

FREMONTIA

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CALIFORNIA NATIVE PLANT SOCIETY

Dedicated to the Preservation of the California Native Flora

The California Native Plant Society (CNPS) is an organization of laypersons and professionals united by an interest in the native plants of California, open to all. Its principal aims are to preserve the native flora and to add to the knowledge of members and the public at large by monitoring rare and endangered plants throughout the state; by acting to save endangered areas through publicity, persuasion, and on occasion, legal action; by providing expert testimony to government bodies; and by supporting financially and otherwise the establishment of native plant preserves. Much of this work is done by volunteers through CNPS Chapters throughout the state. The Society's educational work includes: publication of a quarterly journal, *Fremontia* and a quarterly *Bulletin* which gives news and announcements of Society events and conservation issues. Chapters hold meetings, field trips, and plant and poster sales. Non-members are welcome to attend.

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THE COVER: The genus *Phacelia* (*P. distans* shown here) will now be placed in the Boraginaceae rather than the Hydrophyllaceae. Photograph by L.C. Wheeler.

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In the new classification system, the milkweed family, Asclepiadaceae, will be placed in the dogbane family, Apocynaceae. The prostrate milkweed (*Asclepias solanoana*) from Sonoma County is shown here. Photograph by J. Game.

UPCOMING CHANGES IN FLOWERING PLANT FAMILY NAMES: THOSE PESKY TAXONOMISTS ARE AT IT AGAIN!

by Ellen Dean

We had a sense that beloved plant names were at risk when the scientific name of one of our favorite species, *Zauschneria californica* (California fuchsia), became *Epilobium canum*. That change was suggested more than 25 years ago in the mid-1970s when Peter Raven, the current director of the Missouri Botanical Garden, reexamined the relationships among *Epilobium* (wil-

low herb) and relatives. The name *Epilobium canum* was used for California fuchsia in *The Jepson Manual of Higher Plants of California*, which was published in 1993, and that name change had plenty of company. For example, the generic names of many of the species of *Orthocarpus* (owl's clover) morphed into *Castilleja* or *Triphysaria*, while all of our *Stipa* species (needle grass) took on other generic names, such as *Nassella*

If one examines the name change section of *The Jepson Manual* (Appendix III), one finds hundreds of name changes that were incorporated in the 1993 publication. (See Skinner and Ertter, 1993, for a discussion of this topic with regard to rare plants.) Nearly 10 years after the arrival of *The Jepson Manual*, some of us are still reeling from the loss of *Matricaria matricarioides*, the old name for pineapple weed. (What

a wonderful name; somehow *Chamomilla suaveolens* will never quite do.) I imagine there are California botanists who don't want to see more name changes any time soon, am I right?

Unfortunately, when it comes to plant taxonomy and classification, more changes are imminent, and these are far reaching, often affecting the families we have all known and loved for centuries. In a paper titled "An ordinal classification for the families of flowering plants," which was published in the fall of 1998 by the Angiosperm (flowering plant) Phylogeny Group (APG), a group of 28 authors proposed a new classification system for flowering plants. The APG system is now being taught in college taxonomy courses, thanks to the publication of *Plant Systematics: A Phylogenetic Approach* an excellent new plant systematics textbook by Walter Judd et al. (2002). This text incorporates much of the classification put forth in the APG paper, although it has a few surprises of its own.

For those of us who learned the flowering plant classifications of Arthur Cronquist, Armand Takhtajan, or Robert Thorne when we took plant taxonomy in the 1970s or 1980s, this new classification system may come as a bit of a shock. Most articles and books published in this country over the past 20 years (including *The Jepson Manual*) have followed Cronquist's familial classification. As with most flowering plant classification systems produced during the 20th century, Cronquist divided the flowering plants into a nested hierarchy of groups arranged to reflect an approximation of evolutionary relationships. (See sidebar on pages 4–7 for a more in-depth explanation of classification.)

He proposed two classes: the *monocotyledons* (grasses, lilies, and their allies, all of which have one seedling leaf or cotyledon), and the *dicotyledons* (flowering plants with two

CLADISTICS, CLASSIFICATION, AND NAME CHANGES OR TREES THAT HAVE PLANT NAMES AT THE ENDS OF THEIR BRANCHES

Classification is a basic human endeavor; people classify tools, food, and telephone numbers. Our classifications are often hierarchical, that is, they are nested subsets which may be visualized as venn diagrams (Figure 1) or written out as a hierarchical list (Table 1). Plant classifications using common names are mainly made up of folk genera such as "oak" or "maple," and folk species such as "coast live oak" or "big leaf maple," although other categories like "live oak," "shrub," or "tree," may also be used.

By the 16th century, Europeans had begun the task of classifying every plant and animal in the world by giving them a unique Latin description. In his 18th century works, Carolus Linnaeus was the first to popularize a Latin description consisting of only two words, which have become known as the genus name (e.g., *Quercus*, the Latin common name for oaks) and its modifier, the specific epithet (e.g., *alba*, Latin for white).

When put together, these two words are called the species name (ex. *Quercus alba*). For convenience, Linnaeus placed the species he described into classes based on stamen type, arrangement, and number, which meant that his classes often consisted of unrelated genera and species. His revolutionary innovation was that he provided a rudimentary identification key to the correct class—a huge help in organizing the increasing number of plants that were being collected around the world.

Linnaeus's classification system was replaced by plant classifications that were based on presumed relationships between species. At first these classifications—which were based on as many characteristics of the species as possible—were attempts to understand the order of nature or the plan of a creator. However, by the end of the 19th century, scientists began to incorporate the notion of evolution into classification systems.

The term "phylogeny" was coined to mean "evolutionary history," and a "phylogenetic classifi-

TABLE 1. SIMPLIFIED CLASSIFICATION OF SIX SPECIES OF CALIFORNIA CONIFERS VIEWED AS A HIERARCHICAL LIST

Pines	Foothill pine (<i>Pinus sabiniana</i>)
	Sugar pine (<i>Pinus lambertiana</i>)
Firs	Silver fir (<i>Abies amabilis</i>)
	Red fir (<i>Abies magnifica</i>)
Spruces	Sitka spruce (<i>Picea sitchensis</i>)
	Brewer spruce (<i>Picea breweriana</i>)

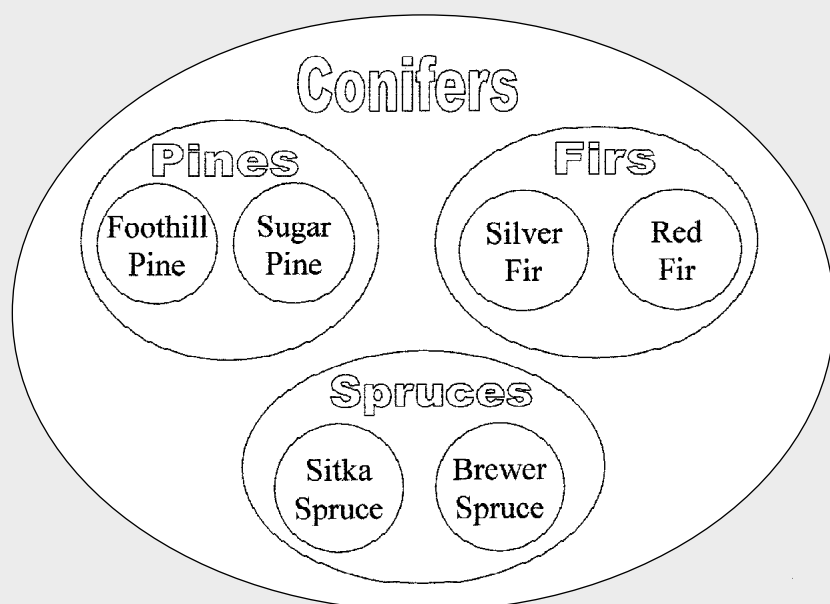


Figure 1. Simplified classification of six species of California conifers viewed as a Venn diagram.

cation” became one that placed species, genera, or families together based on presumed evolutionary relatedness. By the early 20th century, some classifications included drawings of evolutionary trees illustrating the author’s hypothesis of ancestor descendant relationships among the flowering plants. These were called “phylogenetic reconstructions” or “phylogenetic trees.”

In the 1950s, Willi Hennig, a German entomologist, began a school of phylogenetic reconstruction called cladistics. The output of a cladistic analysis is a cladogram, a type of phylogenetic tree. The major contribution of cladistics is the explicit understanding that related species should be grouped based on shared features that are “derived” or different from those possessed by an ancestral population. These shared derived features are termed “synapomorphies.”

For example, the scaly cupule (acorn cap) found in all members of the oak family (Fagaceae) is a morphological synapomorphy for that family (Figure 2). A cluster on a cladogram that includes a branch-

ing point (a putative ancestor) and all the descendants above that branching point is termed a “monophyletic group.” One example is the Fagaceae family, which are shown in Figure 2, although not all genera in the family are shown.

The use of cladistics in taxonomy

did not become popular until the 1980s. Late in the same decade, the use of molecular data to determine relationships between species became commonplace. Scientists now sequence genes to look at the pattern of bases in DNA strands. Patterns between species are compared and analyzed using computerized cladistic analyses or other methods of phylogenetic reconstruction. Well-studied morphological features can also be added to the analyses, and the resulting phylogenetic trees are studied to determine relationships among species, genera, and families.

Current classifications based on cladistic analyses only recognize monophyletic groups of organisms (genera, families, orders). For example, recent classification systems recognize the flowering plants (angiosperms) and monocotyledons, because they form strong monophyletic groups in cladistic analyses (Figure 3). These groups are not only

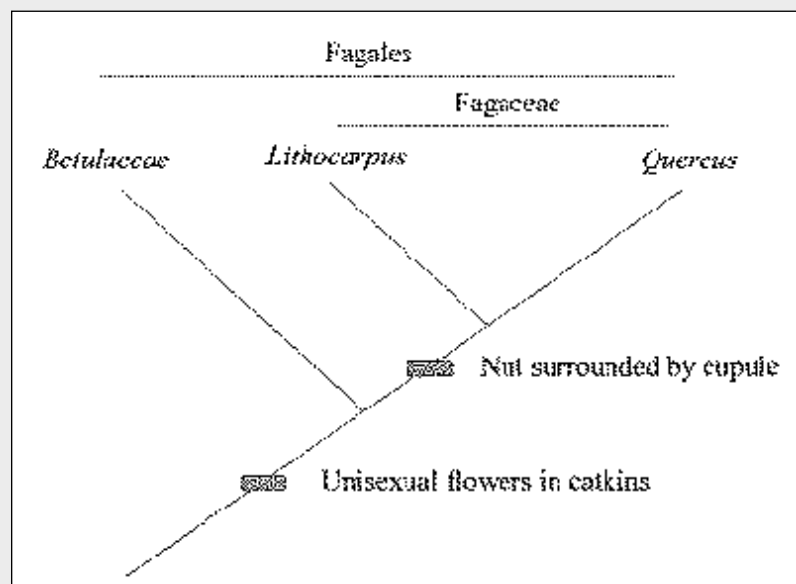


Figure 2. Hypothetical simplified phylogenetic tree of two California plant families in the order Fagales (not all families and genera are shown). Unifying synapomorphies that group members of the Fagales and members of the Fagaceae are indicated on the branches.

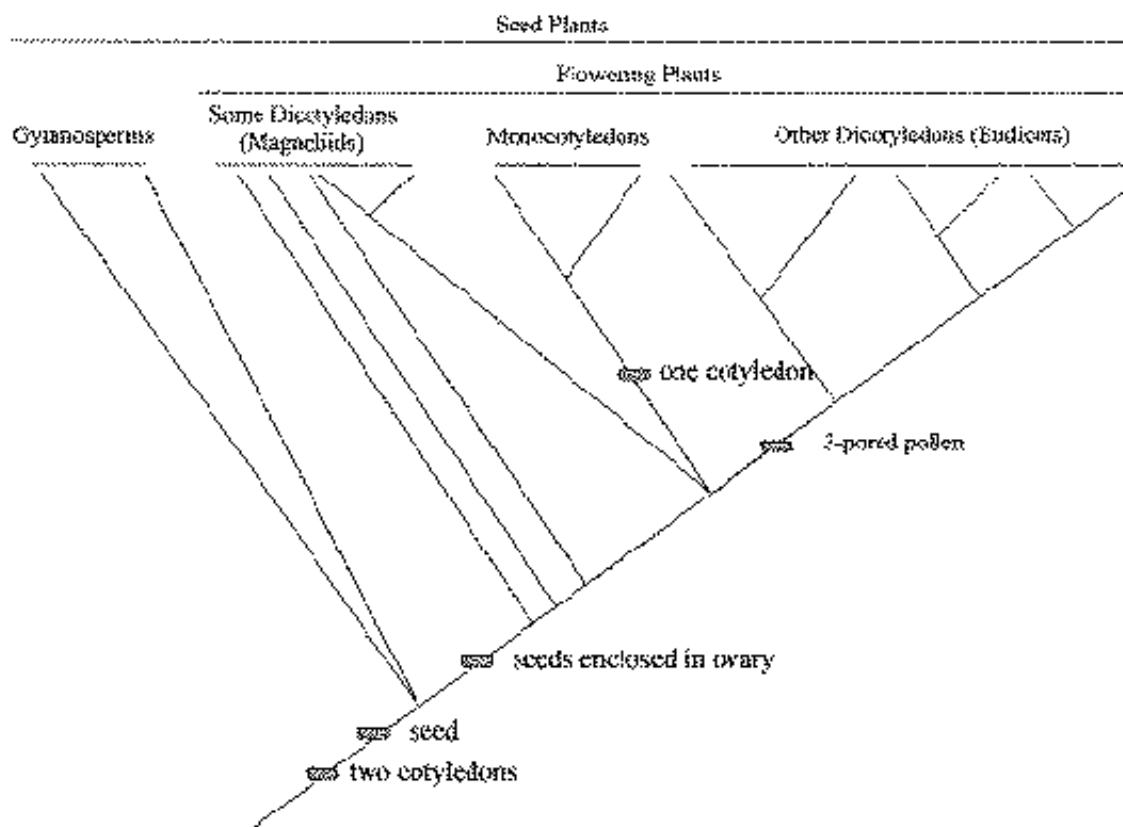


Figure 3. Simplified phylogenetic tree of seed plants with key synapomorphies indicated on the branches. The innovation of one cotyledon unites all monocotyledons into a monophyletic group. As can be seen from this tree, most seed plants have two cotyledons, therefore the presence of this feature in dicotyledons is an ancestral (not a derived) feature. The dicotyledons, therefore, are not a monophyletic group.

supported by molecular data, but they are defined by important morphological synapomorphies—the ovary in the case of the angiosperms, and one cotyledon in the case of the monocotyledons (Figure 3).

In contrast, current classifications do not recognize the dicotyledons (flowering plants with two cotyledons, the members of which are outlined in Figure 3), for it turns out that the possession of two cotyledons is not novel within the flowering plants; having two cotyledons is an ancient feature that most seed plants share. Cronquist's classification recognized many non-monophyletic groups that were based on shared ancestral features. The

elimination of these groups is one reason for the current reshuffling of genera and families.

Cladistic analysis and other types of phylogenetic reconstruction are not perfect, however, because different genes or other characteristics may provide apparent conflicting synapomorphies, producing different phylogenetic trees. In these cases, it is assumed that some such features evolved more than one time or evolved and then reverted to a previous form.

To choose among the hundreds of trees that may be produced by a large analysis, the principle of parsimony is employed. The most parsimonious tree is the shortest tree, requiring the fewest changes in characteristics along the tree

branches. The most parsimonious tree, however, is not necessarily the true evolutionary tree. Therefore, as more information is obtained over the next few decades and new and better forms of analyses are employed, the classification of flowering plants will continue to change.

Unfortunately for all of us, when classifications change, sometimes plant names change. Why is this? The naming of plant groups is guided by an international body of taxonomists and a document called the International Code of Botanical Nomenclature (ICBN) which is updated every five or six years. The Code specifies that every species name be tied to a particular her-

barium specimen which is called its type specimen, every genus name is tied to a type species name, and every family name is tied to a type genus name.

If one wants to use the family name Scrophulariaceae for a particular group of genera, then the type genus *Scrophularia* (bee plants) needs to be one of the genera that is in the group. Similarly, if one wants to use the generic name *Scrophularia* for a particular group of species, then the type species *Scrophularia nodosa* must be included in that group of species. If one wants to use the name *Scrophularia californica* for a particular group of populations, then one needs to make sure that the type specimen of that name matches plants from those populations.

Sometimes, the same entity (a species, genus, or family) has more than one published name. In that case, which name does one choose? Here, we turn once again to the ICBN which says that we must use the oldest published name beginning from 1753 (the publication date of Linnaeus's *Species Plantarum*), unless taxonomists vote to conserve a later name. This is known as the principle of priority.

With the combination of new molecular data, the wide use of cladistic analyses, strict adherence to the rules of cladistic classification, and the application of the rules of the ICBN, you can now see how we have arrived at a point in botanical history where the names of flowering plant groups are changing drastically. We have come a long way in our understanding of the evolution of the flowering plants, and these changes are, we hope, inching us toward a truly phylogenetic system of classification.



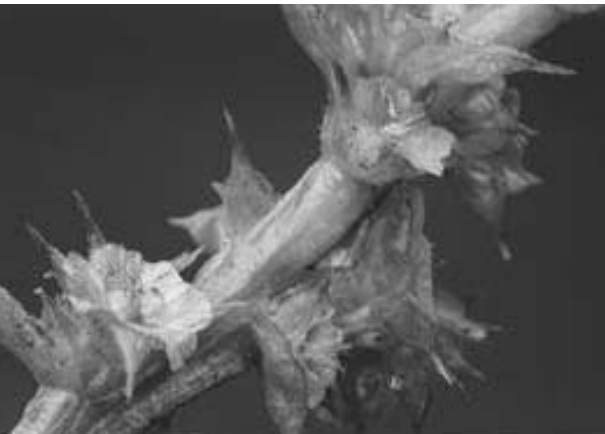
Aceraceae (*Acer macrophyllum* or big-leaf maple shown here) is now placed in the Sapindaceae, a mostly tropical family. Photograph by G. Webster.

seedling leaves). These classes were each divided into a nested hierarchy of subclasses, orders, families, genera, and species. The groups at each level of the hierarchy were defined using all the evidence available at the time. Even so, there were families, orders, or subclasses that were known to be problematic (not clearly defined), and it was certain that further work was needed to clarify their evolutionary relationships.

In the late 1980s, with the increasing use of molecular data analyzed using cladistics, journal articles pointing out the shortcomings of previous classification systems began to appear. The authors published branching diagrams

called cladistic trees, and based on the branching pattern of the trees, “monophyletic” groups of related species, genera, and families were carved out (see sidebar on pages 4–7).

One of the most thought-provoking articles was written by Mark Chase et al. (1993). In it, the authors produced cladistic trees based on chloroplast gene data that called into question a number of Cronquist’s subclasses and orders, not to mention the validity of the dicotyledons as a taxonomic group. As the 1990s continued and the use of DNA sequence data by plant scientists became widespread, articles questioning the make-up of



Salicornia, pickleweed (top) and *Salsola*, Russian thistle (bottom) of what was the Chenopodiaceae. Some genera in this family may end up in the Amaranthaceae. Photographs by L. Wheeler.

various plant families appeared. This research culminated in the publication of the APG paper in 1998 and the textbook by Judd et al. in 1999 (revised in 2002).

Although many plant families recognized in *The Jepson Manual* are changed to some degree in the new classification system (Table 2 is an attempt at a complete listing), some families are affected more than others. The Scrophulariaceae (and closely related families such as Plantaginaceae, Orobanchaceae, Callitrichaceae, and Hippuridaceae) and the Liliaceae are radically reshuffled or broken down into different subunits (see articles by Olmstead and Kelch in this issue). The Lamiaceae and Verbenaceae

also get reshuffled, but the genera involved in the reshuffle are not commonly found in California.

Other *Jepson Manual* families will simply disappear in the new classification system, “gobbled up” by closely-related families of which they are just a more specialized member. Hydrophyllaceae and Lennoaceae are included in Boraginaceae; Empetraceae and Epacridaceae are placed in Ericaceae; and Aceraceae and Hippocastanaceae are being included in a mostly tropical family that wasn’t even included in *The Jepson Manual*—the Sapindaceae (which includes golden rain tree).

In addition, the Chenopodiaceae are placed in Amaranthaceae, Asclepiadaceae in Apocynaceae, Lemnaceae in Araceae, Capparaceae in Brassicaceae, Punicaceae in Lythraceae, Martyniaceae in Pedaliaceae, Philadelphaceae in Hydrangeaceae (a family not included in *The Jepson Manual*), and Cuscutaceae in Convolvulaceae. The Malvaceae become the equivalent of the Cronquistian order Malvales, “inhaling” Sterculiaceae (the chocolate family, which includes our flannelbush, *Fremontodendron* as well as the mostly tropical families Tiliaceae and Bombaceae (neither of which are in *The Jepson Manual*).

Some of the mergers mentioned above are expected, because boundaries between the families in question have been muddy for some time. For instance, some teachers out there may breathe a sigh of relief at the combination of Chenopodiaceae and Amaranthaceae. In other cases, the families that are disappearing consisted of only one genus, and so the addition of that genus to a closely-related family is really not that radical a change.

The converse happens as well. Some families are being narrowed, with an errant genus being removed and placed in a family of its own. For example, *Sparganium* is taken out of Typhaceae and placed in its

own family, *Ruppias* excluded from Potamogetonaceae, *Halesias* being taken out of the Styracaceae, and *Sambucus* and *Viburnum* are being taken out of the Caprifoliaceae and placed in the Adoxaceae.

The bottom line is that change is coming, and if you think that you are in trouble, just think what it will be like trying to incorporate some of these changes into the filing system at the UC Davis Herbarium! We are still trying to curate our collections to agree with some of the name changes in *The Jepson Manual* (we just finished changing *Haplopappus* to *Ericameria*). However, we cannot stick our heads in the sand, because some recent US guidebooks have already begun to incorporate the proposed family name changes, and it looks like we may have to learn to accept that *Triteleia laxa* (Ithuriel’s spear) is now in the Themidaceae (“What?” you say).

Of course, only time will tell how much of the APG system will really be accepted by the scientific community, not to mention lay botanists, especially when our current flora of California follows Cronquist. But if these strange family names begin to appear in California local floras, garden books, and articles, you can haul out this article and use Table 1 to translate into “Jepsonese.”

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TABLE 2. PRELIMINARY SUMMARY OF FAMILIES IN THE JEPSON MANUAL AND THEIR NAME CHANGES ACCORDING TO THE APG * SYSTEM

APG System (1998)		Judd, et al. (2002)
MONOCOTYLEDONS		
Alismataceae		
Aponogetonaceae		
Araceae	Includes Lemnaceae, but excludes Acoraceae.	Same as APG.
Arecaceae		
Commelinaceae		
Cymodoceaceae		
Cyperaceae		
Hydrocharitaceae		
Iridaceae		
Juncaceae	No change?	Perhaps not monophyletic, but no change yet.
Juncaginaceae		
Lemnaceae	Included in Araceae.	Same as APG.
Liliaceae	Narrowed to exclude many genera; see Kelch article on page 23.	Same as APG.
Orchidaceae		
Poaceae		
Pontederiaceae		
Potamogetonaceae	Includes Zannichelliaceae, but excludes Ruppiaceae.	Excludes Ruppiaceae.
Scheuchzeriaceae		
Typhaceae	Excludes Sparganiaceae.	No change.
Zannichelliaceae	Included in Potamogetonaceae.	No change.
Zosteraceae		
DICOTYLEDONS		
Acanthaceae		
Aceraceae	Included in Sapindaceae.	Same as APG.
Aizoaceae		
Amaranthaceae	Broadened. Includes all Chenopodiaceae except Sarcobataceae.	Includes all Chenopodiaceae.
Anacardiaceae		
Apiaceae	Narrowed. <i>Hydrocotyl</i> and related transferred to Araliaceae.	Broadened. Includes all genera Araliaceae.
Apocynaceae	Broadened. Includes Asclepiadaceae.	Same as APG.
Aquifoliaceae		
Araliaceae	Broadened. Includes <i>Hydrocotyl</i> and related genera.	Included in Apiaceae.
Aristolochiaceae		
Asclepiadaceae	Included in Apocynaceae.	Same as APG.
Asteraceae		
Balsaminaceae		
Basellaceae		
Bataceae		
Berberidaceae	*Angiosperm Phylogeny Group	

TABLE 2, <i>continued</i>	APG System (1998)	Judd, et al. (2002)
Betulaceae		
Bignoniaceae		
Boraginaceae	Broadened. Includes Hydrophyllaceae and Lennoaceae.	Includes Hydrophyllaceae except for Hydroleaceae; mentions that Lennoaceae may also be part of Boraginaceae.
Brassicaceae	Broadened. Includes Capparaceae.	Same as APG.
Buddlejaceae		
Burseraceae		
Cabombaceae	Included in Nymphaeaceae.	Same as APG.
Cactaceae		
Callitrichaceae	Included in Plantaginaceae; see article by Olmstead (this issue on page 13).	Same as APG.
Calycanthaceae		
Campanulaceae		
Cannabaceae		
Capparaceae	Included in Brassicaceae.	Same as APG.
Caprifoliaceae	Excludes <i>Sambucus</i> and <i>Viburnum</i> (which are included in the Adoxaceae); excludes Linnaeaceae.	Excludes <i>Sambucus</i> and <i>Viburnum</i> (Adoxaceae) but includes Dipsacaceae and Valerianaceae.
Caryophyllaceae		
Celastraceae	Broadened to include Hippocrateaceae.	Same as APG.
Ceratophyllaceae		
Chenopodiaceae	Included in Amaranthaceae, with the exception of Sarcobataceae.	Included in Amaranthaceae.
Cistaceae		
Convolvulaceae	Broadened to include Cuscutaceae and Dichondraceae.	Same as APG.
Cornaceae	Broadened to include other non-California genera.	Same as APG.
Crassulaceae		
Crossosomataceae		
Cucurbitaceae		
Cuscutaceae	Included in Convolvulaceae.	Same as APG.
Datisceae		
Dipsacaceae	No change.	Included in Caprifoliaceae.
Droseraceae		
Eleagnaceae		
Elatinaceae		
Empetraceae	Included in Ericaceae.	Same as APG.
Ericaceae	Broadened; includes Empetraceae and other non-California genera.	Same as APG.
Euphorbiaceae		
Fabaceae		
Fagaceae		
Fouquieriaceae		
Frankeniaceae		
Garryaceae		
Gentianaceae		
Geraniaceae		

TABLE 2, <i>continued</i>	APG System (1998)	Judd, et al. (2002)
Grossulariaceae		
Gunneraceae		
Haloragaceae		
Hippocastanaceae	Included in Sapindaceae.	Same as APG.
Hippuridaceae	Included in Plantaginaceae; see article by Olmstead (this issue on page 13).	Same as APG.
Hydrophyllaceae	Included in Boraginaceae.	Same as APG.
Hypericaceae	Included in Clusiaceae.	Same as APG.
Juglandaceae		
Koeberliniaceae		
Krameriaceae		
Lamiaceae	Broadened to include many Verbenaceae.	Same as APG.
Lauraceae		
Lennoaceae	Included in Boraginaceae.	Mentioned as perhaps belonging in Boraginaceae.
Lentibulariaceae		
Limnanthaceae		
Linaceae		
Loasaceae		
Lythraceae	Broadened; includes Punicaceae, Sonneratiaceae, and Trapaceae.	Same as APG.
Malvaceae	Broadened, includes Sterculiaceae, Tiliaceae, and Bombacaceae.	Same as APG.
Martyniaceae	Included in Pedaliaceae.	Same as APG.
Meliaceae		
Menyanthaceae		
Molluginaceae		
Moraceae		
Myoporaceae		
Myricaceae		
Myrtaceae		
Nyctaginaceae		
Nymphaeaceae	Broadened. Includes Cabombaceae.	Same as APG.
Oleaceae		
Onagraceae		
Orobanchaceae	Broadened to include root parasites of the Scrophulariaceae; see article by Olmstead (this issue on page 13).	Same as APG.
Oxalidaceae		
Paeoniaceae		
Papaveraceae		
Philadelphaceae	Included in Hydrangeaceae.	Same as APG.
Phytolaccaceae		
Pittosporaceae		
Plantaginaceae	Broadened to include genera of traditional Scrophulariaceae; see article by Olmstead (this issue on page 13).	Same as APG.
Platanaceae		
Plumbaginaceae		
Polemoniaceae		

TABLE 2, <i>continued</i>	APG System (1998)	Judd, et al. (2002)
Polygalaceae		
Polygonaceae		
Portulacaceae	No change?	Discusses the possibility that the family is not monophyletic.
Primulaceae		
Punicaceae	Included in Lythraceae.	Same as APG.
Rafflesiaceae		
Ranunculaceae		
Resedaceae		
Rhamnaceae		
Rosaceae		
Rubiaceae		
Rutaceae		
Salicaceae		
Santalaceae	No change?	Discusses the possibility that the family is not monophyletic.
Sarraceniaceae		
Saururaceae		
Saxifragaceae		
Scrophulariaceae	Narrowed; see article by Olmstead (this issue on page 13).	Same as APG.
Simaroubaceae	Narrowed to exclude genera not found in California.	Narrowed to exclude genera not found in California.
Simmondsiaceae		
Solanaceae		
Staphyleaceae		
Sterculiaceae	Included in Malvaceae.	Same as APG.
Styracaceae	Narrowed. Excludes Halesiaceae.	Same as APG?
Tamaricaceae		
Thymelaeaceae		
Tropaeolaceae		
Ulmaceae	Narrowed. Excludes Celtidaceae.	Same as APG.
Urticaceae		
Valerianaceae	No change.	Included in Caprifoliaceae.
Verbenaceae	Narrowed; excludes many genera now placed in the Lamiaceae; also excludes Avicenniaceae.	Same as APG.
Violaceae		
Viscaceae	Included in Santalaceae.	No change.
Vitaceae		
Zygophyllaceae	Circumscription changed.	A few genera placed in the Peganaceae.

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Pat Reeves collecting water-starwort, *Callitriche verna*. All photographs by R. Olmstead unless otherwise credited.

WHATEVER HAPPENED TO THE SCROPHULARIACEAE?

by *Richard G. Olmstead*

Science has been hard on some of our best-loved plant families recently. Perhaps none have been hit harder than the figwort family, Scrophulariaceae.

My interest in the Scrophulariaceae started innocently enough when an undergraduate student working in my lab, Pat Reeves, decided to look to see where three genera of aquatic plants, *Callitriche*

Hippuris and *Hydrostachys* belonged phylogenetically, that is, were they part of the same branch of an evolutionary lineage. Cronquist, whose classification scheme dominated our views of plant relationships for the last 30 years of the 20th century, assigned each of these genera to its own family and all three to the order Callitrichales. Some preliminary results from my research indicated

that *Callitriche* might be closest to the “scroph” genera *Antirrhinum* (snapdragon) and *Digitalis* (foxglove), rather than near the mint family, Lamiaceae, as others had thought. I suggested to Pat that he should sample a number of other representatives of the Scrophulariaceae, as well as some other members of Cronquist’s orders Lamiales and Scrophulariales.



The very first results seemed to indicate that something was amiss. Two groups of genera, normally assigned to Scrophulariaceae, seemed to form distinct branches on the resulting evolutionary tree, but did not come out together. While we could not be confident of the relationships among all the families included in that study, we were confident that these two groups of genera were as distant from each other as any of several major families in this part of the “tree of life” were from each other, including the Lamiaceae, Acanthaceae, Bignoniaceae, Verbenaceae,



Water-starwort, *Callitriche verna* (top left), and Mare's-tail, *Hippuris vulgaris* (above), are now included in the Veronicaceae.

TREE OF LIFE

The metaphor of the “tree of life” has been used ever since Darwin’s time to conceptualize the pattern of relationships among species. A classification that reflects the tree of life would be hierarchical in nature, with branch tips representing species and the branches themselves representing groups in the classification. Our present system of classification consists of a series of ever-more-inclusive ranks. Closely related species make up a genus (“twig” on the tree metaphor), one or more genera make up a family (larger branch), and so on down the tree towards the “trunk” with order, class, phylum, and kingdom.

In order for the resulting classification to accurately reflect the evolutionary relationships or *phylogeny*, each named group in the classification must connect to the rest of the tree at a single point (or “saw cut,” if we are pruning the “tree”). Each such group is termed *monophyletic* (literally “one branch”), whereas groups that consist of two or more branches pruned separately from the tree are termed *polyphyletic*. Those that require one cut to prune a branch, but then another cut to exclude one of the smaller branches from that branch are termed *paraphyletic*. Traditional classifications are largely monophyletic, but typically have some polyphyletic groups and many paraphyletic groups.

DNA SEQUENCES

Most of the evidence for plant evolutionary relationships in recent years has come from a comparison of the DNA sequences of various genes, usually those found in the chloroplast of the plant cell. A single gene, or even three genes as used in the study on which this article is based, are but a small fraction of the entire genetic material in a plant (its genome). However, the variation in DNA sequences for even a gene of modest length—for example 1,000 nucleotides long—is likely to have more information about evolutionary relationships than the anatomy and morphology on which traditional classifications are based. It is also easier to compare using new computer analyses. In the study of Olmstead et al. (2001), three genes totaling more than 4,200 nucleotides were compared for 65 species of plants in the Scrophulariaceae and related families.

and Gesneriaceae (Olmstead and Reeves 1995). Ever since Darwin said that classification should be “genealogical,” taxonomists have tried their best to continually revise classifications to reflect the natural order of evolutionary relationships, the pattern we call *phylogeny* today. A classification that reflects phylogeny would be one in which all of the species assigned to a given group—whether a genus, family, or any other group we may want to name—share a more recent common ancestor with each other than with any species outside the group. This is what is called a monophyletic group (see sidebar on page 14).

For most of the 150 years since Darwin’s ideas transformed the way we think about living things, the changes in our classifications have come gradually. However, the pace of change has picked up dramatically in recent years due to the combined effect of new, more rigorous ways of assessing phylogenetic relationships and the tremendous influx of data from DNA sequences (see sidebar above).

That first study was modest in scope: after all, it was an undergraduate thesis project! I knew that I would have to dramatically increase the sampling in order to nail down the extent to which changes would need to be made in our classification of the Scrophulariaceae. At this point I contacted a group of researchers at Vanderbilt Univer-

sity—Claude dePamphilis, Andrea Wolfe, and Ned Young, who were studying the parasitic members of the Scrophulariaceae and Orobanchaceae—to better understand the origin and evolution of parasitism. (Parasitism in this case is the ability to develop the parasitic connections called haustoria to the roots of other plants.)

In Pat’s study, we had not sampled any of the parasitic scrophs, not wanting to interfere with their research. However, Claude, Andi, and Ned had some tantalizing evidence that the parasites, including such well known western wildflowers as *Pedicularis* (lousewort), *Castilleja* and *Orthocarpus* (paintbrush and owl’s clover), and *Orobanch* (broom-rape), all formed a closely related group of plants that was not close to either of the two groups we had identified.

As fate would have it, our two labs had only a partially overlapping set of DNA sequences, so we undertook the job of backtracking and obtaining all of the DNA sequence data we would need for all of the species we had sampled. We also added some more species to the list to try to sample as many of the tribes (rank more inclusive than genus, but smaller than family) of Scrophulariaceae as possible from around the world. In all, we sampled 39 genera of scrophs, representing 24 tribes, along with representatives of 15 closely related families for a recently published study (Olmstead et



The genus *Castilleja* (purple owl’s-clover, *C. exserta*, shown here) is now included in the Orobanchaceae family along with broom-rapes and louseworts. Photograph by J. Vale; its use courtesy of Jepson Herbarium, UC.

al. 2001). Our data consisted of DNA sequences for three genes and totaled more than 4,200 nucleotides of DNA. Since the body of evidence for this study was obtained, numerous other species have been sampled and additional genes have been

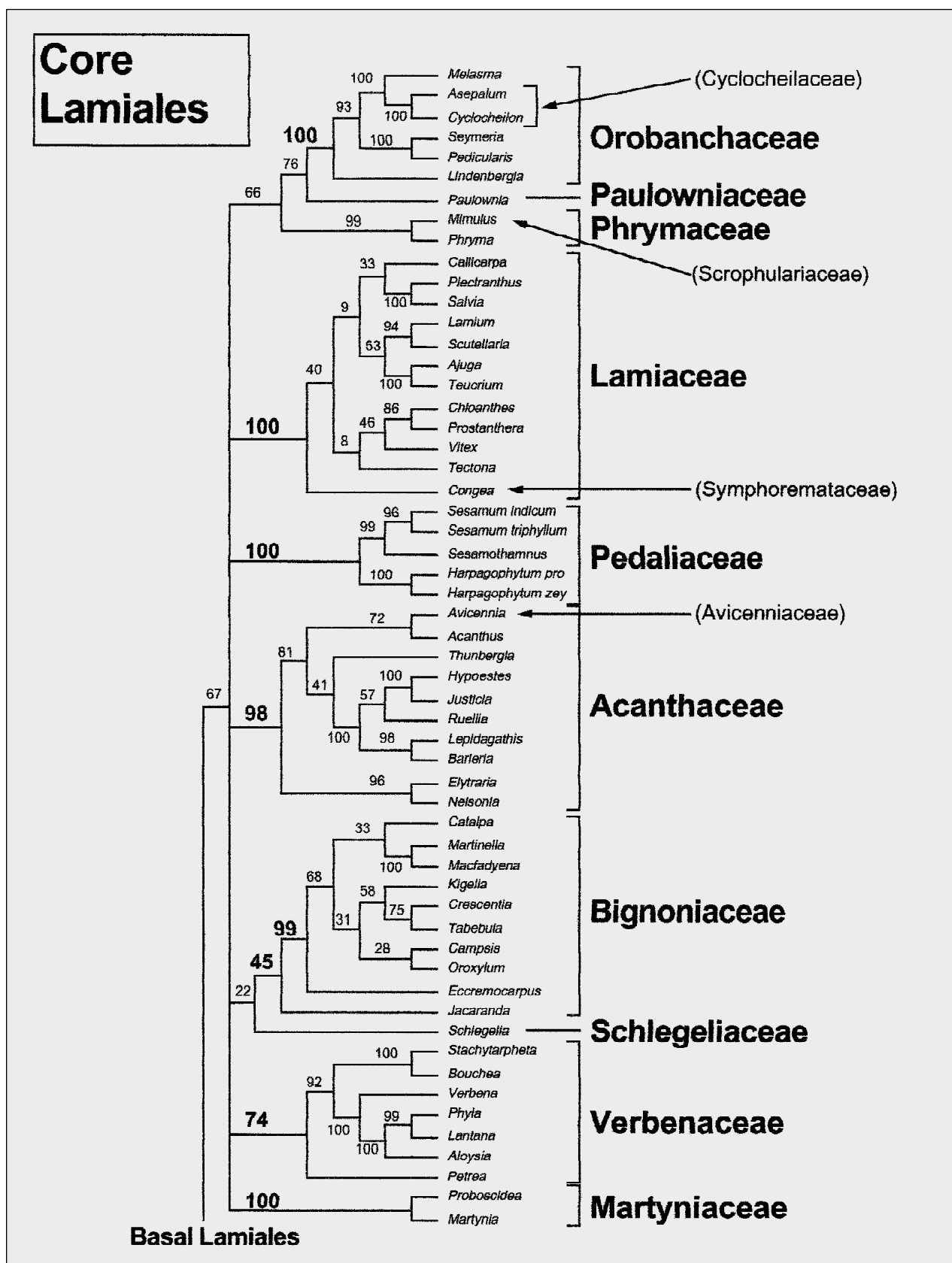
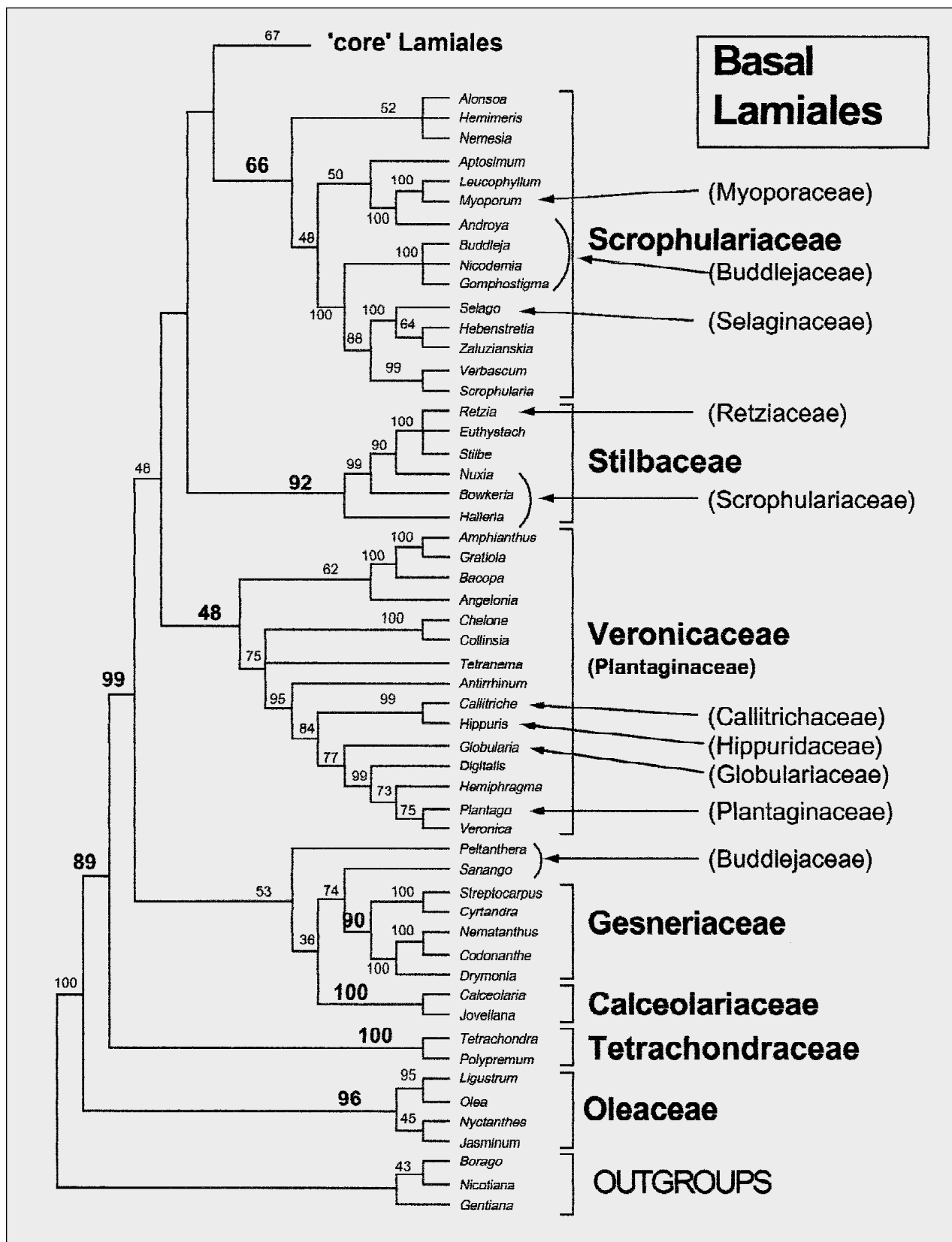


Figure 1. This tree represents the consensus relationships based on the DNA sequences of two genes from the chloroplast genome. Areas of uncertainty regarding relationships are indicated by the unresolved nodes on the tree. Numbers on the branches represent



bootstrap values (scale 0 - 100) which provide a relative measure of support for individual branches. The names on the right in bold are the names of the major groups (indicated by brackets) recognized in our study, while those in parentheses with arrows indicate former family placement of some genera.

TABLE 1. GENERA INCLUDED IN CALLITRICHACEAE, HIPPURIDACEAE, OROBANCHACEAE, PLANTAGINACEAE, AND SCROPHULARIACEAE IN THE JEPSON MANUAL (1993) WITH THEIR NEW FAMILY ASSIGNMENTS

Orobanchaceae (Broom-rape Family)

Bellardia
Boschniakia(ground-cone)
Castilleja(Indian paintbrush, owl's clover)
Cordylanthus(bird's-beak)
Orobancha(broom-rape)
Orthocarpus(owl's clover)
Parentucellia
Pedicularis(lousewort)
Triphysaria

Veronicaceae or Plantaginaceae (Veronica or Plantain Family)

Antirrhinum (snapdragon)
Bacopa(water-hyssop)
Callitriche(water-starwort)
Collinsia
Cymbalaria
Digitalis (foxglove)
Dopatrium
Galvezia
Gratiola(hedge-hyssop)
Hebe
Hippuris(mare's-tale)
Keckiella
Kickxia(fluellin)
Limosella(mudwort)
Linaria (toadflax)
Maurandya
Mohavea
Nothochelone
Penstemon(beardtongue)
Plantago (plantain)
Stemodia
Synthyris(kittentails)
Tonella
Veronica(speedwell, brooklime)

Scrophulariaceae (Figwort Family) includes Buddlejaceae (Loganiaceae) and Myoporaceae

Buddleja(butterfly bush)
Myoporum
Scrophularia(figwort)
Verbascum(mullein)

Phrymaceae

Mimulus(monkey flower)

Unassigned

Lindernia(false pimpernel)



As a member of the genus that the family is named for, lance-leaved figwort, *Scrophularia lanceolata* (above), remains in the Scrophulariaceae. Photograph by M. Denton. • Moth mullein, *Verbascum blattaria* (below right), is still included in the Scrophulariaceae.

sequenced, but the picture that I am about to describe of the demise of the Scrophulariaceae has not been altered substantially by any of those results.

Prior molecular systematic studies had determined that Cronquist's Scrophulariales and Lamiales (minus the Boraginaceae), along with the small orders Callitrichales and Plantaginales, formed a monophyletic group, all of which is now referred to as Lamiales (Olmstead et al. 1993). Flowers of plants in the Lamiales tend to be pretty uniform in their appearance, typically having corollas with bilateral symmetry (often two-lipped, or bilabiate)

that are five-parted, and superior ovaries consisting of two fused carpels. Perhaps the most notable outlier in the group is the olive family (Oleaceae), which have four-parted flowers with two stamens and radial symmetry. The atypical floral morphology of the Oleaceae is not so difficult to explain, considering that its placement in the phylogenetic tree is at the very base of the Lamiales.

Most of the families related to the Scrophulariaceae can be identified by distinguishing traits that are unique to the family (e.g., winged seeds without endosperm in Bignoniaceae; retinacula for ejecting

seeds from the fruit in Acanthaceae), or traits that are clearly uniquely derived, even if shared by some more distantly related family (parietal placentation in Gesneriaceae; ovule number reduced to two per carpel and each carpel divided by a "false septum" in Lamiaceae and Verbenaceae). However, the Scrophulariaceae seem to be characterized by unspecialized floral traits that may represent ancestral traits within the Lamiales.

Even though work to sort out all of the details of evolutionary relationships within the Lamiales is continuing, a sufficiently robust picture of relationships has emerged to enable us to identify major lineages suitable for recognition in a revised classification. The picture that emerges is one that shows some families mixed up with other families (e.g., Lamiaceae and Verbenaceae), some families nested within other families (e.g., Myoporaceae and Buddlejaceae within Scrophulariaceae), and yet other families that are assemblages of unrelated lineages that will need to be dismembered (e.g., Pedaliaceae and Scrophulariaceae).

In some cases, adjusting the classification will mean little more





than changing the rank of some groups (e.g., family to subfamily or vice versa), whereas in other cases, new taxa will need to be named or named taxa will need to be altered dramatically in their circumscription. In any event, the changes that are being made will be a test of how well the traditional Linnaean system of classification, which has served the taxonomic community for 250 years, will hold up in the face of efforts to develop a new system of nomenclature (the method of applying names in a classification, not the classification itself), but this is a subject for another time!

The Scrophulariaceae, as traditionally conceived, is worldwide in distribution and consists of approximately 275 genera and over 5,000 species. The emerging classification for the plants traditionally assigned to Scrophulariaceae will represent at least seven groups that will bear the rank of family. These will vary tremendously in size and several of them will have a distinct geographic focus. Some of these are newly recognized (e.g., Calceolariaceae, Veronicaceae), while others represent expansions of previously recognized families (e.g., Orobanchaceae, Stilbaceae). They are characterized as follows.

Scrophulariaceae. For those of us here in the western US, the Scrophulariaceae will become one of those families that we will encounter on rare occasions in our native flora. Two genera native to North America, *Leucophyllum* in the deserts of the southwest and Mexico, and *Scrophularia* (figwort), are the only native genera that remain in this family; the weed, mullein (*Verbascum*), will be our most frequently

encountered scroph. Both *Scrophularia* and *Verbascum* belong to a small group of genera within the Scrophulariaceae that is distributed in north temperate regions, mostly in Eurasia.

Most of the rest of this family is in the southern hemisphere, particularly South Africa, where four tribes are endemic. Australia has a substantial representation of the Scrophulariaceae in the form of the Myoporaceae, a group that is traditionally considered a distinct family, but now is seen to belong nested within the Scrophulariaceae. Buddlejaceae also is included in this group and is distributed in Africa, Asia, and the New World. Excluding Myoporaceae and Buddlejaceae from Scrophulariaceae would make the remaining group paraphyletic.

Most North American botanists think of *Verbascum* as an oddball for the family due to its nearly radially symmetric flowers. However, most of the Scrophulariaceae, as we now define them, exhibit radial corolla symmetry, so it is *Scrophularia*, with its bilabiate corolla, that is the real oddball. Buddlejaceae, Myoporaceae, and most of the South African scrophs all have corollas that are radially symmetric, or nearly so.

Orobanchaceae. For many years the Orobanchaceae have been accepted somewhat reluctantly as the bastard stepchild of the Scrophulariaceae. It was no secret that they were related to the scrophs and probably derived from them, but the distinctive suite of traits associated with being an obligate parasite, or holoparasite, seemed sufficient to merit their own taxonomic designation.

However, recent molecular sys-

Clustered broom-rape, *Orobanche fasciculata* (top), is included in the Orobanchaceae along with photosynthetic genera such as *Pedicularis* (louseworts). • Applegate Indian paintbrush, *Castilleja applegatei* (middle). Paintbrushes are now included in the Orobanchaceae. Photograph by M. Denton. • English plantain, *Plantago lanceolata* (bottom), is moved from the Plantaginaceae in the strict sense to a larger family, Plantaginaceae or Veronicaceae, which includes such genera as *Antirrhinum* (snapdragons), *Penstemon*, and *Veronica*.



Monkey flowers, such as the above *Mimulus mephiticus* from Yosemite National Park, are now placed in the Phrymaceae. Photograph by C.S. Webber; its use courtesy of Jepson Herbarium, UC.

tematic studies legitimize the Orobanchaceae and reunite them with their rightful siblings, the green hemiparasites (capable of both photosynthesis and parasitism), including such well-known natives as the louseworts (*Pedicularis*), Indian paintbrushes (*Castilleja*), and owl's clovers (*Castilleja* and *Orthocarpus*). Not only are all of the parasites (holo- and hemi-) united into a monophyletic group, thus providing the basis for their acceptance in our classification, they are not particularly close to any of the other major groups of scrophs. Therefore, this is not simply a matter of arbitrarily splitting off a distinctive branch of a larger Scrophulariaceae; these form a distinct and distinctive lineage of plants.

The work of dePamphilis, Wolfe, and Young (dePamphilis et al. 1997; Wolfe & dePamphilis 1997; Young et al. 1999) has shown that parasitism in this group evolved only once. Perhaps more interestingly, they have shown that the loss of chlorophyll and, therefore, the inability to photosynthesize, has oc-

curred multiple times within the descendants of that first parasitic species. Thus the traditional Orobanchaceae, consisting of just the obligate parasites, is not a natural group without also including the hemiparasites with them. Consequently, the Orobanchaceae now assume a much more important role in the flora of western North America.

Veronicaceae. Many of our most familiar scrophs, including snapdragons (*Antirrhinum*), foxglove (*Digitalis*), and such natives as *Collinsia*, *Penstemon*, and *Veronica* belong to a third major lineage. This group is worldwide in distribution and very diverse. Also in this group are several small groups often recognized as individual families by virtue of having distinctive traits that obscure their true relationships. These include *Plantago* (Plantaginaceae), *Globularia* (Globulariaceae), and two of the aquatic genera mentioned in the beginning of this article that were the initial subject of the undergraduate thesis

several years ago, *Callitriche* and *Hippuris* (Olmstead et al. 2000). The third aquatic genus, *Hydrostachys*, is more closely related to the hydrangeas and dogwoods than it is to *Callitriche* and *Hippuris* (Olmstead et al. 2000).

For this group, we have chosen a name calculated to create controversy. The International Code of Botanical Nomenclature requires the use of the earliest validly published name for a family (or genus or species) that is based on the name of a species included in the family. We have chosen Veronicaceae, which is the earliest validly published name (1782) and one that reflects its primary composition as former scrophs, to represent this newly recognized taxonomic group.

However, two rules conspire against this choice. One is a nomenclatural rule that permits exceptions to strict priority, and allows later names to be accepted or "conserved" (in the lingo of taxonomic nomenclature). The second is an obscure rule in an appendix to the

Code of Nomenclature, which further constrains the choice of “conserved” names to a starting date in 1789. The Code requires that Plantaginaceae be used for this group. (Globulariaceae, Callitrichaceae, and Hippuridaceae all are preferred by the Code over any other name, too, but occur later than Plantaginaceae.)

The international committee charged with settling disputes about nomenclature rejected our request to use any name other than Plantaginaceae. However, given that Plantaginaceae already is identified with a well-known and monophyletic group, and recognizing the inadvisability of forcing the many new groups being recognized today to fit into a few Linnaean ranks, we have chosen to ignore the Code and name this group Veronicaceae.

Phrymaceae. If you have studied botany primarily in the western US, chances are you have not heard of this family. As presently conceived, it includes a single genus, *Phryma*, which has either one or two species, depending on whether east Asian and eastern North American populations are considered separate species or not. The plants are small, perennial, understory herbs in deciduous forests with tiny, primarily self-pollinating flowers. The flowers have unusually long curled tips on the calyx and a single-seeded fruit, which accounts for their isolated taxonomic position. However, if you look closely you can see a little monkey face smiling back at you.

The doctoral research of Paul Beardsley at the University of Washington has shown that *Phryma* is, in fact, a monkey flower and is evolutionarily derived from ancestors that we would call *Mimulus* were we to encounter them today. *Phryma*, *Mimulus*, and six to eight other small genera comprise a monophyletic group that is not closely related to any of the other groups of former scrophs. Ironi-

cally, neither the name *Mimulus*, nor any of the names of the other small genera, have been published as the root of a family name. Therefore, Phrymaceae has priority at the rank of family for this group. By this point, you are probably cursing out loud. But, bear up—you’ve just learned a new family!

Are there yet more families? Yes. But these are ones that you won’t encounter here in the wilds of the western US. A pretty ornamental plant, with which many of you may be familiar, *Calceolaria* (pocket-book plant), along with two small genera native to South America and New Zealand, are isolated from all other scrophs and comprise a new family, Calceolariaceae (not just new to us provincial botanists here in the western US, but a newly-described family). In South Africa, a few former scroph genera were found to be related to a group called the Stilbaceae and are transferred to that family. Lastly, *Paulownia* (empress tree), a group of six species of large trees from China with showy flowers reminiscent of *Catalpa* and sometimes placed in the Scrophulariaceae, are isolated from any of the other families and are best considered their own family, Paulowniaceae.

As scientists, we plant taxonomists consider ourselves fortunate to be a part of what is one of the eras of greatest advancement in our field since the tremendous age of discovery in the 18th and 19th centuries. At the same time we recognize the fact that many botanists of our generation, amateur and professional alike, may find the changes in plant classification confusing and even counterproductive to the purpose of communicating about biodiversity. However, if our classification is to truly represent the pattern of biodiversity stemming from the evolutionary history of the plants on earth today, changes we make now will result in a classifica-

tion that will provide a much more stable means of communicating our knowledge of biodiversity many generations into the future.

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The onion *Allium platycaule* (now in Alliaceae) from Soldier Creek, Modoc County. Photograph by J. Vale; its use courtesy of the Jepson Herbarium, UC.

CONSIDER THE LILIES

by Dean G. Kelch

*Consider the lilies of the field,
how they grow; they toil not,
neither do they spin.*

Matthew VI: 28.

There is some controversy as to just what wildflowers are referred to in the biblical passage above. Some have suggested that it is the autumn daffodil, *Sternbergia lutea*. Most scholars are agreed, however, that whatever the

flower, it wasn't a member of the true lily genus *Lilium*.

This particular response reflects a general tendency toward vagueness on the part of botanists. The term lily has been used in a very loose fashion to describe a broad array of plants. Consider the great diversity falling under the rubric lily. Besides the true lilies (*Lilium*) that include the tiger lily, the Oriental lilies, and the Asian lilies, there

are a host of other "imposters" (see Table 1).

These common names refer to plants that aren't necessarily closely related to each other. Not all of them are placed in the lily family, Liliaceae s.l. (*sensu lato* in the broad sense). The most you can say is that they are all monocots. However, if you count the water lily (*Nymphaea*), you can't even say that!

The monocots (short for mono-

TABLE 1. PLANTS THAT HAVE THE COMMON NAME OF LILY THAT ARE NOT TRUE LILIES (LILIUM)

Daylily (*Hemerocallis*)
 Toadlily (*Tricyrtis*)
 Corn lily (*Veratrum*)
 Desert lily (*Hesperocallis*)
 Trout lily (*Erythronium*)
 Lily-of-the-valley (*Convallaria*)
 Lily turf (*Liriodopsis*)
 Rain lily (*Zephyranthes*)
 Voodoo lily (*Amorphophallus*)
 Sego lily (*Calochortis*)
 Calla lily (*Zantedeschia*)
 Lily-of-the-Nile (*Agapanthus*)
 Scarborough lily (*Valloia*)
 Plantain lily (*Hosta*)
 Ginger lily (*Hedychium*)
 Glory lily (*Gloriosa*)
 Checker lily (*Fritillaria*)
 Fortnight lily (*Dietsia*)
 Foxtail lily (*Eremurus*)
 Spear-lily (*Dorothy*)
 Palm lily (*Curculigo*)

Flowers of most monocots are three-parted, an ancient character in flowering plants that is otherwise found in only a few ancient lineages of non-monocots. In many of the “lilies” s.l., the three sepals and three petals are similar in appearance and are referred to collectively as tepals. The vast majority of monocots are herbaceous. The few woody groups (such as palms and yuccas) have odd wood that is unlike the dense, often ringed wood of non-monocot trees and shrubs.

As you can see from the above characteristics, most monocots are relatively simpler in structure than other flowering plants. Therefore, the various natural groups of monocots are less different from each other than many groups of non-monocots. For example, a strap-shaped leaf does not lend itself to as much shape variation as a net-veined leaf (think of the great leaf variety in such non-monocot families as the carrot family, Umbelliferae, and the rose family, Rosaceae). This explains

cotyledons) are one of the largest monophyletic groups of flowering plants. The remainder of the flowering plants are generally referred to as the dicots (dicotyledons), but this latter group is not monophyletic, as the monocots seem to have arisen from within the “dicots” early in the history of flowering plant evolution. The monocots include such diverse groups as arums, palms, ginger, grasses, irises, orchids, and, of course, lilies s.l. The members of these groups all have a single seed leaf (cotyledon), while most flowering plants have two seed leaves (think of a bean or alfalfa sprout).

The cotyledon often isn’t around to look at for very long, but there are other characteristics that are common in monocots. Most monocots have linear or strap-shaped leaves with parallel veins. These leaves generally lack a well-defined petiole (stalk), and the base forms a sheath around the stem.



Sand lily, *Leucocrinum montanum* (now in Anthericaceae), from Lassen County. Photograph by B. Ornduff; its use courtesy of the Jepson Herbarium, UC.

TABLE 2. GENERA INCLUDED IN THE LILIACEAE SENSU LATO IN THE JEPSON MANUAL AND THEIR ASSIGNMENTS TO LILIACEAE SEGREGATE FAMILIES DISCUSSED IN THE TEXT

Assignment of genera to families is based on the references provided.

Agavaceae	<i>Lilium</i> (lily)
<i>Agave</i>	<i>Scoiopus</i> (foetid adder's tongue)
<i>Camassia</i> (camas)	<i>Streptopus</i> (twisted-stalk)
<i>Chlorogalum</i> (soap plant, amole)	Melanthiaceae
<i>Hastingsia</i>	<i>Stenanthium</i>
<i>Hesperocallis</i> (desert lily)	<i>Veratrum</i> (corn lily, false hellebore)
<i>Hesperoyucca</i> (our lord's candle)	<i>Xerophyllum</i> (bear-grass,
<i>Yucca</i> (Spanish bayonet)	Indian basket-grass)
Alliaceae	<i>Zigadenus</i> (death camas)
<i>Allium</i> (onion, garlic)	Nartheciaceae
<i>Ipheion</i> (star flower)	<i>Narthecium</i> (bog asphodel)
<i>Nothoscordum</i> (false garlic)	Smilacaceae
Anthericaceae <i>sensu stricto</i>	<i>Smilax</i> (green briar)
<i>Leucocrinum</i> (sand lily)	Tecophilaeaceae
Asparagaceae	<i>Odontostomum</i>
<i>Asparagus</i>	Themidaceae
Asphodelaceae	<i>Androstephium</i>
<i>Aloe</i>	<i>Bloomeria</i> (goldenstar)
<i>Asphodelus</i> (asphodel)	<i>Brodiaea</i>
Convallariaceae	<i>Dichelostemma</i> (blue dicks, snake lily)
<i>Maianthemum</i> (false lily-of-the-valley)	<i>Muilla</i>
<i>Nolina</i> (beargrass)	<i>Triteleia</i> (Ithuriel's spear, pretty face)
<i>Smilacina</i> (false Solomon's seal)	Tofieldiaceae
Hyacinthaceae	<i>Tofieldia</i> (bog asphodel)
<i>Muscari</i> (grape hyacinth)	Trilliaceae (possibly within the Melanthiaceae)
Liliaceae	<i>Trillium</i> (wakerobin, trillium)
<i>Calochortus</i> (mariposa lily, globe lily)	Uvulariaceae
<i>Erythronium</i> (fawn lily)	<i>Clintonia</i> (queen's cup; potential placement)
<i>Fritillaria</i> (fritillary)	<i>Disporum</i> (twin bells)

why the lily family (Liliaceae) has long been a "catch-all" group that included most monocots with somewhat showy, radially symmetrical flowers and no obvious specializations. (This contrasts with the very specialized flowers of orchid family members, for example, which have the fused male and female flower parts forming a column.)

The lily problem was no secret to botanists. There never was a doubt that the lily family contained groups of quite disparate plants. The problem consisted in how to break up the family in a practical, natural

way. In the late 19th century, it was common to recognize all "lilies" bearing flowers with inferior ovaries as the amaryllis family (Amaryllidaceae). While proponents of this approach could boast of its simplicity, it resulted in such diverse plants as daffodils and agaves being lumped together, while yuccas (close relatives of agaves) were left in the Liliaceae. The traditional Liliaceae s.l. was like a gigantic house of cards: remove one piece and the whole structure was liable to come crashing down.

Obviously, the single character

approach was not useful in discerning the natural groups within the Liliaceae s.l. Luckily, the work of many botanists resulted in the accumulation of a lot of information about the microscopic and chemical characters of monocots. A group led by the Danish botanist Rolf Dahlgren decided to synthesize all of this information and revise the classification of monocots. This work was published in 1985 as *The Families of Monocotyledons* (Dahlgren, et al. 1985). In this book, plants formerly in the Liliaceae s.l. were placed in 40 different families in



Beargrass, *Nolina parryi* (now in Convallariaceae), from the Kingston Mountains. Photograph by C.S. Webber; its use courtesy of the Jepson Herbarium, UC.

three different orders! Botanists and horticulturists are, by and large, rather conservative, and so it has taken a while for these changes in taxonomy to be accepted.

During the 1990s, acceptance of the Dahlgren classification has been hastened by the explosion of the academic discipline molecular systematics. By comparing the DNA sequences for a particular gene or genetic marker for a large number of species, biologists found large numbers of new characters to use in elucidating the evolutionary relationships of living organisms, in-

cluding the members of the monocotyledons. (For more information on this approach, see the sidebars on pages 4–7 and page 15.)

The preliminary published results of this research confirm many of the conclusions reached in *The Families of Monocotyledons*. The results also show that the story may be more complicated than we had hoped. This should come as no surprise, as increased knowledge leads us to a more sophisticated understanding of things. This is how science advances. Nevertheless, publications that closely follow the

system of Dahlgren et al., such as the listing of cultivated taxa in Kelch (2000), will have to be modified in the future.

While it may seem as if our entire classification of plants is sliding into the abyss, things aren't as bad as they appear. The molecular data, by and large, has confirmed much of our understanding of plant relationships. Many traditional plant groups seem to be monophyletic. Of the seriously unnatural groupings, perhaps the families of monocots represent the most extreme case. However, there were earlier indications

that the traditional taxonomy of monocots was seriously flawed from the work of Dahlgren et al. Other groupings that have proven unnatural include the figwort family (Scrophulariaceae s.l.; see the article by Olmstead on page 13), and the dogwood family (Cornaceae).

Liliaceae s.l. will be broken down into a number of smaller families (see Table 2 on page 25). To prepare you for this change, I have included the following listing of the larger families, with information on their defining characteristics. I have also included a discussion of why certain genera are placed in particular families. Some of these conclusions are pretty firm, but others are tentative at this point in time.

Agavaceae. In *The Families of Monocotyledons*, Dahlgren, Clifford, and Yeo recognized that this family was not a natural one if it included such old world taxa as dragon tree (*Dracaena*), Australian grass tree (*Xanthorrhoea*), and New Zealand flax (*Phormium*). As the earth became drier in the late Tertiary Period, drought-adapted, fibrous-leaved, giant herbs evolved several times from smaller, herbaceous plants native to moister, shadier areas. Therefore, the superficial similarity of these plant groups in different areas of the globe is the result of convergent evolution and not shared ancestry.

In the case of the Agavaceae, it seems likely that the desert-adapted plants like agaves evolved from a woodland herb like *Hosta* some intermediate plant resembling the desert lily (*Hesperocallis*) or tuberose (*Polianthes*). This hypothesis receives support from the chromosomes of *Hosta* which are similar in size and number to those of *Agave* and *Yucca*. Also, the flowering spike of *Hosta* is very similar to those of such plants as the desert lily and tuberose; these latter genera are interpreted as including some of the less specialized members of the traditional Agavaceae.

The inclusion in the agave group, based on evidence from comparison of sequences of the chloroplast gene *rbcl*, of some New World genera that Dahlgren had placed in the Hyacinthaceae (*Camassia*, *Hastingsia*, and *Chlorogalum*) was something that no one had predicted (Chase et al. 1995). These plants are very similar to such Old World Hyacinthaceae taxa as squill (*Scilla*) and grape hyacinth (*Muscari*). However, based on the *rbcl* analysis, *Camassia*, *Hastingsia*, and *Chlorogalum* are not closely related to the Old World taxa. Some previous evidence had provided clues. For example, the genus *Camassia* is quite distinct from Old World

Hyacinthaceae and close to *Hosta* based on serological data.

Placing *Hastingsia*, *Chlorogalum*, and *Camassia* in the Agavaceae renders that family difficult to identify based on macroscopic characters. It is possible that further sampling will identify two related lineages: one a desert-adapted Agavaceae and another the forest-adapted Hostaceae (this name replaces the illegitimate Funkiaceae). If, as seems likely, these taxa are all hopelessly related, we may have to place them in one big, dysfunctional family. Until we develop a field lens powerful enough to count chromosomes, or invent a pocket DNA sequencer, this group may be hard to define based on

Bear-grass, *Xerophyllum tenax* (now in the Melanthiaceae), from Glacier National Park, Montana. Photograph by C. Webber; its use courtesy of the Jepson Herbarium, UC.



field characters. However, all included species have a rosette of basal, often undulate leaves. The flowers are borne on a raceme or panicle, with bracts along its length and subtending the flowers. The petals are nearly free, generally being joined at the base.

The monotypic genus *Hesperoyucca* contains the variable *H. whipplei*. This genus rarely has been recognized as distinct from *Yucca*. It can be easily distinguished from *Yucca* s.s. (*sensu stricto* in the narrow sense) in having monocarpic rosettes. The technical, generic difference is that the style is slender with a capitate stigma, while the style of *Yucca* is stout, with a six-lobed stigma. Although this may seem a relatively minor distinction, the style morphology is extremely important in the plant's relationship with its obligate pollinators, the yucca moths. Interestingly, *Tegeticula maculata*, the moth responsible for pollination of *H. whipplei*, is the sister to all other true yucca moths (Pellmyr et al. 1996). According to evidence from chloroplast restriction site analysis, *Hesperoyucca* is more closely related to *Hesperaloe* than it is to *Yucca* s.s. (Bogler and Simpson 1995).

Alliaceae/Themidaceae. The onion family, as circumscribed in *The Families of Monocotyledons*, is very easy to define. It includes all plants with scapose flower spikes, a superior ovary, and flowers borne in umbels. Once again, the evidence from the gene *rbcl* has indicated that there are at least two unrelated lineages in this family in North America (Fay and Chase 1996).

The true Alliaceae contains the few Old World genera, as well as the circumboreal onions (*Allium*), and the South American taxa. This group seems closely related to the amaryllis family (Amaryllidaceae), a group that differs in having flowers with an inferior ovary. Worldwide, most of the genera of Alliaceae have the familiar onion or garlic

smell. In California, our only native genus is *Allium* itself. All *Allium* species have the onion odor, as does the introduced *Ipheion uniflorum*. *Nothoscordum inodorum*, introduced from South America, is also a member of the Alliaceae, but lacks the typical odor. *The Jepson Manual* reports this latter species as a noxious weed in California.

The other lineage comprises Western and Southwestern North American plants. It includes such genera as *Brodiaea*, blue dicks (*Dichelostemma*), and Ithuriel's spear (*Triteleia*). These have been separated in current classifications as the Themidaceae.

Several characters can be used to distinguish Alliaceae from Themidaceae. While Alliaceae have a pair of bracts that encloses the flower buds, Themidaceae have several bracts that do not enclose the young flowers. Alliaceae have a true bulb (composed of swollen leaf bases) with a membranous coat, but the storage organ in Themidaceae is a corm (composed of stem tissue). Most, if not all, Themidaceae lack the onion odor.

Convallariaceae. Another group of desert-dwelling, large, fibrous-leaved plants recognized by Dahlgren are the Nolinaceae, a group including the bear-grasses (*Nolina*), the sotol (*Dasylirion*), and the pony-tail palm (*Beaucarnea*). Not

surprisingly, these were once placed in the Agavaceae. However, a look at their small, starry, cream-colored flowers reveals their true relationship lies with the forest herbs included in the lily-of-the-valley family (Convallariaceae). Further DNA sampling of genera indicates that the Nolinaceae probably evolved from within Convallariaceae, and should be included within this family. Therefore, in California, the Convallariaceae includes two groups with similar flowers, but different ecology; one consists of a group of woodland herbs, such as false lily-of-the-valley (*Maianthemum*) and false Solomon's seal (*Smilacina*), while another consists of large, woody, desert plants (*Nolina*).

Liliaceae/Uvulariaceae. So, what is left of the actual Lily Family? In *The Families of Monocotyledons* the Liliaceae s.s. is sadly decimated. In California, it includes the true lilies (*Lilium* spp.), the fritillaries (*Fritillaria* spp.), and the trout lilies (*Erythronium* spp.). Molecular evidence indicates that more genera are related and could be included in this family. *Calochortus*, placed by Dahlgren et al. in its own monotypic family in *The Families of Monocotyledons*, is closely related to the Liliaceae s.s., despite its having well-differentiated sepals and petals (most members of the Liliaceae s.s. have tepals).

Also, the genera *Streptopus* and *Scoliopus*, placed by Dahlgren in the Uvulariaceae, belong here. Some might advocate including these *Uvularia*-like taxa in a separate family, the Tricyrtidaceae, but I would rather see them added to the lily family. This family is difficult to characterize. It has showy flowers, often with spotted tepals. The inflorescence is usually leafy, but can be scapose, in which case it is single-flowered (as in *Scoliopus* and some *Tulipa*). Seeds are not black-coated. The fruits of this group of related taxa are quite variable, as they can be dry or fleshy.

Tofieldia glutinosa ssp. *occidentalis*, bog asphodel (now in the Tofieldiaceae), from Gold Beach, Oregon. Photograph by C.S. Webber; its use courtesy of the Jepson Herbarium, UC.





Disporum smithii, twin bells (now in the Uvulariaceae), from Eureka, California. Photograph by C.S. Webber; its use courtesy of the Jepson Herbarium, UC.

Melanthiaceae/Nartheciaceae/Tofieldiaceae. The Melanthiaceae once included all three of these families, but it turns out that many of the characters are probably primitive characters in the monocots. These include the three-lobed or three-parted fruit, the lack of a black coating on the seeds, and the presence of calcium oxalate crystals in the cells. There are three distantly related groups in this larger family. All three groups are represented in California. Both Tofieldiaceae and Nartheciaceae have equitant (V-shaped in cross section) leaves. Tofieldiaceae have tailed seeds, while the roots of Nartheciaceae have specialized air spaces. Melanthiaceae have various types of leaves, but they are not equitant. They also lack the specialized seed and root characters of the other two families.

One surprise from *rbcl* analyses is that the Trilliaceae may have

evolved from a lineage within the Melanthiaceae. This result is well-supported by the initial molecular data, but it is so odd based on morphology that I prefer to wait for further evidence and confirming macroscopic characters before merging the two families.

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GROWING NATIVES IN THE GARDEN: MAPLES

by Glenn Keator

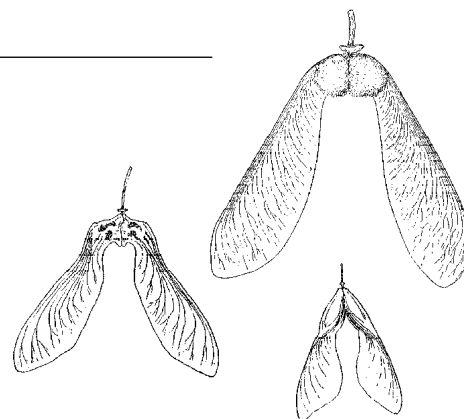
Vine maple (*Acer circinatum*) and Sierra maple (*A. glabrum* var. *torreyi*) are small trees or large shrubs that can be pruned in a variety of ways for use in the garden. Both are most often propagated by seed, which should be collected just after it ripens in fall. Patience is needed because the seeds need a long cold stratification and may germinate best with a second stratification, so it can take more than a year for seeds to finish germinating. Cuttings and layering should be done in the fall; special cultivars of vine maple, available at maple specialty nurseries, may require vegetative propagation to ensure satisfactory results.

Vine maple is the essence of grace. Although the common name

suggests a viny growth form, this is seldom the case. Vine maple is outstanding for seasonal changes: pretty bare reddish twigs in winter, graceful, half-drooping clusters of dull red and white flowers in early spring, delicate, many-lobed leaves that resemble Japanese maples through spring and summer, pink winged samaras in late summer or early fall, and scarlet autumn leaves. Vine maple's forte is in the moist forest garden. Areas of plentiful winter rains and generous summer fogs fit it best. Although tolerant of deep shade, dappled shade provides healthier, more rapid growth.

Vine maple's biggest liability is its slow growth; it can take many years to attain mature size, especially from seed. Establishing a mature specimen is faster from cuttings or layering. Vine maple is tolerant of cold winters and withstands freezing temperatures quite well. It also withstands very hot summers when given adequate shade and water.

In the landscape, vine maple is best used as a backdrop for a woodland garden, against the shaded side of a house, behind a pond, or as a specimen. Its leaves complement many other forest plants, such as rosebay rhododendron (*Rhododendron macrophyllum*), western azalea (*R. occidentale*), salal (*Gaultheria shallon*), evergreen huckleberry



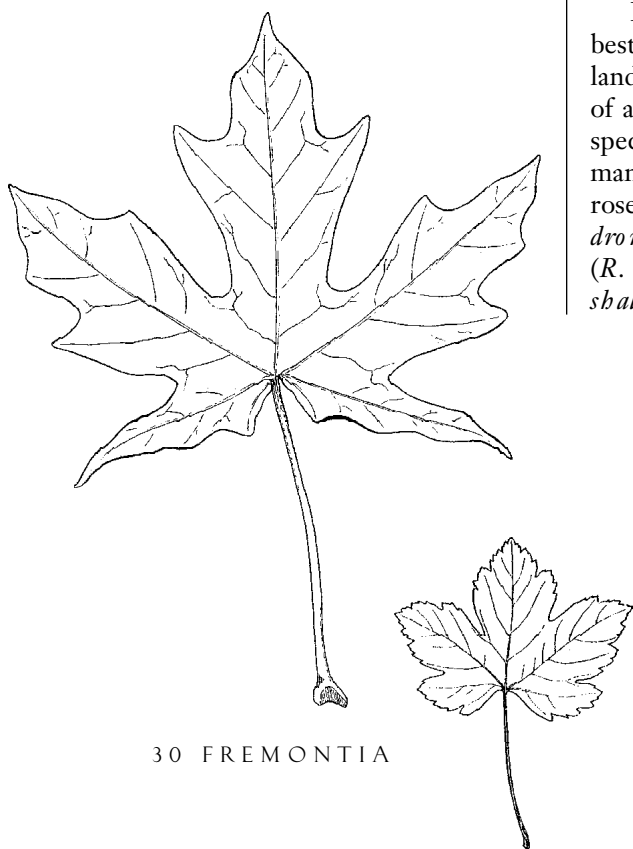
(*Vaccinium ovatum*), lady fern (*Athyrium filix-femina*), sword fern (*Polystichum munitum*) and five-finger fern (*Adiantum aleuticum*).

Sierra maple is a subdued version of a maple, with neither the delicacy of the vine maple nor the grand manner of big-leaf maple (*A. macrophyllum*), but it is an excellent choice for the mountain garden, where winters are severely cold and summers warm. Like most maples, it lives naturally near streams or along lake margins and so must have summer water to succeed.

Sierra maple has small, few-lobed leaves, but they have a glowing sheen when reflecting the late afternoon sun. The tiny, yellow-green flowers and pale yellow fall leaves are unlikely to elicit strong comment, yet this maple is an altogether pleasant companion for a naturally wooded garden, as an underplanting for pines or firs. To make the best garden statement it should stand alone or be planted in company with others of its kind. If you grow it with other shrubs, be sure those shrubs have a bold and different leaf pattern. Natural companions include mountain chinquapin (*Chrysolepis sempervirens*), twin honeysuckle (*Lonicera conjugialis*) and mountain snowberry (*Symphoricarpos rotundifolius*).

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Drawings of leaves and fruits for native maples (*Acer*) from Jepson's 1910 *Silva of California*. Leaves from left to right: *A. macrophyllum*, *A. glabrum*, and *A. circinatum*. Fruits counter-clockwise from top: *A. macrophyllum*, *A. negundo* var. *californicum* (box elder), and *A. glabrum*.





Tree and flowers of big-leaf maple (*Acer macrophyllum*; photographs by J. Vale and J. Hickman, respectively). Vine maple fruits (*A. circinatum*; photographer unknown). Use of all images courtesy of Jepson Herbarium, UC.

LETTERS TO THE EDITOR

Sodaville milkvetch

Dear Editor:

I just finished reading your excellent special issue on rare plant conservation [Volume 29, Nos. 3 & 4], and wanted to address one item raised therein. The article [by Emily Roberson] on endangered species laws included a photograph [on page 6] of Sodaville milkvetch (*Astragalus lentiginos* var. *sesquimetralis*), and the caption stated that it was "... inexplicably withdrawn from the federal listing process..." Having participated in that process as botanist for the Nevada Natural Heritage Program, I still believe that outcome was both explicable and justifiable.

The reason has to do with the unfortunate "second-class" status of plants under the federal Endangered Species Act (ESA), discussed later in the same article. At the time federal listing was proposed, Sodaville milkvetch already had maximum protection under both California and Nevada state laws. The California population, in Death Valley National Park, was already being managed as a de-facto endangered species. While the ESA would have had jurisdiction over that population, it would not likely have increased the effectiveness of conservation efforts already underway.

The two Nevada populations both occur on private lands, where ESA listing provides no protection to plants other than through existing State laws. Unfortunately, most private landowners are unaware of this aspect of the ESA, believing instead that federal listing of a plant would add further regulatory burden to their lives. For this reason, ESA listing of Sodaville milkvetch would likely have hindered cooperative conservation efforts between the State of Nevada and the private landowners, and certainly would not have enhanced them.

Is landowner lack of awareness a good excuse? Of course not. But if it exists, then it behooves those for whom rare plant conservation and protection

is a priority to find the best alternate means for achieving those ends, at least until better education has a chance to take hold. For all the above reasons, my agency recommended against federal listing of Sodaville milkvetch.

For many rare plant advocates in California, that may seem sacrilegious, coming as it does from the combined Nevada equivalent of California's Natural Diversity Database and CNPS Rare Plant Program. Was federal listing of Sodaville milkvetch biologically justified? Absolutely, and it still is. Would it have furthered the conservation and protection of its three small populations? No, and at the time it would have created additional roadblocks toward that end. It was a difficult conundrum, but rare plant conservation was our overriding goal, and on that basis the decision was clear.

The ESA provides many useful tools for biodiversity conservation. And ESA listing also is neither a conservation panacea, nor a good regulatory club to apply indiscriminately across natural and political landscapes. There are situations where ESA listing can detract from, rather than enhance, rare plant protection. In those cases, political agendas should be put aside, and other more effective means should be tried first.

James D. Morefield,
Bristlecone Chapter

Walnut Distribution

Dear Editor,

At the Santa Barbara Botanic Garden we have begun to map the rare plants of the central coast region from Monterey to Ventura counties, in order to try and get a better understanding of rare plant distributions in general. The comments below provide added information about the distribution of native walnuts (*Juglans*) in California. [See article by Anderson in Volume 30, No. 1].

All reports of *Juglans californica* var. *californica* from north of the Santa Ynez Mountains in Santa Barbara County are based on cultivated specimens of *J. hindsii* (also known as *J.*

californica var. *hindsii*). We have never been able to trace the Griffin and Critchfield dots to any specimens, unless they relied on specimens deposited at the Santa Barbara Botanic Garden herbarium (SBBG). The latter records are apparently of cultivated trees of *J. hindsii*. We have not been able to find any specimens of *J. californica* from northern Santa Barbara County at other herbaria, other than those attributable to cultivation.

Consequently, all reports in the literature from Santa Barbara County north of the Santa Ynez Mountains are attributable to cultivated trees. We have checked most of them. They are either associated with old homesteads or with former walnut orchards, as described so well in Anderson's manuscript. They always have turned out to be assignable to *J. hindsii*.

The only native walnut populations in Santa Barbara County, based on historic records (i.e., documented specimens associated with field work by Alice Eastwood, Ralph Hoffmann, Clif Smith, and Henry Pollard) are from two general areas. One population is located in Jalama Canyon, north-northeast of Pt. Conception. The other populations form a series on the coastal side of the Santa Ynez Mountains, from Sycamore Canyon eastward to Casitas Creek near Casitas Pass in Ventura County. They are all assignable to typical *J. californica*.

The Jalama population may even be questionable since it is very near the first olive orchards and vineyards originally established by the Santa Barbara Mission in the late 1700s. On the other hand, the habitat is quite similar to populations along the base of the Santa Ynez Mountains in southeastern Santa Barbara County and western Ventura County.

Dieter Wilken
Channel Islands Chapter

PLANT NAME REFERENCES

The following entries represent several of my favorite references for discovering

common names of plants and other interesting information. I make every effort to provide common names for plants mentioned in *Fremontia*, but sometimes space is limiting.

—Editor

The Plant Book. A Portable Dictionary of the Higher Plants, by D. J. Mabberly. 1997. Cambridge University Press, New York, NY. 858 pages.

This most useful reference provides scientific names for common names of species, and information for Latin names of genera and families as follows. For each genus, the family, subfamily, and tribe membership are provided according to the Cronquist system of classification [see reference on p.12 of this *Fremontia*], as well as approximate number of species, area of geographic distribution, well-known species, and economic uses of species (for example, *Arundo donax* weed in

California, is “the ‘reed’ of the Bible, used for 5,000 years for pipe instruments”). For each family, the subclass and order designation are provided according to the Cronquist system, as well as approximate number of genera and species, geographic distribution, typical morphological traits, noted genera, and other information of interest, such as notes on pollination. Price \$49.50, softcover.

Dictionary of Plant Names, by A.J. Coombes. 1985, 1994. Timber Press, Portland, OR. 195 pages.

Although not as extensive as *The Plant Book* this volume includes the derivation, meaning, and pronunciation of scientific names, and cross-references common names to scientific names. It is limited in scope to the more commonly grown plants, but often includes families, genera, and species native to California (such as red ribbons, *Clarkia concinna*). Price \$22.95, hardcover.

Botanical Latin. History, Grammar, Syntax, Terminology, and Vocabulary, by W.T. Stearn. 1992. Fourth Edition, revised. David and Charles, London, GB. 566 pages.

This is a very complete reference directed mostly to the very academic, such as authors of descriptions of new species and other new taxa, who need guidance for creating accurate Latin diagnoses. The volume also includes a very useful, although somewhat formal, illustrated glossary, and almost 200 pages of vocabulary for both English translations of Latin terms and Latin words for their English counterparts. Price \$44.95, hardcover.

Also available is Stearn's *Dictionary of Plant Names for Gardeners: A Handbook on the Origin and Meaning of the Botanical Names of Some Cultivated Plants* for \$13.97 (price from Internet listing). I have not seen this book, but assume it is quite similar to the reference above by Coombes.

BOOK REVIEWS

An Illustrated Flora of Yosemite National Park, by Stephen Botti. Illustrated by Walter Sydoriak. 2001. Yosemite Association. Yosemite National Park, CA. 484 pages. Price \$125, hardcover.

This flora is a rare combination of exquisite botanical artwork and technical accuracy. Its attractive cover of various showy members of Primulaceae and Rosaceae gives it the appearance of a coffee-table book, and at 11-by-13 inches it is qualified to be one.

In addition to its beauty, this is an unprecedented compilation of taxonomic and ecological information about the vascular plants of Yosemite National Park. The central Sierra Nevada botanists I have spoken to cannot say enough good things about this book, which has been over 18 years in the making, and well worth the wait!

It is appropriately dedicated to the memory of Carl W. Sharsmith, who for 63 years served as teacher, interpreter, guardian, and scientist of the Yosemite Flora. In his foreword, Peter Raven reminisces about his first experiences as a child learning about

the plants of Yosemite. Raven, who is director of the Missouri Botanical Garden and one of the world's leading botanists, mentions how the flora of Yosemite was instrumental in shaping his early interest in plants, which later led to his well-known investigations of the evolutionary systematics of Onagraceae and of the impacts of alien species to native ecosystems.

Raven points out that while Yosemite National Park comprises a mere 0.75% of the land area of California (300 square kilometers), it contains 59.5% of the state's plant families, 38.3% of its genera, and 22.8% of its species. Of the 1,338 species found in the park, only 130 (less than 1%) are non-native. The relatively pristine state of the native plant communities of Yosemite is remarkable, which makes even more imperative the need to protect its native ecosystems from the spread of invasive plants and from other human-caused impacts. Thanks to the existence of this book, it will now be easier to communicate this need to the public.

Steve Botti's introduction presents



Painting of the purple milkweed, *Asclepias cordifolia*, by W. Sydoriak, from S. Botti's new *Yosemite Flora*.

background information that helps the reader understand the climatic, geographic, and topographic basis for the richness of Yosemite's flora. Each major vegetation zone is described briefly, (the book contains a colorful map of all zones), and the percentage of non-

native species in each major vegetation zone is also given. Not surprisingly, the percentage drops as elevation increases, from 23 percent in the chaparral-oak woodland zone to zero in the alpine zone.

This book will delight amateur botanists who simply want to "picture key" plants they encounter, as well as experienced botanists who will appreciate having a picture for every species (a botanist's dream come true!). Most of the pictures are in color, while the technical intricacies of Cyperaceae, Juncaceae, and Poaceae are shown beautifully by black-and-white ink drawings. The illustrated glossary will be enjoyed by all who not only want to understand the meaning of terms used in the keys, but also the meaning of many Latin names. This is an extraordinary book, and anyone interested in the flora of the central Sierra Nevada will want a copy.

Joanna Clines,
Sequoia Chapter

John Charles Frémont, Botanical Explorer, by Stanley L. Welsh. 1998.

Missouri Botanical Garden, St. Louis, Missouri. viii, 450 pages, with illustrations. Price \$49.95, hardcover.

Well-known botanist John Charles Frémont was famous for a lot more than his scientific contributions, which is what makes this biography such fascinating reading. In it, author Stanley Welsh, professor of botany and curator of the herbarium at Brigham Young University, tracks the explorations of the man who was not only a botanist, but also a prominent politician, army officer, and explorer.

Approximately 225 pages of this book contain a detailed inventory of John Charles Frémont's botanical gatherings. Appendix I includes an annotated checklist arranged by species, along with dates of collection and localities, and covers *Abies concolor* (the white fir, first procured at the foot of Pikes Peak on July 20, 1843) through *Zygophyllum californicum* (the creosote bush, first encountered in California's Mojave Desert in April of 1844). Appendix II lists the 41 plants whose scientific names have honored Frémont. Appendix III is a summary by family,

genus, species, and herbarium disposition of Frémont's collections, and Appendix IV lists the collections of the 2nd and 3rd expeditions by year, collection number, and locality. Not to be overlooked is a comprehensive index that includes people, places, things, events, and updated nomenclature.

Frémont once wrote his wife from amidst the Mexican War turmoil that if he had his choice, he would rather be collecting plants than fighting. The first 200 or so pages of this book tells us about Frémont's other exploits when he was not out somewhere botanizing. In five information-filled chapters, Welsh details each of Frémont's great western expeditions from 1842 to 1854, and also provides a personal sketch of the man. The lengthy chapter that follows focuses on the "Botany of the Expeditions," one at a time. This section of the book contains something for every taste. For the political historian, here is Frémont, the first governor of California; its first senator; a territorial governor of Arizona; the first Republican candidate for the United States presidency in 1856; and the man who ran against Lincoln in 1864. The military writer can focus on Frémont's duties as protégé of the Secretary of War, Poinsett: his tour of naval duty aboard the sloop *Natchez*; service with the Army Corps of Topographical Engineers; leadership of the Bear Flag Revolt in Alta California and the subsequent Mexican War in California; an army court-marshal; General of the Army of the West during the Civil War; and later a general battling unsuccessfully in Virginia and West Virginia.

Those fascinated with exploration will find some engaging passages about Frémont's railroad survey to Cincinnati; his expedition to the Cherokee country; the Nicollet Survey in the Old Northwest; and the five great expeditions into the Far West. For the geologist, there are Frémont's notes of mineral resources wherever he traveled (he became one of the richest mining entrepreneurs of the Sierra Gold Belt). And for the social historian, there is the story of Jessie, the beautiful teenage daughter of a senator who became Frémont's lover, lifelong wife, and amanuensis.

Complementing the text are simplified maps for each expedition, some

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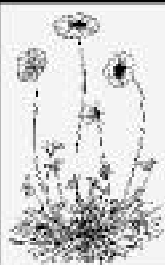
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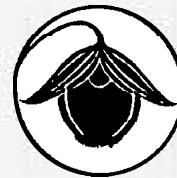


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of Frémont's own exquisite maps, portraits, published plates of his specimens, photographs of actual herbarium sheets, as well as a lengthy roster of references.

Richard G. Beidleman,
East Bay Chapter

Flowering Plants of Edgewood Natural Preserve, by Toni Corelli. 2002. Monocot Press, Half Moon Bay, CA. 366 pages. Price \$25, softcover.

This book will provide an admirable guide for the many wanderers of Edgewood Natural Preserve. Its size is just right for field trips, and it is much easier to work with than *The Jepson Manual*. It is intended for the amateur botanist who knows how to use a key. The keys are easy to use, with language simple enough even for a beginner. Measurements are metric, but there are two metric rulers on the last page of the book for those unaccustomed to the metric system.

Illustrations are nicely drawn by Linda Bea Miller and Judy Mason, with only a few exceptions. For example, *Collinsia multicolor* should have been drawn with full leaves, and sometimes the proportions are a little off, as with *Veronica persica*, which shows the flowers being the same size as the leaves.

The species descriptions are easy to read thanks to good design. There is room to scribble in the bottom margins, should the user discover something new. Efforts to keep species descriptions from going over onto the next page have sometimes caused some tight spacing at the bottom of a page. Spelling errors occur in this book as in many others, but are so few, that they are hardly noticeable amidst the admirable content.

The guide is available from Monocot Press, P.O. Box 773, Half Moon Bay, CA 94019. One can also obtain it

along with a Friends of Edgewood membership from Friends of Edgewood, P.O. Box 3422, Redwood City, CA 94064.

Margriet Wetherwax,
Santa Clara Valley Chapter

BOOKS RECEIVED

Carnivorous Plants in California USA: A Field Guide and Cultural Notes to the Indigenous Species, by C.H. Clayton in conjunction with J. Hawkeye Rondeau and special guest contributor B.A. Meyers-Rice. 2002. 57 pages. Trifid Park, Keysborough Vic, Australia (www.triffidpark.com.au)

This is, according to the authors, an

"evolving" booklet which includes descriptions, photographs, drawings, maps, cultural notes, and other comments on California's carnivorous plants. Price \$36.50, spiral-bound, softcover.

Flowering Plants and Ferns of Mount Diablo, California, by B. Ertter and M.L. Bowerman. 2002. CNPS Press, Sacramento, CA. 424 pages.

This new edition of Bowerman's original flora has been fully revised and updated by UC Jepson Herbarium botanist, Barbara Ertter. It treats over 700 species, including the addition of over 200 native and naturalized species. A full review will occur in the next issue of *Fremontia*. Price \$34.95, hardcover; \$19.95, softcover.

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FROM THE EDITOR

We have all become accustomed to the challenge of keeping up with changes in scientific names, such as when our state grass, *Stipa pulchra* became *Nassella pulchra*. Now there is strong evidence supporting the reshuffling of many California genera into different or even new families. For example, *Penstemon* is not in the Scrophulariaceae and *Phacelia* is in the Borage Family! Thank goodness for Convening Editor Ellen Dean, who has assembled three articles which together summarize these major changes in classification and nomenclature.

Dean wrote the first article, and in it she compares the new and widely

accepted classification of families and genera with that used in *The Jepson Manual*. Richard Olmstead's article describes the fracture of the family Scrophulariaceae. This previously large and diverse family is now split into many smaller families, such as the Orobanchaceae, which includes the broom-rapes (*Orobanch*) as well as the paintbrushes and owl's clovers (*Castilleja* and *Orthocarpus*). Dean Kelch provides an equivalent description of the many small families that the Liliaceae has been split into. Each author explains the philosophy of why these changes are necessary in order to ensure that scientific names (nomenclature) reflect evolutionary lin-

eages (phylogeny). And, for those of you who aren't worried about what belongs in which family, but rather love to garden with natives, Glenn Keator shares an article on growing maples (*Acer*).

This is the second issue in which you will find two inserted membership forms. You could recycle these forms, but better yet, consider giving a CNPS membership to a friend, student, local library, or garden group. After all, one of the best methods to help protect the plants and habitats we cherish is by educating others about their beauty and ecological value; and, change *can* be made one step at a time.

Linda Ann Vorobik, Editor

CONTRIBUTORS

Ellen Dean, PhD, is Director and Curator of the University of California Davis Herbarium and teaches an undergraduate course in California floristics each spring. Her research area is plant systematics, with current emphasis on genera in the Solanaceae (tomato family).

Glenn Keator, PhD, is a free-lance teacher and botanist at California Academy of Science, Strybing Arboretum, Regional Parks Botanic Garden, and Merritt College, and author of many books, including *Introduction to Trees of the San Francisco Bay Region*. His current passion and academic focus is growing California natives in appropriate landscapes.

Dean G. Kelch, PhD, is a research associate of the University and Jepson Herbaria of the University of California, Berkeley, where he studies seed plant phylogeny and evolution. He has collected plants worldwide and enjoys cultivating plants, especially members of the Liliaceae, cacti, and succulents.

Richard Olmstead, PhD, is currently Professor of Botany at the University of Washington (1996–present). He provided the *Scutellaria* treatment in *The Jepson Manual* and his primary research interest is the molecular phylogenetics of the Asteridae with special emphasis on the Lamiales and Solanales.

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