VIVEKANANDA COLLEGE

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TAXONOMY OF ANGIOSPERM

The science of taxonomy or classification, consists of classifying, identifying and assigning living things to groups based on their similarities in anatomical structures. Scientists use scientific names to signify into what groups living things belong. The extant angiosperms (flowering plants), are one of the major groups of all seed plants, with at least 260,000 living species classified in 453 families (Judd et al., 2002; APG II, 2003; Soltis et al., 2005).

Classification shows evolutionary relationships. Prevents duplicate names because all names must be approved by International Naming Congresses. Naming rules are followed called the International Code for Binomial Nomenclature(ICBN).

Classification of plants is a necessity to study the number of plants available in the world.

Objectives of Classification: Following are the objectives of classification:

1. First objective is to name all the plants of the world and fix their specificity to their habit, habitat, distribution, characters etc.

2. Second objective is to arrange them according to their characters in their particular place in the classification.

3. Name the plant according to the International Code of Botanical Nomenclature in which it should have two epithets, the first in the generic name and the second is the specific name.

Many systems of classification of angiosperms have been proposed by many taxonomists from time to time.

It can be divided into three broad categories:

i. Artificial Systems based on superficial features.

ii. Natural systems based on form relationships.

iii. Phylogenetic systems based on evolutionary and genetic relationships.

[I] Artificial systems:

These systems of classification were based on one or few morphological characters.Carolus Linnaeus (1707—1778) gave the Sexual system of classification. He was a physician. First he published some plants in Hortus uplandicus.

Thus his most popular classification based on stamen, type, absence or presence etc. was published in Species plantarum in 1753. He diagnosed nearly 6000 species of 1000 genera.

He used binomial nomenclature of plants in the 23 volumes of Species plantarum. In Philosophia Botanica (1751), Linneaus enumerated67 "natural orders" such as Palms, Orchids, grasses, conifers, borages, composites etc. But there is a mixing of dicots and monocots in these natural orders.

Classification Proposed By Linneaus:

Linneaus divided plant kingdom into 24 Klasses:

1. Monandria (One stamen),

2. Diandria (Two stamen),

3. Triandria (Three stamen),

4. Tetandria (Four stamen),

5. Pentandria (Five stamen),

6. Hexandria (Six stamen),

7. Heptandria (Seven stamen),

8. Octandria (Eight stamen),

9. Enneandria (Nine stamen),

10. Decandria (Ten stamen),

11. Dodecandria (Twelve stamen),

12. Icosandria (Twenty stamen),

13. Polyandria (Many free stamen),

14. Didynamia (Didynamous),

15. Tetradynamia (Tetradynamous),

16. Monadelphia (One bundle),

17. Diadelphia (Two bundle),

18. Polyadelphia (Many bundles),

19. Syngenesia (Anther fused, filament free),

20. Gynandria (Stamen adnate to pistil),

21. Monoecia (Unisexual flowers on one plant),

22. Dioecia (Unisexual flowers on two different plants),

23. Polygamia (Flower Polygamous), and

24. Cryptogamia (Flowerless).

The merits and demerits of the Linnaeus system are:

Merits and Demerits:

Merit:

The only merit of this system is the quick and easy identification of plants based on one or a few characteristics.

Demerits:

1. The system is not at all sexual in proper sense, but based only on numerical relationship of sex organs. Thus, it can be said that this system was developed on differences rather than on similarities of sex organs.

2. The closely related members go apart and the distantly related members become very close to each other for the numerical relation of the sex organs.

3. The Gymnosperms were placed in the 14th class Didynamia along with Labiatae, an angiosperm family.

4. The Monocotyledons, Dicotyledons and Gymnosperms i.e., phanerogamic plants are not considered separately. Thus, the members of Dicotyledons and Monocotyledons become very close, e.g.,

i. In the 1st class Monandria (flower having 1 stamen) – Globba (Zingiberaceae of Monocotyledons) and Mangifera (Anacardiaceae of Dicotyledons).

ii. In the 6th class Hexandria (flowers having 6 stamens) -Alisma (Alismaceae of Monocotyledons) and Rumex (Polygonaceae of Dicotyledons) come very close. Many other examples are also available.

5. Thus it can be said that this classification is just like a dictionary where the words are arranged alphabetically without maintaining any relationship.

II. Natural Systems:

In these systems the organisms are classified on the basis of their natural affinities (i.e. the basic similarities in the morphology) rather than on a single character for determining the affinities.

Bentham and Hooker's Classification:

The most important and well accepted natural systems of classification of seed plants was proposed by two British taxonomists George Bentham (1800-1884), a self trained botanist, and Joseph Dalton Hooker (1817-1911), the first director of the Royal Botanical Garden, Kew (England).

They recorded precise description of most of the plants known at that time. Their monumental work which took about quarter of a century for completion was described in three volumes of Genera Plantarum, published in Latin during July 1862 and April 1883. Bentham and Hooker's system of classification is still used and followed in several herbaria of the world. It is supposed to be the best system for the students to identify plants in the laboratory.

Salient Features of Bentham and Hooker's system:

1. It is a classification of only the "seed plants" or phanerogams.

2. They described 97,205 species of seed plants belonging to 7,569 genera of202 families starting from Ranunculaceae up to Gramineae.

3. They classified all the seed plants into 3 groups or classes i.e. Dicotyledons (165 families), gymnosperms (3 families) and monocotyledons (34 families).

4. They included disputed orders among Ordines Anomali which they could not place satisfactorily.

5. Monocotyledons were described after the dicotyledones.

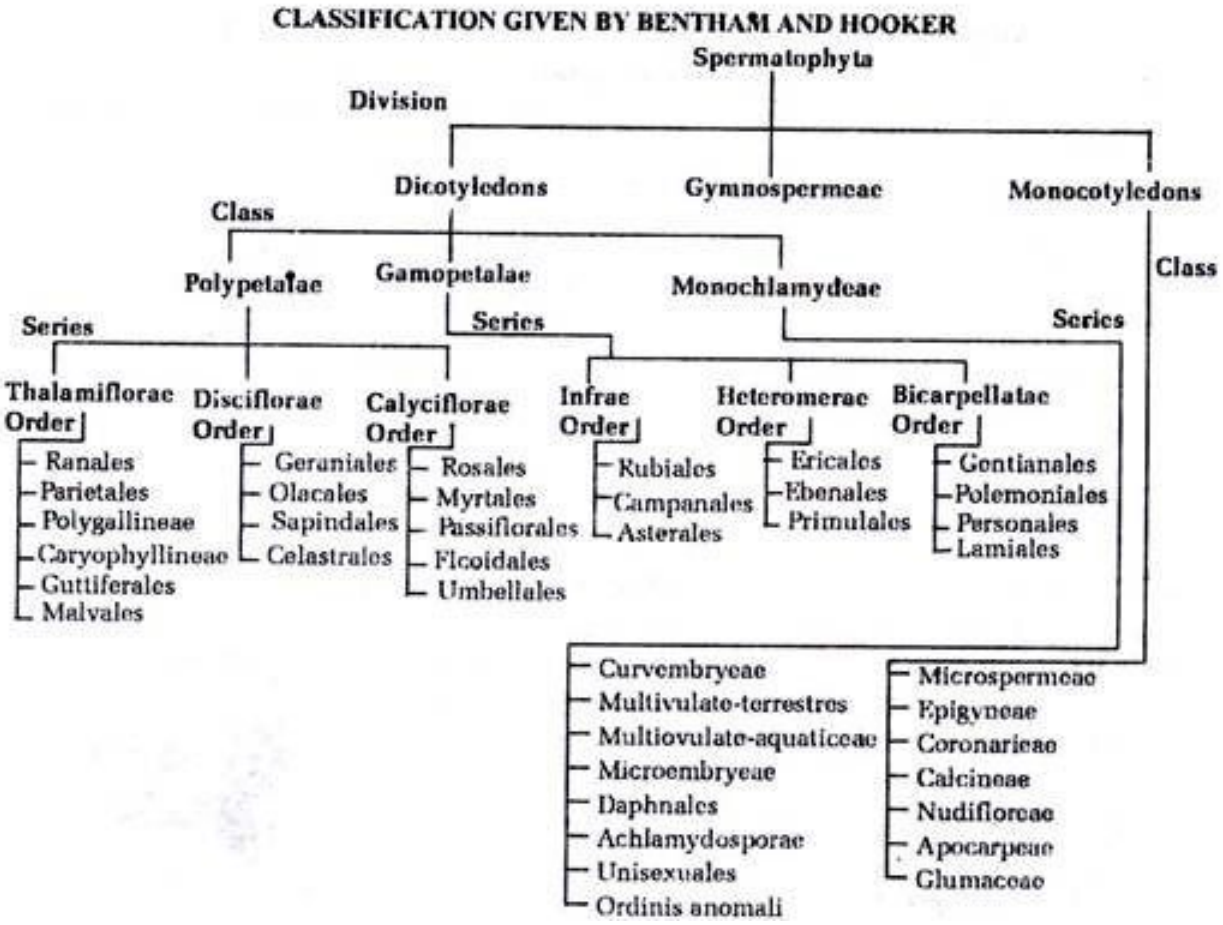
6. The dicotyledons were divided into 3 Divisions (Polypetalae, Gamopetalae and Monochlamydeae) and 14 series. Each series again divided into cohorts (modern orders) and cohorts into orders (modern families).

7. The authors did not mention anything about the origin of the angiosperms.

8. Creation of the Disciflorae, a taxon not described by the earlier taxonomists.

9. Among the Monochlamydeae, major taxa, like the series, were divided on the basis of terrestrial and aquatic habits.

10. Polypetalae carries 82 families, 2610 genera & 31,874 species. Gamopetalae carries 45 families, 2619 genera & 34,556 species. Monochlamydeae includes 36 families, 801 genera & 11,784 species. Similarly Monocotyledons consist of 34 families, 1495 genera and 18,576 species.



Merits of Bentham and Hooker's System:

1. Each plant has been described either from the actual specimen or preserved herbarium sheets so that the descriptions are detailed as well as quite accurate.

2. The system is highly practical and is useful to students of systematic botany for easy identification of species.

3. The flora describes geographical distribution of species and genera.

4. The generic descriptions are complete, accurate and based on direct observations.

5. Larger genera have been divided into sub genera, each with a specific number of species.

6. Dicots begin with the order Ranales which are now universally considered to be the most primitive angiosperms.

7. Placing of monocots after the dicot is again a natural one and according to evolutionary trends.

8. The placing of series disciflorae in between thalami florae and calyciflorae is quite natural.

9. The placing of gamopetalae after polypetalae is justified since union of petals is considered to be an advanced feature over the free condition.

Demerits of Bentham and Hooker's System:

1. Keeping gymnosperms in between dicots and monocots is anomalous.

2. Subclass monochlamydeae is quite artificial.

3. Placing of monochlamydeae after gamopetalae does not seem to be natural.

4. Some of the closely related species are placed distantly while distant species are placed close to each other.

5. Certain families of monochlamydeae are closely related to families in polypetalae, e.g. Chenopodiaceae and Caryophyllaceae.

6. Advanced families, such as Orchidaceae have been considered primitive in this system by placing them in the beginning. Placing Orchidaceae in the beginning of monocotyledons is unnatural as it is one of the most advanced families of monocots. Similarly, Compositae (Asteraceae) has been placed near the beginning of gamopetalae which is quite unnatural.

7. Liliaceae and Amaryllidaceae were kept apart merely on the basis of characters of ovary though they are very closely related.

8. There were no phylogenetic considerations.

III. Phylogenetic Systems:

Classification based on evolutionary features, as well as genetic relationships among different groups of plants is known as a phylogenetic system . In addition to this, it employs as many taxonomic characters as possible

Arthur Cronquist's System of Classification:

Classification is based on evidence from Morphology, Anatomy, Embryology, Palynology, Serology, Phytochemistry, Cytology etc.

Important Features of Classification:

1. Traditional nomenclature of angiosperm, dicots and monocots is replaced as has been done by Takhtajan.

2. Synthetic system of classification took help from other fields of botany to deduce his interpretation.

3. Key for each group upto family is useful.

4. System appears more natural.

5. Evolution relationship amongst the subclasses of dicots has shown in the form of balloons. The size of the balloon is proportional to member of species in each group (Fig. 5).

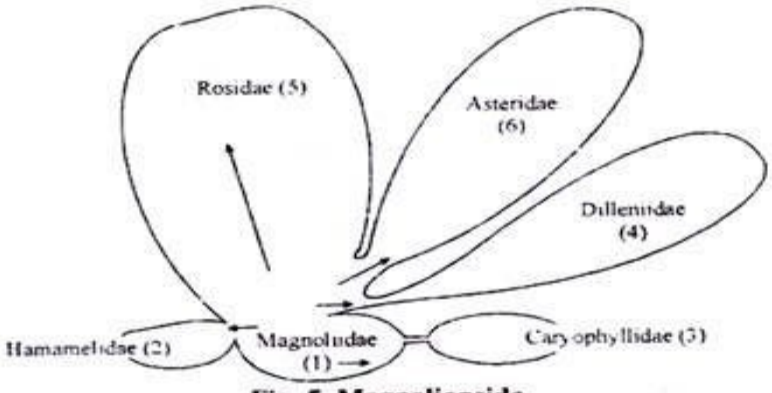


Fig. 5. Magnoliopsida

Cronquist divided Angiosperms Magnoliophyte into 2 classes Magnoliopsida and Liliopsida. Classes are divided into subclass, orders and families. No super orders are formed. Magnoliopsida is divided into 6 subclasses and Liliopsida is divided into 5 subclasses.

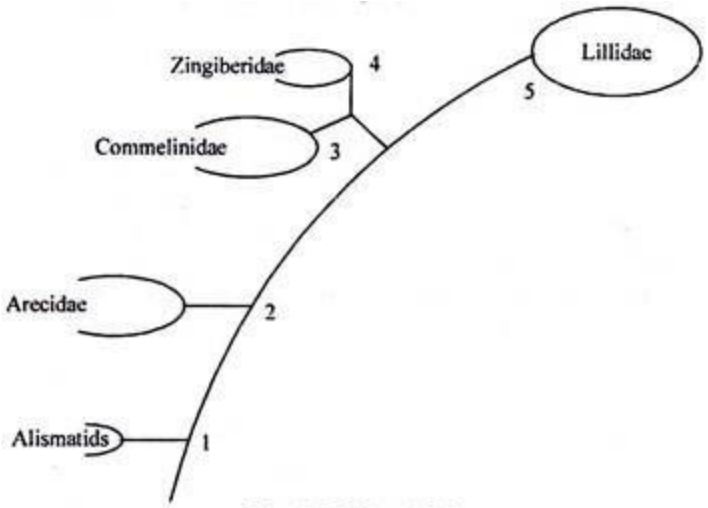


Fig. 6. (Liliopride)

Merits of Cronquist's Classification:

1. It is a phylogenetic classification.

2. He compared all the previous classification and discussed their merits and demerits and proposed a new classification.

3. He considered morphology, anatomy, embryology, palynology, serology, cytology, and phytochemistry in his classification.

4. Key for each group upto families is useful.

Demerits of Cronquist's Classification:

1. Arrangement of some families in Liliales is criticized.

2. Submergence of Amaryllidaceae into Liliaceae is not satisfactory.

3. It shows too much reliance on single character, e.g., free central placentation and centrifugal stamen etc. many times which is not accepted.

4. Traditional nomenclature is replaced.

Differences between Magnoliopsida and Liliopsida:

Magnoliopsida:

1. Dicots,

2. Reticulate Venation,

3. Roots primary and adventitious,

4. Vascular Cambium present,

5. Vascular bundles arranged in a ring in stem,

6. Flower Tetra or Pentamerous, and

7. Pollen grains of various types.

Liliopsida:

1. Monocots,

2. Parallel venation,

3. Roots only adventitious,

4. Vascular Cambium absent,

5. Scattered Vascular Bundles in stem,

6. Flowers usually Trimerous, and

7. Pollen grains mainly monosulcate types.

Important Characters of Different Subclasses

Magnoliopsida

Subclass 1 Magnoliidae: It includes 8 orders, 39 families. The families show primitive characters. Plants generally are woody (shrubs or arborescent). Leaves evergreen, stipulate or exstipulate simple, alternate.

Flowers solitary, actinomorphic, polymerous, floral axis elongated. Calyx and Corolla are not much distinct, i.e., generally perianth. Numerous stamens with laminar to terete filament. Numerous carpels, apocarpous. Fruits generally follicle entomophilous.

The orders start from Magnoliales to Papaverales (herbaceous, syncarpous plants).

Subclass 2. Hamamelidae:

It includes 11 orders and 24 families. Typically plants are woody except order Urticales. Flowers are unisexual (imperfect); perianth apetalous (absent) or reduced, inflorescence with numerous reduced apetalous flowers arranged in catkin or ament. The group is named Amentiferae.

Primitive order is Trochodendrales and advance is Casurinales (multiple fruiting structures).

Subclass 3. Caryophyllidae:

It includes 3 orders, 14 families. Caryophyllales in the largest order. The plants in this order lack anthocyanin instead possess Betalins (Betacyanin

and Betaxanthin). Betalains are otherwise found in fungi only. Perianth is uniseriate. Placentation is either basal or free central.

The older name of the group is Centrospermae as the ovules are present around the placenta in the centre of the ovary. In most of the caryophyllales perisperm is present which is derived from sporophytic tissue (2N) instead of endosperm. Embryo takes a peripheral position in the seed and produced a beak (protrusion of radial)

The families start from Phytolaccaceae to Caryophyllaceae come under the order caryophyllales.

The 3 orders are Caryophyllales, Polygonales and Plumbaginales.

Subclass 4. Dilleniidae:

This subclass includes 13 orders and 78 families. The plants show diverse characters. All the plants have syncarpous flowers except Dilleniales where flowers are apocarpous. Generally parietal, free central axile or basal placentation and Gamopetalous flowers.

Rarely they are poly or apetalous flowers. Lack of connection in gynoecium, e.g., Paeonia-Paeoniaceae order Dilleniales. Dilleniales from a link between Dilleniidae and Magnoliidae. It starts form Dilleniales order and ends in Primulates. Dilleniidae is divided into Pinnate Dilleniales and Palmate Dilleniada.

Subclass 5. Rosidae:

It includes 18 orders 114 families. It is the largest subclass. It includes flowers with diverse characters. Generally the leaves are pinnately

compound, polypetalous, very rarely gamopetalous, nectary disks are present, Gynoecium generally syncarpous, Apocarpous in Fabales and Proteales, and apocarpous- syncarpous in Resales. Placentation marginal, Basal or Axial. Orders start from Rosales to Apiales.

Flowers hypogynous → Perigynous → Epigynous, Polypetalous or basally connate or reduced, nectarias often staminodal in origin, frequently from intra or extra staminal disc.

Stamen initiate in centripetal sequence (except Punicaceae), Gynoecium apocarpous in monocarpellary condition as in Fabales, Proteals etc. Many Rosales have syncarpous gynoecium with ovary superior semi inferior → inferior condition. Placentation varies but the majority is in the axile less commonly parietal or basal.

Subclass 6. Asteridae:

Subclass includes 11 orders and 49 families. One third of the total plants belong to Asteraceae. Flowering actinomorphic or zygomorphic hypogynous- epigynous……. gamopetalous; Gynoecium 2-5 carpels syncarpous, usually are nectariferous disc is style terminal or gynobasic with basal to axial placentation and stamens epipetalous.

Asteridae is considered to be the most advanced dicotyledonous plant. Some of the orders included in it are hypogynous to the Advanced Asteraceae as epigynous. The order starts from Gentianales to Asterals.

Liliopsida:

Subclass 1 Alismatidae:

Subclass Alismatidae includes 4 orders and 16 families. It is considered to be the smallest subclass of Magnoliophyta. Gynoecium 1-α and apocarpous. It may be 2-3 carpels fused below forming pseudomonomerous unilocular. Generally aquatic plants except Triuridales. Orders start from Alismatales to Triuridales. Subclass is considered to be nearer to Magnoliidae through Nymphaeales.

Subclass 2. Arecidae:

It includes 4 orders and 5 families. Flowers small often crowed in spadix, hypogynous, ovary sunken in axis. It includes smallest flowering plants (Lemnaceae) in Arales and the largest monocots (Arecaceae) in Arecales. Largest Angiospemic seed is *Lodoicea maldivic*a belongs to Arecaceae. The largest leaves of *Raphia regalis* are also considered in Arecaceae. The order starts from Arecales to Arales.

Subclass 3. Commelinidae:

It includes 7 orders and 16 families. Flowers bi or unisexual hypogynous nectaries rarely present pollination by wind, Trimerous apomicts. It includes the largest monocot family, the grasses Poaceae. The family is economically as well as ecologically very important. Flowers entomophilous to anemophilous. The orders follow a phyletic pattern. The orders start from Commelinales, to the Typhals.

Subclass 4. Zingiberidae:

The subclass includes 2 orders and 9 families. The two orders are Bromeliales and Zingiberales. Bromeliales show diverse characters. Bromeliales is a monotypic order including epiphytes. Flowers are actinomorphic trimerous hypo or epigynous and hexandrous. In Zingiberales plants are mesophytes with zygomorphic, 6 stamens but 1-5 stamens are functional in flowers. Sometimes flowers are functionally unisexual. They are Bird or Bat pollinated.

Subclass 5. Liliidae:

The last subclass includes 2 orders and 19 families. Flowers are very large and showy; generally petaloid sepals. The orders are Liliales and Orchidales. Liliales include actinomorphic flowers with superior or inferior ovary. Orchidales are characterized by mycotrophic plants, epiphytes, flowers, zygomorphic with inferior ovaries, numerous seeds, anemophilous pollination and non-endospermic embryos.