

## Arthur Cronquist System of Classification of Flowering Plants

Arthur Cronquist was the Senior Curator of New York Botanic Garden and Adjunct Professor of Columbia University. He presented an elaborate interpretation of his concept of classification in "The Evolution and Classification of Flowering Plants" (1968). The further edition of his classification was published in "An Integrated System of Classification of Flowering Plants" (1981). The latest revision was published in the 2<sup>nd</sup> edition in 1988 in "The Evolution and Classification of Flowering Plants". He discussed a wide range of characteristics important to phylogenetic system. He also provided synoptic keys designed to bring the taxa in an appropriate alignment. He also represented his classification in charts to show the relationships of the orders within the various subclasses. His system is more or less parallel to Takhtajan's system but differs in details. He considered that the **Pteridosperms** i.e., the seed ferns as probable ancestors of angiosperm.

### Principles of Classification

1. The earliest angiosperms were shrubs rather than trees
2. The simple leaf is primitive than compound leaf.
3. Reticulate venation is primitive than parallel venation.
4. Paracytic stomata is primitive than the other types.
5. Slender, elongated, long tracheids with numerous scalariform pits are primitive. Further specialisation leads to shorter broad vessels with somewhat thinner walls and transverse end walls with few larger perforations. Later on, the perforation becomes single and large.
6. Long and slender sieve elements with very oblique end walls where the sieve areas scattered along the longitudinal wall with groups of minute pores are primitive. Whereas, the phloem with short sieve tube elements where end walls having a single transverse sieve plate with large openings is a derived condition.
7. The area and activity of cambium and also the length of fusiform initial is more in primitive form which gradually becomes reduced in advanced one.
8. Plants with vascular bundles arranged in a ring are primitive rather than scattered vascular bundle as found in monocots.
9. Plants with large and terminal flowers are primitive, those may arrange in monochusmor dichasia and the other type of inflorescences have been derived from these types.
10. Flowers with many large, free and spirally arranged petals: in any linear and spirally arranged stamens and free carpels as found in Magnoliaceae are primitive, and other types got evolved through gradual reduction, aggregation, elaboration and differentiation of floral members.
11. Plants with unisexual flowers are evolved from bisexual floral ancestors
12. The large and indefinite number of floral members are primitive than the small and definite numbers
13. Androecium with many stamens is primitive than the reduced numbers,

14. Linear stamens with embedded pollen sacs as found in some Magnolian genera are considered more primitive than the others.
15. Uniperforate pollen grains are considered as primitive and the triperforate type are derived from it.
16. Insect pollinated plants are considered as primitive from which wind pollinated plants got evolved
17. The gynoecium comprising of many carpels arranged spirally on a more or less elongated receptacle is considered as primitive. Further evolution leads to the reduction of the number of carpels which are arranged in a single whorl and then undergo further fusion.
18. Axial placentation is primitive from which other types have been evolved
19. Anisotropous ovule is primitive from which other types have been evolved.
20. Ovule with two integuments (bitegmic) is primitive and, either by fusion or abortion, unitegmic condition has been evolved.
21. Embryo-sac with 8-nuclei (Polygonum-type) is primitive from which embryo-sac with 4-nuclei (Oenothera-type) has been derived through reduction.
22. Monocotyledons have been developed from dicotyledons through abortion of one cotyledon.
23. The follicle (fruit) is considered as primitive. Further, dry and dehiscent fruit is more primitive than fleshy and indehiscent fruit.

According to him “many of the evolutionary trends bear little apparent relation to survival value and that there are some reversals”

In 1981 he divided the Division **Magnoliophyta** (Angiosperms) into two classes **Magnoliopsida/Magnoliatac** (Dicotyledons) and **Liliopsida/Liliatac** (Monocotyledons). He divided Magnoliopsida into 6 subclasses and 55 orders, of which Magnoliales is the primitive and Asterales is the advanced taxa. On the other hand, the class Liliopsida has been divided into 4 subclasses and 18 orders, of which Alismatales is the primitive and Orchidales is the advanced taxa. The class Magnoliopsida consists of 64 orders and 321 families and Liliopsida with 19 orders and 65 families.

### **The Evolution and Classification of Flowering Plants 1968 (monocots)**

#### **Class Liliatae (Monocotyledoneae)**

- Subclass Alismatidae 4 orders
  - Order Alismatales
  - ...
  - Order Triuridales
- Subclass Commelinidae 8 orders
  - Order Commelinales
  - ...
  - Order Zingiberales

- Subclass Arecidae 4 orders
  - Order Arecales
  - ...
  - Order Arales
- Subclass Liliidae 2 orders
  - Order Liliales
    - Family Philydraceae
    - Family Pontederiaceae
    - Family Liliaceae
    - Family Iridaceae
    - Family Agavaceae
    - Family Xanthorrhoeaceae
    - Family Velloziaceae
    - Family Haemodoraceae
    - Family Taccaceae
    - Family Cyanastraceae
    - Family Stemonaceae
    - Family Smilacaceae
    - Family Dioscoreaceae
  - Order Orchidales

## **An Integrated System of Classification of Flowering Plants 1981**

### **Class Magnoliopsida (dicotyledons)**

1. Subclass Magnoliidae (mostly basal dicots)
  1. Order Magnoliales
    1. Winteraceae
    2. Degeneriaceae
    3. Himantandraceae
    4. Eupomatiaceae
    5. Austrobaileyaceae
    6. Magnoliaceae (magnolia family)
    7. Lactoridaceae
    8. Annonaceae
    9. Myristicaceae
    10. Canellaceae
  2. Order Laurales
    1. Amborellaceae
    2. Trimeniaceae
    3. Monimiaceae
    4. Gomortegaceae
    5. Calycanthaceae

6. Idiospermaceae
7. Lauraceae (laurel family)
8. Hernandiaceae
3. Order Piperales
  1. Chloranthaceae
  2. Saururaceae
  3. Piperaceae (pepper family)
4. Order Aristolochiales
  1. Aristolochiaceae
5. Order Illiciales
  1. Illiciaceae
  2. Schisandraceae
6. Order Nymphaeales
  1. Nelumbonaceae (lotus family)
  2. Nymphaeaceae (waterlily family)
  3. Barclayaceae
  4. Cabombaceae
  5. Ceratophyllaceae
7. Order Ranunculales
  1. Ranunculaceae (buttercup family)
  2. Circaeasteraceae
  3. Berberidaceae
  4. Sargentodoxaceae
  5. Lardizabalaceae
  6. Menispermaceae
  7. Coriariaceae
  8. Sabiaceae
8. Order Papaverales
  1. Papaveraceae (poppy family)
  2. Fumariaceae
2. Subclass Hamamelidae [sic: correctly Hamamelididae]
  1. Order Trochodendrales
    1. Tetracentraceae
    2. Trochodendraceae
  2. Order Hamamelidales
    1. Cercidiphyllaceae
    2. Eupteleaceae
    3. Platanaceae
    4. Hamamelidaceae
    5. Myrothamnaceae
  3. Order Daphniphyllales
    1. Daphniphyllaceae
  4. Order Didymelales

1. Didymelaceae
5. Order Eucommiales
  1. Eucommiaceae
6. Order Urticales
  1. Barbeyaceae
  2. Ulmaceae
  3. Cannabaceae (cannabis family)
  4. Moraceae (mulberry family)
  5. Cecropiaceae
  6. Urticaceae
7. Order Leitneriales
  1. Leitneriaceae
8. Order Juglandales
  1. Rhoipteleaceae
  2. Juglandaceae
9. Order Myricales
  1. Myricaceae
10. Order Fagales
  1. Balanopaceae
  2. Ticodendraceae
  3. Fagaceae
  4. Nothofagaceae
  5. Betulaceae
11. Order Casuarinales
  1. Casuarinaceae
3. Subclass Caryophyllidae
  1. Order Caryophyllales
    1. Phytolaccaceae
    2. Achatocarpaceae
    3. Nyctaginaceae
    4. Aizoaceae
    5. Didiereaceae
    6. Cactaceae (cactus family)
    7. Chenopodiaceae
    8. Amaranthaceae
    9. Portulacaceae
    10. Basellaceae
    11. Molluginaceae
    12. Caryophyllaceae
  2. Order Polygonales
    1. Polygonaceae
  3. Order Plumbaginales
    1. Plumbaginaceae

4. Subclass Dilleniidae
  1. Order Dilleniales
    1. Dilleniaceae
    2. Paeoniaceae
  2. Order Theales
    1. Ochnaceae
    2. Sphaerosepalaceae
    3. Sarcolaenaceae
    4. Dipterocarpaceae
    5. Caryocaraceae
    6. Theaceae (tea family)
    7. Actinidiaceae (kiwi family)
    8. Scytropetalaceae
    9. Pentaphylacaceae
    10. Tetrameristaceae
    11. Pellicieraceae
    12. Oncothecaceae
    13. Marcgraviaceae
    14. Quiinaceae
    15. Elatinaceae
    16. Paracryphiaceae
    17. Medusagynaceae
    18. Clusiaceae
  3. Order Malvales
    1. Elaeocarpaceae
    2. Tiliaceae
    3. Sterculiaceae
    4. Bombacaceae
    5. Malvaceae (mallow family)
  4. Order Lecythidales
    1. Lecythidaceae
  5. Order Nepenthales
    1. Sarraceniaceae
    2. Nepenthaceae
    3. Droseraceae
  6. Order Violales
    1. Flacourtiaceae
    2. Peridiscaceae
    3. Bixaceae
    4. Cistaceae (rock rose family)
    5. Huaceae
    6. Lacistemataceae
    7. Scyphostegiaceae

8. Stachyuraceae
9. Violaceae (violet family)
10. Tamaricaceae (tamarix family)
11. Frankeniaceae
12. Dioncophyllaceae
13. Ancistrocladaceae
14. Turneraceae
15. Malesherbiaceae
16. Passifloraceae (passionflower family)
17. Achariaceae
18. Caricaceae (papaya family)
19. Fouquieriaceae
20. Hoplostigmataceae
21. Cucurbitaceae (squash family)
22. Datisceae
23. Begoniaceae
24. Loasaceae
7. Order Salicales
  1. Salicaceae
8. Order Capparales
  1. Tovariaceae
  2. Capparaceae
  3. Brassicaceae (mustard family)
  4. Moringaceae
  5. Resedaceae
9. Order Batales
  1. Gyrostemonaceae
  2. Bataceae
10. Order Ericales
  1. Cyrillaceae
  2. Clethraceae
  3. Grubbiaceae
  4. Empetraceae
  5. Epacridaceae
  6. Ericaceae
  7. Pyrolaceae
  8. Monotropaceae
11. Order Diapensiales
  1. Diapensiaceae
12. Order Ebenales
  1. Sapotaceae
  2. Ebenaceae
  3. Styracaceae

- 4. Lissocarpaceae
- 5. Symplocaceae
- 13. Order Primulales
  - 1. Theophrastaceae
  - 2. Myrsinaceae
  - 3. Primulaceae (primula family)
- 5. Subclass Rosidae
  - 1. Order Rosales
    - 1. Brunelliaceae
    - 2. Connaraceae
    - 3. Eucryphiaceae
    - 4. Cunoniaceae
    - 5. Davidsoniaceae
    - 6. Dialypetalanthaceae
    - 7. Pittosporaceae
    - 8. Byblidaceae
    - 9. Hydrangeaceae
    - 10. Columelliaceae
    - 11. Grossulariaceae
    - 12. Greyiaceae
    - 13. Bruniaceae
    - 14. Anisophylleaceae
    - 15. Alseuosmiaceae
    - 16. Crassulaceae
    - 17. Cephalotaceae
    - 18. Saxifragaceae
    - 19. Rosaceae (rose family)
    - 20. Neuradaceae
    - 21. Crossosomataceae
    - 22. Chrysobalanaceae
    - 23. Surianaceae
    - 24. Rhabdodendraceae
  - 2. Order Fabales
    - 1. Mimosaceae (mimosa family)
    - 2. Caesalpiniaceae
    - 3. Fabaceae (legume/pea family)
  - 3. Order Proteales
    - 1. Elaeagnaceae
    - 2. Proteaceae
  - 4. Order Podostemales
    - 1. Podostemaceae
  - 5. Order Haloragales
    - 1. Haloragaceae

2. Gunneraceae
6. Order Myrtales
  1. Sonneratiaceae
  2. Lythraceae
  3. Penaeaceae
  4. Crypteroniaceae
  5. Thymelaeaceae
  6. Trapaceae
  7. Myrtaceae (myrtle family)
  8. Punicaceae
  9. Onagraceae
  10. Oliniaceae
  11. Melastomataceae
  12. Combretaceae
  13. Alzateaceae
  14. Memecylaceae
  15. Rhyncocalycaceae
7. Order Rhizophorales
  1. Rhizophoraceae
8. Order Cornales
  1. Alangiaceae
  2. Nyssaceae
  3. Cornaceae
  4. Garryaceae
9. Order Santalales
  1. Medusandraceae
  2. Dipentodontaceae
  3. Olacaceae
  4. Opiliaceae
  5. Santalaceae
  6. Misodendraceae
  7. Loranthaceae
  8. Viscaceae
  9. Eremolepidaceae
  10. Balanophoraceae
10. Order Rafflesiales
  1. Hydnoraceae
  2. Mitrastemonaceae
  3. Rafflesiaceae (rafflesia family)
11. Order Celastrales
  1. Geissolomataceae
  2. Celastraceae
  3. Hippocrateaceae

4. Stackhousiaceae
5. Salvadoraceae
6. Aquifoliaceae
7. Icacinaceae
8. Aextoxicaceae
9. Cardiopteridaceae
10. Corynocarpaceae
11. Dichapetalaceae
12. Tepuianthaceae
12. Order Euphorbiales
  1. Buxaceae (box family)
  2. Simmondsiaceae
  3. Pandaceae
  4. Euphorbiaceae
13. Order Rhamnales
  1. Rhamnaceae
  2. Leeaceae
  3. Vitaceae (grape family)
14. Order Linales
  1. Erythroxylaceae
  2. Humiriaceae
  3. Ixonanthaceae
  4. Hugoniaceae
  5. Linaceae
15. Order Polygalales
  1. Malpighiaceae
  2. Vochysiaceae
  3. Trigoniaceae
  4. Tremandraceae
  5. Polygalaceae
  6. Xanthophyllaceae
  7. Krameriaceae
16. Order Sapindales
  1. Staphyleaceae
  2. Melianthaceae
  3. Bretschneideraceae
  4. Akaniaceae
  5. Sapindaceae
  6. Hippocastanaceae
  7. Aceraceae
  8. Burseraceae
  9. Anacardiaceae (cashew family)
  10. Julianiaceae

- 11. Simaroubaceae
- 12. Cneoraceae
- 13. Meliaceae
- 14. Rutaceae (citrus family)
- 15. Zygophyllaceae
- 17. Order Geraniales
  - 1. Oxalidaceae
  - 2. Geraniaceae
  - 3. Limnanthaceae
  - 4. Tropaeolaceae
  - 5. Balsaminaceae
- 18. Order Apiales
  - 1. Araliaceae
  - 2. Apiaceae (carrot family)
- 6. Subclass Asteridae
  - 1. Order Gentianales
    - 1. Loganiaceae
    - 2. Retziaceae
    - 3. Gentianaceae
    - 4. Saccifoliaceae
    - 5. Apocynaceae
    - 6. Asclepiadaceae
  - 2. Order Solanales
    - 1. Duceodendraceae
    - 2. Nolanaceae
    - 3. Solanaceae (nightshade/tomato family)
    - 4. Convolvulaceae
    - 5. Cuscutaceae
    - 6. Menyanthaceae
    - 7. Polemoniaceae
    - 8. Hydrophyllaceae
    - 9. Retziaceae
  - 3. Order Lamiales
    - 1. Lennoaceae
    - 2. Boraginaceae
    - 3. Verbenaceae
    - 4. Lamiaceae (mint family)
  - 4. Order Callitrichales
    - 1. Hippuridaceae
    - 2. Callitrichaceae
    - 3. Hydrostachyaceae
  - 5. Order Plantaginales
    - 1. Plantaginaceae

6. Order Scrophulariales
  1. Buddlejaceae
  2. Oleaceae (olive family)
  3. Scrophulariaceae
  4. Globulariaceae
  5. Myoporaceae
  6. Orobanchaceae
  7. Gesneriaceae
  8. Acanthaceae
  9. Pedaliaceae
  10. Bignoniaceae
  11. Mendonciaceae
  12. Lentibulariaceae
7. Order Campanulales
  1. Pentaphragmataceae
  2. Sphenocleaceae
  3. Campanulaceae (bell flower family)
  4. Stylidiaceae
  5. Donatiaceae
  6. Brunoniaceae
  7. Goodeniaceae
8. Order Rubiales
  1. Rubiaceae (coffee family)
  2. Theligonaceae
9. Order Dipsacales
  1. Caprifoliaceae
  2. Adoxaceae
  3. Valerianaceae
  4. Dipsacaceae
10. Order Calycerales
  1. Calyceraceae
11. Order Asterales
  1. Asteraceae (sunflower family)

### **Class Liliopsida (monocotyledons)**

1. Subclass Alismatidae
  1. Order Alismatales
    1. Butomaceae
    2. Limnocharitaceae
    3. Alismataceae
  2. Order Hydrocharitales

1. Hydrocharitaceae
3. Order Najadales
  1. Aponogetonaceae
  2. Scheuchzeriaceae
  3. Juncaginaceae
  4. Potamogetonaceae
  5. Ruppiaceae
  6. Najadaceae
  7. Zannichelliaceae
  8. Posidoniaceae
  9. Cymodoceaceae
  10. Zosteraceae
4. Order Triuridales
  1. Petrosaviaceae
  2. Triuridaceae
2. Subclass Arecidae
  1. Order Arecales
    1. Arecaceae (palm family)
  2. Order Cyclanthales
    1. Cyclanthaceae
  3. Order Pandanales
    1. Pandanaceae (pandan family)
  4. Order Arales
    1. Acoraceae
    2. Araceae
    3. Lemnaceae
3. Subclass Commelinidae
  1. Order Commelinales
    1. Rapateaceae
    2. Xyridaceae
    3. Mayacaceae
    4. Commelinaceae
  2. Order Eriocaulales
    1. Eriocaulaceae
  3. Order Restionales
    1. Flagellariaceae
    2. Joinvilleaceae
    3. Restionaceae
    4. Centrolepidaceae
  4. Order Juncales
    1. Juncaceae
    2. Thurniaceae
  5. Order Cyperales

1. Cyperaceae
2. Poaceae (grass family)
6. Order Hydatellales
  1. Hydatellaceae
7. Order Typhales
  1. Sparganiaceae
  2. Typhaceae
4. Subclass Zingiberidae
  1. Order Bromeliales
    1. Bromeliaceae
  2. Order Zingiberales
    1. Strelitziaceae
    2. Heliconiaceae
    3. Musaceae
    4. Lowiaceae
    5. Zingiberaceae (ginger family)
    6. Costaceae
    7. Cannaceae
    8. Marantaceae
5. Subclass Liliidae
  1. Order Liliales
    1. Philydraceae
    2. Pontederiaceae
    3. Haemodoraceae
    4. Cyanastraceae
    5. Liliaceae (lily family)
    6. Iridaceae (iris family)
    7. Velloziaceae
    8. Aloeaceae (aloe family)
    9. Agavaceae
    10. Xanthorrhoeaceae
    11. Hanguanaceae
    12. Taccaceae
    13. Stemonaceae
    14. Smilacaceae
    15. Dioscoreaceae
  2. Order Orchidales
    1. Geosiridaceae
    2. Burmanniaceae
    3. Corsiaceae
    4. Orchidaceae (orchid family)

## Merits and Demerits

### Merits

- There is general agreement of Cronquist's system with that of other contemporary systems like Takhtajan, Dahlgren and Thorne.
- Detailed information on anatomy, ultra structure phytochemistry and chromosome morphology was presented in the revision of the classification in 1981 and 1988
- The system is highly phylogenetic.
- Nomenclature is in accordance with the ICBN.
- The family Asteraceae in Dicotyledons and Orchidaceae in Monocotyledons are generally regarded as advanced and are rightly placed towards the end of respective groups.
- The relationships of different groups have been described with diagrams which provide valuable information on relative advancement and size of the various subclasses,
- The family Winteraceae (vessel-less wood present similar to Pteridosperms) placed at the beginning of dicotyledons is favoured by many authors.
- The subclass Magnoliidae is considered as the most primitive group of Dicotyledons. The placement of Dicotyledons before Monocotyledons finds general agreements with modern authors
- As the text is in English, the system has been readily adopted in different books.

### Demerits:

1. Though highly phylogenetic and popular in U.S.A., this system is not very useful for identification and adoption in Herbaria since Indented keys for genera are not provided.
2. Dahlgren (1983, 89) and Thorne (1980, 83) treated angiosperms in the rank of a class and not that of a division
3. Superorder as a rank above order has not been recognised here, though it is present in other contemporary classifications like Takhtajan, Thorne and Dahlgren
4. The subclass Asteridae represents a loose assemblage of several diverse sympetalous families.
5. Ehrendorfer (1983) pointed out that the subclass Hamamelidae does not represent an ancient side branch of the subclass Magnoliidae, but is remnant of a transition from Magnoliidae to Dilleniidae, Rosidae, and Asteridae.
6. There is a difference in opinion with other authors regarding the systematic position of some orders like Typhales, Arales, Urticales etc.