An Updated Phylogenetic Classification of the Flowering Plants

Robert F. Thorne
Rancho Santa Ana Botanic Garden

AN UPDATED PHYLOGENETIC CLASSIFICATION OF THE FLOWERING PLANTS

ROBERT F. THORNE

Rancho Santa Ana Botanic Garden
Claremont, California 91711

ABSTRACT

This update of my classification of the flowering plants, or Angiospermae, is based upon about 800 pertinent books, monographs, and other botanical papers published since my last synopsis appeared in the *Nordic Journal of Science* in 1983. Also I have narrowed my family- and ordinal-gap concepts to bring acceptance of family and ordinal limits more in line with those of current taxonomists. This new information and the shift in my phylogenetic philosophy have caused significant changes in my interpretation of relationships and numbers and content of taxa. Also the ending "-anae" has been accepted for superorders in place in the traditional but inappropriate "-iflorae." A new phyletic "shrub" replaces earlier versions, and attempts to indicate relationships among the superorders, orders, and suborders. One table includes a statistical summary of flowering-plant taxa: ca. 235,000 species of 12,615 genera, 440 families, and 711 subfamilies and undivided families in 28 superorders, 70 orders, and 75 suborders of Angiospermae. Three other tables summarize the indigenous distribution of the families and subfamilies of Angiospermae about the world.

Key words: Angiospermae, classification, distribution, endemism, geography, hierarchy, phylogeny, synopsis, taxonomy.

INTRODUCTION

In the years since I published my "Proposed new realignments in the angiosperms" in the *Nordic Journal of Botany* (Thorne 1983) numerous books and scientific papers have been published on the classification, morphology, palynology, paleontology, phytochemistry, karyomorphology, cladistics, etc., of the flowering plants. These significant publications have greatly elucidated some relationships and led to a much better understanding of the phylogeny of the Angiospermae.

At the request of the editor of *Botanical Review* I have prepared a rather lengthy review of this significant recent literature and my interpretation of the classification and geography of the flowering plants. This has been accepted for publication in that journal; however, because of the large backlog of papers awaiting publication in the *Botanical Review,* my paper probably will not be published before late 1992. Therefore, I have prepared an abbreviated paper containing the revised synopsis of my classification, a redrawn chart of the Thorne phyletic shrub, and four statistical tables prepared from the new synopsis.

The review of the new literature, bibliography of nearly 800 titles, and geography of the included angiospermous taxa will be covered in the longer *Botanical Review* paper. Full discussion of my alignment and delineation of the angiospermous taxa must await the completion of my projected book on angiosperm phylogeny.

CLASSIFICATION OF THE ANGIOSPERMS

Since my 1983 classification, a major change in my phyletic philosophy has been my decision to narrow my family- and ordinal-gap concepts to bring my

acceptance of family and ordinal limits more in line with those of current taxonomists, especially in such difficult groups as my former broadly conceived Phytolaccaceae, Aizoaceae, Theaceae, Urticaceae, Linaceae, Rhizophoraceae, Saxifragaceae, Cornaceae, Araliaceae, Solanaceae, Loganiaceae, Verbenaceae, Liliaceae, and Commelinales. My definition of families and other taxa still remains somewhat more conservative than that of most of my phylogenetic peers.

Another important change has been my acceptance of the ending "-anae" for superorders instead of the traditional "-iflorae." This is in line with the treatments by Takhtajan (1986, 1987) and the Dahlgrens (1989a), and is based on the criticism that logically "-iflorae" really is appropriate only for the flower-bearing Angiospermae.

Among other considerable changes in my system of classification are, in the Annonanae, deletion of Aristolochiinae but recognition of Austrobaileyineae, Sparattanthelioideae, and Ceratophyllales. In Chenopodianae, Phytolaccineae and Caryophyllineae are recognized. Significant changes in the Theanae include the transfer of Chrysobalanaceae from Rosales to Theales and of Diegodendraceae (Rhopalocarpaceae) from Theales to Malvales. Fouquieriineae have been elevated to Fouquieriales and transferred to Theanae. Celastrales are separated from Santalanae and elevated to Celastranae.

Within Malvanae Cistineae are transferred back to Violales from Malvales; suborders Sterculiineae and Malvineae and families Monotaceae and Diegodendraceae are recognized in Malvales; Gonystylaceae are recognized in and Aextoxicaceae removed from Euphorbiales (to *taxa incertae sedis*). In Violanae the suborder Salicineae is deleted with removal of Salicaceae to near proximity with Flacourtiaceae; Moringaceae are removed from Capparales and transferred to Sapindineae. Geranianae are reordered with elevation of suborders Linineae, Geraniineae, and Polygalineae to ordinal rank and with addition of Rhizophorales.

In Rutanae, Juglandineae and Myricineae are removed and elevated to Juglandales near Fagales in the Rosanae. A greatly expanded and much revised Rosanae has been created by the combining of Hamamelidanae (Hamamelidiflorae) with Rosanae and the consequent inclusion of Hamamelidales, Casuarinales, Fagales, and Juglandales, along with recognition of Buxales, Pittosporales, Bruniales, Saxifragales, Podostemales, and Cunoniales as separate orders in the superorder.

Cornanae are also rather thoroughly reorganized with recognition and inclusion of Hydrangeales; removal of Rhizophoraceae and Hippuridaceae from and elevation of Gunneraceae to Gunnerineae in Cornales; restructuring of Cornaceae-Nyssaceae and Araliaceae-Apiaceae; recognition of Aralidiaceae, Hydrocotylaceae, Morinaceae, and Triplostegiaceae in the superorder, and transfer of Calyceraceae from Dipsacales to Asterales.

Campanulales are transferred from Solananae to Asteranae, Sphenocleaceae are recognized, and Menyanthaceae are added from Gentianales. *Brunonia* is removed from Goodeniaceae and transferred as Brunoniaceae to *taxa incertae sedis*. In Asteraceae the tribes Barnadesieae, Tarchonantheae, and Coreopsideae are accepted. In Solananae, Fouquieriineae are removed as Fouquieriales to Theanae, and Hoplestigmataceae are added to the Boraginineae.

Within Gentiananae the Oleales are deleted, with Salvadoraceae removed to *taxa incertae sedis* and Oleaceae to Bignoniales. Loganiaceae are much trimmed down with removal of *Desfontainia* to Hydrangeales as Desfontainiaceae and *Retzia* to Stilbaceae in Bignoniales adjacent to Buddlejaceae. Menyanthaceae are

transferred from Gentianales to Campanaulales. In Bignoniales, Oleaceae and Stilbaceae are placed near Buddlejaceae; Globulariaceae and Selaginaceae are recognized as distinct families; and Schlegelieae (Paulownieae) are transferred from Bignonaceae to Scrophulariaceae. Lamiales are reduced in rank to Lamiineae in Bignoniales and Verbenaceae much changed with removal of several groups. Chloanthaceae, Avicenniaceae, Symphoremataceae, Nesogenaceae, and Tetrachondraceae are recognized as distinct families. Hippuridaceae are transferred from Cornanae to Lamiineae near the equally very reduced and largely aquatic Callitrichaceae.

The subclass Monocotyledoneae has also been considerably reorganized here, especially the Lilianae and Commelinanae. Within the superorder Lilianae I have recognized five orders: Liliales, Burmanniales, Asparagales, Dioscoreales, and Orchidales. The Liliales are divided into the suborders Melanthiineae, Liliineae, and Iridineae, and the Asparagales into the suborders Asparagineae and Amaryllidineae. I still regard the Melanthiaceae as the most archaic and least specialized monocots, whereas I consider the Dioscoreales as relatively specialized within the Lilianae. Obviously, my formerly very complex and polyphyletic family Liliaceae has been largely dismantled, with recognition of most of the former subfamilies as distinct families in at least two orders, much as in the treatment by Dahlgren et al. (1985).

The small Australasian family Hydatellaceae remains difficult to interpret but tentatively has been given its own order and superorder and placed between Lilianae and Triuridanae. The superorder Typhanae has been deleted and the Typhales with single family Typhaceae, including Sparganioideae, placed tentatively in the Commelinanae between the Bromeliales and Zingiberales. My former broadly conceived order Commelinales has been redefined, with division into Bromeliales, Commelinales *s.s.*, Cyperales, and Poales. The rather diverse order Bromeliales is divided into the suborders Bromeliineae and Pontederiineae. Similarly the Zingiberales are divided into the suborders Musineae, Strelitziineae, Lowiineae, Heliconiineae, Zingiberineae, and Marantineae; Commelinales into Xyridineae, Commelinineae, and Eriocaulineae; and Poales into Flagellariineae and Poineae. In the Flagellariineae *Joinvillea* and *Ecdeiocolea* are elevated to family rank. It seems fitting that our most economically important and highly diverse, prolific, and specialized family Poaceae should sit atop the monocot "family tree."

As usual, I have terminated the classification with a short list of *Taxa Incertae Sedis* to list therein those taxa whose position remains most uncertain. It is a shifting list that probably should be much longer than it is, and surely will be longer when all the anomalous genera are pruned away from the families where they are now misplaced.

EXPLANATION OF THE PHYLETIC SHRUB

The cladists notwithstanding, I do not think it possible to produce a realistic angiospermous "family tree." Although the Angiospermae are surely monophyletic, their two subclasses must have diverged from common ancestors, possibly seed-ferns, during the apparently Early Cretaceous or possibly late Mesozoic origins of the class. Similarly, most of the superorders diverged early from their long extinct protoangiospermous ancestors. To draw one superorder or other
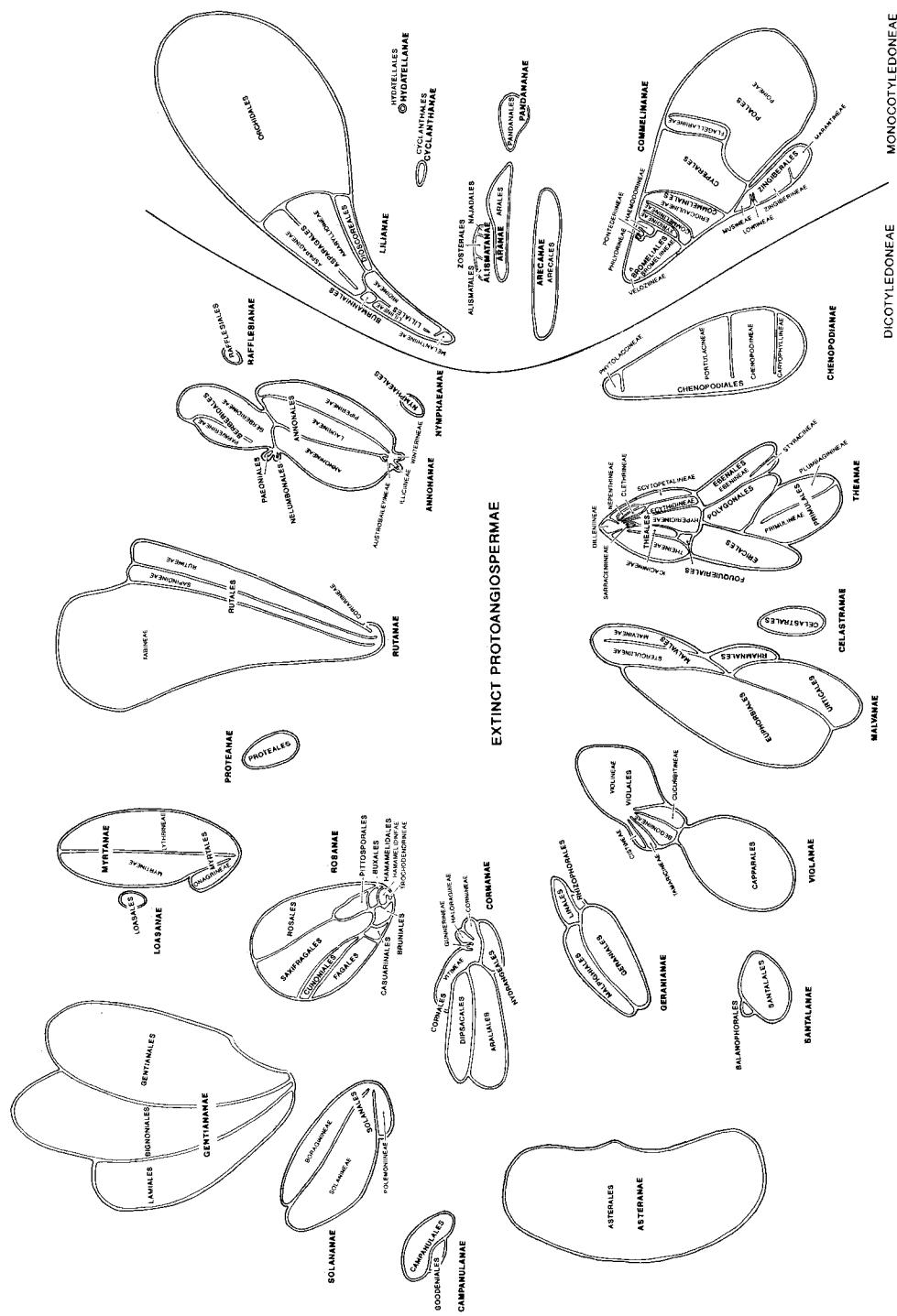
major taxon from another extant major taxon would be a futile exercise and most misleading. Hence, I prefer to treat the extant Angiospermae diagrammatically as a "shrub" diverging as superorders from a hollow center representing the extinct Protoangiospermae.

The position of these superordinal stem cross-sections of the phyletic shrub (Fig. 1) indicates as closely as possible my interpretation of their interrelationships and their relative degree of specialization from their more primitive, archaic ancestors. Those farthest from the hollow center are the most specialized in their characteristics, those closest to the center the least specialized. The size of the superordinal balloons and the contained orders and suborders indicates approximately the number of species accepted for each major taxon, although the size of some of the smallest superorders has been exaggerated to make them visible. Within the superordinal balloons the orders are shown as entire ellipses, the suborders as connected branches.

This phyletic shrub replaces the one published in the *Nordic Journal of Botany* (Thorne 1983) and differs from it rather considerably due to major changes in my classification briefly mentioned above. This diagram was drawn and lettered by my associates Oscar Dorado and Dr. Scott Zona at the Rancho Santa Ana Botanic Garden. Any errors are my own and any divergences from my classification are due to the continuing evolution of the latter. Unfortunately, any such drawing will be somewhat obsolete by the time it is printed due to our rapidly expanding knowledge of the Angiospermae.

<div align="center">EXPLANATION OF THE SYNOPSIS</div>

In the following synopsis of my classification of the flowering plants I have continued to carry the hierarchy of the class down to the subfamily level where appropriate, and even down to the tribal level in the huge family Asteraceae. Subfamilies are important for they display intrafamilial divergence as well as their immediate common ancestry with other subfamilies in the same family.

Despite my narrowed family-gap concept, I still prefer not to multiply taxa unnecessarily where common recent ancestry seems evident. Thus, I would rather not break up such well-defined, if very large, families as Papaveraceae, Fabaceae, and Apocynaceae, whose subfamilies are closely linked by their characteristics and by intermediate taxa. Other taxonomists, however, do object to my extended hierarchy, and often treat my subfamilies as distinct families. This difference in ranking of taxa is not important so long as the relationships are firmly based on all pertinent data.

Anyone interested in my philosophy of classification can find it outlined in my *Evolutionary Biology* paper (Thorne 1976) and earlier publications (Thorne 1958, 1963, 1975). It has not changed greatly over the years, though I have, as mentioned above, seen fit to narrow somewhat my ordinal- and family-gap concepts, leading to my acceptance of somewhat more narrowly defined orders and families. The

←

Fig. 1. Phylogenetic shrub of the Angiospermae, with the superorders, orders, and suborders indicated as stem cross-sections diverging from a hollow center representing the extinct Protoangiospermae.

changed total numbers of all these taxa down to the genus and species are listed in Table 1.

Space limitations prevent me from giving here my reasons for the circumscriptions and alignments accepted in this classification. Until my phylogeny book is available, one can find discussions of many of my realignments, especially those most divergent from those of my phyletic peers, in my previous phylogenetic publications (as Thorne 1968, 1973, 1974*a, b, c,* 1975, 1976, 1977, 1978, 1979, 1981, 1983, 1985, 1989*a, b;* Thorne et al. 1977; Thorne and Scogin 1978).

Names used for the various taxa in the synopsis are according to the *International Code of Botanical Nomenclature* (Greuter et al. 1988), although I have extended the principle of priority to all categories up to the class. Lindley's *Nixus Plantarum* (1833) is the point of departure for ordinal names, for that botanist was the first to apply consistently the ending "-ales" to generic roots. Synonyms or additional included or excluded taxa are listed usually only where the names or treatment of taxa deviate considerably from those in A. Engler's *Syllabus der Pflanzenfamilien,* ed. 12, vol. 2 (Melchior 1964). Subfamilial treatment is based largely upon those authorities that I regard as best informed and phyletically most realistic in their classification. A number of larger families still await realistic subdivision. In a few families well known to me I have devised my own tentative subfamilial classification. In the longer *Botanical Review* paper I have listed the many recent taxonomic treatments that I have found to be especially helpful in the preparation of this synopsis.

Because the reader deserves some indication of the degree of confidence I place in the alignment used, hierarchal level assigned, circumscription accepted, or all of these, I have used in the synopsis for each category above the subfamily a simple "A," "B," "C" scale to indicate degree of confidence. "A," as used with Lactoridaceae, Chrysobalanaceae, and Ceratophyllales, represents limited confidence in the position of all three taxa and in addition the hierarchal ranking of the last taxon. Any less confidence would condemn a taxon to *taxa incertae sedis.* "B," as used with Paeoniales, Rafflesianae, Paracryphiaceae, Oncothecaceae, Asteropeiaceae, Tetrameristaceae, etc., suggests that there is some evidence that the alignment, hierarchal ranking, and circumscription are probably correct. "C," used generally throughout the synopsis, implies considerable confidence that accumulated data have allowed a realistic placement and circumscription.

The numerals following most of the taxa listed are the number of genera and species (15/265 indicating 15 genera and 265 species) accepted for that taxon. Many were taken from *Willis's Dictionary of the Flowering Plants and Ferns,* Student Ed. (Shaw 1985) or *The Plant Book. A Portable Dictionary of the Higher Plants* (Mabberley 1987) except where more accurate information was communicated to me by monographers or could be found in recent, reliable monographs and revisions. These are listed in the projected *Botanical Review* paper. Large numbers have been rounded off to the nearest five or ten to avoid spurious exactitude.

It must be emphasized that each superorder in the synopsis is merely one line of evolution within the numerous-stemmed, many-branched, complex phylogenetic shrub. A phyletic tree, given our limited paleontological record, is unrealistic. A "phylogenetic" hedge, despite its double-entendre appeal, is also not realistic because I do firmly believe in the monophyletic origin of the Angiospermae and

Table 1. Statistical summary from this updated classification of the flowering plants (Class Angiospermae).

	Dicotyledoneae	Monocotyledonae	Total Angiospermae
Species	176,075	58,160	234,235
Genera	9825	2790	12,615
Subfamilies	306	88	394
Families	354	86	440
Subfamilies and undivided families	566	145	711
Suborders	56	20	76
Orders	50	19	69
Suborders and undivided orders	87	33	120
Superorders	19	9	28
Monogeneric families	122	26	148
Monogeneric subfamilies	82	16	98
Monotypic families	41	6	47
Monotypic subfamilies	29	4	33
Digeneric families	29	6	35
Digeneric subfamilies	27	7	34
Ditypic families	31	2	33
Ditypic subfamilies	16	4	20
Trigeneric families	30	6	36
Trigeneric subfamilies	16	7	23
Tritypic families	13	3	16
Tritypic subfamilies	8	2	10

of their two subclasses, as well as most of the lesser-ranked taxa. I hope most of the polyphyletic groups have been rooted out of the classification but surely some remain to be extirpated, a probable example of such being the Lamiaceae (Cantino 1990).

As each superorder, order, or suborder terminates, the classification drops back down the evolutionary ladder to the beginning of the next major line of ascent. By placement in the synopsis I have tried to indicate closeness of relationship and increasing specialization. A linear sequence cannot, of course, approximate the probable branchings nor indicate the numerous interrelationships among the superorders and lesser taxa. It is hoped that the phyletic shrub, illustrated by Figure 1, will be more helpful in these respects.

In the development of this synopsis for the longer paper a large amount of data was accumulated. To make it more readily available I have summarized that information in four tables. Table 1 presents a statistical summary of the various angiosperm taxa in the two subclasses; species, genera, subfamilies, families, suborders, orders, and superorders. The best estimate I could obtain for number of species in the flowering plants was 234,235, give or take a few thousand, with the dicots about three times more numerous than the monocots. In genera the monocots are less than one quarter of the 12,615 angiosperm genera, and in families they are about one fifth of the 440 families that I accept currently as valid. Because some of my phyletic peers (Cronquist 1981; G. Dahlgren 1989a, b; R. Dahlgren et al. 1985; Takhtajan 1987) accept many of my subfamilies as valid families, I have chosen to use subfamilies and undivided families as the most significant units. Thus, the Angiospermae consist of 711 subfamilies and undivided families

Table 2. Putatively indigenous angiosperm families and additional subfamilies of the world.

	Dicots	Monocots	Totals	Total families and additional subfamilies
Asia (excl. Malesia)				
Families	227	62	289	
Add. subfamilies	124	28	152	441
South America (incl. Trinidad)				
Families	215	56	271	
Subfamilies	105	34	139	410
Central America (incl. Mexico)				
Families	197	47	244	
Add. subfamilies	96	33	129	373
Africa (S of Sahara)				
Families	192	55	247	
Add. subfamilies	95	28	123	370
Malesia (Malaya-Fiji)				
Families	194	54	248	
Add. subfamilies	81	26	107	355
Australia (incl. Tasmania)				
Families	162	60	222	
Add. subfamilies	80	30	110	332
North America (N of Mexico)				
Families	167	43	210	
Add. subfamilies	76	24	100	310
West Indies (incl. Bahamas)				
Families	159	37	196	
Add. subfamilies	65	26	91	287
Madagascar and Comoros				
Families	154	41	195	
Add. subfamilies	67	24	91	286
Pacific Basin (excl. Hawaii)				
Families	142	33	175	
Add. subfamilies	60	23	83	258
New Caledonia and Loyalties				
Families	121	34	155	
Add. subfamilies	46	16	62	217
Europe (incl. Med. Africa)				
Families	116	36	152	
Add. subfamilies	48	14	62	214
Indian Ocean Islands				
Families	115	32	147	
Add. subfamilies	49	17	66	213
Atlantic Islands				
Families	96	28	124	
Add. subfamilies	32	8	40	164
New Zealand				
Families	88	23	111	
Add. subfamilies	19	8	27	138

Table 2. Continued.

	Dicots	Monocots	Totals	Total families and additional subfamilies
Hawaiian Islands				
Families	70	14	84	
Add. subfamilies	15	5	20	104
Subantarctic Islands				
Families	35	10	45	
Add. subfamilies	2	3	5	50
Antarctica				
Families	1	1	2	
Add. subfamilies	0	0	0	2

(or 440 families and 271 additional subfamilies, i.e., subfamilies other than the typical subfamilies).

Since I have often been accused of being overly conservative in my recognition of families, I felt it might be informative to count the oligogeneric and oligotypic families listed in the synopsis, 222 of the former and 96 of the latter. Although it may be distressing to the student of flowering plants to have to deal with 47 monospecific families and 33 monospecific subfamilies for a total of 80, one should remember that the angiosperms have been evolving on earth for at least 120 million years and have suffered very heavy extinction even before modern man became too numerous and began to eliminate most of the species-rich environments. Such extinctions have broken up the near phyletic continuum and made it possible to develop our classification, largely based upon phyletic gaps.

Table 2 summarizes the distribution in the world's major regions of those families and subfamilies believed to be indigenous in each. Asia, even without Malesia, is by far the richest region phyletically, partly because of its latitudinal width from the Arctic nearly to the Equator, partly because it is the crossroads between Africa, Europe, and the Americas, and partly because of its easy access to Australasia through immediately adjacent Malesia. It is also significant that the sometime insular continent of South America is second richest in families and subfamilies because of its latitudinal stretch from the Antarctic to north of the Equator, its varied topography from the equatorial rainforests along the Amazon to the snowfields of the highest Andes, and its relatively recent connection with North America through the Panamanian Isthmus and earlier contacts with that continent via Antillean island stepping-stones. Former connections with Africa before the evolution of the South Atlantic and with Australasia via Antarctica are certainly also involved in its floristic richness. The relative floristic paucity of the larger continent of Africa must be due to extinctions caused by climatic catastrophies (Raven and Axelrod 1972) as well as to the earlier tectonic losses of India, Madagascar, and Arabia.

The surprising floristic richness of Central America, here including Mexico, and Malesia must be due to their critical intercontinental positions. That of Australia and the large continental islands of Madagascar and New Caledonia must, on the other hand, be due to their present long isolation following Mesozoic separation of Australia and Madagascar from Africa and New Caledonia from Australia.

Table 3. Angiosperm families and subfamilies of limited distribution.

Major geographic units	Endemic families	Endemic subfamilies	Total families and additional subfamilies
1. Africa (mainland south of Sahara)	21	18	38
2. South America (incl. Trinidad)	18	16	34
3. Asia (excl. Malesia)	16	10	25
4. Australia	14	15	29
5. North America (incl. Central America and West Indies)	10	7	17
6. Madagascar (and Comoro Is.)	7	6	12
7. New Caledonia	5	0	5
8. Malesia (to Fiji)	2	0	2
9. Indian Ocean	1	1	2
10. Pacific Basin	1	0	1
Totals	95	75	166

Later separation of Australia from Antarctica and South America came early in the Tertiary. The floristic poverty of oceanic islands surely is due to isolation from large continental masses, small size, relative recentness of volcanic origin, and genetic drift.

Reasonably consistent with the relative floristic richness of these regions is the relative degree of familial and subfamilial endemism recorded in Table 3. Here, however, the rather isolated continents of Africa and South America far surpass the other areas in endemism. African endemism seems even more striking if we add those taxa endemic to Madagascar and the Indian Ocean islands and four families shared only between Africa and Madagascar—a total of 56 families and additional subfamilies. Even larger figures would ensue for South America if we added those 16 essentially South American families and 20 additional subfamilies that have invaded the West Indies often north to southern Florida and Central America north to Panama, Costa Rica, or even southern Mexico. That total of 69 could be enhanced further by adding the 11 primarily South American families barely represented across the South Atlantic in Africa. One can only conclude that South America and adjacent tropical regions to the north are the richest repository on earth for major angiosperm taxa restricted completely or largely to one continent.

Finally, Table 4 summarizes the world distribution of angiosperm families and subfamilies. The largest number of major angiospermous taxa, 282, belongs to the subcosmopolitan, pantropical, and widespread temperate categories. Next are the narrower disjuncts between continents and/or oceanic regions, 266 taxa. Finally, those major taxa restricted to one continent number 163 taxa and combine with the above to total 711 subfamilies and undivided families.

In the synopsis of the Angiospermae within the two subclasses the hierarchy consists in descending order of superorders (-anae), orders (-ales), suborders (-ineae), families (-aceae), subfamilies (-oideae), and, in Asteraceae, tribes (-eae). An example in the Dicotyledoneae (Annonidae) is:

Superorder: Annonanae (Magnolianae)
    Order: Annonales (Magnoliales)

Table 4.   World distribution of angiosperm families and subfamilies.

	Families	Subfamilies	Subfamilies and undivided families
Subcosmopolitan	98	90	134
Missing from one continent	18	14	26
Pantropical	49	70	94
Missing from one continent	5	3	7
Widespead Temperate	9	8	12
Southern Hemisphere	7	4	9
Other narrower disjuncts	160	131	266
Eurasian (incl. Malesian)–American	36	36	66
N. American (incl. C. Am. and W. Indies)–S. America	22	26	47
American–African	15	12	22
Australian–S. American	8	7	15
Africa–Madagascar–Eurasia; –Australia; –Pacific	24	20	44
Asia–Malesia; –Australia; –Pacific	13	15	28
Other disjunctions	41	15	45
Endemic to one continent	94	72	163
Totals	440	392	711

Suborder: Annonineae (Magnoliineae)
   Family: Magnoliaceae
      Subfamily: Magnolioideae
         (Tribe: Magnolieae).

This example is presented to eliminate the need to list in every case the hierarchal ranks preceding the respective taxa.

SYNOPSIS OF THE CLASS ANGIOSPERMAE (ANNONOPSIDA)

Subclass: DICOTYLEDONEAE (ANNONIDAE)

Annonanae (C; 466/12,380)
   Annonales (incl. Magnoliales) (C; 281/9510)
      Winterineae (C; 8/90)
         Winteraceae (C; 8/90)
      Illiciineae (C; 3/84)
         Illiciaceae (C; 1/37)
         Schisandraceae (C; 2/47)
      Annonineae (incl. Magnoliineae) (C; 178/3250)

Magnoliaceae (C; 12/220)
   Magnolioideae (11/220)
   Liriodendroideae (1/2)
Degeneriaceae (C; 1/2)
Himantandraceae (C; 1/2)
Eupomatiaceae (C; 1/2)
Annonaceae (C; 132/2300)
Aristolochiaceae (C; 8/400)
   Asaroideae (3/71)
   Aristolochioideae (5/330)

Myristicaceae (C; 17/300)
Canellaceae (C; 6/21)
Austrobaileyineae (C; 1/1)
  Austrobaileyaceae (C; 1/1)
Laurineae (C; 77/2975)
  Amborellaceae (C; 1/1)
  Trimeniaceae (C; 1/5)
  Chloranthaceae (C; 4/70)
  Monimiaceae (C; 32/335)
    Hortonioideae (1/3)
    Monimioideae (3/18)
    Mollinedioideae (19/145)
    Atherospermatoideae (7/16)
    Siparunoideae (1/150)
    Glossocalycoideae (1/3)
  Gomortegaceae (C; 1/1)
  Calycanthaceae (C; 3/7)
    Idiospermoideae (1/1)
    Calycanthoideae (2/6)
  Lauraceae (C; 31/2490)
    Lauroideae (30/2470)
    Cassythoideae (1/20)
  Hernandiaceae (C; 4/64)
    Hernandioideae (2/42)
    Gyrocarpoideae (1/7)
    Sparattanthelioideae (1/15)
Piperineae (C; 14/3110)
  Lactoridaceae (C; 1/1)
  Saururaceae (C; 5/7)
  Piperaceae (C; 8/3100)
    Piperoideae (4/2100)
    Peperomioideae (4/1000)
Ceratophyllales (A; 1/6)
  Ceratophyllaceae (C; 1/6)
Nelumbonales (C; 1/2)
  Nelumbonaceae (C; 1/2)
Paeoniales (B; 2/34)
  Paeoniaceae (C; 1/33)
  Glaucidiaceae (C; 1/1)
Berberidales (C; 181/3490)
  Menispermaceae (C; 65/350)
  Lardizabalaceae (C; 9/38)
    Decaisneoideae (C; 1/2)
    Lardizabaloideae (incl. *Sargentodoxa*) (C; 8/36)
  Berberidaceae (C; 16/540)
    Nandinoideae (C; 1/1)
    Berberidoideae (3/520)

Leonticoideae (3/8)
Epimedioideae (9/11)
Hydrastidaceae (C; 1/1)
Ranunculaceae (C; 46/1900)
  Helleboroideae (1/21)
  Isopyroideae (Thalictroideae)
  Ranunculoideae (incl. *Kingdonia*)
Circaeasteraceae (C; 1/1)
Papaverineae (C; 42/660)
  Papaveraceae (C; 42/660)
    Platystemonoideae (3/4)
    Papaveroideae (18/185)
    Eschscholzioideae (3/12)
    Pteridophylloideae (1/1)
    Hypecoideae (1/10)
    Fumarioideae (16/450)
Nymphaeanae (C; 8/70)
  Nymphaeales (C; 8/70)
    Cabombaceae (C; 2/8)
    Nymphaeaceae (C; 6/62)
      Nymphaeoideae (3/55)
      Euryaloideae (2/3)
      Barclayoideae (1/4)
Rafflesianae (B; 10/64)
  Rafflesiales (B; 10/64)
    Hydnoraceae (C; 2/11)
    Rafflesiaceae (C; 8/53)
      Mitrastemonoideae (1/2)
      Cytinoideae (2/10)
      Apodanthoideae (2/26)
      Rafflesioideae (3/15)
Chenopodianae (Centrospermae) (C; 563/8670)
  Chenopodiales (Caryophyllales) (C; 563/8670)
    Phytolaccineae (C; 61/500)
      Phytolaccaceae (C; 7/65)
        Phytolaccoideae (4/45)
        Gisekioideae (1/5)
        Microteoideae (2/15)
      Petiveriaceae (Rivinaceae) (C; 6/40)
      Agdestidaceae (C; 1/1)
      Barbeuiaceae (C; 1/1)
      Achatocarpaceae (C; 2/10)

Stegnospermataceae (C; 1/3)
Nyctaginaceae (C; 30/290)
Portulacineae (C; 264/4070)
　Aizoaceae (C; 141/2040)
　　Aizooideae (6/80)
　　Aptenioideae (Mesembryan-
　　　themoideae) (9/90)
　　Ruschioideae (120/1800)
　　Sesuvioideae (4/20)
　　Tetragonioideae (2/50)
　Molluginaceae (B; 13/90)
　Halophytaceae (C; 1/1)
　Portulacaceae (C; 19/575)
　Hectorellaceae (C; 2/2)
　Basellaceae (C; 4/40)
　Didiereaceae (C; 4/11)
　Cactaceae (C; 93/1400)
　　Pereskioideae (2/18)
　　Opuntioideae (4/250)
　　Cactoideae (87/1130)
Chenopodiineae (C; 168/2350)
　Chenopodiaceae (C; 103/1500)
　　Chenopodioideae (incl. *Dys-
　　　phania*)
　　Salicornioideae
　　Salsoloideae
　Amaranthaceae (C; 65/850)
　　Amaranthoideae
　　Gomphrenoideae
Caryophyllineae (C; 70/1750)
　Caryophyllaceae (incl. *Geocar-
　　pon*) (C; 70/1750)
　　Alsinoideae
　　Paronychioideae
　　Caryophylloideae
Theanae (C; 611/13,460)
　Theales (C; 272/5370)
　　Dilleniineae (C; 9/400)
　　　Dilleniaceae (C; 9/400)
　　　　Dillenioideae (5/280)
　　　　Tetraceroideae (4/120)
　　Theineae (C; 62/1990)
　　　Actinidiaceae (C; 3/350)
　　　　Actinidioideae (1/40)
　　　　Saurauioideae (1/300)
　　　　Clematoclethroideae (1/10)
　　　Paracryphiaceae (B; 1/1)
　　　Stachyuraceae (C; 1/10)

Theaceae (C; 28/500)
　Ternstroemioideae (12/200)
　Theoideae (16/300)
Asteropeiaceae (B; 1/7)
Tetrameristaceae (B; 2/2)
Pellicieraceae (C; 1/1)
Chrysobalanaceae (A; 17/495)
Symplocaceae (C; 1/500)
Caryocaraceae (C; 2/23)
Marcgraviaceae (C; 5/100)
Icacinineae (C; 62/720)
　Oncothecaceae (B; 1/2)
　Aquifoliaceae (C; 1/400)
　Phellinaceae (C; 1/10)
　Icacinaceae (excl. *Metteniusa*)
　　(B; 56/300)
　Sphenostemonaceae (B; 1/7)
　Cardiopteridaceae (B; 1/2)
Sarraceniineae (C; 3/15)
　Sarraceniaceae (C; 3/15)
Clethrineae (B; 5/80)
　Pentaphylacaceae (C; 1/2)
　Clethraceae (C; 1/64)
　Cyrillaceae (C; 3/14)
Scytopetalineae (C; 55/695)
　Ochnaceae (incl. *Lophira*) (C;
　　40/600)
　　Ochnoideae (33/525)
　　Sauvagesioideae (7/75)
　Quiinaceae (C; 4/50)
　Scytopetalaceae (C; 5/20)
　Medusagynaceae (C; 1/1)
　Strasburgeriaceae (B; 1/1)
　Ancistrocladaceae (B; 1/20)
　Dioncophyllaceae (B; 3/3)
Nepenthineae (C; 1/70)
　Nepenthaceae (C; 1/70)
Hypericineae (C; 50/1065)
　Bonnetiaceae (C; 3/22)
　Clusiaceae (incl. Hypericaceae)
　　(C; 45/1010)
　　Kielmeyeroideae (7/47)
　　Calophylloideae
　　Clusioideae
　　Moronoboideae (6/36)
　　Hypericoideae (9/540)
　Elatinaceae (C; 2/35)
Lecythidineae (C; 25/400)

Lecythidaceae (C; 25/400)
  Planchonioideae (6/54)
  Foetidoideae (1/5)
  Lecythidoideae (15/325)
  Napoleonoideae (2/18)
  Asteranthoideae (1/1)
Ericales (C; 132/2650)
  Ericaceae (C; 99/2650)
    Rhododendroideae (15/700)
    Ericoideae (17/865)
    Vaccinioideae (incl. Arbu-
      teae) (54/660)
    Pyroloideae (3/10)
    Monotropoideae (10/12)
  Epacridaceae (excl. *Wittstein-
    ia*) (C; 30/400)
  Empetraceae (C; 3/6)
Fouquieriales (C; 1/11)
  Fouquieriaceae (C; 1/11)
Ebenales (C; 84/1450)
  Ebenineae (Sapotineae) (C; 73/
    1300)
    Ebenaceae (C; 2/500)
    Lissocarpaceae (C; 1/2)
    Sapotaceae (incl. *Sarcosperma*)
      (C; 70/800)
  Styracineae (C; 11/150)
    Styracaceae (C; 11/150)
Primulales (C; 77/2885)
  Primulineae (C; 58/2110)
    Theophrastaceae (C; 5/110)
    Myrsinaceae (C; 33/1000)
      Myrsinoideae (incl. *Aegice-
        ras*) (32/900)
      Maesoideae (1/100)
    Primulaceae (incl. *Coris*) (C; 20/
      1000)
  Plumbaginineae (C; 19/775)
    Plumbaginaceae (C; 19/775)
      Plumbaginoideae (4/24)
      Staticoideae (incl. *Aegialitis*)
        (15/750)
Polygonales (B; 49/1100)
  Polygonaceae (C; 49/1100)
    Eriogonoideae (17/316)
    Polygonoideae (24/550)
    Coccoloboideae (8/230)
Celastranae (A; 60/875)
  Celastrales (B; 60/875)

Celastraceae (C; 55/855)
  Celastroideae (25/?)
  Tripterygioideae (5/34)
  Cassinoideae (20/?)
  Hippocrateoideae (4/100)
  Siphonodontoideae (1/5)
Goupiaceae (B; 1/3)
Lophopyxidaceae (B; 1/2)
Stackhousiaceae (B; 3/16)
  Macgregorioideae (1/1)
  Stackhousioideae (2/15)
Malvanae (C; 769/14,610)
  Malvales (C; 246/3300)
    Sterculiineae (C; 151/2120)
      Sterculiaceae (C; 60/700)
        Sterculioideae (12/?)
        Byttnerioideae (48/?)
      Huaceae (C; 2/3)
      Elaeocarpaceae (excl. *Muntin-
        gia*) (A; 9/350)
      Plagiopteraceae (A; 1/1)
      Tiliaceae (C; 49/450)
        Brownlowioideae (12/56)
        Tetralicoideae (1/3)
        Tilioideae (35/390)
        Neotessmannioideae (1/1)
      Monotaceae (C; 3/21)
        Pakaramaeoideae (1/1)
        Monotoideae (2/20)
      Dipterocarpaceae (C; 16/550)
      Sarcolaenaceae (C; 8/28)
      Diegodendraceae (Rhopalocar-
        paceae) (B; 3/15)
        Rhopalocarpoideae (C; 2/14)
        Diegodendroideae (1/1)
    Malvineae (C; 95/1180)
      Bombacaceae (C; 20/180)
      Malvaceae (C; 75/1000)
  Urticales (excl. *Barbeya*) (C; 116/
    2680)
    Ulmaceae (C; 15/200)
      Celtidoideae
      Ulmoideae
    Moraceae (C; 53/1400)
    Cecropiaceae (C; 6/275)
    Urticaceae (C; 39/800)
    Cannabaceae (C; 3/3)
  Rhamnales (C; 48/900)

Rhamnaceae (C; 45/850)
Elaeagnaceae (C; 3/50)
Euphorbiales (C; 359/7730)
   Euphorbiaceae (C; 304/7030)
    Phyllanthoideae
    Oldfieldioideae (incl. *Picro-dendron*)
    Acalyphoideae
    Crotonoideae
    Euphorbioideae
    Pandoideae (C; 4/28)
   Simmondsiaceae (C; 1/1)
   Dichapetalaceae (B; 4/200)
   Gonystylaceae (C; 3/23)
   Thymelaeaceae (C; 47/475)
    Aquilarioideae (5/40)
    Gilgiodaphnoideae (1/1)
    Thymelaeoideae (41/435)
Violanae (C; 716/9550)
 Violales (C; 288/5350)
  Cistineae (C; 11/225)
   Bixaceae (1/4)
   Cochlospermaceae (C; 2/20)
   Cistaceae (C; 8/200)
  Violineae (incl. Caricineae, Salicales) (C; 144/3185)
   Violaceae (C; 22/900)
    Violoideae (21/895)
    Leonioideae (1/6)
   Flacourtiaceae (C; 79/880)
   Lacistemataceae (C; 2/27)
   Salicaceae (C; 3/530)
   Dipentodontaceae (C; 1/1)
   Peridiscaceae (B; 2/2)
   Scyphostegiaceae (C; 1/1)
   Passifloraceae (incl. Abatieae, Paropsieae) (C; 18/630)
   Turneraceae (C; 8/120)
   Malesherbiaceae (C; 1/35)
   Achariaceae (C; 3/3)
   Caricaceae (C; 4/55)
  Tamaricineae (C; 7/190)
   Tamaricaceae (C; 5/100)
   Frankeniaceae (C; 2/90)
  Begoniineae (C; 126/1750) (incl. Cucurbitineae)
   Cucurbitaceae (C; 118/825)
    Zanonioideae (18/80)
    Cucurbitoideae (100/745)

Begoniaceae (C; 5/920)
Datiscaceae (incl. Tetrameleae) (C; 3/4)
Capparales (C; 428/4200)
 Resedaceae (C; 6/70)
 Capparaceae (C; 47/930)
  Tovarioideae (C; 1/2)
  Pentadiplandroideae (B; 1/2)
  Koeberlinioideae (C; 1/1)
  Capparoideae (incl. *Dipterygium, Oceanopapaver*) (C; 30/640)
  Cleomoideae (incl. *Buhsia, Podandrogyne*) (C; 13/285)
 Brassicaceae (excl. *Dipterygium*) (C; 376/3200)
Santalanae (B; 163/2040)
 Santalales (C; 143/1995)
  Olacaceae (C; 25/250)
   Olacoideae (23/240)
   Octoknemoideae (1/6)
   Erythropaloideae (1/2)
  Opiliaceae (C; 10/30)
  Medusandraceae (C; 1/2)
  Santalaceae (incl. *Okoubaka*) (C; 30/400)
  Misodendraceae (C; 1/11)
  Loranthaceae (C; 65/850)
  Eremolepidaceae (C; 3/12)
  Viscaceae (C; 8/440)
 Balanophorales (B; 19/45)
  Balanophoraceae (C; 18/43)
   Mystropetaloideae (1/1)
   Dactylanthoideae (2/2)
   Sarcophytoideae (2/3)
   Helosidoideae (6/12)
   Lophophytoideae (4/8)
   Balanophoroideae (3/17)
  Cynomoriaceae (B; 1/1-2)
Geranianae (B; 189/5565)
 Linales (C; 56/865)
  Humiriaceae (C; 8/50)
  Ctenolophonaceae (C; 1/3)
  Hugoniaceae (C; 6/55)
  Ixonanthaceae (B; 4/33)
  Linaceae (C; 6/210)
  Erythroxylaceae (C; 2/250)
  Zygophyllaceae (C; 28/255)

Peganoideae (1/6)
Morkillioideae (Chitonoide-
    ae) (3/4)
Tetradiclidoideae (1/1)
Tribuloideae (4/60)
Neoluederitzioideae (2/2)
Zygophylloideae (15/175)
Augeoideae (1/1)
Nitrarioideae (1/8)
Balanitaceae (B; 1/9)
Rhizophorales (B; 12/84)
Rhizophoraceae (C; 12/84)
Geraniales (B; 29/2370)
Oxalidaceae (incl. Averrhoeae,
    Lepidobotrys) (C; 7/890)
Geraniaceae (B; 13/775)
Geranioideae (5/750)
Biebersteinioideae (1/5)
Dirachmoideae (1/1)
Vivianioideae (4/6)
Ledocarpoideae (2/11)
Balsaminaceae (C; 5/600)
Tropaeolaceae (C; 2/92)
Limnanthaceae (C; 1/11)
Malpighiales (C; 92/2245)
Malpighiaceae (C; 66/1200)
Byrsonimoideae
Gaudichaudioideae
Malpighioideae
Trigoniaceae (C; 3/26)
Vochysiaceae (C; 7/200)
Polygalaceae (incl. *Diclidanthe-
    ra, Xanthophyllum*) (C; 15/
    800)
Krameriaceae (B; 1/20)
Rutanae (C; 1135/24,300)
Rutales (C; 1135/24,300)
Rutineae (C; 326/3545)
Rutaceae (C; 154/925)
Rutoideae (incl. Toddalioi-
    deae) (117/?)
Citroideae (=Aurantioideae)
    (30/?)
Flindersioideae (2/17)
Spathelioideae (4/23)
Dictylomatoideae (1/2)
Rhabdodendraceae (B; 1/4)
Cneoraceae (C; 1/3)

Simaroubaceae (C; 27/192)
Simarouboideae (excl. *Har-
    risonia*) (20/116)
Kirkioideae (1/8)
Irvingioideae (incl. *Allanto-
    spermum*) (4/23)
Picramnioideae (1/40)
Alvaradoideae (1/5)
Ptaeroxylaceae (C; 2/5)
Meliaceae (C; 52/1310)
Melioideae (incl. *Nymania*)
    (37/1260)
Quivisianthoideae (1/1)
Capuronianthoideae (1/1)
Swietenioideae (13/47)
Burseraceae (C; 17/500)
Anacardiaceae (incl. *Blepharo-
    carya, Dobinea*, Juliani-
    aceae) (C; 70/600)
Leitneriaceae (B; 1/1)
Tepuianthaceae (A; 1/5)
Coriariineae (C; 1/5)
Coriariaceae (C; 1/5)
Sapindineae (C; 161/2425)
Sapindaceae (incl. *Filicium*) (C;
    143/2000)
Dodonaeoideae (29/120)
Stylobasioideae (1/2)
Emblingioideae (1/1)
Sapindoideae (112/1880)
Gyrostemonaceae (C; 5/17)
Bataceae (B; 1/2)
Sabiaceae (C; 3/160)
Meliosmoideae (2/105)
Sabioideae (B; 1/55)
Melianthaceae (C; 2/15)
Akaniaceae (C; 1/1)
Aceraceae (C; 2/200)
Hippocastanaceae (C; 2/15)
Bretschneideraceae (C; 1/2)
Moringaceae (B; 1/14)
Fabineae (C; 647/18,325)
Surianaceae (A; 1/1)
Connaraceae (C; 16/325)
Connaroideae (15/322)
Jollydoroideae (1/3)
Fabaceae (C; 630/18,000)
Caesalpinioideae (150/2700)

Mimosoideae (40/2500)
Swartzioideae (11/185)
Faboideae (429/12,615)
Proteanae (C; 75/1050)
  Proteales (C; 75/1050)
    Proteaceae (C; 75/1050)
      Persoonioideae (7/43)
      Proteoideae (26/?)
      Sphalmioideae (1/1)
      Carnarvonioideae (1/2)
      Grevilleoideae (40/?)
Rosanae (B; 395/6830)
  Hamamelidales (C; 34/105)
    Trochodendrineae (C; 5/7)
      Trochodendraceae (C; 2/2)
        Trochodendroideae (C; 1/1)
        Tetracentroideae (C; 1/1)
      Eupteleaceae (C; 1/2)
      Cercidiphyllaceae (C; 1/2)
      Eucommiaceae (C; 1/1)
    Hamamelidineae (C; 31/130)
      Platanaceae (C; 1/9)
      Hamamelidaceae (C; 30/120)
        Hamamelidoideae (22/100)
        Rhodoleioideae (1/1)
        Exbucklandioideae (incl.
          Disanthus) (4/5)
        Altingioideae (=Liquidam-
          baroideae) (3/12)
  Casuarinales (C; 4/70)
    Casuarinaceae (C; 4/70)
  Buxales (C; 8/120)
    Buxineae (B; 6/105)
      Buxaceae (excl. *Simmondsia*)
        (C; 5/103)
        Buxoideae (4/100)
        Styloceratoideae (1/3)
      Didymelaceae (B; 1/2)
    Daphniphyllineae (C; 2/17)
      Daphiphyllaceae (C; 1/9)
      Balanopaceae (C; 1/8)
  Pittosporales (C; 14/195)
    Pittosporaceae (C; 10/150)
    Byblidaceae (C; 1/2)
    Tremandraceae (C; 3/43)
  Bruniales (C; 17/115)
    Roridulaceae (C; 1/2)
    Bruniaceae (C; 12/75)

Geissolomataceae (C; 1/1)
Grubbiaceae (C; 1/3)
Myrothamnaceae (C; 1/2)
Hydrostachyaceae (C; 1/30)
Juglandales (A; 13/100)
  Juglandineae (C; 9/60)
    Rhoipteleaceae (C; 1/1)
    Juglandaceae (C; 8/59)
  Myricineae (C; 3/40)
    Myricaceae (incl. *Canacomy-
      rica*) (C; 3/40)
Fagales (C; 17/890)
  Ticodendraceae (C; 1/1)
  Betulaceae (C; 6/157)
    Coryloideae (4/62)
    Betuloideae (2/95)
  Nothofagaceae (C; 1/35)
  Fagaceae (C; 9/700–800)
    Castaneoideae (4/300)
    Fagoideae (5/400–500)
Rosales (C; 110/2050)
  Rosaceae (C; 100/2000)
    Spiraeoideae (incl. *Lyono-
      thamnus*)
    Quillajeoideae (2/8)
    Rosoideae
    Maloideae (incl. *Lindleya,
      Vauquelinia*)
    Prunoideae (incl. *Exochor-
      da*)
  Neuradaceae (B; 3/10)
  Crossosomataceae (incl. *Apache-
    ria, Glossopetalon*) (C;
    3/7)
  Anisophylleaceae (A; 4/34)
Saxifragales (C; 95/2575)
  Tetracarpaeaceae (B; 1/1)
  Crassulaceae (C; 35/1500)
    Sedoideae (incl. Sempervi-
      vieae, Echeverieae)
    Cotyledonoideae (incl. Ka-
      lanchoeae)
    Crassuloideae
  Cephalotaceae (C; 1/1)
  Penthoraceae (C; 1/2)
  Saxifragaceae (C; 30/550)
    Astilboideae (3/40)
    Saxifragoideae (27/510)

Francoaceae (C; 2/2)
Alseuosmiaceae (incl. *Witt-steinia* s.l.) (C; 3/12)
Grossulariaceae (C; 1/150)
Vahliaceae (C; 1/5)
Eremosynaceae (C; 1/1)
Lepuropetalaceae (C; 1/1)
Parnassiaceae (B; 1/50)
Stylidiaceae (B; 6/172)
  Donatioideae (1/2)
  Stylidioideae (5/170)
Droseraceae (C; 4/110)
Greyiaceae (C; 1/3)
Diapensiaceae (excl. *Diplarche*) (B; 6/20)
Podostemales (B; 50/140)
  Podostemaceae (C; 50/140)
    Tristichoideae (5/10)
    Podostemoideae (45/130)
Cunoniales (C; 33/470)
  Cunoniaceae (C; 27/410)
    Cunonioideae (24/350)
    Baueroideae (1/3)
    Eucryphioideae (1/6)
    Brunellioideae (1/52)
  Davidsoniaceae (C; 1/1)
  Staphyleaceae (C; 5/60)
    Staphyleoideae (3/55)
    Tapiscioideae (2/5)
Cornanae (B; 578/7120)
Hydrangeales (B; 42/485)
  Hydrangeaceae (C; 17/250)
    Philadelphoideae (C; 7/135)
    Kirengeshomoideae (C; 1/1)
    Hydrangeoideae (C; 9/114)
  Escalloniaceae (C; 15/200)
    Escallonioideae (incl. *Coro-kia*) (C; 10/165)
    Iteoideae (2/22)
    Tribeloideae (1/1)
    Phyllonomoideae (1/8)
    Pterostemonoideae (1/2)
  Griseliniaceae (B; 1/6)
  Montiniaceae (incl. *Kaliphora, Melanophylla*) (C; 4/13)
  Brexiaceae (B; 3/11)
  Columelliaceae (C; 1/4)
  Desfontainiaceae (B; 1/1)

Cornales (B; 34/985)
  Vitineae (B; 13/735)
    Vitaceae (C; 13/735)
      Vitoideae (12/700)
      Leeoideae (1/34)
  Gunnerineae (B; 1/35)
    Gunneraceae (C; 1/35)
  Haloragineae (B; 9/100)
    Haloragaceae (C; 9/100)
  Corineae (C; 11/115)
    Cornaceae (C; 6/78)
      Davidioideae (1/1)
      Nyssoideae (2/6)
      Mastixioideae (2/25)
      Cornoideae (1/46)
    Curtisiaceae (C; 1/1)
    Alangiaceae (C; 1/19)
    Garryaceae (C; 1/12)
    Aucubaceae (C; 1/3)
    Aralidiaceae (C; 1/1)
Araliales (C; 462/4260)
  Helwingiaceae (C; 1/5)
  Torricelliaceae (C; 1/3)
  Araliaceae (C; 50/1150)
  Hydrocotylaceae (C; 45/300)
  Apiaceae (C; 365/2800)
    Saniculoideae
    Apioideae
Dipsacales (C; 40/1390)
  Caprifoliaceae (C; 12/450)
  Adoxaceae (C; 5/243)
    Adoxoideae (incl. *Sambu-cus*) (C; 4/43)
    Viburnoideae (1/200)
  Valerianaceae (C; 13/400)
  Triplostegiaceae (C; 1/2)
  Dipsacaceae (C; 8/280)
  Morinaceae (C; 1/17)
Asteranae (incl. Campanulanae) (B; 1251/21,500)
  Asterales (C; 1164/19,125)
    Calyceraceae (C; 4/40)
    Asteraceae (C; 1160/19,085)
      Lactucoideae (Cichorioide-ae) (340/6370)
        Barnadesieae (9/95)
        Mutisieae (81/800)
        Tarchonantheae (2/27)

Cardueae (incl. Carlineae, Echinopsideae, Eremothamneae, Gundelieae) (80/2610)

Vernonieae (incl. *Stokesia, Trichospira*) (70/1500)

Liabeae (15/160)

Lactuceae (Cichorieae) (70/1000)

Arctoteae (excl. *Ursinia*) (13/180)

Asteroideae (820/12,715)

Astereae (135/2500)

Anthemidae (incl. *Ursinia, Cotula*) (107/1650)

Inuleae (incl. Gnaphalieae) (185/2050)

Senecioneae (incl. *Blennosperma*) (100/2000)

Calenduleae (7/110)

Eupatorieae (60/2000)

Heliantheae (incl. *Arnica,* Bahiinae, Gaillardiinae, Helenieae, Madieae) (177/1630)

Coreopsideae (32/535)

Tageteae (17/240)

Campanulales (C; 87/2370)

Menyanthaceae (C; 5/40)

Pentaphragmataceae (C; 1/30)

Sphenocleaceae (C; 1/2)

Campanulaceae (C; 65/2000)

Campanuloideae (34/820)

Cyphioideae (1/50)

Lobelioideae (incl. *Cyphocarpus*) (30/1130)

Goodeniaceae (excl. *Brunonia*) (C; 15/300)

Goodenioideae (12/210)

Dampieroideae (3/88)

Solananae (C; 295/7730)

Solanales (C; 295/7730)

Solanineae (C; 142/4755)

Solanaceae (C; 76/2900)

Solanoideae (55/2400)

Cestroideae (20/485)

Sclerophylacoideae (1/12)

Duckeodendraceae (B; 1/1)

Goetzeaceae (B; 4/5)

Nolanaceae (C; 1/18)

Convolvulaceae (C; 59/1830)

Humbertioideae (1/1)

Dichondroideae (2/9)

Convolvuloideae (55/1650)

Cuscutoideae (1/170)

Boraginineae (C; 137/2655)

Hydrophyllaceae (C; 18/250)

Boraginaceae (C; 116/2400)

Ehretioideae (11/145)

Cordioideae (4/255)

Heliotropoideae (incl. *Ixorhea, Nogalia*) (6/430)

Boraginoideae (95/1570)

Wellstedioideae (1/2)

Hoplestigmataceae (B; 1/2)

Lennoaceae (C; 2/4)

Polemoniineae (C; 16/320)

Polemoniaceae (incl. *Cobaea*) (C; 16/320)

Loasanae (A; 13/280)

Loasales (C; 13/280)

Loasaceae (C; 13/280)

Mentzelioideae (2/71)

Loasoideae (7/200)

Gronovioideae (4/8)

Myrtanae (C; 463/8120)

Myrtales (C; 463/8120)

Lythrineae (B; 301/4465)

Lythraceae (C; 25/460)

Lythroideae (22/450)

Duabangoideae (1/3)

Sonneratioideae (1/4)

Punicoideae (1/2)

Alzateaceae (C; 1/2)

Rhynchocalycaceae (C; 1/1)

Penaeaceae (C; 5/25)

Oliniaceae (C; 1/10)

Trapaceae (B; 1/1–3)

Crypteroniaceae (C; 3/10)

Melastomataceae (C; 244/3360)

Melastomatoideae (237/2950)

Memecyloideae (incl. *Astronia*) (7/410)

Combretaceae (C; 20/600)

Strephonematoideae (1/6)

Combretoideae (19/595)

Onagrineae (C; 18/650)

Onagraceae (C; 18/650)
Myrtineae (C; 144/3000)
Myrtaceae (C; 144/3000)
Heteropyxidoideae (incl. *Psiloxylon*) (2/2)
Myrtoideae (incl. Leptospermoideae) (142/3000)
Gentiananae (C; 2039/31,825)
Gentianales (C; 958/14,145)
Loganiaceae (B; 22/545)
Loganioideae (18/480)
Potalioideae (3/65)
Plocospermatoideae (1/1)
Rubiaceae (C; 500–600/9000)
Cinchonoideae (incl. *Hillia*)
Antirrheoideae (=Guettardoideae)
Ixoroideae
Rubioideae (incl. Theligoneae, Henriquesieae)
Apocynaceae (incl. Asclepiadaceae) (C; 355/3700)
Plumerioideae (incl. Cerbereae) (101/?)
Apocynoideae (87/?)
Periplocoideae (C; 45/200)
Secamonoideae
Asclepiadoideae
Gentianaceae (C; 80/900)
Saccifoliaceae (B; 1/1)
Bignoniales (C; 1083/17,680)
Bignonineae (C; 786/10,820)
Oleaceae (C; 29/600)
Jasminoideae (incl. *Nyctanthes*)
Oleoideae (incl. *Hesperelaea*)
Buddlejaceae (C; 10/150)
Stilbaceae (C; 6/13)
Retzioideae (1/1)
Stilboideae (5/12)
Bignoniaceae (excl. Schlegelieae=Paulownieae) (C; 113/800)

Pedaliaceae (incl. *Trapella*) (C; 12/70)
Martyniaceae (C; 2/12)
Myoporaceae (C; 3/135)
Scrophulariaceae (incl. Schlegelieae, Leucophylleae, *Oftia*) (C; 212/2700)
Scrophularioideae
Rhinanthoideae
Orobanchoideae (13/150)
Selaginaceae (C; 8/300)
Globulariaceae (C; 2/30)
Plantaginaceae (C; 3/220)
Lentibulariaceae (C; 4/170)
Acanthaceae (C; 256/2770)
Nelsonioideae (5/15)
Thunbergioideae (4/205)
Mendoncioideae (2/60)
Acanthoideae
Ruellioideae
Gesneriaceae (C; 126/2850)
Gesnerioideae (54/1280)
Coronantheroideae (9/20)
Cyrtandroideae (63/1550)
Lamiineae (C; 297/6860)
Verbenaceae (C; 99/3150)
Viticoideae
Verbenoideae
Caryopteridoideae (6/40)
Phrymatoideae (1/1)
Symphoremataceae (B; 3/34)
Chloanthaceae (excl. *Spartothamnella*) (C; 9/105)
Nesogenaceae (B; 2/11)
Avicenniaceae (C; 1/15)
Lamiaceae (C; 180/3500)
Ocimoideae
Lamioideae
Tetrachondraceae (C; 1/2)
Callitrichaceae (C; 1/40–60)
Hippuridaceae (B; 1/3)

Subclass: MONOCOTYLEDONEAE (LILIIDAE)

Lilianae (B; 1176/29,300)
  Liliales (B; 155/2690)
    Melanthiineae (C; 25/155)
      Melanthiaceae (incl. *Aletris,*
        Chionographideae, *Lophi-*
        ola, Narthecieae, Petrosa-
        vieae, Tofieldieae, Xero-
        phylleae) (C; 23/150)
      Campynemataceae (C; 2/4)
    Liliineae (B; 52/880)
      Alstroemeriaceae (C; 4/160)
      Philesiaceae (B; 7/13)
        Philesioideae (2/2)
        Luzuriagoideae (incl. *Dry-*
          mophila) (5/11)
      Colchicaceae (incl. Anguillar-
        ieae, Iphigenieae) (C; 17/
        170)
      Liliaceae (B; 22/485)
        Tricyrtidoideae (incl. Uvu-
          larieae) (8/40)
        Lilioideae (incl. *Calochortus,*
          Gageae, Medeoleae, Tu-
          lipeae) (14/445)
      Trilliaceae (C; 2/50)
    Iridineae (C; 78/1655)
      Iridaceae (C; 78/1655)
        Isophysidoideae (1/1)
        Nivenioideae (incl. *Geosiris*)
          (6/85)
        Iridoideae (incl. Sisyrinchi-
          eae, Tigrideae, Marice-
          ae) (43/700)
        Ixioideae (28/870)
  Burmanniales (C; 17/145)
    Burmanniaceae (C; 15/135)
      Burmannioideae (9/100)
      Thismioideae (6/35)
    Corsiaceae (C; 2/9)
  Asparagales (B; 252/5290)
    Asparagineae (B; 120/2570)
      Asparagaceae (B; 26/440)
        Convallarioideae (incl. As-
          pidistreae, Ophiopogon-
          eae, Polygonatae) (19/
          110)

Asparagoideae (1/312)
Ruscoideae (3/8)
Herrerioideae (3/9)
Asphodelaceae (incl. Aloeae) (B;
  15/800)
Aphyllanthaceae (incl. Anther-
  icaceae: Caesieae, Hodg-
  sonioleae, Johnsonieae,
  Leucocrinum, Simethide-
  ae, Thysanoteae) (34/620)
Phormiaceae (B; 8/35)
  Phormioideae (incl. Dianel-
    leae) (B; 7/32)
  Doryanthoideae (1/3)
Tecophilaeaceae (incl. Waller-
  ieae) (B; 5/20)
Lanariaceae (C; 1/1)
Hemerocallidaceae (C; 1/16)
Dracaenaceae (B; 9/230)
  Dracaenoideae (incl. Sanse-
    vierieae) (2/130)
  Nolinoideae (3/50)
  Astelioideae (4/50)
Hanguanaceae (B; 1/1 or 2)
Agavaceae (incl. only Agaveae,
  Yucceae) (C; 8/300)
  Yuccoideae (2/42)
  Agavoideae (6/260)
Hostaceae (C; 1/10)
Blandfordiaceae (B; 1/4)
Dasypogonaceae (B; 9/72)
  Dasypogonoideae (1/3)
  Calectasioideae (1/2)
  Lomandroideae (incl. Lo-
    mandreae, Xeroteae) (5/
    65)
  Kingioideae (2/2)
Xanthorrhoeaceae (C; 1/28)
Amaryllidineae (B; 133/2720)
  Ixiolirionaceae (C; 1/4)
  Hyacinthaceae (=Scilloideae)
    (incl. Bowieae, Chloragal-
    eae, Hyacintheae, Masson-
    ieae, Scilleae) (C; 40/900)

Alliaceae (C; 30/720)
  Agapanthoideae (2/31)
  Allioideae (incl. Brodiaeeae,
    Milleae) (19/665)
  Gilliesioideae (9/25)
Amaryllidaceae (C; 50/860)
Hypoxidaceae (B; 10/150)
Cyanastraceae (C; 1/6)
Eriospermaceae (C; 1/80)
Dioscoreales (B; 16/1050)
  Rhipogonaceae (C; 1/70)
  Smilacaceae (C; 3/310)
  Petermanniaceae (C; 1/1)
  Dioscoreaceae (C; 5/625)
    Stenomeridoideae (2/6)
    Dioscoreoideae (3/620)
  Trichopodaceae (C; 1/1)
  Stemonaceae (C; 4/32)
  Taccaceae (C; 1/10)
Orchidales (C; 736/20,120
  Orchidaceae (C; 736/20,120)
    Apostasioideae (2/18)
    Cypripedioideae (4/100–150)
    Orchidoideae (incl. Neottioi-
      deae)
    Epidendroideae (incl. Van-
      doideae)
Hydatellanae (A; 2/8)
  Hydatellales (C; 2/8)
    Hydatellaceae (C; 2/8)
Triuridanae (B; 8/80)
  Triuridales (C; 8/80)
    Triuridaceae (incl. *Lacandon-
      ia, Peltophyllum*) (8/80)
Alismatanae (C; 57/440)
  Alismatales (C; 33/180)
    Butomaceae (C; 1/1)
    Alismataceae (C; 16/100)
      Limnocharitoideae (3/11)
      Alismatoideae (13/90)
    Hydrocharitaceae (C; 16/80)
      Hydrocharitoideae (incl. *En-
        halus*) (4/11)
      Vallisnerioideae (10/64)
      Thalassioideae (1/2)
      Halophiloideae (1/4)
  Zosterales (C; 23/209)
    Aponogetonineae (C; 1/47)
      Aponogetonaceae (C; 1/47)

Potamogetonineae (C; 19/162)
  Scheuchzeriaceae (C; 1/1)
  Juncaginaceae (C; 5/17)
    Juncaginoideae (C; 4/16)
    Lilaeoideae (C; 1/1)
  Potamogetonaceae (C; 3/95)
    Potamogetonoideae (2/90)
    Ruppioideae (1/3–7)
  Posidoniaceae (C; 1/3)
  Cymodoceaceae (C; 5/16)
  Zannichelliaceae (C; 4/12)
  Zosteraceae (C; 3/18)
Najadales (C; 1/50)
  Najadaceae (C; 1/50)
Aranae (C; 105/2500)
  Arales (C; 105/2500)
    Acoraceae (A; 1/3)
    Araceae (C; 104/2500)
      Pothoideae (incl. Monster-
        oideae) (19/1000)
      Calloideae (incl. Philoden-
        droideae) (40/800)
      Colocasioideae (15/205)
      Lasioideae (incl. Symplocar-
        peae, Orontieae) (12/80)
      Aroideae (incl. *Pistia*) (18/
        415)
    Lemnaceae (C; 4/28)
      Lemnoideae (2/14)
      Wolffioideae (2/14)
Cyclanthanae (B; 11/240)
  Cyclanthales (C; 11/240)
    Cyclanthaceae (C; 11/240)
      Carludovicoideae (10/240)
      Cyclanthoideae (1/1)
Pandananae (B; 3/700)
  Pandanales (C; 3/700)
    Pandanaceae (C; 3/700)
      Pandanoideae (2/600)
      Freycinetioideae (1/100)
Arecanae (C; 200/2780)
  Arecales (C; 200/2780)
    Arecaceae (C; 200/2780)
      Coryphoideae (incl. *Phoenix,
        Borassoideae*) (39/395)
      Calamoideae (=Lepidocar-
        yoideae) (22/665)
      Nypoideae (1/1)
      Ceroxyloideae (11/180)

Arecoideae (incl. Caryotoid-
    eae, Cocosoideae) (124/
    1525)
Phytelephantoideae (3/15)
Commelinanae (C; 1229/22,120)
  Bromeliales (C; 79/1905)
    Bromeliineae (C; 56/1790)
      Bromeliaceae (C; 51/1520)
        Bromelioideae (30/425)
        Pitcairnioideae (incl. *Navia*)
          (13/420)
        Tillandsioideae (8/675)
      Velloziaceae (C; 5/250)
        Vellozioideae (2/125)
        Barbacenioideae (6/125)
    Pontederiineae (C; 23/115)
      Philydraceae (C; 3/6)
      Pontederiaceae (C; 6/30)
      Haemodoraceae (C; 14/80)
  Typhales (C; 2/30)
      Typhaceae (C; 2/30)
        Sparganioideae (1/14)
        Typhoideae (1/15)
  Zingiberales (C; 92/1975)
    Musineae (C; 2/42)
      Musaceae (C; 2/42)
    Strelitziineae (C; 3/7)
      Strelitziaceae (C; 3/7)
    Lowiineae (C; 1/6)
      Lowiaceae (C; 1/6)
    Heliconiineae (C; 1/250)
      Heliconiaceae (C; 1/250)
    Zingiberineae (C; 54/1150)
      Zingiberaceae (C; 50/1000)
      Costaceae (C; 4/150)
    Marantineae (C; 31/520)
      Cannaceae (C; 1/20)
      Marantaceae (C; 30/500)
  Commelinales (C; 74/2140)
    Xyridineae (C; 20/350)
      Rapateaceae (C; 16/80)
        Saxofridericioideae (8/40)
        Rapateoideae (8/40)
      Xyridaceae (C; 4/270)
        Xyridoideae (2/250)
        Abolbodoideae (2/20)
    Commelinineae (C; 41/615)
      Commelinaceae (C; 40/605)

Cartonematoideae (C; 2/7)
Commelinoideae (C; 38/600)
  Mayacaceae (C; 1/10)
Eriocaulineae (C; 13/1175)
  Eriocaulaceae (C; 13/1175)
    Eriocauloideae (2/410)
    Syngonanthoideae (2/200)
    Paepalanthoideae (5/565)
Cyperales (C; 155/5620)
  Thurniaceae (C; 1/3)
  Juncaceae (C; 8/300)
  Cyperaceae (C; 146/5315)
    Mapanioideae (14/200)
    Cyperoideae (57/2750)
    Sclerioideae (70/365)
    Caricoideae (15/2000)
Poales (C; 800/10,450)
  Flagellariineae (C; 49/450)
    Flagellariaceae (excl. *Hangua-
      na*) (C; 1/4)
    Joinvilleaceae (C; 1/2)
    Restionaceae (C; 41/105)
      Restionoideae (40/400)
      Anarthrioideae (1/7)
    Ecdeiocoleaceae (2/2)
    Centrolepidaceae (C; 4/30–35)
  Poineae (C; 750/10,000)
    Poaceae (C; 750/10,000)
      Bambusoideae (incl. Ano-
        mochloeae, Arundinar-
        ieae, Ehrharteae, Olyreae,
        Parianeae, Streptochaet-
        eae) (94/?)
      Oryzoideae (incl. Oryzeae,
        Zizanieae) (8/?)
      Arundinoideae (incl. Aristid-
        eae, Arundineae, Cento-
        steceae, Micrairieae, Sti-
        peae, Thysanolaeneae)
        (65/?)
      Poiideae (incl. Agrostideae,
        Aveneae, Bromeae, Ly-
        geae, Nardeae, Triti-
        ceae) (161/?)
      Chloridoideae (incl. Eragros-
        tideae, *Muhlenbergia,
        Neyraudia,* Pappophor-
        ineae, *Triraphis*) (122/?)

Panicoideae (incl. Andropo-
goneae, *Eriachne*)
(237/?)

TAXA INCERTAE SEDIS

Aextoxicon Ruiz & Pav., Aextoxic-
aceae (1)—removed from Euphor-
biales.
Barbeya Schweinf., Barbeyaceae (1)—
removed from Urticales.
Brunonia Sm. ex R. Br., Brunoniaceae
(1)—removed from Goodeniaceae.
Carpodetus J. R. & G. Forst., Carpo-
detaceae (10)—removed from Es-
calloniaceae.
Corynocarpus Forster & Forster, Cor-
ynocarpaceae (5)—removed from
Cunoniales.

Haptanthus Goldberg & Nelson—re-
lationships still unknown.
Heteranthia Nesse et Mart. (1)—prob-
ably in or near Solanaceae.
Metteniusa Karst, Metteniusaceae
(6)—removed from Alangiaceae or
Icacinaceae, possibly related to lat-
ter.
Physena Nor. ex Thou., Physenaceae
(2)—removed from Capparaceae or
Passifloraceae.
Pteleocarpa Oliv. (1)—removed from
Ehretioideae of Boraginaceae.
Salvadoraceae (3/12)—removed from
Celastrales or Oleales.
Setchellanthus T. S. Brandegee (1)—
removed from Capparaceae.
Trichostephanus Gilg (1)—removed
from Flacourtiaceae.

LITERATURE CITED

Cantino, P. D. 1990. Evidence for a polyphyletic origin of the Labiatae. Suppl. Amer. J. Bot. 77(6):
110. (Abstr.)
Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia Univ. Press,
New York. 1262 p.
Dahlgren, G. 1989a. The last Dahlgrenogram: system of classification of the dicotyledons, pp. 249–
260. *In* K. Tan, R. R. Mill, and T. S. Elias [eds.], Plant taxonomy, phytogeography and related
subjects. Edinburgh Univ. Press, Edinburgh.
———. 1989b. An updated angiosperm classification. J. Linn. Soc., Bot. 100:197–203.
Dahlgren, R. T., H. T. Clifford, and P. F. Yeo. 1985. The families of the Monocotyledons: structure,
evolution, and taxonomy. Springer-Verlag, New York. 520 p.
Greuter, W., and other members of Editorial Committee [eds.]. 1988. International code of botanical
nomenclature. Adopted by the Fourteenth International Botanical Congress, Berlin, July–August
1987. Reg. Veg. 118:1–328.
Lindley, J. 1833. Nixus Plantarum. London. × + 44 p.
Mabberley, D. J. 1987. The plant book. A portable dictionary of the higher plants. Cambridge Univ.
Press, New York. xii + 706 p.
Melchior, H. [ed.] 1964. A. Engler's Syllabus der Pflanzenfamilien, II. Angiospermen. 12th ed. Gebr.
Borntraeger, Berlin. 666 p.

Raven, P. H., and D. I. Axelrod. 1972. Angiosperm biogeography and past continental movements. Ann. Missouri Bot. Gard. 61:539–673.

Shaw, H. K. Airy. 1985. A dictionary of the flowering plants and ferns by the late J. C. Willis. 8th (Student) Ed. Cambridge University Press, Cambridge. 1245 & lxvi p.

Takhtajan, A. L. 1986. Floristic regions of the world. Univ. Calif. Press, Berkeley. 522 p.

———. 1987. Systema Magnoliophytorum. Nauka, Leningrad. 439 p. (in Russian).

Thorne, R. F. 1958. Some guiding principles of angiosperm phylogeny. Brittonia 10:72–77.

———. 1963. Some problems and guiding principles of angiosperm phylogeny. Amer. Naturalist 97:287–305.

———. 1968. Synopsis of a putatively phylogenetic classification of the flowering plants. Aliso 6(4): 57–66.

———. 1973. Inclusion of the Apiaceae (Umbelliferae) in the Araliaceae. Notes Roy. Bot. Gard. Edinburgh 32:161–165.

———. 1973 [publ. 1974a]. The "Amentiferae" or Hamamelidae as an artificial group: a summary statement. Brittonia 25:395–405.

———. 1974b. Sapindales. Encycl. Brit. Ed. 15, 16:239–244.

———. 1974c. A phylogenetic classification of the Annoniflorae. Aliso 8:147–209.

———. 1975. Angiosperm phylogeny and geography. Ann. Missouri Bot. Gard. 62:362–367.

———. 1976. A phylogenetic classification of the Angiospermae. Evol. Biol. 9:35–106.

———. 1977. Some realignments in the Angiospermae. Pl. Syst. Evol. Suppl. 1:299–319.

———. 1978. Winteraceae, p. 28. In V. H. Heywood, D. M. Moore, I. B. K. Richardson, and W. T. Stearn [eds.], Flowering plants of the world. Mayflower Books, New York.

———. 1979. Parasites and phytophages—pragmatic chemists?, pp. 200–209. In I. Hedberg [ed.], Parasites as plant taxonomists. Proceedings of Symposium Held in Uppsala Aug. 25–27, 1978, in Commemoration of C. Linnaus, C. P. Thunberg, E. Fries. Sym. Bot. Upsal. 22 (4).

———. 1981. Phytochemistry and angiosperm phylogeny: a summary statement, pp. 233–295. In D. A. Young and D. S. Seigler (eds.), Phytochemistry and angiosperm phylogeny. Praeger Sci., New York.

———. 1983. Proposed new realignments in the angiosperms. Nord. J. Bot. 3:85–117.

———. 1985. Phylogenetic relationships of the monotypic family Simmondsiaceae. Jojoba Happenings 13(2):8.

———. 1989a. Phylogeny and phytogeography. Rhodora 91:10–24.

———. 1989b. 'Hamamelididae': a commentary, pp. 9–16, Vol. 1. In P. R. Crane and S. Blackmore [eds.], Evolution, systematics, and fossil history of the Hamamelidae. Systematics Assoc., Clarendon Press, Oxford.

———, L. DeBuhr, and R. Scogin. 1977. Glossopetalon A. Gray, a third genus in the Crossosomataceae (Rosineae, Rosales). Bot. Soc. Amer. Misc. Ser., Publ. 154:70. (Abstr.)

———, and R. Scogin. 1978. Forsellesia Greene (Glossopetalon A. Gray), a third genus in the Crossosomataceae, Rosineae, Rosales. Aliso 9:171–178.