BENTHAM AND HOOKER'S SYSTEM OF PLANT CLASSIFICATION

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The most accepted natural system of classification of seed plants is that of Bentham and Hooker. It is a natural system of classification and is based on important characters of the plants. Even today this system is being followed in India, United Kingdom and several other Commonwealth countries. It is also used in a number of herbaria and botanical gardens all over the world. It is a well-known and widely accepted classification of seeded plants. It was proposed by two **British botanists George Bentham** (1800-1884) and **Sir Joseph Dalton Hooker** (1817-1911). They were associated with Royal Botanical Garden at Kew and adopted a very comprehensive system of classification which is purely natural and most convenient and extremely suitable system for practical utility in identification of plants providing them, their respective taxon. This was the greatest taxonomic work ever produced in the United Kingdom and has ever since been an inspiration to generations of Kew botanists. Their system of classification was published in '***Genera Plantarum***' in three volumes and they had described **97,205 species** of seeded plants in **202 orders (now referred to as families**). This three-volume monumental work which required quarter of a century, comprised description of all genera of seed plants known to science at that time and they were classified according to the system proposed by them. This system was published well before there were internationally accepted rules for botanical nomenclature. It indicates a **family** by "**order**"; an **order** is indicated by "**cohorts**" (in the first two volumes) or "**series**" (in the third volume); in the first two volumes "**series**" refers to a rank above that of **order**. The system of classification by Bentham and Hooker is based on groups of plant characters which are correlated with each other. For example, if a specimen consistently shows syngenesious stamens, inferior, bicarpellary, unilocular ovary, with basal placentation, then it can confidently be assigned to the family Compositae. Basically, it is on the same basis as that of the de Candolle but with some modifications such as greater emphasis on the free and fused condition of petals.

SALIENT FEATURES OF CLASSIFICATION

1. This system includes the names and descriptions of all genera, of seed plants known so far and classified accordingly.
2. This system divided seed plants into 97,205 species under 202 order or families.
3. They divide seed plants into three classes in sequence- Discotyledon, Gymnosperm and Monocotyledon. 4. Dicots divided into 3-divisions and 14 series on the basis of the natural and visual characteristic which provides key for identification.
5. Dicots started with family Ranunculaceae having free sepals and petals and indefinite number of stamens and carpels where as it ends with Labiatae having fused sepals and petals with definite number of carpels and stamens.
6. Among monocots out of seven series with epigynous flower i.e. Orchidaceous and Scitamineae were kept first and second respectively followed by with petaloid hypogynous flowers and finally ended with Graminae and Cyperaceous.

Table 1 Number of orders, genera and families described by Bentham and Hooker

PLANT GROUPS	ORDERS (FAMILIES)	GENERA	SPECIES
Dicotyledons			
a. Polypetalae	82	2610	31872
b. Gamopetalae	45	2619	34554
c. Monochlamydae	36	801	11784
Gymnosperms	3	44	415
Monocotyledons	34	1495	18576

OUTLINE OF CLASSIFICATION SYSTEM PROPOSED BY BENTHAM AND HOOKER

An outline of this classification system is presented here, but we name Cohorts and Ordines (Ordos) of Bentham and Hooker, respectively as Orders and Families. The seeded plants are divided into three classes Dicotyledonae, Gymnospermae and Monocotyledonae.

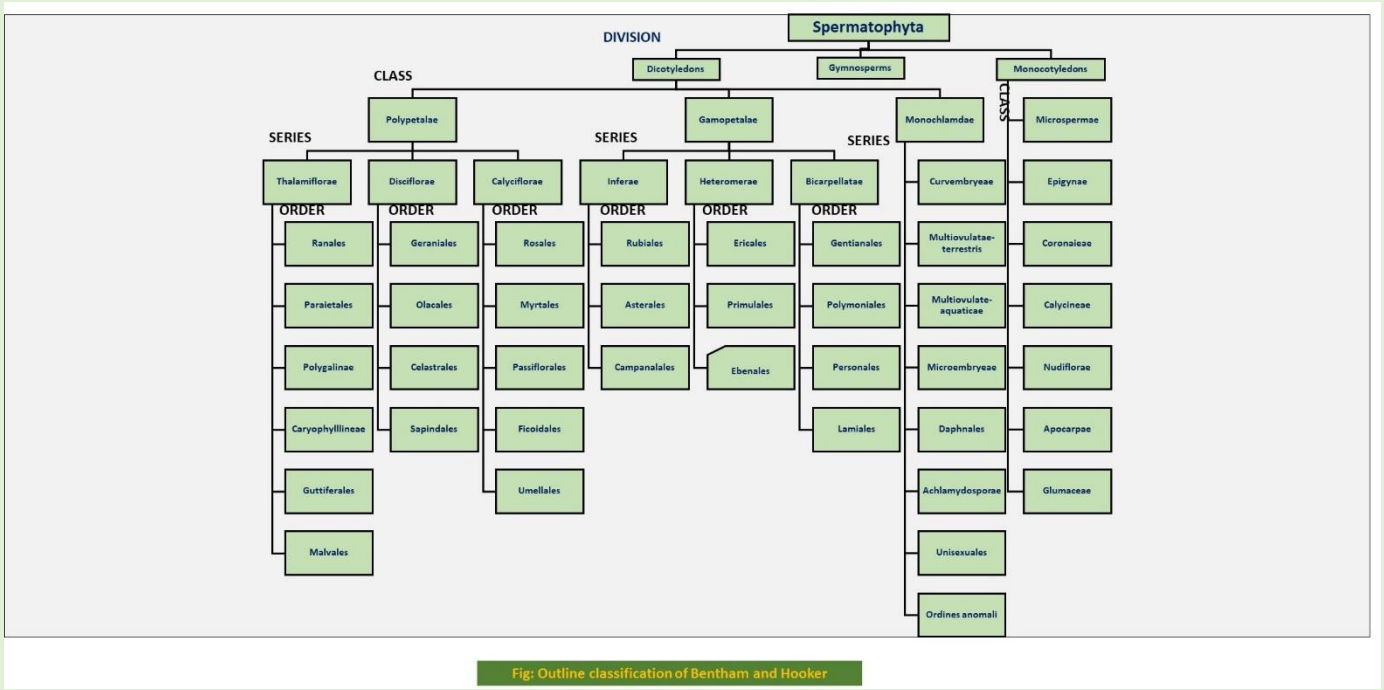

Fig: Outline classification of Bentham and Hooker

Class-I Dicotyledonae

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

- It includes three sub-classes **Polypetalae, Gamopetalae and Monochlamydeae**.

Sub-class 1. 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. Petals and stamens hypogynous, Disc present. Thalamiflorae includes **6 orders and 34 families**. The six orders or cohorts and the respective families are

Orders or cohorts

I. **Ranales** : Families: Ranunculaceae, Dilleniaceae, Calycanthaceae, Magnoliaceae, Anonaceae, Menispermaceae, Berberideae, and Nymphaceae.
II. **Paraietales :** Families: Sarraceniaceae, Papaveraceae, Cruciferae, Capparideae, Resedaceae, Cistineae, Violarieae, Canellaceae and Bixineae.
III. **Polygalineae** : Families Pittosporeae, Tremandreae, Polygalae and Vochysiaceaaaaae.
IV. **Caryophyllineae:** Families: Frankeniaceae, Caryophylleae, Portulaceae and Tamariscinea.
V. **Guttiferales:** Families: Elatineae, Hypericineae, Guttiferae, Ternstroemiaceae, Dipterocarpeae and Chlenaceae; and
VI. **Malvales:** Families: Malvaceae, Sterculiaceae and Tiliaceae.

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**. The four orders or cohorts and the respective families of Disciflorae are

Orders or cohorts

I. **Geraniales:** Families: Lineae, Humiriaceae, Malpighiaceae, Zygophylleae, Geraniaceae, Rutaceae, Simarubeae, Ochnaceae, Burseraceae, Meliaceae and Chailletiaceae.

II. **Olacales:** Families: Olacineae, Ilicineae and Cyrillaceae.
III. **Celastrales:** Families: Celastrineae, Stackhousieae, Rhamneae and Mpelideae; and
IV. **Sapindales :** Families: Sapindaceae, Sabiaceae, Anacardiaceae, Coriariae and Moringeae.

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. The five orders or cohorts of Calyciflorae and their respective families are

Orders or cohorts

I. **Rosales:** Families: Connaraceae, Leguminosae, Rosaceae, Saxifragaceae,Crassulaceae, Droseraceae, Hamamelideae, Bruniaceae and Halorageae.
II. **Myrtales:** Families: Rhizophoreae, Combretaceae, Myrtaceae, Melastomaceae, Lythrarieae and Onagrarieae.
III. **Passiflorales:** Families: Samydaceae, Loaseae, Turneraceae, Passifloreae, Cucurbitaceae, Begoniaceae and Datisceae.
IV. **Ficoidales :** Families: Cacteae and Ficioideae; and
V. **Umbellales:** Families: Umbelliferae, Araliaceae and Cornacea).

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. The three cohorts of Inferae are

Orders or cohorts

I. **Rubiales:** Families: Caprifoliaceae and Rubiaceae.
II. **Asterales:** Families: Valerianeae, Dipsaceae, Calcereae and Compositae; and
III. **Campanales:** Families: Stylidieae, Goodenovieae and Campanulaceae.

Series-II Heteromerae

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

Orders or cohorts

I. **Ericales :** Families: Vacciniaceae, Ericaceae, Monotropeae, Epacrideae, Diapensiaceae and Lennoaceae.
II. **Primulales:** Families: Plumbagineae,Primulaceae and Myrsineae; and
III. **Ebenales:** Families: Sapotaceae, Ebenaceae and Styraceae.

Series-III Bicarpellatae

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

Orders or cohorts

I. **Gentianales:** Families: Oleaceae, Salvadoraceae, Apocynaceae, Asclepiadeae, Loganiaceae and Gentianeae.
II. **Polemoniales:** Families: Polemoniaceae, Hydrophyllaceae, Boragineae, Convolvulaceae and Solanaceae.
III. **Personales:** Families: Scrophularineae, Orobranchaceae, Lentibularieae, Columelliaceae, Gesneraceae, Bignoniaceae, Pedalineae and Acanthaceae; and
IV. **Lamiales :** Families: Myoporineae, Selagineae, Verbenaceae, Labiatae and Plantagineae.

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 whorls are absent. Monochlamydeae includes 8 series and 36 families.

(i) Curembryeae (embryo curved round the endosperm, ovule usually one). Curembryeae is represented by families like

Nyctagineae, Illecebraceae, Amarantaceae, Chenopodiaceae, Phytolaccaceae, Batideae and Polygonaceae.
(ii) **Multiovulate aquaticae** (aquatics with numerous ovules). It is represented by a single family of Podostemonaceae.
(iii) **Multiovulate terrestris** (terrestrial plants with numerous ovules). The various families of the series are Nepenthaceae, Cytinaceae and Aristolochiaceae.
(iv) Microembryeae (embryo very small in copious endosperm). Piperaceae, Chlorantaceae, Myristiceae and Monimiaceae are its representative families.
(v) Daphnales (ovary usually with one carpel and single ovule). Daphnales is represented by families like Laurineae, Proteaceae, Thymelaceae, Penaeaceae and Elaeagnaceae.
(vi) Achlamydosporae (ovary usually inferior, unilocular and one to three ovuled). It is represented by families like Loranthacceae, Santalaceae and Balanophoreae.
(vii) Unisexualis (flowers unisexual). The various families of Unisexualis are Euphorbiaceae, Balanopeae, Urticaceae, Platanaceae, Leitnerieae, Juglandeae, Myricaceae, Casuarineae and Cupuliferae.
(viii) Ordines anomali (the families of uncertain relationship were placed in this series). The various families of Ordines anomaly are Salicineae, Lacistemaceae, Empetraceae and Cerastophlleae.

Class II Gymnospermae

The members of this class have naked ovules or seeds. Ovary is absent and gymnospermae includes three families –
Family I. **Gnetaceae**
Family I. **Coniferae and**
Family I. **Cycadaceae**.

Class-III Monocotyledons

Usually herbs, some are shrubs, seed with one cotyledon in embryo. It includes seven series, viz
Series (i) Microspermae (ovary inferior, seeds very small). The various families of Microspermae are Hydrocharideae, Burmanniaceae and Orchideae.
Series (ii) Epigynae (ovary usually inferior, seeds large). The various families of Epigynae are Scitamineae, Bromeliaceae, Haemodoraceae, Iirideae, Amaryllideae,Taccaceae and Dioscoreaceae.
Series (iii) Coronarieae (perianth petaloid, ovary superior). The various families of Coronarieae are Roxburghiaceae, Liliaceae, Pontederiaceae, Philydraceae, Xyrideae, Mayaceae,. Commelinaceae and Rapateaceae.
Series (iv) Calycinae (perianth sepaloid, ovary superior). Calycinae include families like Flagellarieae, Juncaceae and Palmae.
Series (v) Nudiflorae (perianth mostly lacking, ovary superior). Nudiflorae include the families like Pandaneae, Cyclanthaceae,Typhaceae, Aroideae and Lemnaceae.
Series (vi) Apocarpae (carpels free). The Apocarpae is represented by families like Triurideae, Alismaceae and Naiadaceae. **Series (vii) Glumaceae** (perianth small, scale-like or chaffy). The Glumaceae is represented by families like Eriocauleae, Centrolepideae, Restiaceae, Cyperaceae and Gramineae.

MERITS AND DEMERITS OF BENTHAM AND HOOKER'S SYSTEM OF CLASSIFICATION

From this classification, it is understood that if we proceed from the beginning considering the morphological characters of a species we can easily identify it to place it in its specific taxon not a single classification can claim to be perfect, satisfactory and free of vice. This fact forms the basis for the wide array of classificatory systems from time to time. The above system is no exception and a number of its merits and demerits have come to limelight.

MERITS

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. Each family had a synopsis at the beginning which is very useful in identification.
6. The gamopetalae placed after polypetalae is justified since union of petals is considered to be an advanced feature.
7. Treating Cucurbitaceae and Umballiferae at the end of Polypetalae as connecting links between polypetalous and gamopetalous families.
8. Creation of Monochlamydeae at the end of Dicots.
9. Disputed families included in Ordines anomaly.
10. Placing of unisexual monocot families after bisexual families e.g. Palmae and Araceae after Liliaceae.
11. The series Glumaceae with extremely reduced flowers and inflorescences, placed at the end of the flowering plants.
12. The placement of monocotyledonae after the dicotyledonae also appears to be in accordance with the evolutionary trends.
13. The system was never conceived by its authors on the basis of phylogeny. The theory of organic evolution was announced independently by Darwin and Wallace in 1869. So, any criticism of the system on the basis of phylogeny is not too justified.

DEMERITS

1. The system does not give any idea as to the evolutionary history of any genus, family or order.
2. In this system grouping of plants is mainly based on single and artificial characters, with the result, that closely allied families are widely apart.
3. The group Monochlamydeae is entirely artificial.
4. The placement of Gymnospermae in between dicotyledonae and monocotyledonae is an error.
5. Several important floral characters have been neglected in this system.
6. Advanced family Orchidaceae has been considered as primitive among monocotyledons and it is placed in the beginning of the system.
7. 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.
8. 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.
9. The position of series Apicarpae is unsatisfactory due to its free and superior carpels.
However, in spite of all its disadvantages, the Bentham and Hooker system is still very popular in many countries, because identification of plants in the field is comparatively easy. It is followed in the Kew Herbarium for the arrangement of plant specimens, as also in many other herbaria, particularly those of the Commonwealth countries.

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