mm long; inflorescence a terminal thyrse; corolla yellow.

40 Leaf 2-5 cm long, with 5-7 leaflets

41 Flowers radially symmetrical, stamens 4-5; fruit a drupe; leaves without stipules

42 Leaflets serrate.

43 Leaflets entire.

44 Leaflets serrate.

45 Inflorescences axillary.

46 Plant a tree, freely branched; thimble inner bark not brightly colored; flowers bisexual, 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.

47 Inflorescences terminal.

48 Flowers bilaterally symmetrical, papilionaceous (reduced in Amorpha to a single petal); stamens 10; fruit a legume; leaves with stipules.

49 Fruit an inflated capsule, 30-50 mm long; inflorescence a terminal thyrse; corolla yellow.

40 Leaf 2-5 cm long, with 5-7 leaflets

41 Flowers radially symmetrical, stamens 4-5; fruit a drupe; leaves without stipules

42 Leaflets serrate.

43 Leaflets entire.

44 Leaflets serrate.

45 Inflorescences axillary.

46 Plant a tree, freely branched; thimble inner bark not brightly colored; flowers bisexual, 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.

47 Inflorescences terminal.

48 Flowers bilaterally symmetrical, papilionaceous (reduced in Amorpha to a single petal); stamens 10; fruit a legume; leaves with stipules.

49 Fruit an inflated capsule, 30-50 mm long; inflorescence a terminal thyrse; corolla yellow.
KEYS TO FAMILIES AND GENERA

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). .......................................................... [see Poaceae, Key A]
   3 Leaves palmately lobed (3, 5, or more veins diverging from the base of the leaf blade into the lobes) .......................................................... [see Poaceae, Key A]

Key G1 – woody plants with alternate, simple, pinnately 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).
   2 Woody grasses (bamboos), infrequently flowering, with hollow stems .......................................................... [see Poaceae, Key A]
   3 Lianas, shrubs, or trees, not grasses, generally with solid stems.

Key G2 – woody plants with alternate, simple, palmately lobed 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) .......................................................... [see Poaceae, Key A]
   3 Leaves palmately lobed (3, 5, or more veins diverging from the base of the leaf blade into the lobes) .......................................................... [see Poaceae, Key A]

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

1 Lianas climbing by twining or by tendrils.
   2 Lianas climbing by adventitious roots ..................................................................................................................

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

1 Shrubs or subshrubs.
   6 Leaves entire............................................................................. [see Poaceae, Key A]
   6 Leaves serrate, crenate, serrulate, crenulate, or doubly serrate............................................................................. [see Poaceae, Key A]

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

1 Shrubs or subshrubs.
   6 Leaves entire............................................................................. [see Poaceae, Key A]

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

1 Trees.
   7 Leaves (entire sometimes ciliate or scabrous on the margin) ........ [see Poaceae, Key A]
   7 Leaves serrate, crenate, serrulate, crenulate, or doubly serrate............................................................................. [see Poaceae, Key A]

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

1 Trees.
   7 Leaves (entire sometimes ciliate or scabrous on the margin) ........ [see Poaceae, Key A]
   7 Leaves serrate, crenate, serrulate, crenulate, or doubly serrate............................................................................. [see Poaceae, Key A]

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 involucrate head.......................................................... [Santolina] ASTERACEAE
   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
   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. .......................................................................................... [Pavonia] MALVACEAE
   5 Leaves hastate, with 2 acute basal lobes, merely serrate towards the apex; [alien species, of s. GA southward] .......................................................... [Maclura] MORACEAE
   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..........................................................
   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 ..........................................................
   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

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. ..........................................................

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

1 Lianas climbing by twining or by tendrils. .......................................................... [Calycocarpum, Coccus, Menispermum] MENISPERMACEAE

2 Lianas climbing by twining or by tendrils. ..........................................................

2 Lianas climbing by tendrils. .......................................................... [Calycocarpum, Coccus, Menispermum] MENISPERMACEAE
1 Trees or shrubs.
6 Trees.
7 Leaves > 5 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..................
8 Leaf blades (3-) 5 (-7) lobed, to 15 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)................................. [Platane] 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.
12 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 entire.
3 Stems with well-developed prickles; tendrils paired, stipular (diverging from the leaf petiole above its base); [Monocots].............................. [Smilax] SMILACACEAE
4 Plant climbing by dense, reddish adventitious roots .................................................................................. [Hedera] ARALIACEAE
4 Plant climbing by twining or by tendrils.
5 Plant climbing by tendrils.......................................................... [Antigonon, Brunnichia, 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 thyrs 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.
9 Inflorescence a solitary, axillary flower.......................... [Schisandra] SCHISANDRACAE
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 pinnae, 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 pinnae 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 Menispernum), 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, Menispernum] MENISPERMACAE

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
1 Leaves deciduous.

2 Leaves > 10 mm long.

3 Leaves linear, > 15× as long as wide; [Monocots] Agavaceae

4 Leaves broader, < 15× as long as wide; [Eudicots, Basal Angiosperms, or Monocots].

5 Inflorescence solitary (Illicium) or variously branched, spicate, or fascicled, not an involucrete head.

6 Carpels separate; fruit an aggregate of follicles arranged in a whorl; fresh foliage very fragrant; [Basal Angiosperms].

7 Carpels fused; fruit a berry, drupe, acorn (nut), capsule, or legume; fresh foliage not strongly fragrant; [Eudicots and Monocots].

8 Ovary with 3 carpels; fruit a berry; [Monocots].

9 Ovary with 1, 2, 4, or 5 carpels; fruit a berry, drupe, capsule, legume, or nut; [Eudicots].

10 Leaves narrowly elliptic, broadest near the middle; fresh plants strongly fragrant with a citrus-like aroma; stems unarmed; fruit a drupe, with a single seed; [Eucalyptus, Laurus] Lauraceae

11 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, Liriodendron] Lauraceae

12 Leaves papilionaceous, bright yellow; fruit a legume; [Elaeagnus, Hovenia] Elaeagnaceae

13 Inflorescence a catkin; flowers unisexual; plants dioecious; [Salix] Salicaceae

14 Inflorescence 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; [Eggertia, Listera] Lauraceae

17 Leaves 20 cm long; stems armed; leaves have 6-9 leaflets; [Elaeagnus, Hovenia] Elaeagnaceae

18 Fruit a single-seeded drupe; leaves have 6-9 leaflets; [Elaeagnus, Hovenia] Elaeagnaceae

19 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; [Eucalyptus, Liriodendron].

20 Ovary inferior or half-inferior; inflorescence a solitary fascicle or raceme, or an axillary terminal raceme.

21 Fruit a spherical berry, with 10 or more seeds; [Gaylussacia, Vaccinium] Ericaceae

22 Fruit an elongate drupe (definitely longer than thick), with 1 seed.

23 Fruits spherical, < 10 mm long.
KEYS TO FAMILIES AND GENERA

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 Leaves < 3 cm wide, lacking punctate glands; fruit a 1-seeded nut or samara ............................. [Alnus, Corylus] BETULACEAE

26 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.

26 Leaves punctate-glandular on one or both surfaces; fruit a 1-seeded waxy drupe. .... [Morella, Myrica] MYRICACEAE

26 Leaves lacking punctate glands; fruit a capsule. .......................................................... [Sorbus] MALVACEAE

26 Flowers arrayed variously, but not in catkins; perianth present, conspicuous; fruit a 1-many-seeded capsule, pome, berry, or follicle.

27 Inflorescence an involucre head subtended by phylaries, 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 ...........................................

27 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.

28 Leaves > 5 mm wide; corolla with petals fused (distinct in Amelanchier, Aronia, Cheronemoea, Cytisus, Eriobotrya, Prunus, Rhodotypos) ROSACEAE

28 Leaves < 2.5 mm wide; corolla with petals distinct; plant creeping ...................................

28 Leaves flat, not fleshy; petals white or pale pink.

28 Leaves < 1.5 cm wide, finely toothed or entire; flowers with sepals and petals; [native species, collectively widespread and common].

28 Leaves fleshy, terete in -section; petals 5, bright pink .......................................................... [Talinum] TALINACEAE

28 Leaves deciduous.

28 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.

29 Subshrubs or dwarf shrubs, aboveground stems creeping or erect, < 15 cm tall; leaves evergreen.

30 Leaves 1.5-3 cm wide, coarsely toothed; flowers lacking sepals and petals; [alien species, sparingly naturalized or spreading in suburban situations]................................................................. [Pachysandra] BUXACEAE

30 Leaves < 1.5 cm wide, finely toothed or entire; flowers with sepals and petals; [native species, collectively widespread and common].

30 Leaves flat, not fleshy; petals white or pale pink.

30 Leaves < 2.5 mm wide; corolla with petals distinct; plant creeping ...................................

30 Leaves > 5 mm wide; corolla with petals fused (distinct in Chimaphila); plant creeping or erect.......................................................... [Chimaphila, Epigaea, Gaultheria, Vaccinium] ERICACEAE

30 Subshrubs, aboveground stems erect, > 30 cm tall; leaves evergreen or deciduous.

31 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

31 Inflorescence an axillary cluster; fruit > 4 mm in diameter

32 Leaves < 3 cm wide, lacking punctate glands; fruit a 1-seeded nut or samara ............................. [Alnus, Corylus] BETULACEAE

32 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.

32 Leaves punctate-glandular on one or both surfaces; fruit a 1-seeded waxy drupe. .... [Morella, Myrica] MYRICACEAE

32 Leaves lacking punctate glands; fruit a capsule. .......................................................... [Sorbus] MALVACEAE

32 Flowers arrayed variously, but not in catkins; perianth present, conspicuous; fruit a 1-many-seeded capsule, pome, berry, or follicle.

33 Inflorescence an involucre head subtended by phylaries, 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 ...........................................

33 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.

34 Leaves > 5 mm wide; corolla with petals fused (distinct in Amelanchier, Aronia, Cheronemoea, Cytisus, Eriobotrya, Prunus, Rhodotypos) ROSACEAE

34 Leaves < 2.5 mm wide; corolla with petals distinct; plant creeping ...................................

34 Leaves flat, not fleshy; petals white or pale pink.

34 Leaves < 1.5 cm wide, finely toothed or entire; flowers with sepals and petals; [native species, collectively widespread and common].

34 Leaves fleshy, terete in -section; petals 5, bright pink .......................................................... [Talinum] TALINACEAE

34 Leaves deciduous.

34 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.

35 Leaves > 5 mm wide; corolla with petals fused (distinct in Amelanchier, Aronia, Cheronemoea, Cytisus, Eriobotrya, Prunus, Rhodotypos) ROSACEAE

35 Leaves < 2.5 mm wide; corolla with petals distinct; plant creeping ...................................

35 Leaves flat, not fleshy; petals white or pale pink.

35 Leaves < 1.5 cm wide, finely toothed or entire; flowers with sepals and petals; [native species, collectively widespread and common].

35 Leaves fleshy, terete in -section; petals 5, bright pink .......................................................... [Talinum] TALINACEAE

35 Leaves deciduous.

35 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.
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] ITAECEAE

26 Stamens 10; ovary and capsule 3-locular; leaves ovate (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 either 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

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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

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 monoeccious; the male flowers in yellow to brownish catkins, the female flowers solitary or in small spikes; fruit a nut in a capsule (an acorn) ........................................................................................................ [Quercus] FAGACEAE

5 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 dehiscing 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 Persoon in LAURACEAE and Sideroxylon in SAPOTACEAE, to 30 cm long in Rhododendron in EICRACEAE); fruit either drupaceous, fleshy to dry, but not regularly dehiscent along sutures, or a capsule, dehiscing 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, dehiscing along 5 longitudinal sutures ................................................................. [Kalina, Rhododendron] EICRACEAE

6 Inflorescence axillary, a raceme, panicule, 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 silikly 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 obovateolate (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.
1 Leaves deciduous.

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]........................................................................................................[Magnolia (acuminata)] MAGNOLIACEAE

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; [Euphorbiaceae]........................................................................................................[Magnolia (grandiflora)] MAGNOLIACEAE

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........................................................................................................[Magnolia (lutea)] CANNABACEAE

11 Plants armed with nodal thorns; stamens 5 and staminodia 5, epipetalous; fruit a berry or drupe with 1 seed; flowers 5-merous ........................................................................................................[Magnolia (large leaved taxa, auriculate and not)] MAGNOLIACEAE

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.

12 Leaf base cuneate, rounded, truncate, suborbicular, or auriculate (with 2 small "earlobe-like" lobes at the base of the leaf blade), with (mid) vein from the base in Celtis in CANNABACEAE; leaf blade about as wide as long, or somewhat to much longer, 0.9-10× as long as wide.

13 Juncture of petiole and leaf blade 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 (5-7)........................................................................................................[Celtis] 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)........................................................................................................[Celtis] EUPHORBIACEAE

14 Leaves 0.9-1.4× as long as wide (some taxa key in both leads).

15 Stipule scars circumferential, forming a line around the twig; flowers and aggregate fruits solitary, terminal; [Basal Angiosperms]........................................................................................................[Celtis] CANNABACEAE

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]........................................................................................................[Magnolia (acuminata)] MAGNOLIACEAE

16 Leaf blade 3-6 cm long, 1-1.5× as long as the flexuous petiole........................................................................................................[Triadica] EUPHORBIEAE

16 Leaf blade 4-30 cm long, > 3× as long as the stiff petiole.

17 Petioles 1-5 (or more) 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 simple or absent; fruit a fleshy drupe........................................................................................................[Cotinus] ANACARDIACEAE

17 Petioles 1.5-80 cm long; [FL southward] ........................................................................................................[Ximenia] OLACACEAE

18 Fruit a nut in a cup (acorn)........................................................................................................[Quercus] FAGACEAE

18 Fruit a nut in a cupule (an acorn); flowers unisexual, greenish or brownish, individually inconspicuous, the male flowers borne in catkins........................................................................................................[Magnolia (tomentosa)] FAGACEAE

18 Fruit a drupe, 3-valved capsule, with 1 seed; flowers bisexual, white, conspicuous........................................................................................................[Magnolia (grandifolia)] STYRACACEAE

18 Fruit a dry, subglobose 3-valved capsule, with 1 seed; flowers bisexual, white, conspicuous........................................................................................................[Magnolia (acuminata)] MAGNOLIACEAE

19 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........................................................................................................[Magnolia (lutea)] CANNABACEAE

19 Plants bearing nodal thorns; leaves elliptic to obovate, 3-9 cm long, 1.5-4× as long as wide.

20 Plants unarmed (except spiny in MORACEAE); leaves various in shape, from broadest towards the base, near the middle, or towards the apex, 3-80 cm long, 1.3-10× as long as wide.

21 Sap clear, not viscid; sepals 4; petals 4, densely long-hairy on their upper (inner) side); fruit a yellow, 1-seeded drupe, 20-30 mm long; [FL southward] ........................................................................................................[Magnolia (acuminata)] MAGNOLIACEAE

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] ........................................................................................................[Cannabina] SAPOTACEAE

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.

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).

23 Fruit a spherical, dry drupe, 4-8 mm in diameter, with a single seed; leaf 1.5-6 cm wide........................................................................................................[Magnolia (acuminata)] MAGNOLIACEAE

23 Fruit a spherical, fleshy multiple, 80-120 mm in diameter; leaf 5-8 cm wide........................................................................................................[Magnolia (grandiflora)] MAGNOLIACEAE

24 Pubescence of the foliage simple or absent (except sometimes stellate in STYRACACEAE); flowers bisexual, conspicuous, borne variously, but not in catkins; fruit various.

24 Pubescence of the foliage stellate or downy (except sometimes stellate in EUPHORBIACEAE); flowers bisexual, stamens 4-7, not epipetalous

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 broaden towards the apex (> 0.6× of the way from the leaf blade base to apex) (except Magnolia acuminata, which is sometimes both broader, narrower, and broadest near the middle or towards the base); [Basal Angiosperms].

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 broaden towards the apex (> 0.6× of the way from the leaf blade base to apex) (except Magnolia acuminata, which is sometimes both broader, narrower, and broadest near the middle or towards the base); [Basal Angiosperms].

27 Flowers axillary, < 2 cm across, brown or maroon; perianth 3-merous, spiraled; fresh foliage with a strong musky odor; fruit a fleshy berry; leaves cuneate at the base; twigs lacking circumferential stipule scars at each node........................................................................................................[Magnolia (acuminata)] 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 (acuminata)] ANNONACEAE
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-arcing secondary veins; inflorescence a terminal corymb; leaves clustered at the tips of the twigs, agamospermy apparent pseudo-whorled; trichomes of the leaf underside predominating, simple or branched (some simple) (use at least 10× magnification); flowers 4-merous; fruit a blue drupe; small tree...

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28 Leaves with secondary veins more obscure and complexly branching to tertiary veins; inflorescence axillary (often on the previous year’s wood), solitary to variously fascicled, clustered, or in racemes; leaves arranged distichously along horizontal or arching twigs, not prominently clustered or pseudo-whorled (except often in *Cyrilla* in *CYRILLACEAE*, *Symlocos* in *SYMPLOCACEAE*, and *Nyssa* in *NYSSACEAE*); trichomes of the leaf underside usually 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 indescent 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, indescent, either longitudinally 2-4-winged or not winged.....[Halesia, Styx] 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, 2.5 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................................................................................................................................. [Corylus] 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........[Symlocos] 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 1-5, 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 (monoeccious); stamens 5-12; widest point of the leaf usually beyond or at the middle, the apex obtuse to strikingly and abruptly acuminate........................................................................................................................................[Nyssa] NYSSACEAE

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

1 Leaves evergreen.

2 Petiole flanged or winged, constricted at the base of the blade; 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, 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 Leaves 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, hemisphærica)] 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 androecious; 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 or branching or reticulating well before reaching the leaf margin; fruit various.
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 Leaves bisexual; 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 rejoicing 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 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 rejoins 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 eilate-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 berryle 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 ×-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; [Eucalyc.]
3 Plant a shrub, < 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).................................................................[Callitris] PINNONIACEAE
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.................................................................[Kalina] 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
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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] RANUNCLULACEAE
6 Leaves 1 (-3) foliolate; flowers blue, bilaterally symmetrical, biseriate, with green calyx and blue corolla .... [Vitex] LAMIACEAE
7 Leaves pinnately compound, bipinnately compound, or more complexly compound.
8 Plant a liana (woody vine).
9 Leaves 3-9-lobed, the margins generally serrate or sublobed; fruit either a drupe or a schizocarp of 2 samaroid mericarps (maple "keys").

Key J – woody plants with opposite, simple leaves

1 Leaves palmately compound.
8 Leaflets serrate; flowers white, yellow, or red; fruit a leathery capsule, 2-9 cm in diameter, 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).

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 < ½× as long as the leaf blade ........................................... [Viburnum (acerifolium)] ADOXACEAE
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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 upper side 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 serrate (not spiny), 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)........................................................................................................[Loniceru] 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 capular and with several seeds.
10 Flowers 4- or 5-merous; petals separate; fruit capsular, dehiscent, several-seeded; [collectively widespread in our area] ...............
10 Flowers 5-merous; petals fused; fruit indehiscent, 1-seeded; [montane, from e. TN, WV, and w. MD northwards in our area]...............

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 variably 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 drupe; flowers 5-merous, with a fused, tubular corolla..............................................................................[Loniceru] 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
15 Upright shrubs or trees, lacking any adaptations for climbing.
16 Leaves harshly scabrous on the upper surface; fruit a multiple of achenes; leaf venation pinnate but irregular...........................................
16 Leaves not scabrous; fruit a 2-4-seeded drupe; leaf venation neatly pinnate, the lateral veins nearly straight and parallel to one another.................................................................[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
17 Shrubs; leaves strictly opposite (or often a mix of alternate and opposite in RHAMNACEAE).
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, coryumbs, 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
25 Flowers many, in terminal racemes, panicles, or coryumbs; stamens 8–10 -30; stems brown, tan or gray.
25 Inflorescence a raceme; stamens 15-30.................................................................[Exochorda] ROSACEAE
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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 thryse .................................................. [Buddleja] SCROPHULARIACEAE
29 Petals 5; inflorescence a terminal panicle or an axillary cyme.
30 Inflorescence an axillary cyme .......................................................... [Callicarpa] LAMIAEAE
30 Inflorescence a terminal panicle .......................................................... [Kolkwitzia] LINNAEACEAE

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 YYYYY .......................................................................................... [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..........[Piperita, Thysanotella, Trachelospermum, Anguedenia, Vincia] 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............................................................ [Loniceria] 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................................................................. [Borrichia, 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 10x 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, or axillary or terminal, or staminate flowers in axillary pedunculate umbels; fruit a 1-seeded drupe; leaves acute to acuminate at the apex................................................................. [Buckleya, Nestria] 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 (?), 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), 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 ............... [Fragaria, 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................................. [Kalania, 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, Forsythia, Forsythia, Jasminum, Ligustrum, Osmanthus, Syringa] OLEACEAE

[add: [Lagerstroemia] LYTHRACEAE; [Punicia] 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 < 2 mm 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-arcing 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, >10x as long as wide; leaf undersurface with curly simple hairs; nectar glands present in the main vein axes 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, < 2x as long as wide; leaf undersurface with branched (dendritic or stellate) hairs; nectar glands absent........................................................................................................ [Paulownia] PAULOINIACEAE

[add [Pinus] RUBIACEAE, and others from spreadsheet]

Key K – holoparasites and holomyctrophes

1 Stems thin, flexible, twining, yellow to bright orange ................................................................. [Cuscuta] CONVOLVULACEAE

1 Stems erect, stiff, straight, variously colored (tan, red, violet, brown, white, pink).

2 Flowers radially symmetrical ......................................................................................................................... [Hypopitys, Monotropa, Monotropis] 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 Pleisterum, 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, Epipogus, Orobanche] ORBACHACEAE

Key L – epiphytic angiosperms

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

1 Stems yellow to bright orange, lacking leaves ........................................................................... [Cuscuta] CONVOLVULACEAE

1 Stems green or brown, with leaves (scale-like or larger).
KEY TO FAMILIES AND GENERA

2 Leaves opposite, orbicular or ob lanceolate, 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 Primary inflorescences of dense spikes, spadices, heads, or glomerules; perianth present, often very small and variously colored.

2 Leaf sheaths generally split lengthwise on the side opposite the leaf blade; leaves usually 2-ranked; stems round or flattened in ×-section, or compound, or palmately divided .............................................................. 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 Inflorescences of sparse spikes, spadices, heads, or glomerules; perianth present, very often 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 ........... [Crocosmia, Freesia, Gladiolus, Iris, Styraxchium] 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, exerted; inner 3 and outer 3 tepals equal in length; rhizomes at roots of fresh plants white to brown................. [Lophiola] NARTHÉCIACEAE

7 Inflorescence a terminal raceme (the flowers attached to the rachis in groups of 3 or more in Triuntha in TOFIELDIACEAE); corolla white, cream, or yellow, glabrous; roots white or brown.

9 Flowers yellow; capsule loculicidal ........................................................................................................ [Narthecium] NARTHÉCIACEAE

9 Flowers white (yellow in Harperocallis, endemic to FL Panhandle); capsule septicidal...................................................... [Harperocallis, Pleea, Tofieldia, Triuntha] 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] ERIOCULACEAE

12 Flowers in multiple heads, not scapose; leaves basal and usually also prominently cauleine; 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 ................................................................. [Orchis] ORCHIDACEAE

14 Flowers radially weakly bilaterally symmetrical; stamens 6 (rarely 3); tepals > 6× (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 cauleine.

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] ASPARAGACEAE
<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Leaves (at least the larger) &gt; 25 mm long, linear or narrowly lanceolate; leaves basal, basally disposed (or rarely mostly or entirely cauleine).</td>
</tr>
<tr>
<td>16</td>
<td>Ovary inferior (or partly inferior; ambiguous taxa keyed both ways).</td>
</tr>
<tr>
<td>17</td>
<td>Inflorescence axillary, a raceme or umbel (or reduced to a single flower); petaloid tepals yellow.</td>
</tr>
<tr>
<td>18</td>
<td>Inflorescence terminal; petaloid tepals various (including yellow).</td>
</tr>
<tr>
<td>19</td>
<td>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.</td>
</tr>
<tr>
<td>20</td>
<td>Stamens 3; inflorescence ebracteate, with &gt; 10 flowers; leaf without a terminal pore; carpels ascending, appressed to one another.</td>
</tr>
<tr>
<td>21</td>
<td>Stamens 3; inflorescence either a fan-shaped pair of cymes or seemingly racemose (or rarely solitary (e.g. Crocus) .......</td>
</tr>
</tbody>
</table>
1 Leaves compound.

2 Plants herbaceous; leaves palmately 3-foliolate or pedately compound into > 20 segments .................................................... [Arisaema, Pinellia] ARACEAE

2 Plants woody; leaves either palmately divided or pinnately compound into > 20 segments .................................................... [Camassia] AGAVACEAE

3 Leaves opposite or whorled, cauline.

4 Leaves opposite; flowers bilaterally symmetrical .............................................................. [Listeria] ORCHIDACEAE

5 Plant with 2 or more leaf-bearer nodes (all nodes whorled or some alternate).

6 Leaves broad, < 2x as long as wide, cordate at the base; flowers unisexual and plants dioecious ........................................................... [Dioscorea] DIOSCOREACEAE

7 Leaves lanceolate, obovate or narrowly elliptic, > 4x as long as wide, cuneate at the base; flowers bisexual and plants hermaphrodite ........................................................... [Listeria] ORCHIDACEAE

8 Leaves whorled; flowers radially or bilaterally symmetrical.

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 Crotalaria) .................................................... [Arum, Calla, Colocasia, Onontium, Peltandra, Symphocarpus, Xanthosoma] ARACEAE

10 Inflorescence a raceme; flowers bilaterally symmetrical; inflorescence lacking well-developed spathaceous bracts ........................................................... [Orchidaceae]

11 Inflorescence a raceme; flowers bilaterally symmetrical; flowers strongly to slightly bilaterally symmetrical; inflorescence lacking well-developed spathaceous bracts ........................................................... [Sweat Pea]

12 Flowers radialy symmetrical; stamens 6 (rarely 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. ................................. [Sweat Pea] ORCHIDACEAE

13 Ovary superior; fruit a capsule; stamens 6; [plants mainly of uplands (sometimes, Murdannia and sometimes Commelina, of wetlands)] ........................................................... [Callisia, Commelina, Gibasis, Murdannia, Tradescantia] COMELLINACEAE

14 Ovary inferior; fruit a berry; stamens 9 or 12 (or 15 or 18); [plants of wetlands] ........................................................... [Linum] HYDROCHARITACEAE

15 Inflorescence not subtended by spathes, though individual small green bracts sometimes subtending individual flowers.

16 Leaves 2 (rarely 3 in Convallaria in RUSCACEAE).
1 Leaves compound........................................[Convallaria] RUSCACEAE
2 Leaves 2-foliolate or palmately 4-11-foliolate (all the leaflets attached at a common point). [Jeffersonia] BERBERIDACEAE

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
3 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....[many] ASTERACEAE

1 Inflorescence a terminal umbel; fruit a blue or black berry; tepals white or yellow; flowers bisexual........................................[Clintonia] LILIACEAE
2 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 MELANTHACEAE)
3 Inflorescence ebracteate, lacking bracts subtending pedicels; flowers bisexual (Helonias) or predominantly unisexual and on different plants (dioecious) (Chamaelirium) or white to cream (Chamaelirium).................................................................[Helonias] HELONIADACEAE

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; auxiliary tendrils often present (absent in some species)...[Smilas] SMILACACEAE

Key N2 – herbaceous dicots with mainly basal, simple leaves

1 Leaves simple..................................................................................................................................[Key N2] – herbaceous dicots with mainly basal, simple leaves

25 Leaves arrayed spirally around an erect, unbranched stem; fruit a septicidal capsule; flowers a mixture of bisexual and unisexual (stamine) on a plant; perianth greenish white.........................[Veratrum] MELANTHACEAE

28 Stem brown, wavy, puberulent; distalmost 2 leaves on each branch approximated to one another (sometimes subopposite) and with noticeably oblique bases; flowers and fruits terminal on the branches.......................................................[Prosartes] LILIACEAE

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

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
7 Flowers bilaterally symmetrical; fruit a legume; [plant of uplands]..................................................[many] FABACEAE

18 Flowers in an umbel, white; fresh plants with oniony odor..............[Allium] LILIACEAE
19 Inflorescence a terminal umbel; fruit a blue or black berry; tepals white or yellow; flowers bisexual........................................[Clintonia] LILIACEAE
20 Inflorescence ebracteate, lacking bracts subtending pedicels; flowers bisexual (Helonias) or predominantly unisexual and on different plants (dioecious) (Chamaelirium) or white to cream (Chamaelirium).................................................................[Helonias] HELONIADACEAE

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 Leaves either entire or rarely 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
7 Flowers bilaterally symmetrical; fruit a legume; [plant of uplands]..................................................[many] FABACEAE

KEYS TO FAMILIES AND GENERA

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 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...

...........................................................................................................................................................................

[many] ASTERACEAE

15 Inflorescence, flower, and fruit structure various, but not with the combination of features as above.

16 Flowers bilaterally symmetrical; fruit a legume ............................................................... FABACEAE

17 Flowers radially symmetrical; fruit a silique/silicle, or a schizocarp of mericarps, or an achene.

16 Flowers radially symmetrical; fruit a legume ............................................................... FABACEAE

17 Petals 4; stamens 6; fruit a silique/silicle, or a schizocarp of mericarps, or an achene.

..................................................................................................................................................... [Cardamine] BRASSICACEAE

17 Petals 0 or 5 (if 0, the sepals petaloid); stamens 2, 4, 5, or many.

18 Stamens 2, 4, or many; fruit an achene .......................................................... [Coriandrum, Oxypolis, Pastinaca, Sium] APIACEAE

18 Stamens 2, 4, or many; fruit an achene .......................................................... [Poteridium, Poterium, Sanguisorba] ROSEACEAE

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.

..........................................................................................................................................................................

[Capnoideae, Corydalis, Dicentra, Fumaria] FUMARICACEAE

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

...................................................................................................................................................................

[Nigella, Thalictrum (coelevis)] RANUNCULACEAE

22 Carpels 5-10 or many, separate; fruit an aggregate; flower radially symmetrical

...................................................................................................................................................................

[Menyanthes] FUMARICACEAE

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] FUMARICACEAE

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

..................................................................................................................................................... [Caulopygium] 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;

[Actaea] SAXIFRAGACEAE

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 (monoeccious); 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 hermaphrodite), 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 hermaphrodite); carpels 1-8 per flower; inflorescence a panicle of achenes, 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] ROSEACEAE
KEYS TO FAMILIES AND GENERA

Key N2 – herbaceous dicots with mainly basal, simple leaves

1 Inflorescence an involucreate 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

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

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

6 Stamens many; sepals 2, petals 4; fresh plants with yellow, orange, or white milky juice...........[many] PAPAVERACEAE

7 Petals 4, distinct; stamens 6..............................................................[many] BRASSICACEAE

8 Corolla radially symmetrical; stamens 5..................................................[Hydrophyllum, Phacelia] BORAGINACEAE

9 Corolla 2-lipped but the corolla lobes twisted so as to make the flower asymmetrical; stamens 4..........................................................[Pedicularis] OROBANCHACEAE

10 Leaf lobing palmate.

11 Petiole attachment peltate.

12 Leaves < 10 cm in diameter............................................................[Hydrocotyle] ARALIACEAE

13 Leaves > 15 cm in diameter............................................................[Diphylleia, Podophyllum] BERBERIDACEAE

14 Ovary inferior.

15 Petiole attachment marginal.

16 Ovary superior.

17 Petals 4; stamens 8; fruit a capsule......................................................[Oenothera] ONAGRACEAE

18 Petals 5; stamens 5; fruit a schizocarp of 2 mericarps.

19 Fruit tubercululate; leaves 3-lobed....................................................[Eryngium (prostratum)] APIACEAE

20 Fruit smooth; leaves with 5 or more lobes ..............................................[Hydrocotyle] ARALIACEAE

21 Ovary superior, or half-inferior by fusion of a hypanthium a part of the way up the ovary wall.

22 Gynoecium of separate pistils (each with a single carpel); fruit an aggregate.

23 Perianth of 5 green sepalas and 5 colored petals.

24 Flowers bilaterally symmetrical; inflorescence a terminal spike (with > 20 flowers); petals 4, usually scarious, transparent; sepals 4, green; stamens 4..........................................................[Plantago] PLANTAGINACEAE

25 Flowers radially symmetrical; inflorescence either of a solitary flower or of a 1-7-flowered terminal cyme, or of a solitary axillary or terminal flower.

26 Flowers either of a single carpel with 6 carpels or of a single carpel 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.

27 Flowers brown, of 3 fused brown or greenish petaloid sepals (and 0 petals); carpels 6; stamens 12; leaves 4-10 cm wide...

28 Gynoecium of separate pistils (each with a single carpel); fruit an aggregate; perianth of 5 green sepalas and 5 colored petals.

29 Gynoecium of separate pistils (each with a single carpel); fruit an aggregate; perianth of 5 green sepalas and 5 colored petals.
KEYS TO FAMILIES AND GENERA

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 drupes 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-lobe capsule. [Viola] VIOLACEAE
32 Flowers radially symmetrical; inflorescence an umbel (or composite of umbel-like 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 siliqua. [Alliaria] BRASSICACEAE
34 Inflorescence a terminal panicle; perianth of 6 cream-colored sepals; fruit a siliculose. [Rheum] Polygonaceae

35 Petiole attachment peltate
35 Petiole attachment collateral (the blade cling to the petiole).

36 Leaf blades longer than wide, sharply V-cleft at the base and otherwise shallowly denticate. [Limosella] FAUVACEA
36 Leaf blades as broad or broader than long, cleft at the base and also irregularly serrate or crenate around the margin. [Centella] APIACEAE

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, phylloclad leaves sometimes present as well, common in the winter in some species, such as S. roepphila) [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 yellow, the upper lip often slightly to strongly maroon, hooded but the corolla lobes twisted so as to make the corolla asymmetrical. [Buchnera] ORBACEAE
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 white, lavender, or blue, 2-lipped and bilaterally symmetrical. [Pinguicula, Utricularia] LENTIBULARIACEAE
41 Sepals separate to the base or nearly so, not forming a tube. [Lindernia] LINERINACEAE
41 Sepals connate for at least 0.3× their length to form a tube. [Mazus] PHRYMACEAE

42 Petals separate; stamens 10. [Oenothera] ONAGRACEAE
42 Petals united for a short length (< ¼ its length). [Papaver] PAPAVERACEAE

43 Ovary superior.

44 Perianth 4-merous; stamens 8. [Galax] POLYGONACEAE
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

46 Ovary inferior (or half-inferior in Samolus).

47 Corolla radially symmetrical; stamens 5, 10, 4-6, or 9. [Myosurus] RANUNCULACEAE
47 Corolla lacking sticky gland-tipped hairs.

48 Stems 6-8 or 10.
49 Petals separate; stamens 10. [Hydatica] SAXIFRAGACEAE
49 Petals fused; stamens 10 or 6-8.
50 Stamens 10, monadelphous. [Polygala] POLYGALACEAE
50 Stamens 6-8, epipetalous. [Lindernia] LINERINACEAE

48 Stems 2 or 4.
51 Stems 2. [Pinguicula, Urnicularia] LENTIBULARIACEAE
51 Stems 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 8-petalled. [Eriogonum, Ranunculus] 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. [Dracera] DROSERAECES
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 siliqua/silicule (or uricle 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 (< ½ its length).
59 Leaves serrate. [Shortia] DIAPENSIACEAE
59 Leaves entire. [Parnassia] PARNASSIACEAE

57 Inflorescence of several to many flowers; carpels 5 (3 in Galax in DIAPENSIACEAE).
58 Inflorescence an umbel; petals recurved, pink to almost white. [Primula] PRIMULACEAE
58 Inflorescence a raceme or panicle.
KEYS TO FAMILIES AND GENERA

1 Leaves either 3-foliolate or palmately 4-11-foliolate (all the leaflets attached at a common point).
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 ............................................... 
   4 Corolla radially symmetrical; petals 4 or 5; fruit .......................... {many} FABACEAE
   5 Leaflets radially symmetrical; petals 4 or 5; fruit either an elongate capsule or a berry; carpels 1, 2 or 5 ...................................
   6 Carpels 2; fruit a red berry; petals connate, purplish-blue ........................................ {Solanum (dulcamara)} SOLANACEAE
   7 Carpels 1; fruit a capsule; petals separate, white, pink, or yellow; inflorescence terminal and racemose; carpels 1 or 2 .............................. 
   8 Carpels 2; fruit a red berry; petals connate, purplish-blue ............ 
   9 Carpel spiny; fruit a capsule, or a capsular schizocarp of 5 mericarps; pistil 1; fruit a capsule or a capsular schizocarp of 5 mericarps ........................... {Cardamine} BRASSICACEAE
   10 Carpel spiny; fruit a capsule, or a capsular schizocarp of 5 mericarps; pistil 1; fruit a capsule or a capsular schizocarp of 5 mericarps ........................................ {Cardamine} BRASSICACEAE
   11 Carpel spiny; fruit a capsule, or a capsular schizocarp of 5 mericarps; pistil 1; fruit a capsule or a capsular schizocarp of 5 mericarps ........................... {Cardamine} BRASSICACEAE
   12 Petals 4-5 ................................................................. 
   13 Petals 4, distinct; stamens 6; inflorescence a terminal raceme; fruit a silique/silicule .......................... 
   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
15 Fruit a berry; fresh plant rankly fragrant .......................... {Solanum (lycopersicum, tuberosum, others)} SOLANACEAE
16 Fruit a capsule; fresh plant not aromatic.
KEYS TO FAMILIES AND GENERA

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........... [Acacia, 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-mer 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), (Curculigo, Fumaria) FUMARIACEAE

20 Ovary of 1-5-mer 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

indeshiscent berry-like fruit.

24 Flowers bisexual; carpels 1-8; fruit an aggregate of follicles, a single follicle, or an indeshiscent berry-like fruit...........

......................................................................................................................... [Actaea] RANUNCULACEAE

24 Flowers unisexual; carpels (in pistillate flowers) of 3 (-5) carpels; fruit an aggregate of follicles.................

......................................................................................................................... [Anemone] ROSACEAE

25 Inflorescence an umbel; ovary inferior, of 2 fused carpels; fruit a schizocarp of 2 mericarps.........................

......................................................................................................................... [some, e.g. Taenia] 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........

.......................................................................................................................... [Adonis, 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

.......................................................... 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), some leaflets at least attached to second-order branches from the rachis.

17 Leaves 2× even-pinnate; flowers in spikes or spherical heads; XXXX........... [Acacia, 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-mer 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), (Curculigo, Fumaria) FUMARIACEAE

20 Ovary of 1-5-mer 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

indeshiscent berry-like fruit.

24 Flowers bisexual; carpels 1-8; fruit an aggregate of follicles, a single follicle, or an indeshiscent berry-like fruit...........

......................................................................................................................... [Actaea] RANUNCULACEAE

24 Flowers unisexual; carpels (in pistillate flowers) of 3 (-5) carpels; fruit an aggregate of follicles.................

......................................................................................................................... [Anemone] ROSACEAE

25 Inflorescence an umbel; ovary inferior, of 2 fused carpels; fruit a schizocarp of 2 mericarps.........................

......................................................................................................................... [some, e.g. Taenia] 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........

.......................................................................................................................... [Adonis, 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, and unlobed leaves on the stem

1 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...... [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 cyme, 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 cyme 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 cyme (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 opposite spike 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 glocheries, 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 glocheries, 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 cylinodra, 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] ARISTOLOCHIACEAE
11 Leaf base cuneate, rounded, or truncate; calyx of 3-5 distinct sepals, radially symmetrical, white or yellow; fruit a dry, nulike drupe or an achene.
12 Leaves subsessile or very short petiolate, elliptic or narrowly elliptic, broadest near the middle; [native]............................[Comandra] SANTALACEAE
13 Inflorescence of a single axillary flower.........................................................[Tetragonia] AZOACEAE
13 Inflorescence terminal, spike-like..........................................................[Beta] AMARANTHACEAE
10 Ovary superior.
14 Inflorescence a leaf-opposed (sometimes apparently terminal) spike or raceme; flowers visually white from white petaloid sepal, 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] PHOTOLACCEAE
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 cordinate or subcordate; plant an herb 1-12 dm tall, the stems usually green; [Basal Angiosperms].
16 Fruit a 1-seeded drupe; stamens 2; flowers visually white from white petaloid sepals..............................................................[Peperomia] PIPERACEAE
16 Fruit a capsule or schizocarp with 3-4 mericarps; stamens 3 or 6-8..............................................................[Hostunnia, 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, redish, scarious, or greenish.
17 Stipules tubular, sheathing (= ocreae); flowers subtended by tubular, sheathing bracteoles (= ocreoleae); 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 ocrealeae; 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] PHYLANTHACEAE
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, Suueda] AMARANTHACEAE
20 Styles 1, stigma 1; flowers unisexual..............................................................[Parietaria] URTICACEAE

Perianth biseriate (represented by differentiated whorls of sepal 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.........................................................[Sphenoloea] 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, Jasionne, Platycoodon, Troidanis, 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, Eupatorium, 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 Kramera 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 RESEDAEAE); fruit a legume or 1-, 2-, or 5-loculed capsule (except a 1-seeded indehiscent pod in Kramera 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 septicidal; pubescence of the stem and leaves either gland-tipped or dendritically branched ............................................................... [Verbasca] SCROPHULARIACEAE
31 Stamens 4; corolla with a distinct spur or sac at the base between the 2 lower calyx lobes (except not spurred in Digitalis and Schwalbea); capsule loculicidal (only at the summit in Antirrhinum and Chaenorhinum, and septicidal in Schwalbea); pubescence of the stem and leaves neither gland-tipped (except in Antirrhinum and Chaenorhinum) nor dendritically branched.
32 Capsule septicidal; corolla not spurred ................................................................. [Schwalbea] OROANCHACEAE
32 Capsule loculicidal; corolla spurred (except Digitalis) .............................................................. [Antirrhinum, Chaenorhinum, Digitalis, Kickxia, Linaria, Nuttallanthus, Plantago] PLANTAGINACEAE

[add under 28a: [Krameria] KRAMERIACEAE, [Macranthera, Striga] OROANCHACEAE]

29 Stamens 6-10-25, more than the number (4 or 5) of petals and the number (4 or 5) of the sepals; flower a legume or a 2-5-mericarpellate capsule.

30 Petals distinct; stamens 5-many.

37 Pistils 4-10 (each 1-3 carpellate) in a ring, these sometimes fused basally, each with its own style/stigma; flower 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, Sempernum] CRASSULACEAE
39 Fruit a 5 (-7) locular capsule; leaves membranous in texture; leaves serrate; plants of wet habitats ........................................................................................................ [Penthorum] PENTHORACEAE

40 Leaves many; inflorescence of solitary flowers, or diffuse.

41 Leaves cuneate at the base; flowers in a diffuse inflorescence ......................................... [Ranunculus] RANUNCULACEAE
40 Leaves coriaceous at the base; flowers solitary, on long pedicels ............................................ [Rabus (dahlbana)] ROSACEAE

41 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.

42 Leaves many, connate into a staminal tube; carpels 5-many; flower a capsule or ring of mericarps; leaves usually serrate ........................................................... [Aubatlon, Hibiscus, Malvastrum, Malvaviscus, Sida] MALVACEAE

42 Stamens 5-many, distinct; carpels 2-5; flower a capsule; leaves entire (serrate in Croton in EUHORBIACEAE).

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] EUHORBIACEAE

44 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 septicidal capsule ................................................................. [Lythrum] LYTHRACEAE
45 Flowers 5-merous, the petals and sepals 5, stamens 5 or various multiples of 5; corolla yellow, reddish, or blue; fruit a loculicidal or septicidal capsule.
45 Stamens 5; corolla yellow or blue; capsule 10-locular, septicidal............................................................................. [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 .............. [Crocanthemum, 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 .............................................................................................. [Amssincxia, 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 Pysidanthra in DIAPENSIACEAE, but then spreading); petals 5-7, stamens 5-7.
50 Leaves 2-8 mm long; plant a creeping shrub (keyed here as a failsafe) ....... [Pysidanthra] DIAPENSIACEAE
50 Leaves > 15 mm long; plant an herb, erect or sprawling.

51 Leaves cordate at the base; plant a twining vine .................................................................................. [Caustega, Convolvulus, Ipomoea, Jacquemontella] 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.
52 Corolla lobes longer than the fused corolla cup; 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.
KEYS TO FAMILIES AND GENERA

49

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] CONVOLVULACEAE
56 Stamens opposite the corolla lobes; flower ca. 1 mm in diameter.........................[Lysimachia] PRIMULACEAE
57 Flower with either solitary and obviously pedicelled, or several in an axillary inflorescence.
58 Flowering heads much larger than the fused corolla, blue..............................[Hydrodea] HYDROELEACEAE
59 Corolla lobes very much shorter than the corolla 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] CONVOLVULACEAE
58 Fruit a berry or capsule, many-seeded .................................................................[Atakekengi, 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 involucrate head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla conuate 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 containing 4 mericarps, etc.).
2 Plant a vine, climbing by tendrils or twining.
3 Vine climbing by tendrils.
4 Leaf margins entire; flowers bisexual; plants hermaphroditic; petals connate, large and showy ..............................................................[Merremia, Ipomoea] CONVOLVULACEAE
4 Leaf margins serrate; flowers unisexual; plants dioecious; petals absent...........................................[Humulus] CANNABACEAE
3 Vine climbing by tendrils.
5 Ovary inferior; petals connate; flowers unisexual.............................................................................[Cucurbitaceae] 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] RALILLACEAE
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 Cnidoscolus); flowers unisexual; plants either with stinging hairs or not ...............................................................[Cnidoscolus, Ricinus] EUPHORBIACEAE
8 Perianth biseriate (uniseriate in Aphanes in ROSACEAE and in Trautvetteria in RANUNCULACEAE); flowers bisexual; plants lacking stinging hairs.
9 Pistil 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 hypophylum; achenes short-beaked ..................................................................[Ranunculus] RANUNCULACEAE
12 Flowers with a prominent hypophylum; 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...............[Proboscidaria] MARTYNIAEACEAE
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
18 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] CONVOLVULACEAE
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
KEYS TO FAMILIES AND GENERA

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

1 Inflorescence an involucrate head subtended by phyllaries, the heads solitary or many and variously arrayed in secondary inflorescences, the ovary inferior, the corolla conuate 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 unisemiter, with only undifferentiated tepals; flowers many and small, greenish or brownish, inconspicuous individually;

infloroscence of glomerules that are usually further aggregated into racemes or panicles; fruit an achene or utricle ..........................................................

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11 Stamen(s) 4; corolla blue or almost white ................................................................. [Collinsia, Natallanthus] PLANTAGINACEAE  
11 Stamen(s) 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 10x 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] CISSACEAE  
15 Corolla yellow .......................................................................................... [Alkanna] APOCYNACEAE  
1 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 (quadrijuga)] 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  

[a] Platycodon] CAMANULACEAE  

Key R – herbaceous dicots with opposite, compound leaves on the stem  
1 Inflorescence an involucreate 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 serrat and sometimes with additional lobes).  
5 YYY...................................................................................................................... [Cannabis] CANNABACEAE  
5 XXX...................................................................................................................... [Anemone] RANUNCULACEAE  

Key S – herbaceous dicots with opposite, simple leaves on the stem  
1 Leaves unlobed (though sometimes serrate or crenate)............................................................................................................... ASTERACEAE  
1 Leaves lobed 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 involucreate 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. Pyxantherum 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 involucral bracts).  
5 Leaves herbaceous, suborbicular, about as long as wide or wider than long; calyx 3- or 4-merous; stamens 4, 8, or 12.
3 Ovary superior.

16 Perianth in 2 whorls (sepalas and petals both present).

4 Perianth in 2 whorls (sepalas and petals both present).

3 Perianth in 2 whorls (sepalas and petals both present).

2 Perianth in 2 whorls (sepalas and petals both present).

1 Perianth in 2 whorls (sepalas and petals both present).

Plants ascidating, with a single node (2 leaves); leaves > 6 cm long and wide; calyx 3-merous, brown to yellowish; stamens 12...

..................[Asarum] ARISTOLOCHIACEAE

6 Plant creeping, with many nodes; leaves 3-15 mm long and wide; calyx 4-merous, yellow to greenish; stamens 4 or 5 ............

..................[Chrysogenium] SAXIFRAGACEAE

5 Leaves fleshy, linear, lanceolate, to broadly ovate, at least slightly longer than broad; calyx 3-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..........................[Lomatogonion] COMPOSITAE

8 Flowers 1 (or 2) in leaf axils; leaves entire.

10 Petals 5; stamens 3, 4, or 5.

11 Inflorescence axillary, of 1-several flowers; stamens 5.................................[Triostium] CAPRIFOLIACEAE

12 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

13 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.

14 Leaves serrate; corolla bilaterally symmetrical (especially the flowers near the outer edge of the head); inflorescence a head

..................[Dipsacus, Knaudia] DIPSACACEAE

15 Leaves entire; corolla radially symmetrical; inflorescence a head or more diffuse (see below).

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

17 Inflorescence a cyathium, consisting of a single pistillate flower (reduced to a single-sepallate 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

23 Styles 2-30 mm long, 0.5-8 mm wide, linear or narrowly elliptic

..................[Achyrocline, Alchemilla, Althaea, Gomphrena, Guilleminia, Iris, Salsola, Sueda] AMaranthACEAE

22 Leaves serrate, regularly and sharply so; plants with stinging hairs (or not)....[Boehmeria, Pilea, Urtica] URTICACEAE

24 Gynoecium either of 1 pistil (with 1 or more carpels), or of 2 pistils, united only by the style and stigma (APOCYNACEAE).

25 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 fascicules; petals yellow or pinkish..................[Hypericum] HYPERICACEAE

26 Petals not at all connate, not even at their bases.

18 Flowers 1 (or 2) in leaf axils; leaves entire.

19 Flowers unisexual; sepals 0; flowers (staminate) with 1 stamen....[Callitrichaceae] PLANTAGINACEAE

20 XXXX ..................................[Trianthema] AIZOACEAE

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

23 Styles 2-30 mm long, 0.5-8 mm wide, linear or narrowly elliptic

..................[Achyrocline, Alchemilla, Althaea, Gomphrena, Guilleminia, Iris, Salsola, Sueda] AMaranthACEAE

24 Gynoecium either of 1 pistil (with 1 or more carpels), or of 2 pistils, united only by the style and stigma (APOCYNACEAE).

25 Petals 3; sepals 5, dimorphic, the 2 outer sepals narrower than the 3 inner and concave sepals; stamens (3-) 5-15 (-25).

..................[Lechea] CITACEAE

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 fascicules; petals yellow or pinkish..................[Hypericum] HYPERICACEAE

28 Sepals 2; stamens opposite the petals..................[Claytonia, Montia] PORTULACACEAE

29 Petals 3; sepals 5, dimorphic, the 2 outer sepals narrower than the 3 inner and concave sepals; stamens (3-) 5-15 (-25).

..................[Lechea] CITACEAE

20 Petals 4-7; sepals 4-7, normally monomorphous; stamens 4, 5, 6, 8, 10, or 12 (or sometimes rarely 2 or 3).

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
32 Capsule 10-locular (each of the 5 carpels divided at maturity), septicidal; 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 mistaken 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, Seurera] APOCYNACEAE
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, Seurera] APOCYNACEAE
31 Pistils 1 (of 2-5 fused carpels); fruit either a 2-locular 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 (and the flower as a whole) strictly radially symmetrical.
38 Capsule septicidal; corolla white, pink, blue, yellowish white, or greenish white; inflorescence either a terminal or axillary cyme, or a terminal or axillary raceme; or a terminal or axillary cyme made bilaterally symmetrical by the 4 stamens; [Bartonia, Centaurium, Eustoma, Gentiana, Gentianella, Gentianopsis, Obolaria, Sabatia, Schenka] 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] LOGANIAEE
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 capsule of 4 mericarps; stamens inserted near the middle of the corolla tube.................................................. [Verbena] VERBENACEAE
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 thyrse, verticillaster, or terminal cyme, the flowers borne in cymose lateral branches; corolla strongly bilaterally symmetrical (rarely nearly radially symmetrical); stems square in ×-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 Phyma).
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............. [Dichiptera, Justicia, Pseuderanthemum] ACANTHACEAE
45 Inflorescence of solitary (rarely 2) axillary flower.
46 Sepals 4................................................................. [Hemianthus, Micranthemum] LINDERNIAEE
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] LINDERNIAEE
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
KEYS TO FAMILIES AND GENERA

51 Sepals connate for at least 0.3× their length to form a tube (this cup-like and flaring in Scrophulariaceae).

52 Inflorescence a diffuse panicle; corolla 5-11 mm long, reddish-brown (sometimes with some yellow); fruit a septifragal capsule...........................[Scrophularia] SCROPHULARIACEAE

53 Corolla 10-50 mm long, pink, blue, purple, or yellow; fruit a loculicidal capsule...........................[Agalinis, Aureolaria, Buchnera, Pedicularis] OROBANCHACEAE

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

58 Sepals separate to the base or nearly so, not forming a tube.

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

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

61 Corolla white, pale blue, lavender, or pink (sometimes with yellow markings); leaves broader, mostly lanceolate; plants not blackening on drying; corolla strongly bilabiate..............................[Agalinis] OROBANCHACEAE

61 Corolla 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 not hooded and enclosing the anthers ............[Melampyrum] OROBANCHACEAE

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 bicolor, the upper lip white or very pale blue, the lower lip bright blue; 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

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

3 Leaves with peltate petiolo attachment; carpel 1; petals present, white...........................[Diphylleia, Podophyllum] BERBERIDACEAE

4 Leaves with petiolo 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

2 Flowers tiny, individually inconspicuous; perianth absent or vestigial; fruit a uricle,...............................[Atriplex] AMARANTHACEAE

3 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).

4 Stamens 5; fruit a capsule.................................................................[Ellisiopsis] BORAGINACEAE

5 Stamens many; fruit an aggregate of plumose achenes...............................................................[Clematis] RANUNCULACEAE
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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
L1. LYCOPODIACEAE

THE FLORA

SECTION 1: LYCOPODIOPHYTA (CLUBMOSSES)

L1. 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 lattissimo) of our area into six genera in three subfamilies, as follows: Huperzia in Subfamily Huperzioidae, Lycopodium and Diphasiastrium 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), Diphasiastrium (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 Diphasiastrium) 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 Lycopidioidae].

5 Branches 1-5 mm wide (including the leaves), compressed to quadrangular, with 4 ranks of leaves; branching of strobili stalks dichotomous............................................................6. Diphasiastrium

5 Branches 4-12 mm wide, terete (to somewhat compressed in Dendrolycopodium obscurum), with 6 or more ranks of leaves; branching of strobili 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 spine; horizontal shoots at or near the ground surface, with winter bud constrictions..............................7. Spinulum

1. Huperzia Bernhardi (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) Bernhardi 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]...

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..................

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* [H. lucidula × porophila].

**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 ×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 (Ollgaard in Kramer & Green 1990, Wikström & Kenrick 2000). References: Wagner & Beitel in FNA (1993b); Ollgaard 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][......]

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. inundata

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

3 Prostrate stems arching, not in contact with the ground (and rooting) all along their length, 8-11 mm wide (including leaves), the stem (striped 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 (striped 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 – C, F, G, Md, S, W]


All pairwise combinations of sympatric species form fertile hybrids (only L. inundata and L. prostrata are entirely allopatic 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 × prostrata. [= Lycopodiella ×brucei Cranfill – K, WH3; = Lycopodium ×brucei (Cranfill) Lellinger]


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 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; = Lycopodium 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

2 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 (27°-) ca. 27° (+36°) angle from the branchlet, thus the branchlet and leaves together ca. 6-9 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. 3.5-6 (-7) 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 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 e. 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)
8. Lycopodium Linnaeus 1753 (Running Clubmoss)


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); Öllgaard 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, W; > 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); Öllgaard in Kramer & Green (1990); Haines (2002b, 2003a)=Z. [also see Dendrolycopodium, Diphasiastrum, Huperzia, Lycopodiella, Palhinhaea, Pseudolycopodiella, and Spinulum]


1. Lycopodium clavatum (Linnaeus) A. Haines, Running Clubmoss. Openings, balds, roadbanks, open forests. July-September. Circumboreal, south in e. North America along the Appalachians to NC and 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]
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)


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*
3  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*
4  Velum covering 0-10% of the sporangium; leaves (7.9-) avg. 11.5 (-14.9) cm long; [endemic to Franklin County, NC]...............................
5  Leaves (4.2-) avg. 9.3 (-14.2) cm long; [endemic to Wake County, NC] ............................................................................. *I. species 6 “carolinae-septentrionalis”*

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 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] .............................................

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


**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** Engelmann, Butler's Quillwort. Seepeage 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. 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 louisianensis Thieret, Louisiana Quillwort. Small streams. S. AL, MS, and LA. [= FNA, K]  {add to synonymy}


Isoetes piedmontana (N.E. Pfeiffer) C.F. Reed, Piedmont Quillwort. In seepage on granitic flatrocks and on Altamaha grit. [= K, Z; <I. melanopoda – FNA, K; <I. virginica – C, FNA, 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]
**L3. ISOETACEAE**


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

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

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


*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 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]


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

A family of 1–several genera (the generic circumpscriptions 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) (Soják 1992; Škoda 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 Vald despino 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 tips 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** Soják 1992 (Spikemoss)

A genus of about 50 species, widespread in distribution. References: Vald despino in FNA (1993b); Tryon (1955); Lellinger (1985); Buck (1977); Somers & Buck (1975); Jermy in Kramer & Green (1990). Key adapted in part from Vald despino 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 ..................
L2. SELAGINELLACEAE

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

3 Leaves of the underground (rhizomatous) stems not scalelike; rhizophores mostly aerial; sporophyll base pubescent; leaf and sporophyll apices often pubescent.  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**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]

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; stomatic lines 1-2 on each slope of the stem ridges. [= C, FNA, G, K, Pa; E. ×litorale, S, and FNA, of the occurrence of E. ×litorale]
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]
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. [= C, FNA, G, K, Pa; 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 nearly equal to sheath; spores green, spherical. [= E. arvense]
7 Lowest whorl of branches with 1st internode longer than sheath; spores white, misshapen. [= E. ×litorale]

Equisetum arvense Linnaeus, Field Horsetail. Moist streambanks, bottomlands, moist disturbed sites, road banks, railroad banks. March-August. 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 (Shelter & Orli 2000), for KY (Campbell & Medley 2007), and for all 75 counties of AR (Peck 2011). [= C, FNA, K, Pa; > E. ferrissii Clute – A.A. Eaton; > Hippochaete ×ferrissii (Clute) Škoda & Holub]


Equisetum litorale 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, F, FNA, G, K; > E. hyemale Linnaeus var. intermediate A.A. Eaton – F; > E. kansanum Schaffner – G; = Hippochaete litorale (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. pauciramosum Mild – 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*

2. Sterile 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*

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*

4. 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)


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*

2 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.

3 Sterile blade 0.2-1 cm wide, the polygonal venation areoles usually lacking both smaller areoles and free included veinlets ... *O. nudicaule*

4 Sterile blade (0.5-) 1.2-5 cm wide, the polygonal venation areoles either with smaller areoles or with free included veinlets. .... *O. engelmannii*

5 Sterile blade 1-2 cm wide, the polygonal venation areoles mostly > 2 mm wide, without included veinlets .................................................. *O. petiolatum*

6 Sterile blade ovate-lanceolate, the base obtuse to nearly truncate, broadest 3/5 of the way from the base to the tip; primary areoles mostly < 2 mm wide, with included veinlets.

7 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*

8 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, WH; > 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, WH)

**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, Africa. First reported from NC by Thomas & Marx (1979). (= RAB, FNA, K, WH; > 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)


*Botrypus virginianus* (Linnaeus) Michaux, Rattlesnake Fern, Sang-fond. 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)


| 1 | Sterile leaf 4-pinnate-pinnatifid, finely divided, the ultimate segments lacerate and linear, < 3 mm wide................................. | *S. dissectum* |
| 1 | Sterile leaf 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 15-70 mm long; roots irregularly ribbed, blackish; ultimate leaf segments fan-shaped, ovate, longer than wide, pinnately veined, the midrib weakly developed; sporulating August-October ........................................ | *S. jennmani* |
| 4 | Stalk of the basal sterile pinnae 4-15 (-20) mm long; roots smooth, yellowish; ultimate leaf segments about as long as wide, sublabellately 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. bibernaturn* |
| 6 | Sterile blade mostly 3-pinnate (or more divided, those forms keyed above), the segments entire to obscurely serrulate or crenulate...... | |

**Sceptridium bibernaturn** (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 bibernaturn (Savigny) Underwood – RAB, C, FNA, K, S, W, WH3; = B. dissectum var. tunafolium (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. bibernaturn*. *S. 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 Wilddenow) Clute – G; > B. dissectum var. dissectum – G; > B. dissectum – S; > B. obliquum Muhlenberg ex Wilddenow – S; < B. dissectum (Sprengel) Lyon – WH]
**Botrychium lunarioides** (Michaux) Skoda; = *Botrypus lunarioides* Michaux

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<tr>
<th>Subgenus</th>
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<td><em>B. alabamense</em></td>
<td>= <em>B. alabamense</em> (D.C. Eaton) Farwell – F, G</td>
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**F.6. PSILOTACEAE** Kanitz 1887 (Whisk Fern 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 (Whisk Fern)

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, Whisk Fern. 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]

**F.8. OSMUNDACEAE** Martinov 1820 (Royal Fern Family) [in OSMUNDALES]


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 hairs ............................................................

2. 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 rachis ........................................................................................................................

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; c. Asia. The species also occurs in c. 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 Cladostoma] ................................................................. 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 Moran (1993b); Ebihara et al. (2006, 2007); Ivatsuki 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") bivalve (deeply divided into 2 flaps); receptacle not exserted 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 funnel-form, sometimes slightly 2-lobed; receptacle long and whiplike, exserted 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 expending into humid north temperate regions. Sphaerocionium C. Presl and other segregates are often recognized; these segregates may well be warranted. Ivatsuki 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); Ivatsuki 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 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 spathulate 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 spathulate 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).

2. Didymoglossum Desvaux 1827


**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, WH]

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 I – Z]

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


*Dicranopteris* Bernhardi 1805 (Forking-fern)


* 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. [= RAB, 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**


**F14. SCHIZAEACEAE** Kaulfuss 1827 (Curly-grass Family) [in SCHIZAEALES]
Schizaea J.E. Smith 1793 (Curly-grass Fern)


Schizaea pusilla Parsch, Curly-grass Fern. Moist, peaty oil in Coastal Plain bogs, often associated with Pseudolycopodiella caroliniana, Drosera filiformis, and Chamaecyparis thyoides (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]


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 (Watercloveer)


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. quadripodia
   2 Roots present only at the nodes
5 Distal tooth absent or a very low bump.................................................................M. macropodia
5 Distal tooth 0.4-1.2 mm long, sharply acute to pointed, often hooked ..........................................................M. vestita

* Marsilea macropoda Engelmann ex A. Braun, Golden Watercloveer, Big-footed Watercloveer. {habitat}; native of s. TX and Mexico. Reported as introduced eastward in AL and c. and s. peninsular FL. [= FNA, K, WH3, Z]
* Marsilea mutica Mettenius, Nardoo, Australian Watercloveer. Ditches, ponds; native of Australasia. Apparently spreading rapidly in VA. [= WH3, Z]
* Marsilea quadripodia Linnaeus, European Watercloveer. 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]

Pilularia Linnaeus 1753 (Pillwort)


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
MARSILEACEAE (F16)

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 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)


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. DENGSTAEDETIACEAE 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
2 Leaf blades elongate in outline, at least 2× as long as broad, membranaceous; sori globular, separate

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 *Asplenium*, *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]


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** Bernhardi 1801 (Cuplet Fern)

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, & Mehltrer (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** Gleditsch ex Scopoli 1760 (Bracken)

A family of about 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, & Mehltrer (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*


Acrostichum danaeifolium (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. [= FNA, C, F, G, K, W, WH3, WV; = P. latiusculum (Desvaux) Hieronymus var. pseudocaudatum (Clute) Mason – 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), Cryptogrammaceae (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. Cryptogramma R. Brown 1823 (Parsley Fern)


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)


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. danaeifolium – 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]
2 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. richardi
   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 richardi 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 > 3× as long as wide ............................................. P. vittata
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 deahlata (Pursh) Windham, Powdery Cloak Fern. Limestone cliffs. IL, MO, and KS south to AR and TX; disjunct in sc. K.Y. [= FNA, K; = Notholaena deahlata (Pursh) Kunze – C, F, G; = Cheilanthes deahlata Pursh; = Pellaea deahlata (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]

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<th>Character</th>
<th>1. Leaf surfaces glabrescent [&quot;Cheilanthes alabamensis group&quot;]</th>
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|           | 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*
|           | 3. Petiole and rachis with a mixture of flattened scales (in *C. tomentosa* these very narrow and superficially mistakeable 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 scarious flap (false indusium) that covers the sori; [subgenus Physopteris]. |
|           | 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). |
|           | 5. Petiole and rachis glabrous to sparsely pubescent with rather straight hairs; leaves 3-pinnate, with 12-20 pairs of pinnae, the lower surface white, tan, or silver-gray. |

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**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]

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**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]

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**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]

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**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 c. 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]

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**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] .......................................................... 1. *A. integrerrima*

1 Scales of the upper leaf surface sparse and usually deciduous; largest pinnae usually symmetrically lobed; [rare eastern disjunct known from GA] ................................................................................................................................................ 1. *A. sinuata* ssp. *sinuata*

**Astrolepis integrerrima** (Hooker) D.M. Benham & Windham. Outcrops of Ketona dolostone. OK, NM, AZ, and NV south into Mexico; disjunct c. AL (Bibb County); also disjunct in Hispaniola. This taxon is apparently an apogamous triploid derived from *Astrolepis coxhisensis* (Goodding) D.M. Benham & Windham and an unknown taxon. [= FNA; = *Astrolepis* ×*integrerrima* – K; = Cheilanthes integrerrima (Hooker) Mickel; = Notholaena integrerrima (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 0-4 (-6) mm long; [strictly of calcareous substrates] ........................................................................................................................................................................... 2. *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] ........................................................................................................................................................................... 2. *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 ......................... 3. *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] ........................................................................................................................................................................... 4. *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] ........................................................................................................................................................................... 4. *P. weightiana*

**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 wrightiana* (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* Goodding. [= RAB, FNA, K]

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


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 sediments. 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 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 ...

...............................................................................................................................................................................................

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)...............................................................................................................................................................................................

**Vittaria appalachiana** Farrar & Mickel, Appalachian Shoestring Fern, "Appalachian Gametophyte." Shaded grotores, 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]


**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 protona × tennesseensis*, *Cystopteris protona × tenuis*, *Cystopteris tenesseensis × tenuis* (= C. ×wagneri R.C. Moran).

1 Lowest pair of pinnae the longest, thus the leaf widest at the base; bulblets never 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 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. tennesseensis
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] ...............................................................................................................................................................................

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 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 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 HHPP (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 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. Hauffer, 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 mossy 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, S; < C. fragilis – WV]

Gymnocarpium Newman 1851 (Oak Fern)

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

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

1 Sessile basiscopic pinnule of the proximal pinnae with basal basiscopic pinnulet more or less equal in length to the adjacent pinnule; pinnae of second pair usually sessile, with basal pinnules more or less equal in length to the adjacent pinnule; spores 34-39 µm in diameter.... ..............................................................................................................G. dryopteris

Gymnocarpium appalachianum Pryer & Hauffer, 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 & Hauffer (1993) for a detailed analysis of the distinguishing features

Triploids are known from the mountains of VA. Their identity is uncertain; based on geography they are presumably *G. appalachianum × dryopteris* [AAJJ], but could be *G. ×brittonii* (Sarvela) Pryer & Haufler [= *G. disjunctum × dryopteris* = AAJJ]. 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*
3. Leaf blades 10-40 mm wide, lanceolate, lance-attenuate, or oblong.
4. Leaf apex acute or obtuse, not attenuate, not producing plantlets at the tip; veins free.
5. 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. rhizophyllum*
6. 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. americanum*

1. Leaves pinnae (at least in the lower half of the leaf), pinnate, pinnate-pinatifid, bipinnate, or tripinnate, the apex obtuse, acute, acuminate, or attenuate; veins free.
2. Rachis dull green throughout its length, or at least toward the tip; leaves pinnae at each pinnae, the outline of the leaf blade narrowly to broadly triangular, widest at the base (or slightly above the base in *A. abscissum*).
3. Petiole dark throughout its length (from base to first leaflet).
4. Leaves bipinnate at the base, pinnatifid above; spores abortive (or normal in *A. tutwileriae*, known only from Hale County, AL).
5. Spores abortive ........................................................................ *A. echinoides*
6. Spores normal; [endemic (as far as known) to Hale County, AL] ................................................................. *A. tutwileriae*

6. Petiole partially or entirely green (darkened or not at its base).
7. Leaves pinnatifid or pinnate through most or all of their lengths.
8. Leaves pinnae, sometimes fully pinnate at the base; spores normal ......................................................... *A. pinnatifidum*
9. Leaves pinnae (sometimes pinnate-pinnatifid at the base in *A. ×trudellii*); spores abortive (*A. ×trudellii*) or normal (*A. abscissum*).
10. Spores normal ........................................................................ *A. echinoides*
11. Spores abortive ........................................................................ *A. abscissum*

9. Leaves of calcareous rocks] ......................................................... *A. ruta-muraria var. cryptolepis*
10. Rachis shiny black or dark brown throughout its length; leaves pinnate, the outline of the leaf blade linear, lanceolate, or ob lanceolate, with more-or-less parallel sides for much of its length.
11. Main pinnae deeply lobed into 3-many segments (the leaves therefore pinnate-pinnatifid); [of FL] ........................................ *A. verecundum*
12. Rachis 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*
13. Rachis darkened toward the base; pinnules toothed; leaves bipinnate, the leaf blades ovate-triangular; ultimate leaf segments mostly stalked; [of calcareous rocks] ......................................................... *A. bradleyi *
14. Rachis darkened toward the base; pinnules toothed; leaves bipinnate to tripinnate, the leaf blades lanceolate-ovate to lanceolate-oblong; ultimate leaf segments sessile or nearly so; [of acidic rocks] ......................................................... *A. montanum*
Aspleniaceae  

Asplenium abscissum  
Wildenow, 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, WH3]

Asplenium bradleyi  
D.C. Eaton, Bradley's Spleenwort. Dry outcrops of felsic sedimentary or metasedimentary rocks, such as sandstone, quartzite, or metarhyolite, at low to moderate elevations. April-October. PA, MD, OH, KY, s. IL, and MO south to c. NC, e. 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. bradleyi]

Asplenium ×ebenoides R.R. Scott (pro species) [A. platyneuron × 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. ×ebenoides 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. tenuifolium. Populations of this taxon, especially if consisting of many individuals, should be checked for fertile spores. [= Pa, WV; = A. ×ebenoides rhabdomerum (R.R. Scott) Wherry – G; = A. ×ebenoides – K; < A. ×ebenoides – FNA, S]

Asplenium heterochromum Kunze, Bicolored Spleenwort. Fairly moist outcrops of calcareous sedimentary rocks, such as coquina limestone ("marl"). Sc. 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. heterochromum Kunze – S]

Asplenium heteroresilens W.H. Wagner, Marl Spleenwort, Carolina Spleenwort, Wagner's Spleenwort, Morzen'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) allotetraploid derived from hybridization of the sexual tetraploid H. heterochromum Kunze (of Florida and the West Indies) and the apogamous triploid A. resiliens. Its chromosome complement can be symbolized EEEEHHH. [= RAB; = A. ×heteroresilens – FNA, K, WH3; < A. heterochromum Kunze – S]

Asplenium monanthus 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. monanthus 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 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, 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; 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. pinnatifidum* in general, and var. *pinnatifidum* specifically, is by far the most common of our *Asplenium* species, and the only one found characteristically away from rock. *A. pinnatifidum* var. *pinnatifidum* does not seem to warrant taxonomic recognition. Strikingly large plants of the outer Atlantic Coastal Plain have been named var. *bacculatum* (Featherman) Fernald; they are probably not worthy of taxonomic recognition. They can be distinguished as follows: var. *bacculatum* 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 subentire 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. 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 of the reticulately evolved Appalachian *Asplenium* complex. It is one parent of *A. bradleyi* and *A. ×ebenoides* (as well as other sterile hybrids). *A. platyneuron* 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 have been named var. *bacculatum-rubrum* (Featherman) Fernald; they are probably not worthy of taxonomic recognition. They can be distinguished as follows: var. *bacculatum-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 subentire 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. *bacculatum-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* species, 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, Pa, RAB, W; = Camptosorus rhizophyllus (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. *lanceolatum* 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. [= C, 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 parent. 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; = ×Asplenonosorus trudellii (Wherry) Mickel]

Asplenium tutwilerae Small ex Pichi-Sermolli 1977 (Glade Fern)

Homalosorus pycnocarpos (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

2 Midribs of the pinnae with an adaxial groove; leaf pinnate to pinnate-pinnatifid. .............................................................................. Thelypteris

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


* Macrothelypteris toresiana (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 toresiana (Gaudichaud-Beaupré) Alston]

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


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

2 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

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


* Macrothelypteris toresiana (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 toresiana (Gaudichaud-Beaupré) Alston]

Thelypteris (Michaux) Fée, Broad Beech Fern. Mesic to submesic woods. 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]
kunthii, *Thelypteris 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*].

2 Leaves 5-15 (-20) cm wide; rhizome scales 1-4 mm long, lanceolate to ovate, glabrous, pale brown to golden brown, flexible and rather thick; [subgenus *Cyclosorus* or genus *Christella*].

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*.

4 Leaf blade broadest near the base, the pinnae stopping abruptly, the petiole 2/3 to fully as long as the blade; [of wetland habitats].

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*.

7 Rachises and petioles usually purplish; costae densely short-hairy on the lower surface, the hairs 0.0-0.1 (-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*.

8 Upper surface of the costae and costules glabrous above (rarely minutely hairy, the hairs never > 0.2 mm long), eglandular..................

9 Lowermost pair of pinnae equal to or very slightly shorter than the next pair above; basal veins from adjacent lobes of the pinna always meeting ................................................................. *T. ovata* var. *ovata*.

10 Lowermost 1-2 pairs of pinnae distinctly shorter than the pair above (ca. ¾ as long); basal veins from adjacent lobes of the pinna at the sinus at the same point ................................................................. *T. kunthii*.


*Thelypteris dentata* (Forsskål) E. P. 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 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 in and around suburban forests. May-August. Sc. NC south to s. FL and west to c. TX; Mexico south through Central America into t. South America; West Indies. [= RAB, FNA, K, WH3; < T. normals (C. Christensen) Moxley – S; < *Christella normals* (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. WOODSIAEAE** 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]

4 Leaves 2-pinnate to 3-pinnate (the pinnae at least 1-pinnate); sori elongate, 2.5-6× as long as wide, even the larger sori generally straight and not extending across the veins.

5 Leaves 1-pinnate, the pinnae pinnatifid (the pinnae entire or pinnatifid); sori elongate, 4-6× as long as wide, the larger sori generally straight and not extending across the veins.

6 Leaves 1-pinnate, the pinnae entire. .................................................................................................................................................................................... [see *Deparia* in ATHYRIACEAE]

7 Leaves 1-pinnate, the pinnae pinnatifid. .................................................................................................................................................................................... [see *Homalosorus* in DIPAZIOPSIDACEAE]

8 Sori round, indusia present or absent, if present cupulate or lateral (but not attached along a long side).

9 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]

10 Leaf blades lanceolate, oblong, or ovate in outline, 2× or more as long as wide; rhizome more than 2 mm in diameter.

11 Indusium attached under one side of the sorus, hoodlike or pocketlike, arching over the sorus; petioles glabrous or sparsely beset with scales, the petiole bases not persistent. .................................................................................................................................................................................... [see *Cystopteris* in CYSTOPTERIDACEAE]

12 Indusium attached under the sorus, cuplike (divided into 3-6 lanceolate to ovate lobes which surround the sorus from below) or of minute numerous sepatate 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 sepatate hairs and pale linear scales); indusium of numerous filamentous segments. .................................................. *W. ilvensis*

2 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. .................................................................................................................................................................................... *W. appalachiana*
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]


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*, *Matteuccia*, 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 struthioteris* (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. *struthioteris* on the basis of its concolorous rhizome scales (vs. bicolorous scales) and less truncate pinna lobes. [= FNA, G; < *M. struthioteris* – C, K, Pa; = *Pteretis pensylvanica* (Willdenow) Fernald – F; = *M. pensylvanica* (Willdenow) Raymond – WV; = *Onoclea struthioteris* (Linnaeus) Roth var. *pensylvanica* (Willdenow) B. Boivin]

Onoclea Linnaeus 1753 (Sensitive Fern)


*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,

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

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).

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.

Identification notes: In sterile leaf, Woodwardia areolata is sometimes confused with Osmoclea, 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).
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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.

Athyrium angustum (Wildenow) 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. michauii (Sprengel) Farwell – C, F, G; = A. filix-femina var. angustum (Wildenow) G. Lawson – FNA, Pa; = A. filix-femina ssp. angustum (Wildenow) Clausen – K, W]


* 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.

Diploziopsis (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]

Diploziopsis (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 e. and s. GA, AL, s. MS, and FL. [= FNA, WH3; = Deparia petersenii – 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 .......................................................... Diplazium
1 Leaves 1-pinnate; veins free ........................................................................ D. esculentum

* 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 Veins anastomosing, rejoicing to form a netlike pattern; pinnae 4-25 pairs per leaf; [non-native, rarely naturalized] ............... Cyrtomium
4 Veins branching dichotomously, free, not rejoicing 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).

* 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, 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)

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 pinnate-pinnatifid to bipinnate (or to bipinnate-pinnatifid 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*
3 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.
4 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*
5 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*

Identification notes

1 Leaves bipinnate-pinnatifid to tripinnate-pinnatifid (or to quadripinnate in the lower pinnae).
2 Leaves evergreen, 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 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*
3 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.
4 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*
5 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*

Identification notes

1 Leaves pinnate-pinnatifid to bipinnate (or to bipinnate-pinnatifid in the lower pinnae).
4 Sori medial or submedial; leaves evergreen, dark-green, leathery in texture ................................................................. *D. margins*
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 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. clinomontana*
7 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.
8 Costa with bullate (blistered-appearing) scales abundant, usually dark; [rarely naturalized alien]................................. *D. cristata*
9 Leaves deciduous with sori medial, 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*
10 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*
11 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.
12 Costa with bullate (blistered-appearing) scales abundant, usually dark; [rarely naturalized alien]................................. *D. erythrosora*
13 Costa lacking bullate scales; [native, sometimes also cultivated].
14 Sori medial or submedial; leaves evergreen, gray-green, leathery in texture ................................................................. *D. margins*
15 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*
16 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.
17 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*
18 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*
**Dryopteris clintoniana** (D.C. 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 GGLLLS. [= 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. ludoviciana.* [= RAB, C, FNA, G, K, Pa, S, W, WV; = *D. cristata* var. cristata – F]  

**Dryopteris erythrosora** (D.C. Eaton) Kunz, 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. spinulosus* (O.F. Mueller) Watt var. intermedia (Muhlenberg ex Willdenow) Underwood – F; = *D. austriaca* (Jacquin) Woynar 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)  


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 nc. 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]  


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).


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


**Nephrolepis** Schott 1834 (Sword Fern)

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

<table>
<thead>
<tr>
<th>1 Plants larger, the leaf blades 7-90 cm long; [occurring in moist to dry habitats]</th>
<th>1 Pinnae 2.5-23 cm long; midleaf pinnae with veins densely pubescent on the upper surface; pinnae not distinctly auricled at base</th>
<th>N. biserrata</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Leaf blade densely scaly on the lower surface; rhizome 1-2 mm in diameter; leaf segment margins entire</td>
<td>2 Scales on the upper surface of the rachis bicolor (pale but distinctly darker at the base); pinnae attachments spaced 5-12 mm apart; rhizomes bearing spherical tubers (not always present)</td>
<td>N. cordifolia</td>
</tr>
<tr>
<td>2 Scales on the upper surface of the rachis concolor (pale to reddish brown throughout); pinnae attachments spaced 7-21 mm apart; rhizomes not bearing tubers</td>
<td>N. exaltata</td>
<td></td>
</tr>
</tbody>
</table>

* 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. Christensensen]

* 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 America; widely introduced elsewhere. [= FNA, S, WH3; N. exaltata ssp. exaltata – K]

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**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 *Micropropodium*). References: Smith in FNA (1993b); Smith et al. (2006); Hennipman, Veldhoen, & Kramer in Kramer & Green (1990); Parris in Kramer & Green (1990).

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 | S. 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 |

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 |

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1. *Micropropodium* Hayata (Dwarf Polypody)

A genus of about 30 species, mainly of tropical America and e. and se. Asia. *Micropropodium* 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 *Micropropodium* 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); (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. [\( Z = \text{Grammitis nimbata} \) Jenman Proctor – RAB, FNA, K]

2. **Polypodium** Linnaeus 1753 (Polypody)


**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 (sporangiasters) usually > 40 per sorus (range of 25-120); leaves mostly lobed to apex, without an attenuate, unlobed tip. ................................. **P. appalachianum**

1. Leaf blade averaging 4.5 cm wide (range of 3.0-5.8 cm); blade widest near the middle, thus the blade oblong to narrowly lanceolate in outline; rhizome scales averaging 1.5 mm wide, mostly brown, with a dark central stripe; paraphyses (sporangiasters) usually < 40 per sorus (range of 7-69); leaves mostly with an attenuate, unlobed tip. ................................................................. **P. virginianum**

1. Characters intermediate; spores abortive .............................................................. **P. ×incognitum**

**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*. [\( = \text{FNA, K, Pa, Z; < P. virginianum} \) – RAB, C, F, S, W, WV; < P. vulgar Lineaeus var. virginianum (Lineaeus) Eaton – G]

**Polypodium ×incognitum** Cusick is the triploid hybrid [\( P. appalachianum \times P. virginianum \)]. 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** Lineaeus [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. [\( = \text{FNA, K, Pa, Z; < P. virginianum} \) – RAB, C, F, S, W, WV (also see *P. appalachianum*); < P. vulgar Lineaeus var. virginianum (Lineaeus) 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** (Lineaeus) 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). [\( = \text{FNA, K, S, WH3; = Polypodium aureum} \) Lineaeus]
4. *Pecluma* M.G. Price (Rockcap Fern)


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*

*Pecluma 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]

*Pecluma 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; = *Pecluma ptilodon* (Kunze) M.G. Price var. *caespitosa* (Jenman) Lellinger – FNA; = *Pecluma 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]
SECTION 3: ACROGYMNOSPERMAE (EXTANT GYMNOSPERMS)

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)


*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. *florida* 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]


*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]


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*
3 Leaves evergreen; cones 6-12 cm long ................................................................................................................................................... *Cedrus*
4 Leaves deciduous; cones 1-2 cm long ........................................................................................................................................... *Larix*
5 Leaves alternate; [subfamily *Abietoideae*].
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 exserted beyond the scales; staminal 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; staminal 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, median (and usually with up to 2 additional marginal canals); cone bracts exserted 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 exserted 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 s. 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 Allegany, 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]
CUPRESSACEAE (G11)

*Cedrus* Trew 1757 (Cedar)


* 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 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] ............

1 Cones 2.5-4.5 cm long; upper branches ascending, the lower spreading; outer bud scales prolonged into minute hairlike projections; [plant an alien, but widely planted as an ornamental and sometimes escaping in the high mountains of NC. [= F, K, Pa] L. 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 Britsich Columbia. [= FNA, C, F, G, K, Pa, WV]

1 Needles 5 in each bundle; each needle with 1 vascular bundle; [subgenus Strobus, section Strobus]..........................*P. strobus*

1 Needles 2-3 (-4) in each bundle; each needle with 2 vascular bundles; [subgenus Pinus].

2 Bracts and bud scales fimbriate; sheath > 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*

* Picea A. Dietrich 1824 (Spruce)


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. [= F, K, Pa, WV]

1 Needles 5 in each bundle; each needle with 1 vascular bundle; [subgenus Strobus, section Strobus]..........................*P. strobus*

1 Needles 2-3 (-4) in each bundle; each needle with 2 vascular bundles; [subgenus Pinus].

2 Bracts and bud scales fimbriate; sheath > 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*

* Picea* 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); Gemandt 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 Strobus, section Strobus]..........................*P. strobus*

1 Needles 2-3 (-4) in each bundle; each needle with 2 vascular bundles; [subgenus Pinus].

2 Bracts and bud scales fimbriate; sheath > 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*

13 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.

14 Needles 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*

14 Needles 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 1.3-2.0 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*

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 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, WH3, WV, Z]

Pinus elliottii 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. elliottii* 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. elliottii* var. densa is perhaps better treated as a full species, *Pinus densa* (Little & Dorman) de Laubenfels & Silba. *P. elliottii* 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. elliottii* resembles both *P. palustris* and *P. taeda*, with cone size and needle length intermediate. *P. elliottii* 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. elliottii* – 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 turpentining, 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, 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 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 top. 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. [= FNA; = P. rigida P. Miller ssp. serotina (Michaux) Claesen]

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, c. 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. elliottii 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 Parin]

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)


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 Engelmann, 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
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
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
1. Cunninghamia L. Brown 1826 (China-fir)


* 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 *Cryptomeria*. 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 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*

*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; < *T. distichum* – F; = *T. distichum* var. *imbricarium* (Nuttall) Croom – F; = *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* – F; = *T. distichum* – F (also see *T. ascendens*)]

3. Thuya Linnaeus 1753 (Arborvitaes)


*Thuya occidentalis* Linnaeus, American Arborvitaes, 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 homesteads 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 relocalized 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 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

3 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].

2 Female cones (“berries”) 3-4 mm long; terminal twigs 0.75-0.90 mm wide (including the scale-like leaves); scale leaves l.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 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, S, WH3; > C. thyoides var. henryae (H.L. Li) Little – Y; Z; > C. thyoides var. thyoides – Y; Z; = Cupressus thyoides Linnaeus]
* 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, N, A, 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)


* 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]


* 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.......................................................................................................................................................... Taxus

1 Leaves stiff, the tips piercing to the touch; fleshy "cone" 2.5-3 cm long, ca. 2 cm in diameter, dark green to purple when ripe, seed entirely surrounded by fleshy tissue...................................................................................................................................................................... Torreya

* Taxus* Linnaeus 1753 (Yew)

The genus consists of about 8 (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).
TAXACEAE (G12b) 110

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]


Torreya Arnott 1838 (Torreya, Stinking Cedar)


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 petalate; plants coated with a layer of transparent, mucilaginous jelly; floating petalate leaves 3.5-11 cm long, 2-6.5 cm wide; [subfamily Hydroptiloidae] ................................................................. Brasenia

1 Plants with submersed leaves dichotomously divided into linear segments; plants not coated with mucilaginous material; floating petalate 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, petalate, floating leaves and mucilaginous petioles make Brasenia unmistakable.

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, K, Pa, S, W]

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 Nymphaeideae] ................................................................................................................. 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. rubrodisca); stigmatic disc red; fruit deeply constricted below the stigmatic disc; leaf blades 3.5-25 cm long; [section Nuphar].


Nuphar orbicularis (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. orbicularis (Small) E.O. Beal – K; > Nymphaea orbiculara Small – S; > Nymphaea bombycina (Miller & Standley) Standley – S; = Nuphar advena (Aiton) Aiton f. ssp. orbiculara (Small) D. Padgett – X, Y; = Nuphar luteum ssp. orbiculatum (Small) E.O. Beal – Z]


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 submerged 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 phytogeographic connection between se. NC and Panhandle FL. DePoe & Beal (1969) and Beal & Southall (1977) argue that this taxon and N. advena intergrade clinaly, 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. sagittifolia (Walter) E.O. Beal – RAB, GW, W, Z; = Nuphar sagittitofolia – F, G, orthographic variant; = Nuphar lutea J.E. Smith ssp. sagittifolia (Walter) E.O. Beal – K; = Nymphaea sagittifolia Walter – S]

**NYMPHAEACEAE**

*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 var. variegata (Durand) E.O. Beal – K; = Nuphar luteum ssp. variegatum (Durand) E.O. Beal – Z]

*Nymphaea* Linnaeus 1753 (Waterlily)


<table>
<thead>
<tr>
<th>1 Leaf margins sinuate-dentate</th>
<th>.............................................................................................................................</th>
<th>N. capensis var. zanzibariensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Leaf margins entire.</td>
<td>2 Petals yellow or white (to pink).</td>
<td>N. elegans</td>
</tr>
<tr>
<td>2 Petals blue.</td>
<td>3 Petals yellow; plants producing stolons.</td>
<td>N. mexicana</td>
</tr>
<tr>
<td>3 Petals white (to pink); plants not producing stolons.</td>
<td>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 ........................................</td>
<td>N. odorata ssp. odorata</td>
</tr>
<tr>
<td></td>
<td>4 Petiole striped; leaf length/width ratio (-0.55-) 0.63 (-0.73); leaf lobes with pointed tips; lower leaf surface green ............................................................</td>
<td>N. odorata ssp. tuberosa</td>
</tr>
</tbody>
</table>

* 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 flavia (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 Femald – F; > Castalia odorata (W.T. Aiton) Wood – S; > Castalia minor (Sims) Nyar – S; > Castalia lekophylla Small – S]


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


**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).
**ILLICIACEAE**

1. Flowers 2-5-5 cm across; tepals 21-33, red-maroon (rarely white or pinkish); leaf tips acute to acuminate. \textit{I. floridanum}

2. Flowers 0.8-1.2 cm across; tepals 11-16, yellowish green; leaf tips obtuse or rounded. \textit{I. parviflorum}

\textit{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). [\textit{= FNA, GW, K, S, WH}]

\textit{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). [\textit{= FNA, K, S, WH}]

\textbf{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).

\textbf{Schisandra} Michaux 1803 (Star-vine)


\textit{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). [\textit{= RAB, K, WH, Y, Z; = Schizandra coccinea} Michaux – S, orthographic variant; = S. coccinea Michaux – W]

\textbf{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 (\textit{Saururus, Gymnotheca, Houttuynia}), w. North America (\textit{Anemopsis}), and e. North America (\textit{Saururus}). One other member of the family occurs in North America: \textit{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 locale; stamens 3. \textit{Houttuynia}

2. Ovary of (3-) 4 carpels fused only at the base; stamens 6. \textit{Saururus}

\textbf{Houttuynia} Thunberg


* \textbf{Houttuynia cordata} Thunberg. Disturbed areas; moist suburban forests; native of e. Asia.

\textbf{Saururus} Linnaeus 1753 (Lizard's-tail, Water-dragon)


\textbf{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, \textit{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 \textit{Saururus cernuus}, and found that pollination was both by wind and by insects. [\textit{= RAB, C, F, FNA, G, GW, K, Pa, S, W, WH, WV}]

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\begin{itemize}
  \item \textit{I. 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). [\textit{= FNA, GW, K, S, WH}]
  \item \textit{I. 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). [\textit{= FNA, K, S, WH}]
  \item \textit{Schisandra} Michaux 1803 (Star-vine)
    \item \textit{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). [\textit{= RAB, K, WH, Y, Z; = Schizandra coccinea} Michaux – S, orthographic variant; = S. coccinea Michaux – W]
  \item \textit{Houttuynia} Thunberg
    \item \textit{Houttuynia cordata} Thunberg. Disturbed areas; moist suburban forests; native of e. Asia.
  \item \textit{Saururus} Linnaeus 1753 (Lizard's-tail, Water-dragon)
    \item \textit{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, \textit{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 \textit{Saururus cernuus}, and found that pollination was both by wind and by insects. [\textit{= RAB, C, F, FNA, G, GW, K, Pa, S, W, WH, WV}]
\end{itemize}
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)


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


* **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
3. Leaves evergreen, glabrous, not paired ........................................................................................................................................... Hexastylis

1. Twining vine or caulescent herb; calyx tube bent, bilaterally symmetrical; stamens 6; [subfamily Aristolochioideae, tribe Aristolochieae].
2. 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
5. 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
2. Plant a woody vine; flowers brownish-purple and white, ca. 10 cm across ................................................................................. A. elegans


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

**Asarum** Linnaeus 1753 (Wild Ginger)

ARISTOLOCHIACEAE

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
2 Calyx lobes 10-35 mm long, spreading to ascending from the base, acuminate to caudate, the tubular tips 4-20 mm long. ................................................................. A. acuminatum


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. ambiguus (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, 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. (Oh-i-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 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 for reducing (often drastically, as in C) the number of taxa recognized. To those familiar with this genus in the field, however, relate to the shape and size of the fleshy and brittle calyx – characters which are difficult to describe and are largely lost when...
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.

6 Calyx tube cylindrical to narrowly urceolate-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. 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 Michaux – WH; = Asarum callifolium Michaux var. callifolia (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 Packera paupercula var. appalachiana, Thalictrum macrostylum, Sporobolus heterolepis, and Symphyotrichum 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. rhombifolium); = Asarum contractum (Blomquist) Barringer]


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 ne. 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; < H. virginica – S; = 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 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 & Gonzalez (2003); Huber in Kubitzki, Rohwer, & Bittrich (1993).

1 Plant nearly glabrous; leaves abruptly pointed (short acuminate); calyx purple or brown; [of the Mountains]……………………………………………………………………………….1. 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]………………………………………………………………………………………………………………………………………………………………………………………………………………1. tomentosum

**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

**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 & Nooteboom (2004); Frodin & Govaerts (1996); Nooteboom 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 Liriodendrophyllae]..................................................................................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 dehiscing to reveal a scarlet seed, at first connected to the follicle by a thread-like strand; [subfamily Magnolioideae].................Magnolia

**Liriodendron** Linnaeus (Tulip-tree)


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, WZ]

**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 & Nooteboom (2004). References: Toeb (1998)=; Spongberg (1998)=X; Frodin & Govaerts (1996)=V; Palmoralas-Bejerano, Romanov, & Bobrov (2008)=U; Azuma, Thien, & Kawano (1999); Azuma et al. (2001); Figlar & Nooteboom (2004); Nooteboom 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 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 (300-580; 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
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, NY, 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; = M. virginiana var. australis]

Magnolia kobus (Weatherby, 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 the blue-leaved Magnolia.
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) Pampinini – 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, WH, WV, X, Y, Z; *Huopoa* 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, Thienn, & Kawano 1999). Based on the studies of Azuma et al. (2011), Azuma, Thienn, & 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, WH, X, Z; = *M. virginiana* ssp. *australis* (Sargent) A.E. Murray – U]


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


**Asimina** Adanson 1763 (Pawpaw)


**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, acutate-acuminete 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*
3 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 mm long; plant a tree to 15 m tall; [widespread in our area] = *A. triflora*
4 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].
5 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.
ANNONACEAE

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].

5 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.

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

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

8 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; < Pityothamnus angustifolius (Rafinesque) Small – S]


Asimina obovata (Wildenow) Nash. Scrub, sandhills, open dry hammocks. FL peninsula, north to Clay County. [= FNA, K, V, WH, X, Y, Z; = Pityothamnus obovatus (Wildenow) 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, se. TN, and n. MS. [= RAB, C, F, G, FNA, K, S, V, 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; = Pityothamnus pygmeus (W. Bartram) Small – S]


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; < Pityothamnus angustifolius (Rafinesque) Small – S; < A. angustifolia Rafinesque – K, WH, Y]

Asimina trifolia (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, G, G, K, Pa, S, V, 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)
ANNONACEAE

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)


* Chimonanthus praecox (Linnaeus) Link, Wintersweet. Reported as at least persistent in City of Alexandria, VA (Steyr 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. Lauras obilis 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 Perseaee].
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 Laureeae].
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)

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 oblong-elliptic, pubescent and whitened below; leaves and bark aromatic, the odor leomy ........... 1. 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-fragnant when crushed; shrubs not colonial, often multi-stemmed from base, short to tall (to 5 m tall) ......................... 2. 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)................................. 2. melissifolia

Lindera benzoin (Linnaeus) Blume, Northern Spicebush. Rich alluvial forests, mesic forests on slopes with circumneural 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, c. 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. melissafolia – RAB, F, GW, orthographic variant; = Benzoin melissaeformium (Walter) Nees – S]

Lindera subcoriacea B.E. Wofford, Bog Spicebush. Peaty seepage bogs in headwaters of blackwater streams, in the sandhills and immediately adjacent 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]

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. ND (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. borbonia
   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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