Syllabus: 2020-2021

Unit – I

Scope and importance of Taxonomy.

Classification of Angiosperms-

Bentham and Hooker system & Cronquist.

Flora, revision and Monographs.

Botanical nomenclature (ICBN),

Taxonomic hierarchy, typification,

principles of priority, publication,

Keys and their types,

Preparation and role of Herbarium.

Importance of Botanical gardens.

PLANT KINGDOM

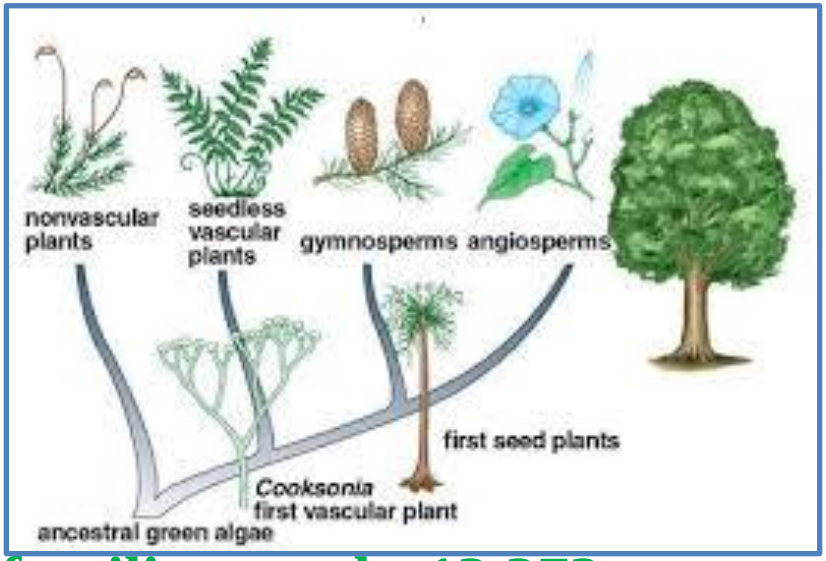
Amongst plants nearly

15,000 species belong to Mosses and Liverworts,

12,700 Ferns and their allies,

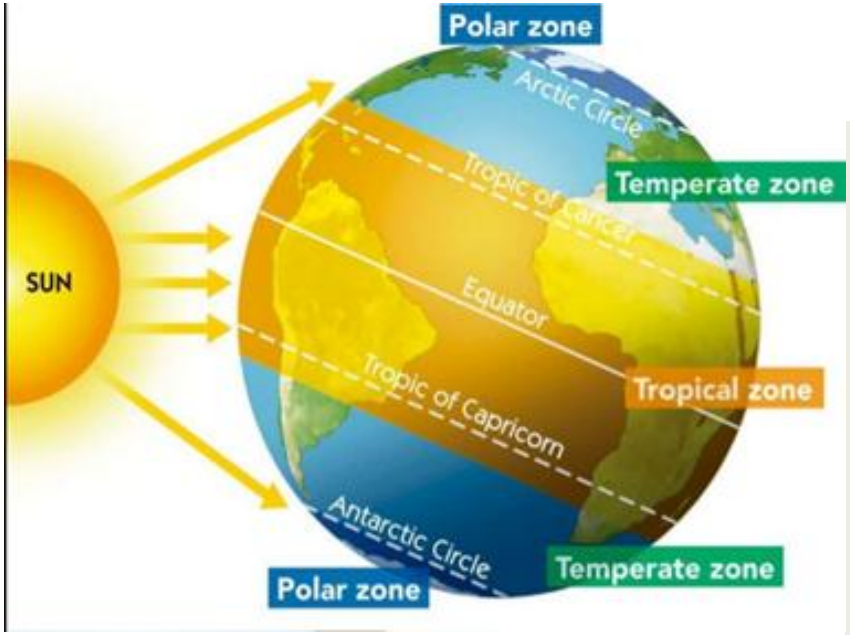
1,079 Gymnosperms and

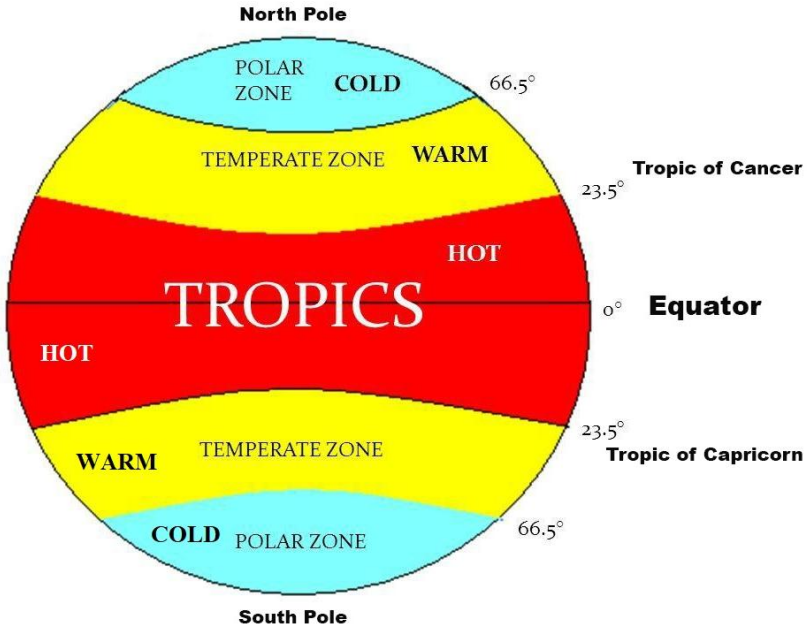
295,383 Angiosperms



(belonging to about 485 families and 13,372 genera), considered to be the most recent and vigorous group of plants that have occurred on earth.

Angiosperms occupy the majority of the terrestrial space on earth, and are the major components of the world's vegetation.





Brazil (First) and Colombia (second), both located in the tropics considered to be countries with the most diverse angiosperms floras

China (Third) even though the main part of her land is not located in the tropics, the number of angiosperms still occupies the third place in the world.

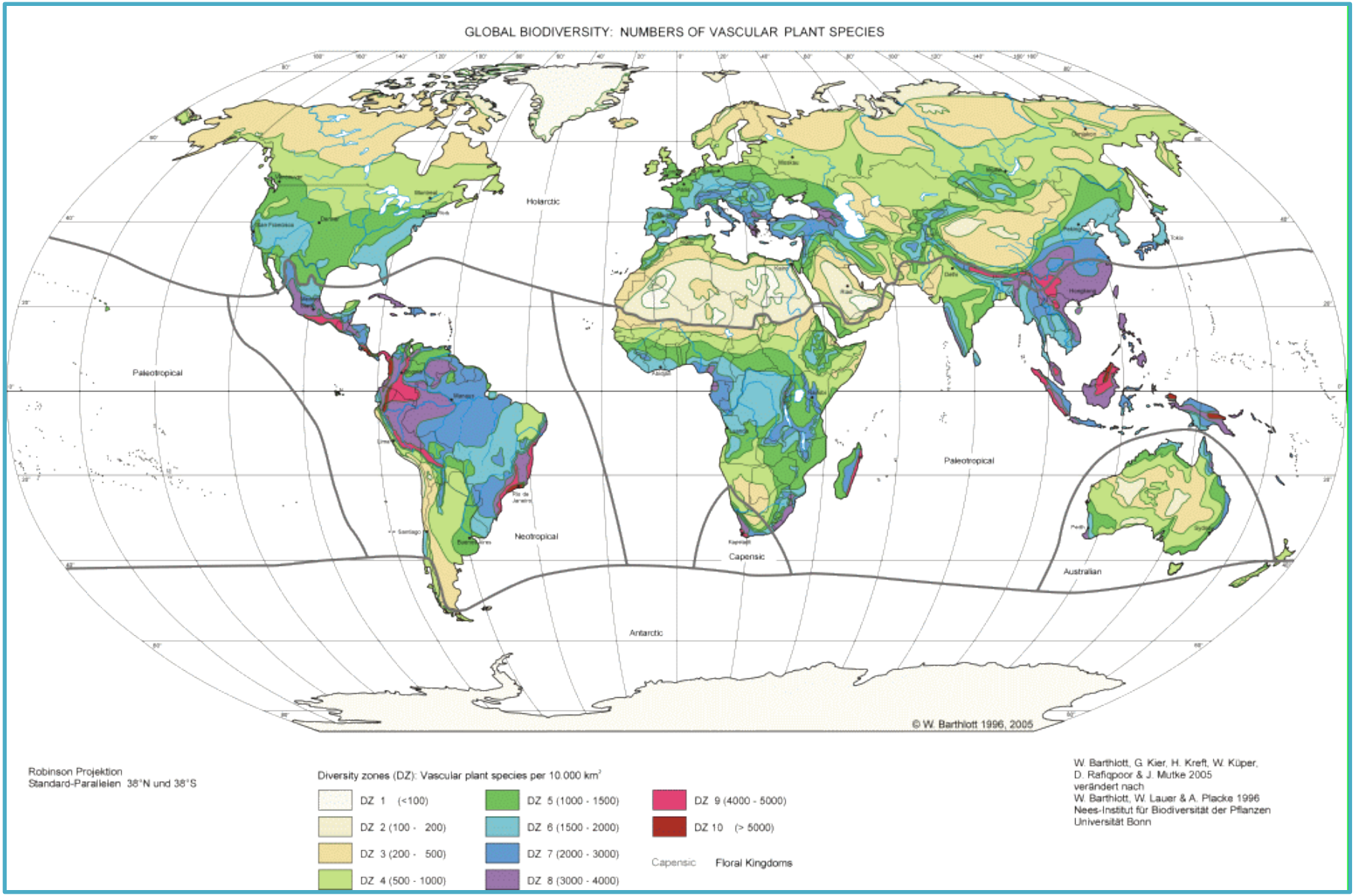
In INDIA there are about 18042 species of flowering plants approximately 320 families, 40 genera and 30,000 species.

TABLE: TOTAL NUMBER OF PLANT SPECIES (INCLUDING VIRUS, BACTERIA, ALGAE, FUNGI AND LICHENS) AND THEIR STATUS IN INDIA

Sl. No.	Type	Number of known Species		Percentage of Occurrence in India	Number of Endemic Species in India	Number of Threatened Species in India (EX, EW, CR, EN, VU)
		World	India			
I	**Flowering Plants**					
1.	Gymnosperms	1021	82	8.03%	12	**12** (CR-1; EN-5; VU-6)
2.	Angiosperms	2,68,600	18,666	6.95%	4,303	**416** (Ex-6; EW-2; CR-80; EN-179; VU-149)
III	**Non-flowering Plants**					
1.	Bryophytes	16,236	2,780	17.12%	629	**7** (CR-1; EN-4; VU-2)
2.	Pteridophytes	12,000	1,302	10.85%	66	**2** (EN-2)
III	**Others**					
1.	Virus and Bacteria	11,813	1,223	10.35 %	Not known	Not known
2.	Algae	40,000	7,411	18.53%	1,924	Not known
3.	Fungi	98,998	15,396	15.55%	c. 4,100	**1** (EN-1)
4.	Lichen	17,000	2,581	15.18%	c. 520	Not known
Total		**4,65,688**	**49,441**	–	–	–

IUCN Red list Categories: EX –Extinct; EW- Extinct in the Wild-Threatened; CR -Critically Endangered; VU- Vulnerable

Angiosperm (Flowering Plants)
SPECIES RICHNESS AROUND THE WORLD



PLANT CLASSIFICATION

Theophrastus's (372–287 BC)-FATHER OF BOTANY

Historia Plantarum **- the earliest surviving treatise on plants in which Theophrastus listed the names of over 500 plant species.**

Artificial system of Classification

Theophrastus attempted common groupings of folklore combined with growth form such as (Tree Shrub; Undershrub); or Herb. Or (Annual and Biennials plants) or (Cyme and Raceme inflorescences) or (Archichlamydeae and Meta chlamydeae) or (Upper or Lower ovarian).

TAXONOMY AND SYSTEMATICS

Taxonomy was recognized as a formal subject only in 1813 by A. P. de Candolle as a combination of Greek words *taxis* (arrangement) and *nomos* (rules or laws) in his famous work *Theorie elementaire de la botanique*.

A. P. de Candolle is called Father of taxonomy

For a long time plant taxonomy was considered as *'the science of identifying, naming, and classifying plants'*

Since identification and nomenclature are important prerequisites for any Classification, taxonomy is often defined as the 'science dealing with the study of classification, including its bases, principles, rules and procedures'

Plant Systematics was recognized as a formal major field of study only during the latter half of twentieth century.

Derived from the Latin word *systema* meaning (organized whole), forming the title of the famous work of Carl Linnaeus *Systema naturae* (1735).
The term Systematics first appeared in his *Genera Plantarum* (1737).

Simpson (1961) defined systematics as a 'scientific study of the kinds and diversity of organisms, and of any and all relationships between them'.

Many systems of classification of angiosperms (Flowering Plants) have been proposed by many taxonomists from time to time.

It can be divided into three broad categories:

i. Artificial System based on superficial features.
This systems of classification was based on one or few morphological characters.
ii. Natural system based on morphological characters.
In these systems the plants 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.
iii. Phylogenetic systems based on evolutionary and genetic relationships.
Classification based on evolutionary features is known as phylogenetic system.

OBJECTIVES OF TAXONOMY

- To build a global inventory the Flora
- To provide a method for identification and communication
- To produce a coherent and universal system of classification
- To demonstrate the evolutionary implications of plant diversity
- To provide single Latin “Scientific name” for every group of plants in the world, both living and extinct.
- To arrange plants in such a way as to give us an idea about the sequence of their evolution from simpler, earlier and more primitive type to more complexes, more recent, more advanced type in different periods of history

SCOPE OF PLANT TAXONOMY

Establishing the Phylogenetic relationship that exists in naturally occurring groups of plants

Using nomenclature principles and rules all plants are named.

It has a great value in Forestry because all forest trees have been named and classified.

It has wide importance in Agriculture, Horticulture, etc

To study ecology, the knowledge of taxonomy / systematic botany became essential, plant ecologist must be aware of the names of plants and their relationship to habitat and environment.

- Various classifications are available now
- Each one refining the preexisting one incorporating latest scientific evidences generated through modern tools and techniques
- Also more branches of sciences such as Anatomy, Embryology, Cytology, Biochemistry, Genomics, Proteomics etc….

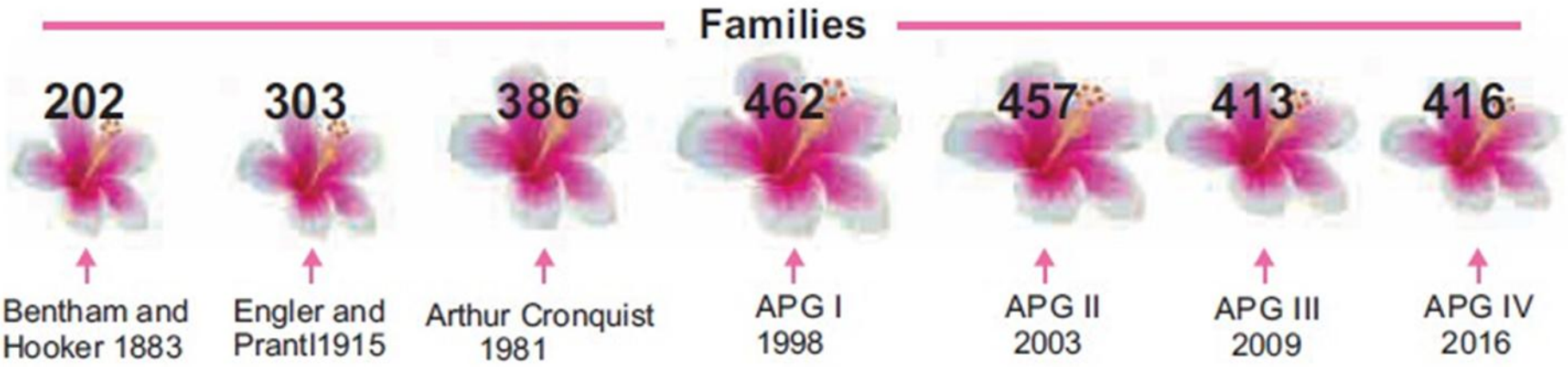
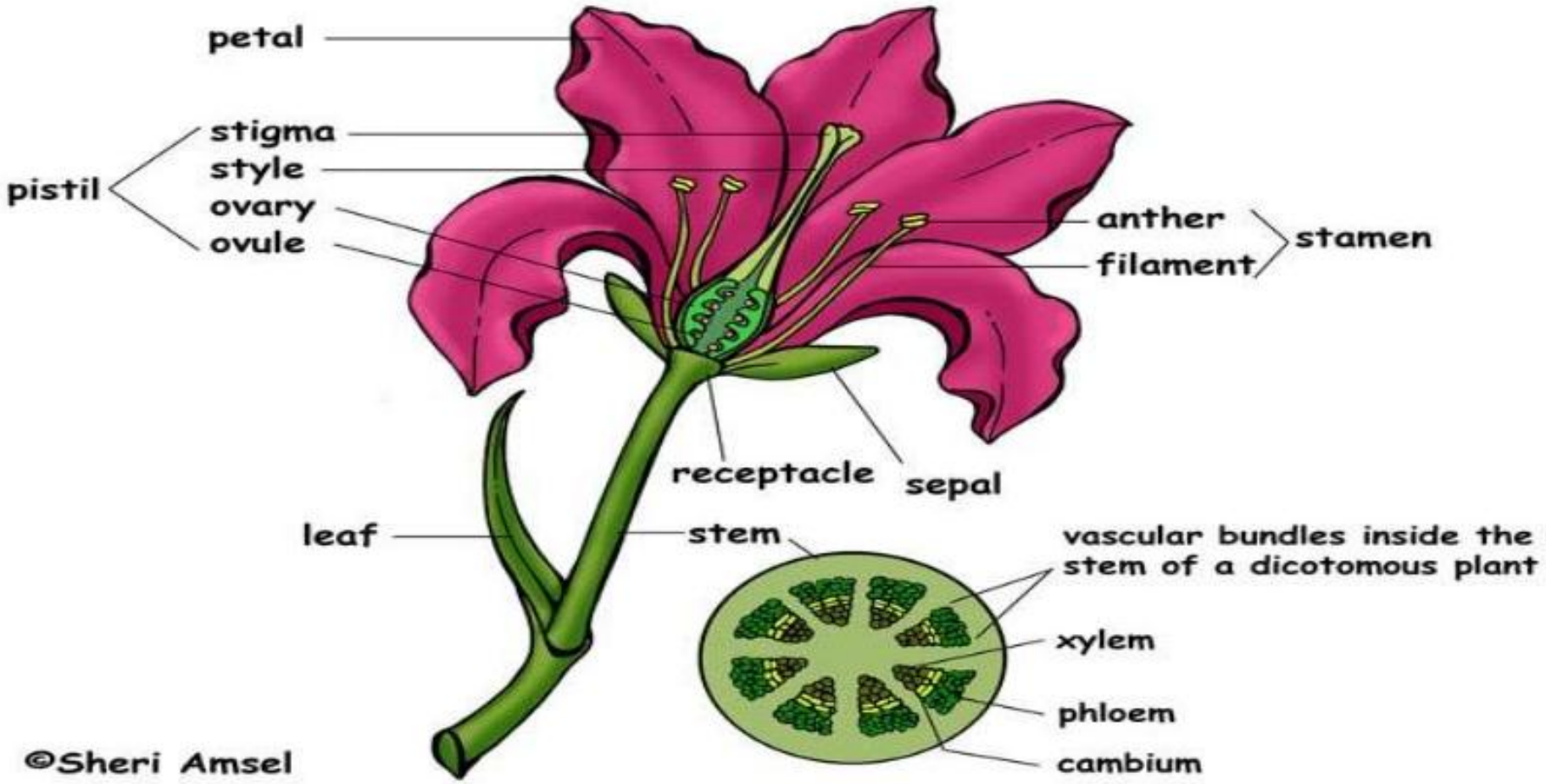


Figure 5.12: A timeline showing the history of classifying flowering plants into families.
(Source: Royal Botanic Gardens Kew State of World's Plant 2017)

The Parts of the Flower



BENTHAM AND HOOKER'S SYSTEM OF CLASSIFICATION

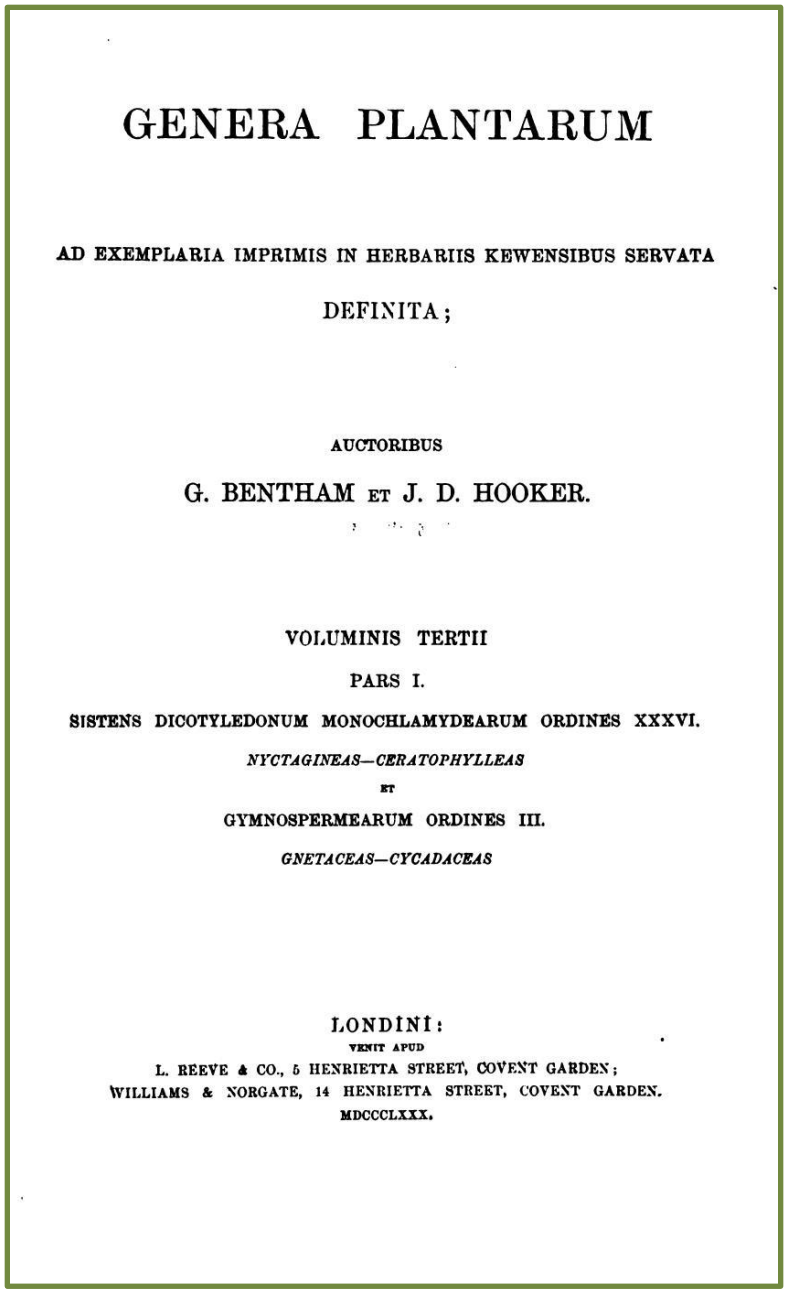
- This is the best known natural system of classification of Flowering Plants
- Put forwarded by two English botanists

Bentham and Hooker (July 1862 and April 1883)

George Bentham (1800 – 1884)

Sir Joseph Dalton Hooker (1817 -1911)

This system of classification was published in the book 'Genera Plantarum' (1862 -1883) which became the most popular classification in European countries.



GENERA PLANTARUM

AD EXEMPLARIA IMPRIMIS IN HERBARIIS KEWENSIBUS SERVATA DEFINITA;

AUCTORIBUS

G. BENTHAM ET J. D. HOOKER.

VOLUMINIS TERTII

PARS I.

SISTENS DICOTYLEDONUM MONOCHLAMYDEARUM ORDINES XXXVI.

NYCTAGINEAS—CERATOPHYLLEAS

ET

GYMNOSPERMEARUM ORDINES III.

GNETACEAS—CYCADACEAS

LONDINI:

VENIT APUD

L. REEVE & CO., 5 HENRIETTA STREET, COVENT GARDEN;

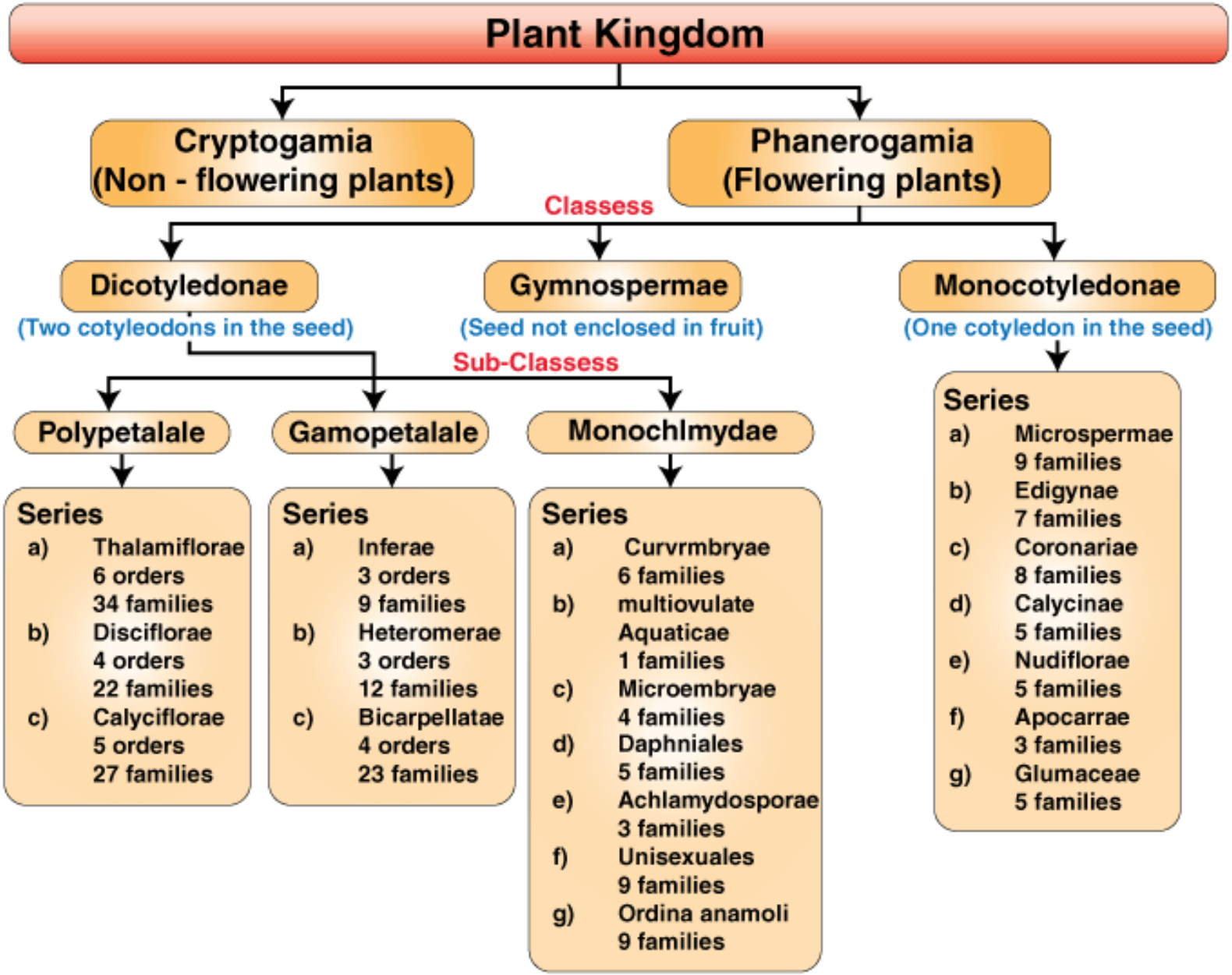
WILLIAMS & NORGATE, 14 HENRIETTA STREET, COVENT GARDEN.

MDCCCLXXX.

They described 97,205 species of seed plants belonging to 7,569 genera of 202 families starting from Ranunculaceae up to Gramineae.

They divided Dicotyledons into 3 sub-classes, sub-classes into 14 series, series into 25 cohorts (=order) and cohorts into 65 orders (=family).

Monocotyledons into 7 series.


Plant Kingdom
Cryptogamia
(Non - flowering plants)
Phanerogamia
(Flowering plants)
Classess
Dicotyledonae
(Two cotyleodons in the seed)
Gymnospermae
(Seed not enclosed in fruit)
Monocotyledonae
(One cotyledon in the seed)
Sub-Classess
Polypetalale
Gamopetalale
Monochlmydae
Series
a) Thalamiflorae
6 orders
34 families
b) Disciflorae
4 orders
22 families
c) Calyciflorae
5 orders
27 families
Series
a) Inferae
3 orders
9 families
b) Heteromerae
3 orders
12 families
c) Bicarpellatae
4 orders
23 families
Series
a) Curvrmbryae
6 families
b) multiovulate
Aquaticae
1 families
c) Microembryae
4 families
d) Daphniales
5 families
e) Achlamydosporae
3 families
f) Unisexuales
9 families
g) Ordina anamoli
9 families
Series
a) Microspermae
9 families
b) Edigynae
7 families
c) Coronariae
8 families
d) Calycinae
5 families
e) Nudiflorae
5 families
f) Apocarrae
3 families
g) Glumaceae
5 families

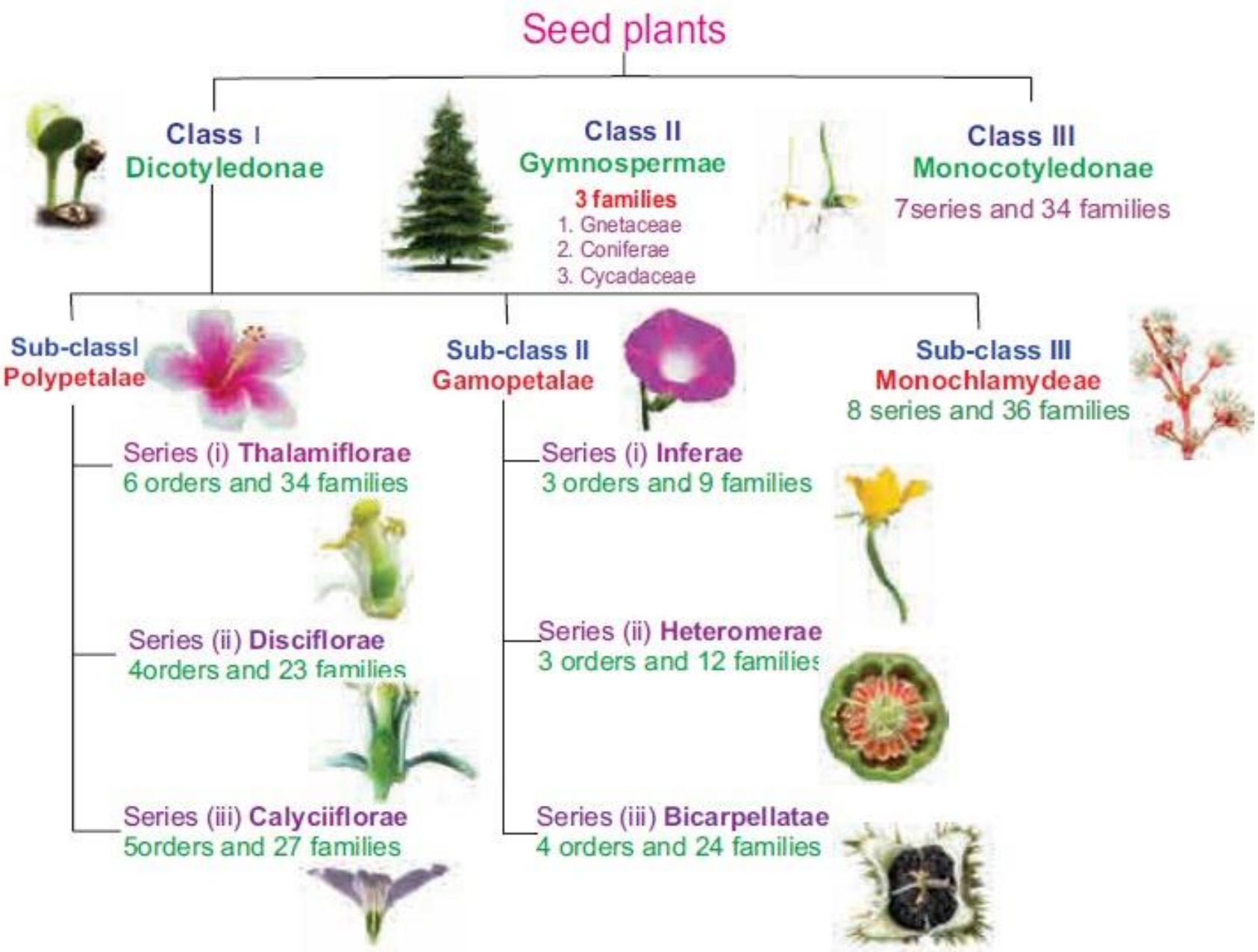


Figure 5.6: Bentham and Hooker system of classification

The delimitation of genera was based on natural affinities and was pre-Darwinian in concept.

The B & H system divided all the seed plants into three classes

–Dicotyledons (165 families)
–Gymnosperms (3 families) and
–Monocotyledons (34 families).

Class 1: Dicotyledons

Seed with 2 cotyledons

- **Flowers with pentamerous or tetramerous**
- **Reticulate venation**

Subclass 1: Polypetalae

Polypetalae: sepals and petals distinct, petals free (14 series, 15 orders and 165 families)

–**Thalamiflorae:** flowers hypogynous, stamens many, disc absent

- **6 Orders:** Ranales, Parietales, Polygalineae, Caryophyllineae, Guttiferales and Malvales

–**Disciflorae:** flowers hypogynous, disc present below the ovary

- **4 Orders:** Geraniales, Olacales, Celastrales and Sapindales

–**Calyciflorae:** flowers perigynous or epigynous

- **5 Orders:** Rosales, Myrtales, Passiflorales, Ficoidales and Umbellales

Subclass 2: Gamopetalae

Gamopetalae: Sepals and petals distinct, petals fused

–Inferae: ovary inferior

•3 orders: Rubiales, Asterales and Campanales

–Heteromerae: Ovary superior, stamens in one or two whorls, carpels more than 2

•3 orders: Ericales, Primulales and Ebenales

–Bicarpellatae: Ovary superior, stamens in one whorls, carpels 2

•4 orders: Gentianales, Polemoniales, Personales and Lamiales

Subclass 3: Monochlamydeae

- **Monochlamydeae: flowers apetalous, perianth lacking or if present not differentiated into sepals and petals**

–**Curvembryeae:** embryo coiled, ovule usually 1

–**Multiovulate aquaticae:** aquatic plants, ovules many

–**Multiovulate terrestress:** terrestrial plants, ovules many

–**Microembryeae:** embryo minute

–**Daphnales :** carpel 1, ovule 1

–**Achlamydosporae:** ovary inferior, unilocular, ovules 1-3

–**Unisexuales:** flowers unisexual

–**Ordines anomali:** relationship uncertain

Class 2: Gymnospermae

Ovules naked
–3 families

Class 3: Monocotyledons

Flowers trimerous, venation parallel

–**Microspermae :** ovary inferior, seeds minute

–**Epigynae:** ovary inferior, seeds large

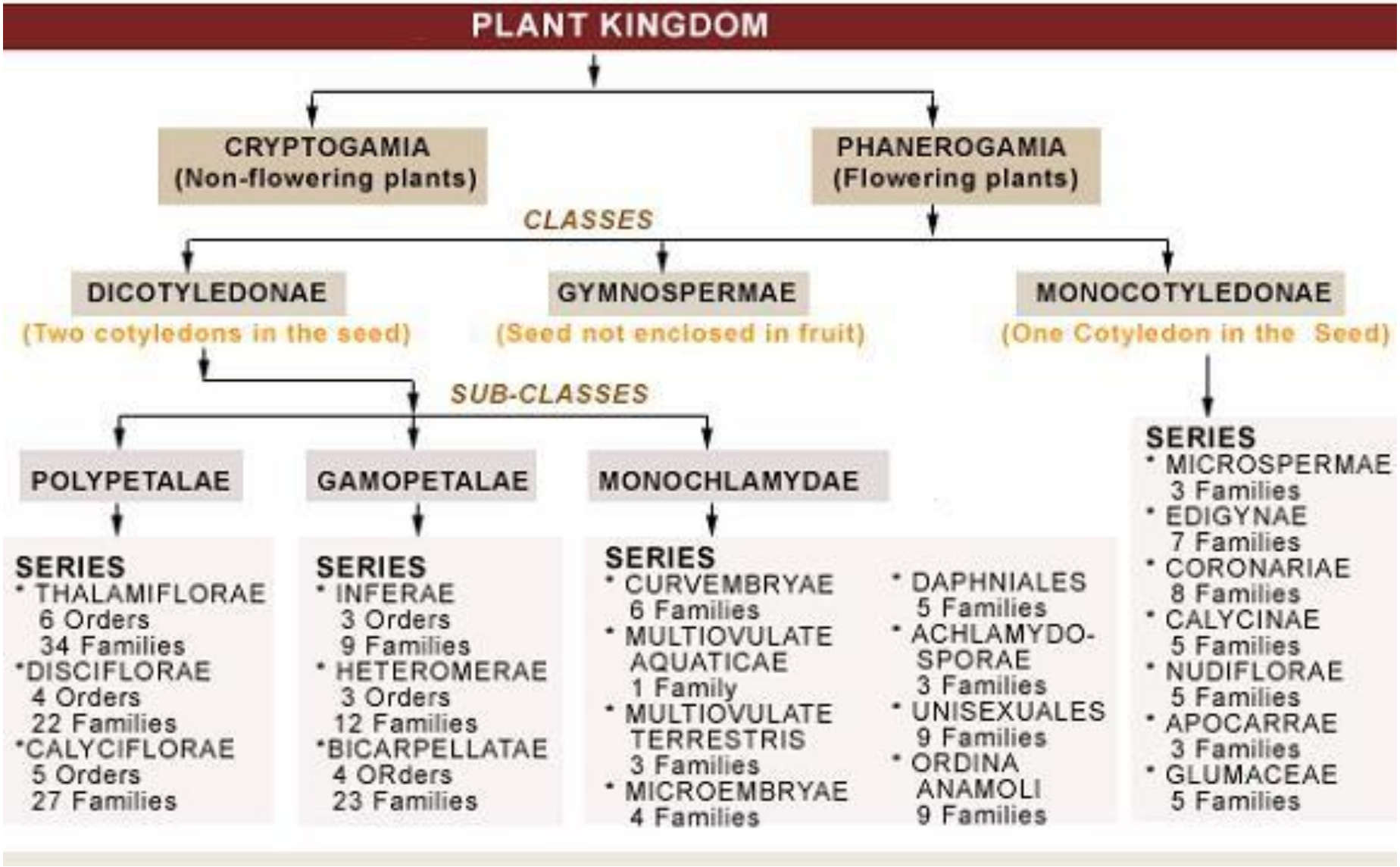
–**Coronarieae** : ovary superior, carpels united, perianth colored

–**Calycinae:** ovary superior, carpels united, perianth green

–**Nudiflorae:** ovary superior, perianth absent

–**Apocarpae:** ovary superior, carpels more than 1, free

–**Glumaceae :** ovary superior, perianth reduced, flowers enclosed in glumes


PLANT KINGDOM
CRYPTOGAMIA
(Non-flowering plants)
PHANEROGAMIA
(Flowering plants)
CLASSES
DICOTYLEDONAE
(Two cotyledons in the seed)
GYMNOSPERMAE
(Seed not enclosed in fruit)
MONOCOTYLEDONAE
(One Cotyledon in the Seed)
SUB-CLASSES
POLYPETALAE
GAMOPETALAE
MONOCHLAMYDAE
SERIES
• THALAMIFLORAE
6 Orders
34 Families
•DISCIFLORAE
4 Orders
22 Families
•CALYCIFLORAE
5 Orders
27 Families
SERIES
• INFERAE
3 Orders
9 Families
• HETEROMERAE
3 Orders
12 Families
•BICARPELLATAE
4 ORders
23 Families
SERIES
• CURVEMBRYAE
6 Families
• MULTIOVULATE AQUATICAE
1 Family
• MULTIOVULATE TERRESTRIS
3 Families
• MICROEMBRYAE
4 Families
• DAPHNIALES
5 Families
• ACHLAMYDO-SPORAE
3 Families
• UNISEXUALES
9 Families
• ORDINA ANAMOLI
9 Families
SERIES
• MICROSPERMAE
3 Families
• EDIGYNAE
7 Families
• CORONARIAE
8 Families
• CALYCINAE
5 Families
• NUDIFLORAE
5 Families
• APOCARRAE
3 Families
• GLUMACEAE
5 Families

Merits:

1. It is a greatly mentioned system or natural system of classification
2. It is very suitable and important for practical purposes.
3. Monocotyledons are derived from dicotyledonous.
4. In class monocotyledons, stress is being laid on the relative position of ovary and perianth characters.
5. Full and complete description of each plant was prepared from studies and dissection of individual plants.
6. For the sake of convenience, every genus was sub-divided into sub-genera and sections each of which was named and diagnosed together with the assignment of important spp belonging them.
7. The system was accepted by the entire British Empire, USA, and other European countries.
8. The system is a result of very careful comparative examination of all known genera of Phanerogams.
9. Valuable for identification of seed plants.
10. A special feature of this system is an addition of disciflorae and arrangement of certain groups on basis of aquatic and terrestrial characters.

Demerits:

1. **The position of gymnosperms b/w dicotyledons and monocotyledons which is anomalous.**
2. **Origin of angiosperms is not established.**
3. **In monocots stress in being laid on ovary position and perianth character which is unjustified in case of some orders.**
4. **The position of Orchidaceae and Scitamineae at beginning of monocots is not satisfactory.**
5. **Among the dicotyledons, monchlamydeae is being regarded as the most evolved group and the polypetalae as the most primitive group. Gamopetalae has been placed in between the two such an arrangement does not follow an evolutionary trend.**
6. **Some of the related orders (families) are being widely separated due to an arbitrary selection of characters.**
7. **Monochlamydeae is being regarded as an artificial group. It includes a no of orders (families) possessing affinities with those of bisereate perianth.**
8. **Separation of Liliaceae forms Iridaceae and Amaryllidaceae merely on the character of inferior ovary, without making more of the comparative study.**

The outline of Bentham and Hooker's classification

Class I Dicotyledonae

Seeds of dicotyledonous plants contain two cotyledons. Leaves show reticulate venation. Flowers are tetramerous or pentamerous having four or five members in various floral whorls respectively.

Three subclasses:- Polypetalae, Gamopetalae and Monochlamydeae.

Sub-class I Polypetalae

Plants having flowers with free petals come under polypetalae. The flowers are with distinct calyx and corolla. It is further divided into three series - Thalamiflorae, Disciflorae and Calyciflorae.

Series (i) Thalamiflorae

It includes plants having flowers with dome or conical thalamus. Ovary is superior. Thalamiflorae includes 6 orders and 34 families.

Series (ii) Disciflorae

It includes flowers having prominent disc shaped thalamus below the ovary. Ovary is superior. Disciflorae is divided into 4 orders and 23 families.

Series (iii) Calyciflorae

It includes plants having flowers with cup shaped thalamus. Ovary is superior or inferior sometimes half inferior. Calyciflorae includes 5 orders and 27 families.

Sub-class 2. Gamopetalae

Plants having flowers with petals, which are either partially or completely fused to one another are placed under Gamopetalae. The sepals and petals are distinct. Gamopetalae is further divided into three series ' Inferae, Heteromerae and Bicarpellatae.

Series (i) Inferae

The flowers are epigynous and ovary is inferior. Inferae includes 3 orders and 9 families.

Series (ii) Heteromerae

The flowers are hypogynous and ovary is superior with more than two carpels. Heteromerae includes 3 orders and 12 families.

Series (iii) Bicarpellatae

The flowers are hypogynous and ovary is superior with two carpels only. Bicarpellatae includes 4 orders and 24 families.

Sub-class 3. Monochlamydeae

Plants having flowers with single whorl of perianth are placed under Monochlamydeae. Flowers are incomplete. The sepals and petals are not distinguished and they are called perianth. Tepals are present in two whorls. Sometimes both the whirls are absent. Monochlamydeae includes 8 series and 36 families.

Class II Gymnospermae

The members of this class have naked ovules or seeds. Ovary is absent and gymnospermae includes three families ' Gnetaceae, Coniferae and Cycadaceae.

Class III Monocotyledonae

Seeds of monocotyledonous plants contain only one cotyledon. Leaves show parallel venation. Flowers are trimerous having three members in various floral whorls. The plants have fibrous root system. The Monocotyledonae has 7 series and 34 families

Series I. Microspermae *(inferior ovary; minute seeds): Orchidaceae, and two more families.*

Series II. Epigynae *(inferior ovary; large seeds): Iridaceae, Amaryllidaceae, and five more families.*

Series III. Coronarieae *(superior ovary; coloured perianth): Liliaceae, Commelinaceae, and six more families.*

Series IV. Calycineae *(superior ovary; green perianth): Juncaceae, Palmae, Flagellariaceae.*

Series V. Nudiflorae *(perianth usually absent; superior ovary): Typhaceae, Araceae, and three more families.*

Series VI. Apocarpae *(carpels free): Alismaceae, and two more families.*

Series VII. Glumaceae *(reduced perianth; bracts large, scaly): Cyperaceae, Gramineae, and three more families.*

Merits of Bentham and Hooker's classification of plants

1. Bentham and Hooker's classification is the most natural system, based on actual examination of specimens.

2. The description of plants is quite accurate and reliable.

3. As it is easy to follow, it is used as a key for the identification of plants in Kew herbarium and several other herbaria of the world.

4. Although this system is natural, most of the aspects of this system show affinity to modern concepts of evolution. For example, the order Ranales, which is the first order in the arrangement of plants, has been given a primitive position in this system. Recent taxonomic findings also indicate that the members of Ranales are the most primitive living angiosperms.

5. The placement of monocotyledonae after the dicotyledonae also appears to be in accordance with the evolutionary trends.

Demerits of Bentham and Hooker's classification of plants

1. The placement of Gymnospermae in between dicotyledonae and monocotyledonae is an error.

2. Several important floral characters have been neglected in this system.

3. Advanced family Orchidaceae has been considered as primitive among monocotyledons and it is placed in the beginning of the system.

4. In this system, some closely related families have been separated and placed under different groups. For example, all the families of series

Curvembryeae of Monochlamydeae are related to Caryophyllaceae of series Thalamiflorae of Polypetalae, but they are separated.

Unrelated families have been grouped nearer. For example, Podostemaceae of series Multiovulatae aquaticae of Monochlamydeae deserves a place in Rosales of the series Calyciflorae of Polypetalae. Similarly Laurineae of series Daphnales of Monochlamydeae deserves a place in Ranales of the series Thalamiflorae of polypetalae. Thus, two unrelated families Podostemaceae and Laurineae are grouped nearer.

CURRENT SYSTEMS OF CLASSIFICATION

Phylogenetic classification

The following Taxonomists used the recent data and information of palaeobotany, biochemical systematics, and the ultrastructural details unveiled by the electron microscope, along with the information of the traditional sources such as morphology and anatomy of plants.

Armen Takhtajan (1980) of Russia,

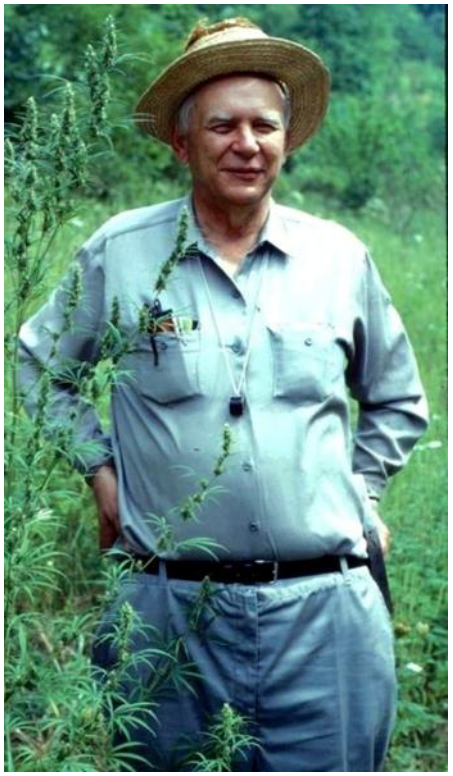
Arthur Cronquist (1981) of U.S.A.,

Rolf Dahlgren (1983) of Denmark,

Robert F. Thorne (1983) of U.S.A

Cronquist gave more importance to morphology

Classical Taxonomy	Modern Taxonomy
It is called old systematics or Alpha (α) taxonomy or Taxonomy	It is called Neosystematics or Biosystematics or Omega (Ω) taxonomy
It is pre Darwinean	It is post Darwinean
Species is considered as basic unit and is static	species is considered as dynamic entity and ever changing
Classification is mainly based on morphological characters	Classification is based on morpho-logical, reproduc-tive characters and phylogenetic (evolu-tionary) relationship of the organism
This system is based on the observation of a few samples/ individuals	This system is based on the observation of large number of sam-ples/individuals



Arthur Cronquist (1919-1992),

A leading American taxonomist, associated with the New York Botanical Garden.

He produced a detailed classification of angiosperms in 1968 in his book The **Evolution and Classification of Flowering Plants**.

The classification was further elaborated in 1981 in his book ***An Integrated System of Classification of Flowering Plants.***

The final revision was published in the second edition (1988) of The Evolution and Classification of Flowering Plants. Some realignments in Dicotyledons were published in Nordic Journal of Botany in 1983.

BASIS OF CLASSIFICATION

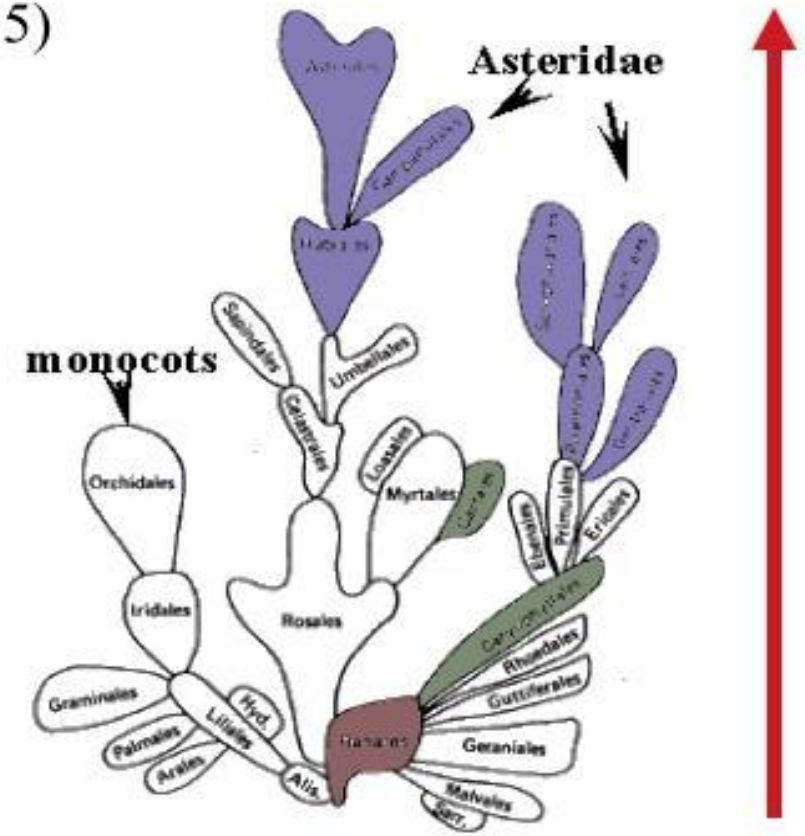
This system of classification is an elaboration of Bessey's system of classification and a refinement over Takhtajan's system (1964), which is based on morphological, anatomical, embryological, palynological, serological, cytological, chemical as well as ultra structural evidences.

According to Cronquist's system of classification, the angiosperms have been divided into two Classes

The cactus-tree of C. Bessey (1915)

Dogmas of evolution

- Woody → herbaceous
- Simple → compound leaves
- Perfect → unisexual flowers
- Many → few floral parts
- Hypo- → epigyny



Ranales most primitive → Asteridae most derived

His ideas are greatly influential for twentieth century evolutionary thought

There are 6 subclasses, 64 orders, 320 families and about 165,000 species in Magnoliopsida, whereas in Liliopsida there are 5 sub classes, 19 orders, 66 families and about 50,000 species.

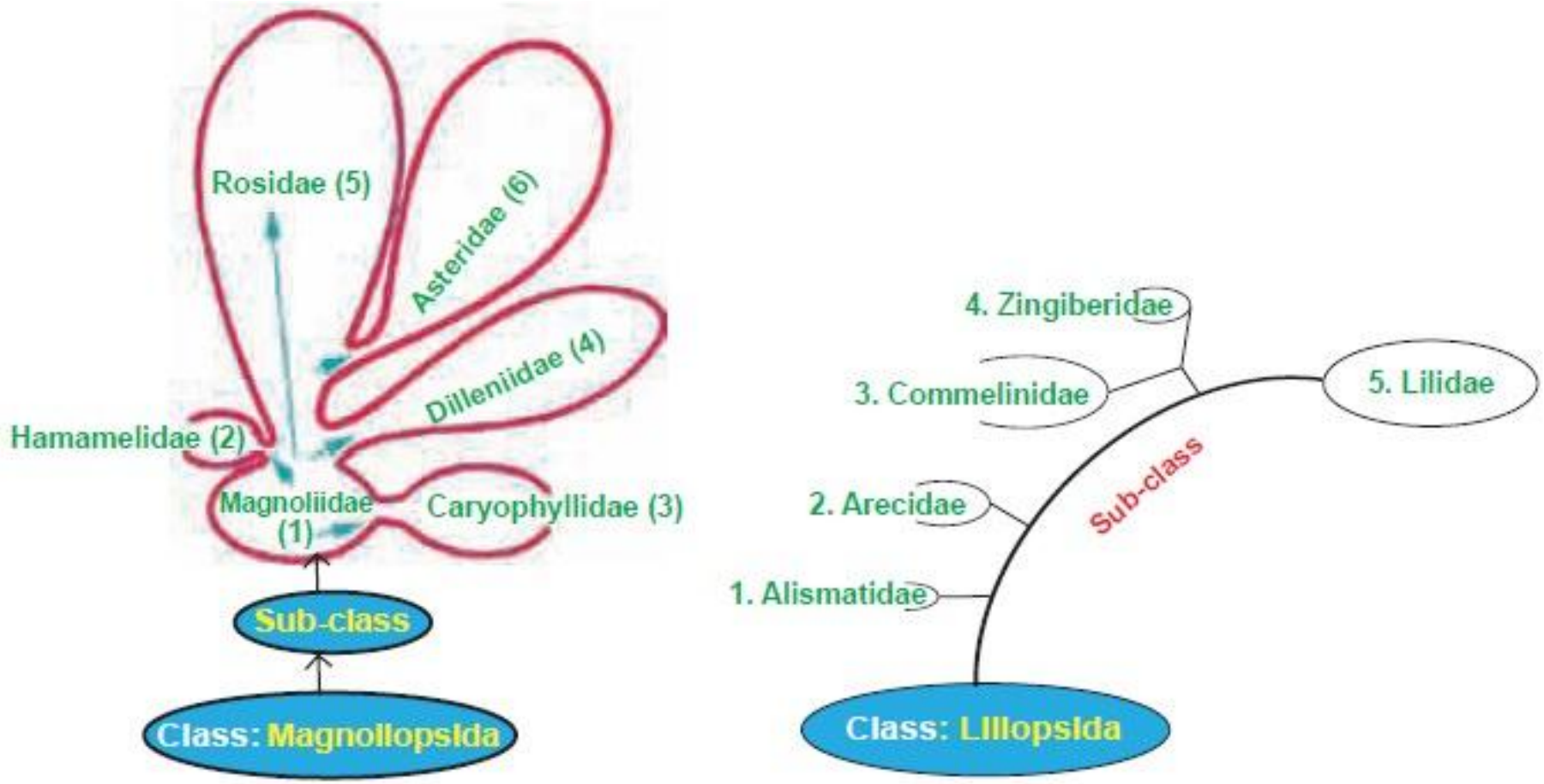


Figure 5.10: Diagramatic representation of the relationship between class Magnoliopsida and Liliopsida.

A- Class Magnoliopsida

A.1- Subclass Magnoliidae (mostly basal dicots) (8 Orders, 39 families)

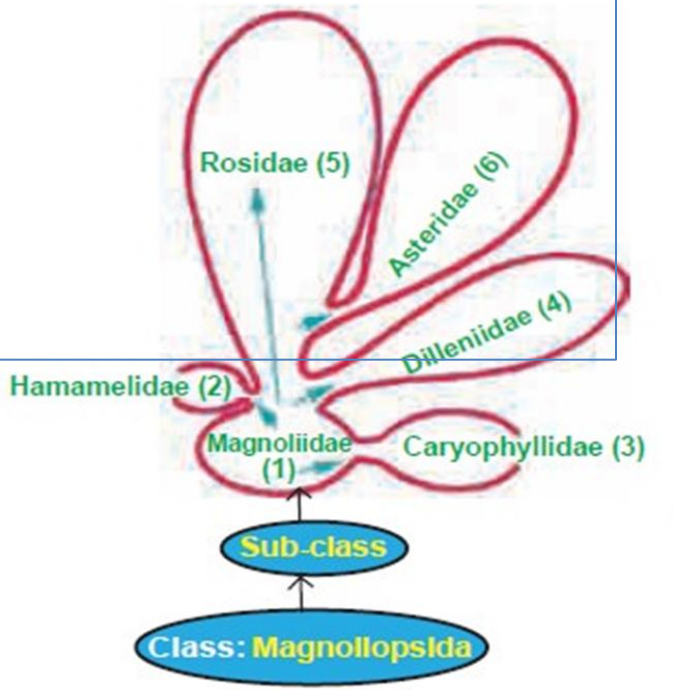
A.2- Subclass Hamamelidae [correctly Hamamelididae] [11 Orders, 25 families]

A.3- Subclass Caryophyllidae [3 Orders, 14 families]

A.4- Subclass Dilleniidae [13 Oders, 78 families]

A.5- Subclass Rosidae [18 Orders, 118 families]

A.6- Subclass Asteridae [11 Orders, 50 Families]



B- Class Liliopsida

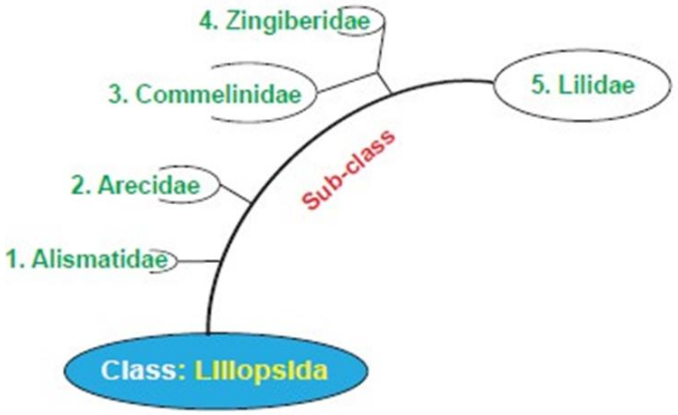
B.1- Subclass Alismatidae [4 Oders, 16 Families]

B.2- Subclass Arecidae [4 Orders, 6 Families]

B.3- Subclass Commelinidae [7 Orders, 16 Families]

B.4- Subclass Zingiberidae [2 Orders, 9 Families]

B.5- Subclass Liliidae [2 Orders, 19 Families]



Division. Magnoliophyta- 2 classes, 11 subclasses, 83 orders and 386 families; 219,300 species

Class 1. Magnoliopsida (Dicotyledons)- *6 subclasses, 64 orders, 320 families; 169,400 species*

Subclass 1. Magnoliidae (12 orders: Magnoliales, Laurales, Piperales, ristolochiales, Illiciales, Nymphaeales, Ranunculales and Papaverales)- 39 families.

2. Hamamelidae (11 orders: Trochodendrales, Hamamelidales, Daphniphyllales, Didymelales, Eucommiales, Urticales, Leitneriales, Juglandales, Myricales, Fagales and Casuarinales) - 25 families

3. Caryophyllidae (3 orders: Caryophyllales, Polygonales and Plumbaginales)- 14 families

4. Dilleniidae (13 orders: Dilleniales, Theales, Malvales, Lecythidales, Nepenthales, Violales, Salicales, Capparales, Batales, Ericales, Diapensiales, Ebenales and Primulales)- 78 families

5. Rosidae (18 orders: Rosales, Fabales, Proteales, Podostemales, Haloragales, Myrtales, Rhizophorales, Cornales, Santalales, Rafflesiales, Celastrales, Euphorbiales, Rhamnales, Linales, Polygalales, Sapindales, Geraniales and Apiales)- 118 families

6. Asteridae (11 orders: Gentianales, Solanales, Lamiales, Callitrichales, Plantaginales, Scrophularial Campanulales, Rubiales, Dipsacales, Calycerales and Asterales)50 families

Class 2. Liliopsida (Monocotyledons)-

5 subclasses, 19 orders, 66 families; 49,900 species

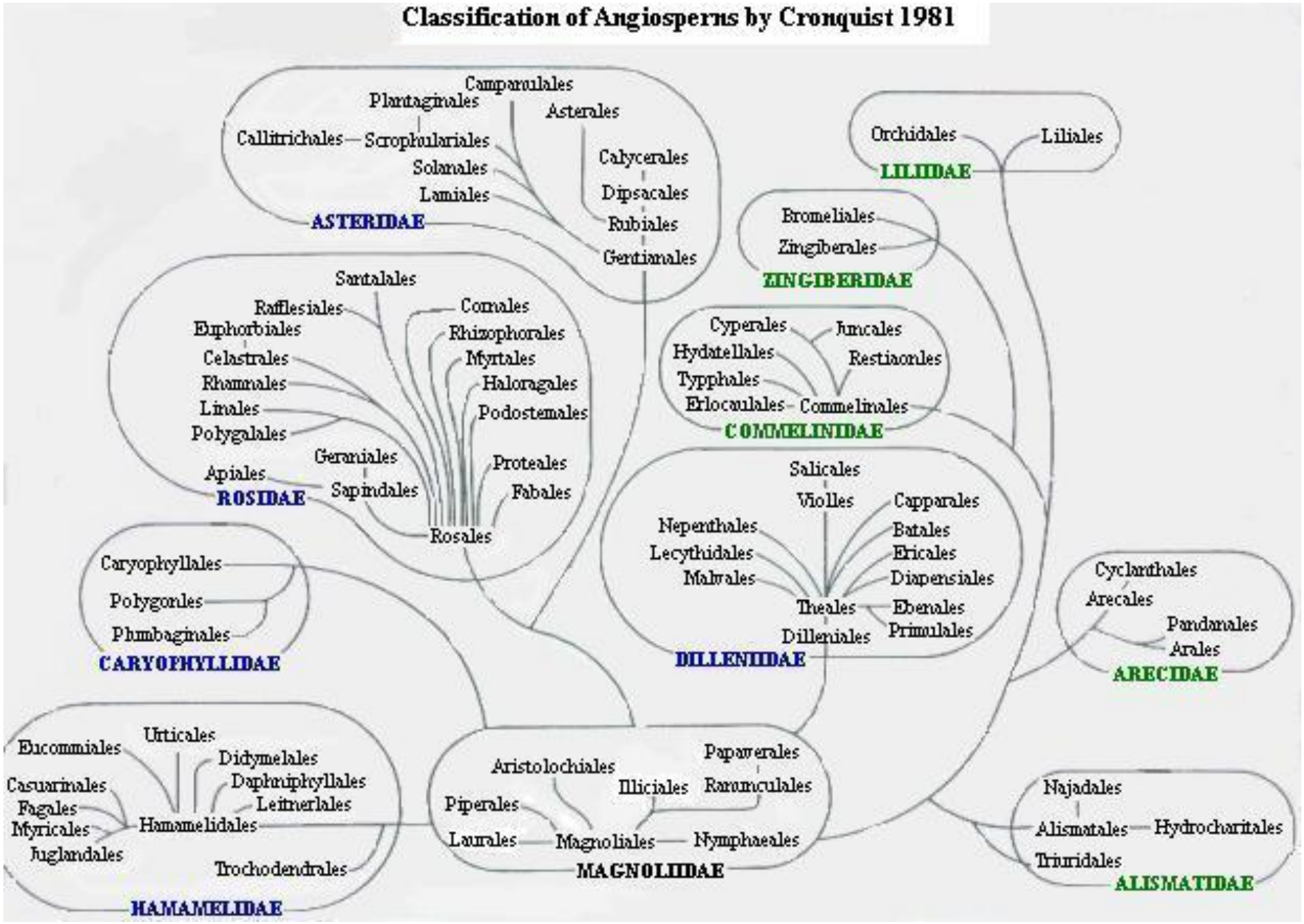
Subclass 1. Alismatidae (4 orders: Alismatales, Hydrocharitales, Najadales, and Triuridales) - 16 Families

2. Arecidae (4 orders: Arecales, Cyclanthales, Pandanales and Arales)- 6 Families

3. Commelinidae (7 orders: Commelinales, Eriocaulales, Restionales, Juncales, Cyperales, Hydatellales and Typhales)- 16 Families

4. Zingiberidae (2 orders: Bromeliales and Zingiberales) 9 Families

5. Liliidae (2 orders: Liliales and Orchidales) - 19 Families


Classification of Angiosperms by Cronquist 1981
Campanulales
Plantaginales
Asterales
Callitrichales
Scrophulariales
Calycerales
Solanales
Dipsacales
Lamiales
Rubiales
ASTERIDAE
Gentianales
Orchidales
Liliales
LILIIDAE
Bromeliales
Zingiberales
ZINGIBERIDAE
Santalales
Rafflesiales
Cornales
Euphorbiales
Rhizophorales
Cyperales
Juncales
Hydatellales
Myrtales
Restiaorales
Celastrales
Typphales
Haloragales
Rhamnales
Eriocaulales
Commelinales
Podostemales
Linales
COMMELINIDAE
Polygalales
Geraniales
Proteales
Apiales
Sapindales
Fabales
ROSIDAE
Rosales
Salicales
Violles
Capparales
Nepenthales
Batales
Lecythidales
Ericales
Malvales
Diapensiales
Theales
Ebenales
Primulales
Dilleniales
DILLENIIDAE
Caryophyllales
Polygonales
Plumbaginales
CARYOPHYLLIDAE
Cyclanthales
Arecales
Pandanales
Arales
ARECIDAE
Eucommiales
Urticales
Didymelales
Casuarinales
Daphniphyllales
Fagales
Leitneriales
Myricales
Hamamelidales
Juglandales
Trochodendrales
HAMAMELIDAE
Aristolochiales
Papaverales
Illiciales
Ranunculales
Piperales
Laurales
Magnoliales
Nymphaeales
MAGNOLIIDAE
Najadales
Alismatales
Hydrocharitales
Triuridales
ALISMATIDAE

MERITS:

There is general agreement of Cronquist's system with that of other contemporary systems like Takhtajan, Dahlgren and Thorne.

2. Detailed information on anatomy, ultra- structure phytochemistry and chromosome — besides morphology — was presented in the revision of the classification in 1981 and 1988.

3. The system is highly phylogenetic.

4. Nomenclature is in accordance with the ICBN.

5. The family Asteraceae in Dicotyledons and Orchidaceae in Monocotyledons are generally regarded as advanced and are rightly placed towards the end of respective groups.

6. The relationships of different groups have been described with diagrams which provide valuable information on relative advancement and size of the various subclasses.

7. The family Winteraceae (vessel-less wood present similar to Pteridosperms) placed at the beginning of dicotyledons is favoured by many authors.

8. The subclass Magnoliidae is considered as the most primitive group of Dicotyledons. The placement of Dicotyledons before Monocotyledons finds general agreements with modern authors.

9. 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

INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE or ICBN.

Nomenclature *is the formal naming of taxa according to some standardized system.*

a taxon is a group of organisms typically treated at a given rank.

Taxonomists have traditionally agreed upon a method for classifying organisms that utilizes categories called ranks.

These taxonomic ranks are ***hierarchical****, meaning that each rank is inclusive of all other ranks beneath it*

Major Taxonomic Ranks	Taxa
Kingdom	Plantae
Phylum (**Division** also acceptable)	Magnoliophyta
Class	Liliopsida (Monocots)
Order	Arecales
Family	Arecaceae
Genus (plural: genera)	*Cocos*
Species (plural: species)	*Cocos nucifera*

Species names are known as binomials (literally meaning two names) and this type of nomenclature is called binomial nomenclature, first formalized in the mid-18th century by Carolus Linnaeus.

ICBN deals with the names of extant or extinct (fossil) organisms traditionally treated as plants, i.e., encompassed by the field of botany

For plants, algae, and fungi, the rules and regulations for the naming of taxa

A separate code is utilized for cultivated plants, the International Code of Nomenclature for Cultivated Plants.

The International Code of Botanical Nomenclature (ICBN) is the set of rules and recommendations dealing with the formal botanical names that are given to plants. Its aim is that each taxonomic group ("taxon", plural "taxa") of plants has only one correct name that is accepted worldwide.

- **The first 'International Botanical Congress (IBC), was held in Paris in 1867 where Alphonse de Candolle was the president.**
- **Botanists from several countries were attended there.**
- **They adopted a set of rules of plant nomenclature, most of which were proposed by Alphonse de candolle.**
- **The excellent rules of plant nomenclature are known as 'de Candolle rules or Paris Code of 1967'.**

The names of all the codes along with the years are –

1. ***Paris Code (1867),***
2. ***Rochester Code (1892),***
3. ***Vienna Code (1905),***
4. ***American Code (1907),***
5. ***Brussels Code (1912),***
6. ***Cambridge Code (1930),***
7. ***Amsterdam Code (1947),***
8. ***Stockholm Code (1966),***
9. ***Paris Code (1956),***
10. ***Montreal Code (1961),***
11. ***Edinburgh Code (1966),***
12. ***Seattle Code (1972),***
13. ***Leningard Code (1978),***
14. ***Sydney Code (1983),***
15. ***Berlin Code (1988),***
16. ***Tokyo Code (1994),***
17. ***St Louis Code (1999),***
18. ***Vienna Code (2005),***
19. ***Melbourne Code (2011).***
20. ***Shenzhen, China (2017).***

The general agreement regarding the internationally acceptable rules of plant nomenclature was reached in the meeting of the IBC at Cambridge in 1930.

In the above meeting for the first time in botanical history a code of nomenclature came into being that was international in function as well as in name.

This code is called the

International Code of Botanical Nomenclature.

The ICBN is divided into Principles, Rules and Recommendations.

The present code consists of 6 principles, about 75 rules set out in the Article, 57recommendations and a number of notes and examples. It also includes Appendices I, II and III and a guide for the determination of types and citations of botanical literature.

PRINCIPLES OF ICBN

The philosophical basis of the code is formed by the following six principles –

1. Botanical nomenclature is independent of zoological nomenclature.

2. The application of names of taxonomic groups is determined by means of nomenclatural types.

3. The nomenclature of a taxonomic group is based upon 'priority of publication'.

4. Each taxonomic group with a particular circumscription, position and rank can bear only one correct name, the earliest that is in accordance with the rules, except in specific cases.

5. Scientific names of groups are treated as Latin regardless of their derivation.

6. The rules of nomenclature are retroactive unless expressly limited.

1. Principle of Priority of Publication:

Principle II of ICBN states that the nomenclature of a taxonomic group is based on priority of publication.

One plant might have been described under different botanical names by various plant nomenclaturists in different parts of the world.

But according to the 'Principle of Priority' each taxon is known by its earliest name, however the same species was named differently in different parts of the world.

For example – Indian Coral tree (*Erythrina variegate L.*) has asmany as 200 scientific names.

Limitations of Priority of Publication:-

The rule of priority has certain limitations.
It cannot be applied to all names published.

Valid publication of names of different groups of plants is treated as beginning on various dates as provided in the code (Article 13).

In case of Spermatophytes and Pteridophytes, it is 1 May 1753, the date of publication of Linnaeus 'Species Plantarum'.Names published before this date need not be considered in applying, the rule of priority.

2. Typication/ Type Method/ Nomenclatural Type:

Type method is one of the important principles of the Code. The Type Method is a legal device to provide the correct name of the taxon.

A 'type specimen' is a herbarium sheet (or rarely a drawing or a photograph) of a specimen which was used by the author to provide its authentic description.

Article 7 of the Code states that, the application of the names of taxa of the rank of family or below is determined by means of 'nomenclatural types'.

According to Article 9 of ICBN, the type of a genus is a species (e,g., the typespecies of the genus *Brassica* is *B. compestris* or *B. compestris* is the typespecies of the genus *Brassica.* Similarly, the type of the family is a genus (e.g., *Brassica* is the type genus of the family Brassicaceae).

Kinds of 'Type':- The different kinds of ' **type**' designated by ICBN areas follows –

(a) Holotype –

It is a specimen used by the author in the original publication as the nomenclatural type.

(b) Isotype –

It is a duplicate specimen of the holotype, i.e., from the same collection with the same locality, date and number as the holotype.

(c) Lectotype –

It is a specimen selected from the original material, when no holotype was designated at the time of publication or as long as it is missing or destroyed.

(d) Neotype –

It is a specimen selected to serve as a substitute of holotype when all the material on which the name of the taxon was based is missing.

(e) Cotypes or Paratypes –

A cotype is a second specimen from the same plant from where the holotype was collected. It is often mentioned in the literature.

EFFECTIVE AND VALID PUBLICATION

1) Name must be effectively published

2) Name must be published in the correct form, properly Latinized with the correct rank ending.

3) Name must be published with a Latin description or diagnosis or with a reference to such. [Vernacular description typically included].

4) Nomenclatural type must be indicated (for genus and below).

AUTHOR CITATION

1. **Joint authors -** If only two, both should be cited, e.g. Smith & Jones, or Smith *et* Jones, if more than two then Smith *et al*.

2. **Name proposal - S**ometimes one author proposes but doesn't validly publish the name him/herself. In this case the one who proposed it is listed first followed by *ex* and the author who validly published it. *Ex* means validly published by. For example,. *Arenaria rossii* R.Br. *ex* Richards. 1823.

3. Publication in anothers work - Sometimes one person supplies the new name for publication in others work, e.g. many floras. He/she should get credit so cited as Smith in Jones, or if shortened Smith.

4.Abbreviated names: Usually the names are cited in abbreviated forms but never underlined or italicized e.g., *Vitex* Linn., *V .trifolia* Linn. etc.

5.Double Citation: If a genus or taxon of lower rank is altered in rank or position, but retains its name or epithet, the name of the author who first published the name or epithet (basionym) must be cited in parenthesis followed by the name of author who effected the change e.g.,*Leucaena latisiliqua* (Linn.) Gillis (1974)..Basionym: *Mimosa latisiliqua.*

RULE OF PRIORITY

Law of Priority says that if a genus or species has been accidentally given two names, only the earlier one is valid. The later name becomes a "junior synonym".

***Polygala* L.(1753)** , *Poligalia* Neck.(1768), *Polygaloides* Agosti (1770).

REJECTION OF NAMES

1. Synonym - a rejected name due to misapplication or difference in taxonomic judgment.

2. Basionym - a specific epithet or infraspecific epithet that has priority and is retained when transferred to a new or different taxon, e.g. *Arnica cordifolia* Hook. if transferred to *Senecio* by Smith becomes *Senecio cordifolia* (Hook.) Smith. The type specimen for *Senecio cordifolia* is actually that of *Arnica cordifolia*.

3. **Homonym** - one of two or more identical names based on different types, only one of which can be legitimate i.e. identical names can not be applied to different taxa.

4. **Tautonym** - an illegitimate binomial in which the generic name and specific epithet are the same, e.g. if transfer *Arnica cordifolia* Hook. to the genus *Cordifolia* would make *Cordifolia cordifolia* (Hook.)

5. **Autonym** - an automatically created name for infrageneric or infraspecific taxa, e.g. *Arnica* subgenus *Arnica* or *Arnica cordifolia* Hook. subspecies *cordifolia*. Not *genuina* or *typicus.*

6. **Nomen nudum-** It is a name that does not fulfill the criteria set by ICBN.

RETENTION OF NAMES
Of
Taxa which are divided

When a genus/species is divided into two or more genera/spp. The original name must be retained for the type species.

E.g.,

Lychnis dioica was divided by Miller into 2 species which were named as *L. dioica* L. emend Mill. And *L. alba* Miller.

RETENTION OF NAMES
Of
Taxa on Transference

If a species is transferred to another genus without change of rank, its original name must be retained if a species with that name does not exist in other genus. The name of original author is bracketed followed by the name of second author. For example, *Hydrocotyle asiatica* L. when transferred to genus *Centella* was named as *Centella asiatica* (Linn.) Urban.

CHOICE OF NAMES

Following are the criteria for the choice of name of a taxon:

1. When the taxon rank is changed, for e.g., a species becomes a genus, the earliest legitimate name in its new rank is its correct name.
2. When 2 or more taxa of the same rank are united into one, e.g., two or more genera are united , the oldest legitimate name of these taxa should be retained as the name of united taxon.

TAXONOMY AS A SYNTHETIC DISCIPLINE

Taxonomy provides a classification based on evolutionary relationships. But the goal of attaining a truly natural system of classification remains unfulfilled. So ,it is essential to have a comprehensive knowledge of the taxa from various aspects and various branches of botany. Therefore ,various aspects of botany like anatomy, embryology, phyto-chemistry and the newly developed techniques of molecular biology and new aspects of taxonomy i.e. numerical taxonomy are include under taxonomy and thus, taxonomy has now become a synthetic discipline.

FLORA

"Flora" comes from the Latin name of Flora, the goddess of plants, flowers, and fertility in Roman mythology

- **Inventory of plants of a defined geographical region or time, generally the naturally occurring or indigenous—native plant life.**
- **The flora is the taxonomic composition of a community was first made by Jules thurmann.**

A Flora may be fairly exhaustive or simply synoptic.

SCOPE AND USES OF FLORA

Flora typically include a dichotomous key for identification purposes and often time will include range maps as well.

All these Data are well-aggregated in a systematic manner in the different forms Taxonomic Literature

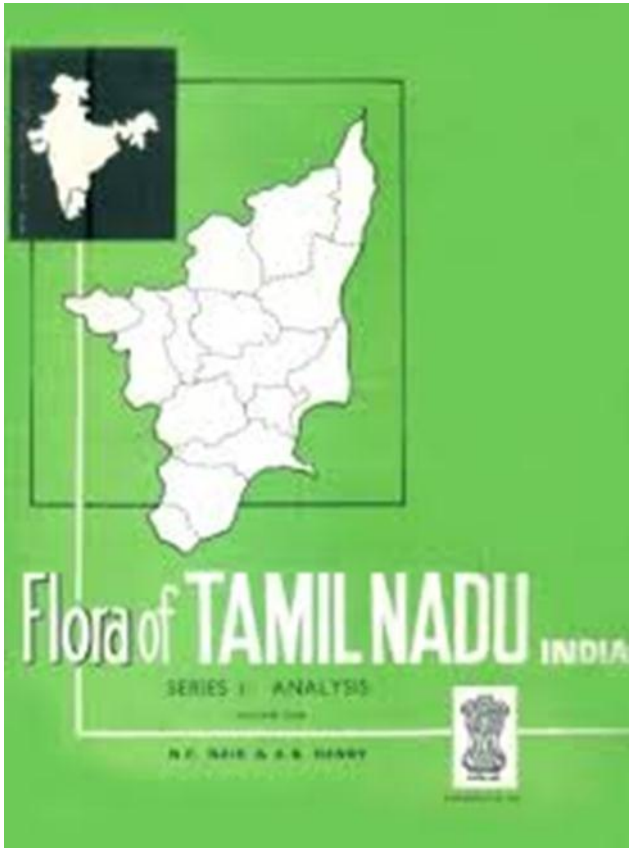
- **Literature are useful for easy and proper identification of plants.**

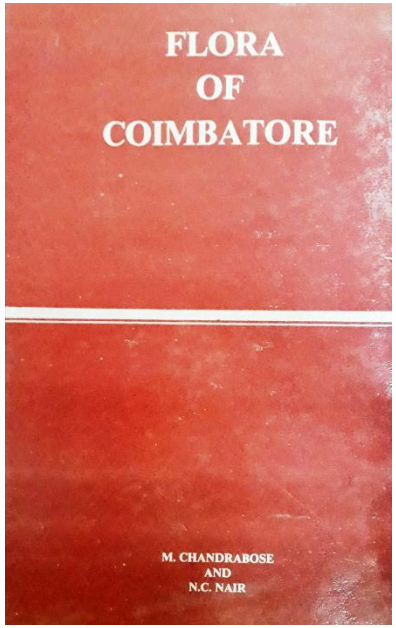
- **Several biographic references, indexes and guides are available with these literature to help taxonomists to locate relevant literature concerning a taxonomic group or geographical area.**

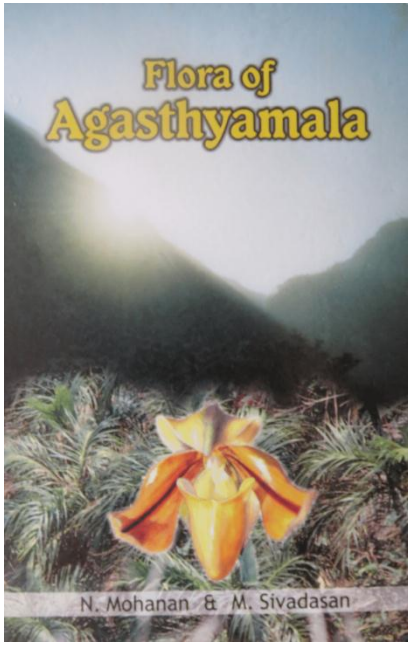
Depending on the scope and the area covered, the Floras are categorized as:

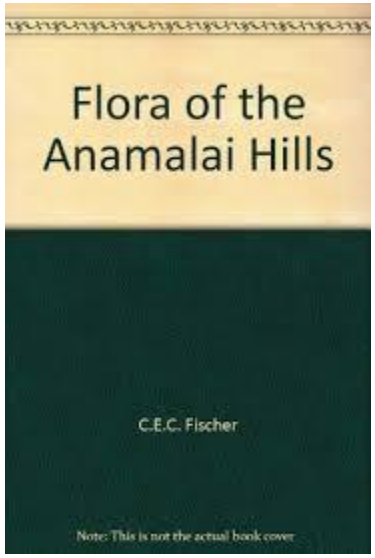
1. **Local Flora covers a limited geographical area, usually a state, county, city, a valley or a small mountain range.**

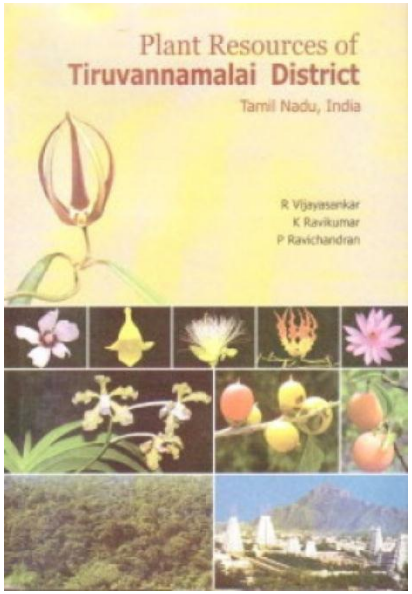
Examples:


Flora of TAMIL NADU INDIA
SERIES 1 ANALYSIS


FLORA
OF
COIMBATORE
M. CHANDRABOSE
AND
N.C. NAIR


Flora of
Agasthyamala
N. Mohanan & M. Sivadasan

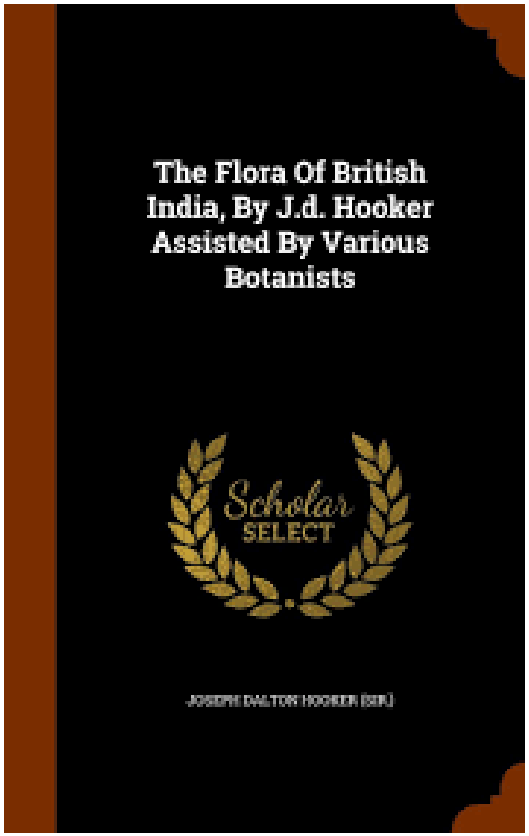

Flora of the
Anamalai Hills
C.E.C. Fischer
Note: This is not the actual book cover

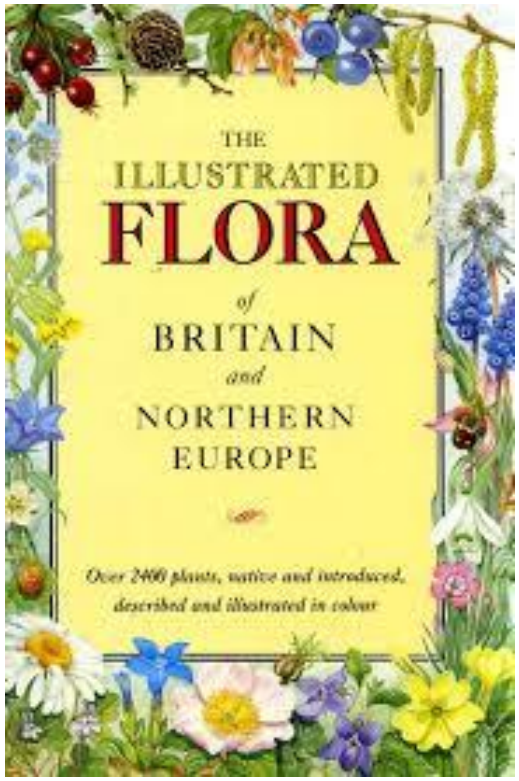

Plant Resources of
Tiruvannamalai District
Tamil Nadu, India
R Vijayasankar
K Ravikumar
P Ravichandran

2. Regional Flora includes a larger geographical area, usually a large country or a botanical region.

Examples:

***Flora of British India* by Sir J.D. Hooker (1872-1897)**

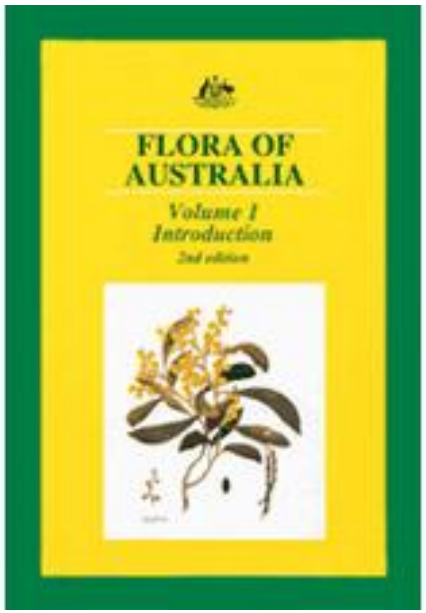


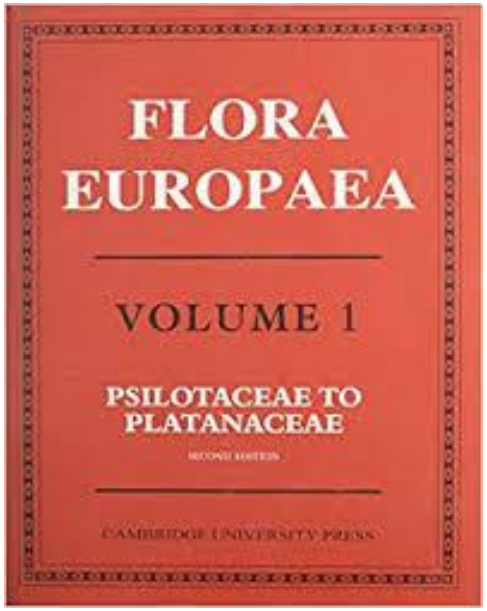


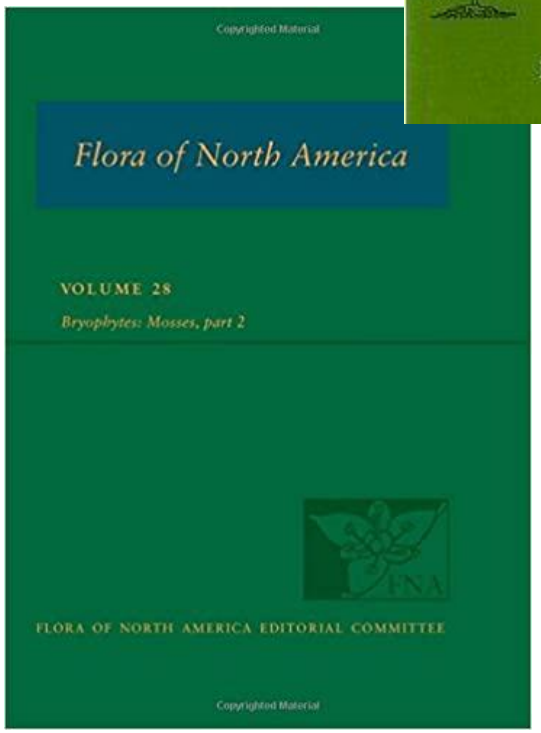
***A Flora covering a country is more appropriately known as a National Flora*.**

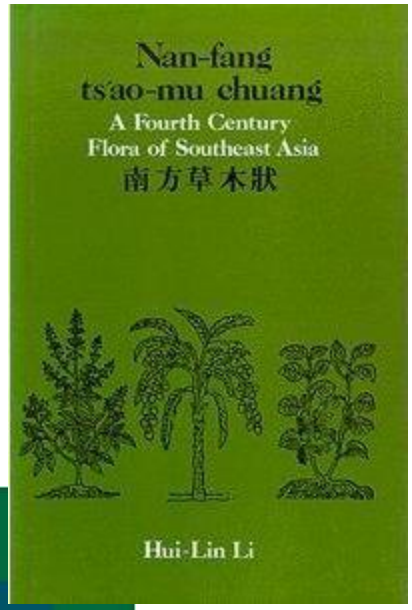
3. Continental Flora covers the entire continent.

Examples:







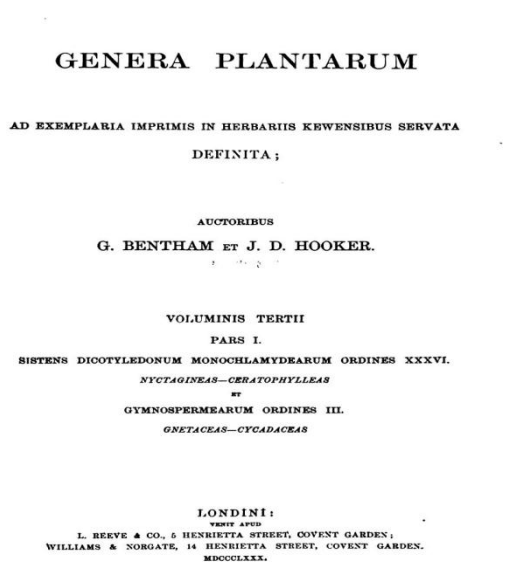


4. Comprehensive treatments have a much broader scope.

Although no world Flora has ever been written, several important works have attempted a worldwide view.

Examples:

***Genera plantarum* of G. Bentham and J.D. Hooker (1862-83), *Die Naturlichen flanzenfamilien* of A. Engler and K.A. Prantl (1887-1915) and *Das Pflanzenreich* of A. Engler (1900-1954).**



GENERA PLANTARUM

AD EXEMPLARIA IMPRIMIS IN HERBARIIS KEWENSIBUS SERVATA DEFINITA;

AUCTORIBUS

G. BENTHAM ET J. D. HOOKER.

VOLUMINIS TERTII

PARS I.

SISTENS DICOTYLEDONUM MONOCHLAMYDEARUM ORDINES XXXVI.

NYCTAGINEAS—CERATOPHYLLEAS

ET

GYMNOSPERMEARUM ORDINES III.

GNETACEAS—CYCADACEAS

LONDINI:

VENIT APUD

L. REEVE & CO., 5 HENRIETTA STREET, COVENT GARDEN;

WILLIAMS & NORGATE, 14 HENRIETTA STREET, COVENT GARDEN.

MDCCCLXXX.

DIE NATÜRLICHEN

PFLANZENFAMILIEN

NEBST IHREN GATTUNGEN

UND WICHTIGEREN ARTEN INSBESONDERE

DEN NUTZPFLANZEN

A. ENGLER

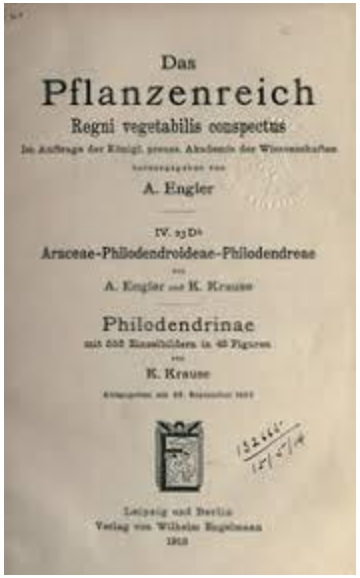
A. ENGLER

10. BAND

LEIPZIG

VERLAG VON WILHELM ENGELMANN

1924



Das

Pflanzenreich

Regni vegetabilis conspectus

A. Engler

IV. 23 D*

Araceae-Philodendroideae-Philodendreae

A. Engler und K. Krause

Philodendrinae

K. Krause

Leipzig und Berlin

Verlag von Wilhelm Engelmann

1913

Electronic Floras (eFloras)

The electronic age have made available the online availability of digitized form of many popular floras.

These Online Floras known as Electronic Floras (eFloras) provide opportunity for users to work dynamically on floristic treatments, and to browse and search these treatments.

Prepared by combining together the information from several Floras including Flora of Chile, Flora of China, Flora of Missouri, Flora of North America, Flora of Pakistan, Moss Flora of China, Trees and Shrubs of Andes and Ecuador, as also the Annotated Checklist of Flowering Plants of Nepal.

These Floras can be searched through common search engine to obtain relevant information. The hyperlinks to families, genera and species are very handy in identification and retrieving information.

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All Projects

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Annotated Checklist of the Flowering Plants of Nepal

- Family List

Flora of Chile

- Family List
- Volumes: 1 2 3 4 5 6

Flora of China

- Family List
- Volumes: 1 2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 22 23 24 25

Flora of Missouri

- Family List
- Volumes: 1 2 3

Flora of North America

- Family List
- Volumes: 1 2 3 4 5 6 7 8 9 12 19 20 21 22 23 26 27 28

Moss Flora of China

- Family List
- Volumes: 1 2

Trees and shrubs of the Andes of Ecuador

- Family List

Nannoglottis gynura

Nannoglottis gynura

Photos by The Biodiversity of the Hengduan Mountains Project

Credit: Jipei Yue

Primary Resources

All Resources

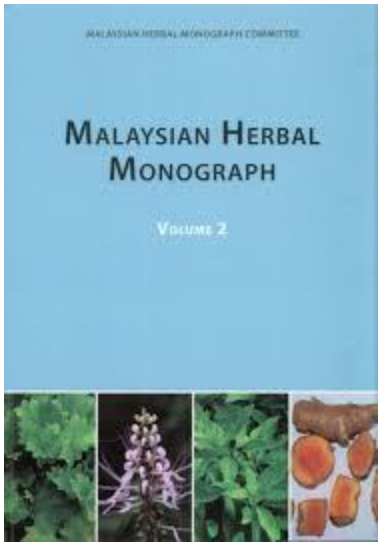
- Botanical Publications
- Botanical Specimens
- Botanists
- Citing eFloras.org

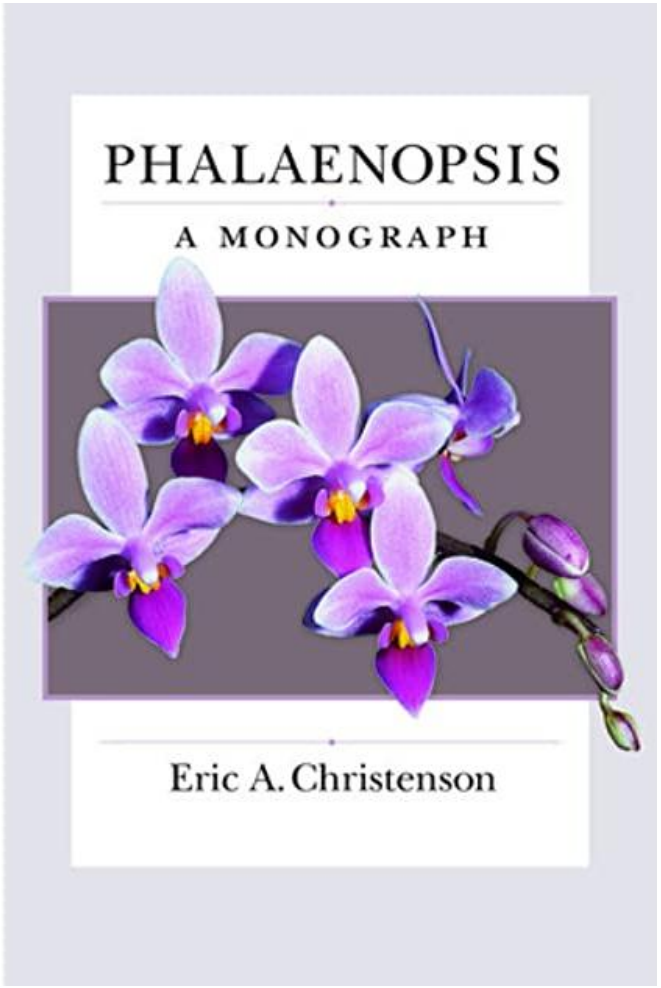
Monographs

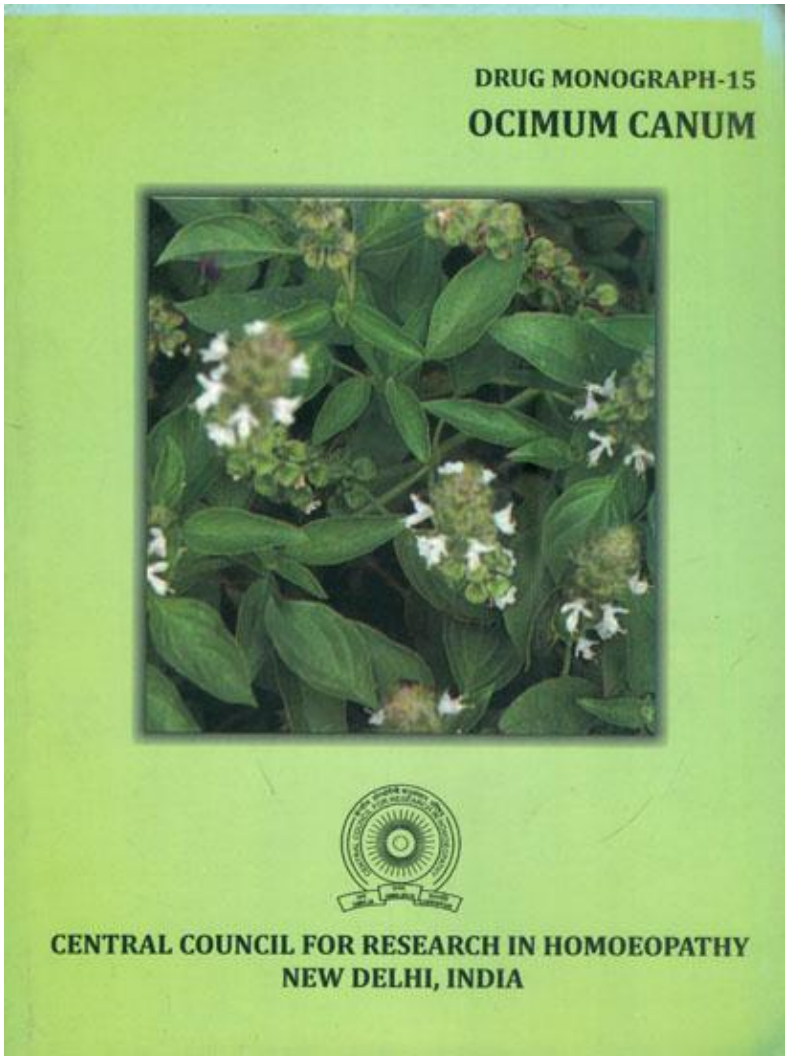
A **monograph** *is a comprehensive taxonomic treatment of a taxonomic group, generally a genus or a family, providing all taxonomic data relating to that group.*

Usually the geographical scope is worldwide since it is impossible to discuss a taxon without including all its members, and often all its species, subspecies, varieties and forms are discussed.

The monograph also includes an exhaustive review of literature, as also a report on author's research work. A monograph includes all information related to nomenclature, designated types, keys, exhaustive description, full synonymy and citation of specimens examined.


MALAYSIAN HERBAL MONOGRAPH COMMITTEE
MALAYSIAN HERBAL MONOGRAPH
VOLUME 2

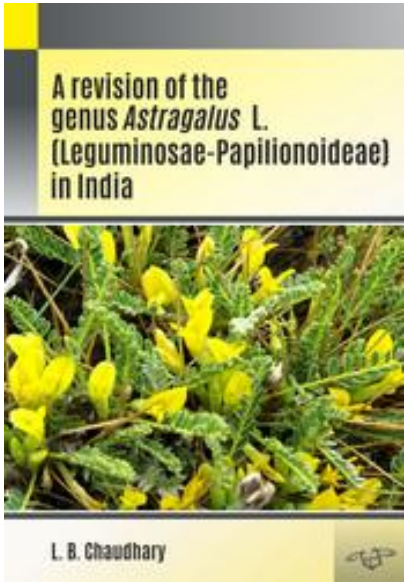

PHALAENOPSIS
A MONOGRAPH
Eric A. Christenson


DRUG MONOGRAPH-15
OCIMUM CANUM
CENTRAL COUNCIL FOR RESEARCH IN HOMOEOPATHY
NEW DELHI, INDIA

REVISION

A revision is less comprehensive than a monograph, incorporating less introductory material and including a synoptic literature review.

A revision includes a complete synonymy but the descriptions are shorter and often confined to diagnostic characters. The geographical scope is usually worldwide.



Keys and their types

IDENTIFICATION WITH KEYS

A key is an artificial arrangement or analytical device whereby a choice is provided between two contradictory statements resulting in the acceptance of one and the rejection of the other. A single pair of contradictory statements in a key is called a couplet. Each statement of a couplet is termed a lead. Leads are usually the best contrasting characters. Characters following the lead are called secondary key characters.

Keys are of two types:

1. Punched cards keys

2. Dichotomous keys.

Punched Cards Keys

These consist of cards having names of all the taxa (i.e. all species, genera or families for which the key is meant) printed on all of them. On one of the corners of each card is printed any one character and a definite number. All the taxa showing this particular character are indicated by a perforation in front of their names, and the taxa lacking this character are without any perforation. The number of the cards and the characters chosen for the purpose are the same. For identifying a plant, only those cards showing characters possessed by this plant, are selected. Combination of characters shown by this plant will allow only one perforation in he selected set of cards. The plant is then referred to that particular family to which he card shows this perforation.

Dichotomous Keys.

These keys consist of pairs of contrasting characters or couplets, each statement of which is a lead. Both the leads are numbered, and begin with the same word as far as possible.

Dichotomous keys are of two general types i.e.

1. Indented key and 2. Bracket key.

(a) In the indented or yoked key, each of the couplets is indented a fixed instance from the left margin of the page. An example of the indented key is given below in the form of identification of 5 common genera of Ranunculaceae (Buttercup family), i.e, Ranunculus, Clematis, Anemone, Aquilegia and Delphinium:

Fruit a group of achenes; unspurred flowers.
Petals absent
Sepals usually 4; involucre absent.....*Clematis*
Sepals usually 5; involucre present.....*Anemone*
Petals present.....*Ranunculus*
Fruit a group of follicles; spurred flowers.
Spurs 5; flowers regular.....*Aquilegia*
Spur 1; flowers irregular.....*Delphinium*

(b) In the *bracket* or *parallel key,* the two couplets are always next to each other in consecutive lines on the page. At the end of each line in the key, there is either a number or a name referring to a couplet. An example of the bracket key is given below, in which all the same five genera of Ranunculaceae (i.e. *Ranunculus, Clematis, Anemone, Aquilegia* and *Delphinium*) are identified:

(1) Fruit a group of achenes; unspurred flowers..... (2)
(1) Fruit a group of follicles; spurred flowers.....(4)
(2) Petals absent.....(3)
(2) Petals present.....*Ranunculus*
(3) Sepals usually 4; involucre absent.....*Clematis*
(3) Sepals usually 5; involucre present.....*Anemone*
(4) Spurs 5; flowers regular.....*Aquilegia*
(4) Spur 1; flowers irregular.....*Delphinium*

Botanical gardens

Botanical gardens are the institutions that maintain the living plant collections of different varieties of plants, including the ornamental and cultivated ones, wild, medicinal, of economic importance, of various geographical regions, of special interest, etc.

A botanical garden or botanic garden is a garden dedicated to the collection, cultivation, preservation and display of a wide range of plants labeled with their botanical names. It may contain specialist plant collections such as cacti and other

succulent plants, herb gardens, plants from particular parts of the world, and so on; there may be greenhouses, shadehouses, again with special collections such as tropical plants, alpine plants, or other exotic plants. Visitor services at a botanical garden might include tours, educational displays, art exhibitions, book rooms, open-air theatrical and musical performances, and other entertainment.

They are of value not only to the botanists, horticulturists and foresters but also to the millions of tourists. A big botanical garden contains plant species from several corners of the globe. It also includes greenhouses, a library, a herbarium, research laboratories, and several miscellaneous resources including photographs, paintings, illustrations, reprints, note-books and specimens of several types. It is, therefore, not merely a garden but a botanical institution.

Modern botanical gardens serve as centres for documentation, research, reference, data storage, education, conservation, and several other biological facilities to mankind.

At present there are over 600 botanical gardens in the world.

Famous botanic gardens of the world are given below:

1. Royal Botanic Garden, Kew, London:

This was a private garden of the Capel family to begin with. In 1728 it was taken over on lease by Prince Frederick, Prince of Wales. From that time it came to be known as the Royal Garden and later was given to the nation by the Royal family.

It gradually developed into one of the best botanic gardens in all aspects by the efforts of the botanists and horticulturists working in the garden. It covers an area of 300 acres and has the world's largest herbarium. The garden has different sections and several large conservatories. Sir Joseph Dalton Hooker, author of 'Flora of British India' and of many other important botanical works including "Genera Plant-arum" giving a natural system of classification of flowering plants jointly with George Bentham, was once a Director of this garden, and John Hutchinson who proposed a new phylogenetic system worked in the herbarium of this garden.

2. Royal Botanic Garden, Edinburgh:

This covers an area of 50 acres. This was at the beginning a garden of medicinal herbs established in the middle of 17th century Later it developed into a botanic garden. It has a beautiful rock garden and a herba-rium with a good collection of specimens from central Asia, among other things.

3. Botanical Garden, Berlin—Dahlem:

The Botanical Garden of Berlin had been situated in 2 other places before it was transferred to Dahlem in 1880. The area of the garden is 103 acres. Associated with it are the Botanical Museum and the Herbarium, both having rich collections? The garden is mainly geographically arranged while in one part arc arranged different families according to the system of classification of Engler and Prantl.

There are large conservatories, good rock-garden and several decorative pools. Prof. Adolf Engler was one of the Directors of this garden, by whose efforts the garden became one of the most important botanic gardens for the scientific arrangement and for the beautiful lay out.

4. Bundrs Garden, Vienna:

This is a large garden and one of the oldest in Europe covering an area of 400 acres. It has a fine Alpine garden with varieties of cool-climate plants collected from high mountains as well as from artic region.

5. Main Botanic Garden, Moscow:

This is the largest Botanic Garden in Europe with an area of 900 acres. It has a long line of conservatories and several tropical houses. Introduction and acclimatization of exotic trees and shrubs is one of the main features of this garden. It has .i large herbarium and good laboratory and library.

6. New York Botanical Garden,New York City

The Bronx’s best-known National Historic Landmark was established in 1891 by botanists Nathaniel Lord Britton and his wife, Elizabeth. Inspired by a visit to Kew Gardens, the couple founded their own botanical paradise on the north side of Bronx Park, close to an old-growth forest and the babbling Bronx River. Nearly 130 years and 250 acres later, that picturesque greenspace has morphed into the New York Botanical Garden, the largest city-based botanical garden in the

United States. Its 50 specialty gardens feature more than a million plants and 12,000 species, including lilacs and magnolias. Highlights of any visit include a stroll through the Victorian-style glasshouse conservatory, the impressive northeastern North American native plant garden, and what is widely considered one of the world's most sustainable rose gardens. With that kind of cache, it's no surprise the NYBG also books marquee exhibitions.

Famous Botanical Gardens in India

The following points highlight the top five botanical gardens in India. They are: 1. Indian Botanical Garden, Kolkata 2. National Botanical Garden, Lucknow 3. Lalbagh or The Mysore State Botanical Garden, Bangalore 4. Botanical Garden of Forest Research Institute, Dehradun 5. Lloyd Botanic Garden, Darjeeling.

1.Indian Botanical Garden, Kolkata:

This famous botanical garden which is the largest and oldest of its kind in India, and considered to be the oldest botanical garden in South East Asia, is located at Shibpur near Kolkata, on the west bank of the river Hooghly. It was founded by Lt. Col. Robert Kyd in 1787, with an aim to establish a stock of plants which may be disseminated and prove beneficial to the inhabitants, rather than with a purpose of collecting rare plants as things of mere curiosity or furnishing articles for the gratification of luxury. Thus, this garden has long been known for its distinct role in the introduction, naturalization and development, as well as expanding cultivation of tea, jute, cinchona, teak and mahogany in India. Lt. Kyd was later succeeded by William Roxburg in 1787. He is considered as the Father of Indian Botany, and held the post of the second director till 1813. It was he who founded the famous herbarium of this garden. Presently, the garden is under the control of Botanical Survey of India and Dr. K. Biswas, was the first Indian to be appointed as Superintendent of this garden in 1937.

Covering an area of 110 hectares of land, this garden has nearly 12,000 living plants from various countries of the world. The chief attraction of this garden is the great Banyan tree, which is considered to be more than 200 years old and has over 1600 aerial roots actually rooted to the ground. This gives it a look of a miniature forest with a circumference of about 404 meter, and maximum height of about 30 meter. The other major attractions of this garden are its well-

maintained Bambusatum, the Orchid house, Pinetum, Cacti-collection, Fernary, the Palm house including the creeper Porana paniculata and the branching palm Hyphaene thebaca.One of the latest inclusions of this palm house is the double coconut (Lodoicea maldivica), palm like tree [Family – Arecaceae (Palmae)], also known as coco de mer, of the Seychelles, which produces a two-lobed edible nut, one of the largest known fruits from Maldives.This species grows only on a very small island named Praslin, located in the Seychelles Archipielago, in the Indian Ocean and has the world's largest and heaviest seed, measuring 12 inches in length and nearly 3 feet in circumference and with a weight of about 40 pounds, which looks like two coconuts fused together. The giant water lily of the Amazon, Victoria amazonica, which can hold a baby of 5 kilograms, is grown in the ponds of this garden, which attracts visitors and scientists all round the year. With its library, herbarium, laboratories and offices located within the garden, it has become a centre for valuable scientific communication and research.

2.National Botanical Garden, Lucknow:

This garden situated on the banks of river Gomti, was established in 1789, by the emperor Nawab Sadat Ali Khan. It was named as Sikander Bagh by Nawab Wajid Ali Shah, in remembrance of his beloved wife Begum Sikander Mahal. It was later converted into a Botanical Garden in 1946 with Professor K.N. Kaul as its first director and is now known as the National Botanical Research Institute, Lucknow, which is one of the numerous national laboratories under the Council of Scientific and Industrial Research. It also has a sub-centre at Banthra, about 20 kms. from Lucknow, covering an area of 120 hectares, where economic plants are grown on large scale.

The main garden covers an area of 30 hectares and is famous for its Palm house, Fern house, Rosarium, Cactus house, Orchid house, orchards of mango, guava and Citrus and medicinal plants section. Attached with this garden are a herbarium, library and laboratories carrying on extensive research in various fields of Botany.

3.Lalbagh or The Mysore State Botanical Garden, Bangalore:

This is the best botanical garden in South India, which was named 'Lalbagh' by Hyder Ali in 1760 because of its beautiful rose garden and red flowers. Its first director was Major Waugh (1799- 1819), who introduced a number of exotic plants from various countries into this garden. Later, this garden was converted into a proper botanical garden in 1856 and Rao Bahadur H.C. Jayaraja was its first Indian director. This garden is now famous for its beautiful layout and as a big centre of horticultural activities. It has a grape orchard, economic garden, a herbal garden, a tropical nursery and well-equipped laboratories for seed testing and soil testing.

4.Botanical Garden of Forest Research Institute, Dehradun:

This garden was established at Dehradun in 1934 by C.E. Parkinson. It covers an area of 20 acres and is the major centre of research in problems related to plant introduction. It now has about 700 different species of plants from different countries of the world, a green house, a cactus house and a Plant Introductory Nursery. It also has a large herbarium attached with it.

5. Lloyd Botanic Garden, Darjeeling:

This garden situated at an altitude of about 2100 meters in the heart of Darjeeling town, West Bengal was established as a branch of the then Royal Botanic Garden, Kolkata, in 1878 by William Lloyd, after whom it was named. Today, it stretches over an area of 40 acres. Initially it served as a nursery for the cultivation of many exotic ornamental plants. It now has a rich collection of many Indian and foreign plants from the temperate region.

The garden has been divided into seven divisions: an orchid house having more than 46 orchids, a large conservatory and a small conservatory, a cactus house having about 40 species of Cacti, a herbarium, a living fossil and a rock garden which is a botanist's paradise conserving some rare species of plants, most of them with ethno-medicinal importance. The most frequented spots on this track are the areas housing the two living fossils – Ginkgo biloba and Metasequoia glyptostroboides. The conservatories have some of the most endangered plant species from different parts of the world. The most interesting plant over here is the 118 year-old woody climber Wisteria chinensis. The herbarium contains about 3230 species of different plants belonging to 173 families.

Preparation and role of Herbarium

A herbarium is a collection of pressed and dried plant specimens arranged in some systematic order that facilitates examination of all of the material of a particular taxon.

The aim of an herbarium is to accumulate in one place all possible information about the habits, habitats, variations and uses of all the plants with which it may be concerned. An herbarium may be concerned with a particular local area, such as a township, county, or state, or it may attempt to cover a nation, a continent or the world. It may attempt to accumulate all information available about a single taxon, such as a species, or about a few taxa, such as those included in a genus or a family, or it may attempt to contain information about all of the kinds of plants. It may deal with cultivated plants, wild plants, or both. However big or small it may be, it is a repository of information and a research tool of considerable value.

The preparation of a herbarium involves:

(i) Field visits,

(ii) Collection of specimens

(iii) Drying,

(iv) Mounting on a herbarium sheet,

(v) Preservation,

(vi) Labelling and

(vii) Proper storage.

(a) Field visits and specimen collection:

A complete specimen possesses all parts including root system, flowers and fruits. Therefore, regular field visits are necessary to obtain information at every stage of growth and reproduction of a plant species. In the fields, the tools required are mainly trowel (digger) for digging roots, scissors and knife for cutting twigs, a stick with a hook for collection of parts of tall trees, a field note book, polythene bag, old newspaper and magazines.

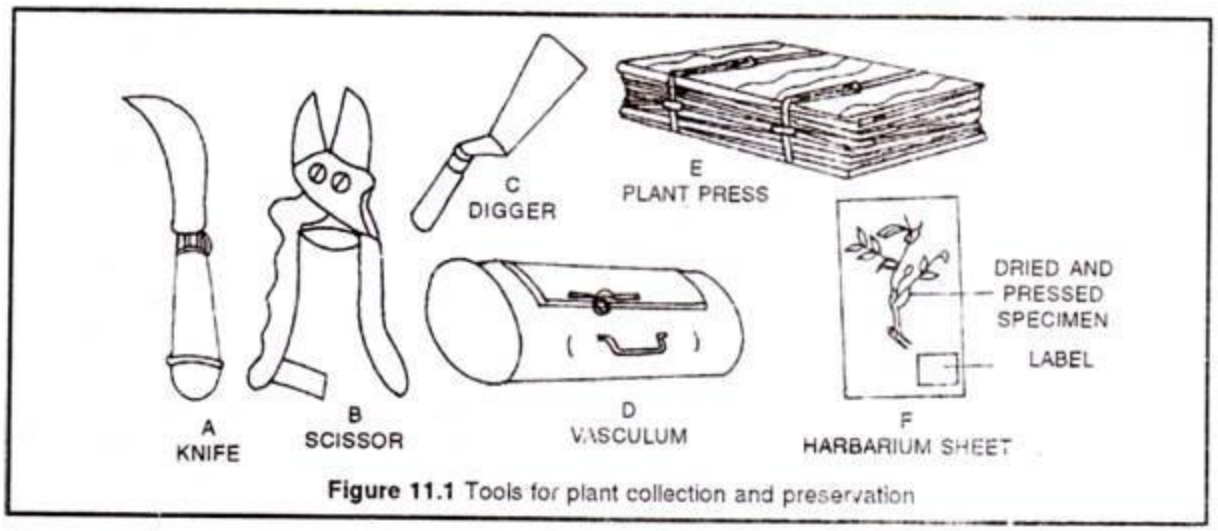


Figure 11.1 Tools for plant collection and preservation

To avoid damage during transportation and preservation at least 5-G specimens of a plant should by collected. The collected specimens are transported in a vasculum (specimen box) to prevent willing, livery collected specimen must be tagged with a field number and necessary information should be recorded in a field note book.

Tools for plant collection and presevation

(b) Pressing and drying:

The specimens are spread out between the folds of old newspapers or blotting sheets avoiding overlapping of parts. The larger specimen may' folded in 'N' or' W' shapes. The blotting sheets with plant specimen should be placed in the plant press for drying. After 24 to 48 hrs the press is opened.

(c) Mounting:

The dried specimens are mounted on herbarium sheets of standard size (41 x 29 cm). Mounting is done with die help of glue, adhesive or cello-tape. The bulky plant parts like dry fruits seeds, cones etc. are dried without pressing and are put in small envelops called fragment packets. Succulent plants are not mounted on herbarium sheets but are collected in 4% formalin or FAA (Formalin Acetic Alcohol).

(d) Preservation:

The mounted specimens are sprayed with fungicides like 2% solution of mercuric chloride.

(e) Labelling:

A label is pasted or printed on the lower right hand corner. The label should indicate the information about the locality, altitude, habit, date and lime of collection, name of collector, common name, complete scientific name etc.

(f) Storage:

Properly dried, pressed and identified plant specimens are placed in thin paper folds (specimen covers) which are kept together in thicker paper folders genus overs), and finally they are incorporated into the herbarium cupboards in their proper position according to a well known system of classification. In India Bentham and Hooker's system of classification is used for' his purpose. Type specimens are generally stored in separate and safe places.