جامعة الملك سعود
King Saud University

PRINCIPLES OF FLOWERING PLANT TAXONOMY

BOT 222

Professor (Dr.) M. Ajmal Ali, PhD

Updated
22 Feb 2026

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA

2024
TP-153

Course Specification
(Bachelor)

Course Title:	Principles of Flowering Plant Taxonomy
Course Code:	BOT 222
Program:	BSc in Botany
Department:	Botany and Microbiology
College:	Science
Institution:	King Saud University
Version:	4th
Last Revision Date:	2/22/2026

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Education & Training Evaluation Commission

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: 3

3 (2+0+1)

2. Course type

A.	☐University	☐College	☒ Department	☐Track	☐Others
B.	☒ Required		☐Elective		

3. Level/year at which this course is offered: (5th /2nd)

4. Course General Description:

This course introduces the fundamental principles of flowering plant taxonomy with emphasis on morphological characters, botanical terminology, and identification of major angiosperm families. Students gain practical experience in using taxonomic keys and preparing herbarium specimens, forming a foundation for advanced systematic and evolutionary studies in later levels.

5. Pre-requirements for this course (if any):

BOT 102

6. Co-requisites for this course (if any):

NA

7. Course Main Objective(s):

1. To introduce the fundamental principles of flowering plant taxonomy, including botanical nomenclature and morphological terminology.
2. To develop students' skills in identifying major angiosperm families using diagnostic characters and taxonomic keys.
3. To provide practical training in herbarium preparation, plant description, and the ethical handling of plant collections.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	%100
2	Blended		
3	• E-learning		
4	Distance learning		
5	Other		

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3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	Lectures	30
2.	Laboratory/Studio	30
3.	Tutorial	
4.	Others (specify)	
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods: By the end of this course students will be able to:

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	Explain the basic principles and rules of the International Code of Botanical Nomenclature (ICBN).	K1, K2	Interactive lectures, guided discussion, and short exercises	Written exams (MCQ & short answers), quizzes
1.2	Recognize diagnostic features of selected major angiosperm families.	K3	Lab sessions, comparative tables, and group discussion	Practical exam, oral questioning
2.0	Skills			
2.1	Apply taxonomic keys to identify unknown plant specimens.	S1	Laboratory training	Practical exam
2.2	Construct accurate floral diagrams and longitudinal sections based on flower dissection.	S2	Guided hands-on dissection	reports sheets +Practical Lab Exam
3.0	Values, autonomy, and responsibility			
3.1	Work collaboratively in taxonomic tasks	V1	Group activities, peer collaboration	instructor observation

C. Course Content:

No		Contact Hours
1.	Introduction to the science of taxonomy	1
2.	Taxonomic systems used in each stage of study and the most famous scientists	2
3.	Deal With the formal variation of flowers as the basis used in this science, with an understanding of their scientific terms	4
4.	Nomenclature	2
5.	Floral characters (Calyx, Corolla, Androecium, Gynaecium and Inflorescences)	6
6.	Inflorescences	4
7.	Placentation	2
8.	Floral diagram	2
9.	Floral formula	2
10	Fruits	2
11	The plant families	5
	Total	30

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	First monthly exam	7th	10%
2.	Second monthly exam	14th	10%
3.	Attendance: Topic presentation and discussion	1-14th	10%
4.	Practical	1-14th	30%
5	Final exam	15th	40%
	Total		100

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	T. G. Lammers, *Course Manual: Biol 304/504 Plant Taxonomy,* 3rd ed. (UWO Doc Services, 2007).. :
Supportive References	Journals in Plant Taxonomy Science
Electronic Materials	https://letstalkscience.ca/educational-resources/backgrounders/plant-taxonomy https://employees.csbsju.edu/SSAUPE/biol308/lecture_notes.htm

Other Learning Materials	Computer-based programs/CD, professional standards

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	The lecture room is provided with a data show projector. e-learning room to enable students to read and revise the course. Internet to search for new technology concerning the course- -Laboratories with many facilities e.g. dissecting microscopes. -Botanical Garden in Department.
Technology equipment (projector, smart board, software)	AV, data show, Smart Board
Other equipment (depending on the nature of the specialty)	Available

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Instructor or the Department	Peer to Peer Reviewing
Effectiveness of Students assessment	Students	Through three student surveys
Quality of learning resources	Students & Faculty	Evaluation survey,
The extent to which CLOs have been achieved	Faculty	Course report, analysis of the course evaluation survey, a sample of assignments, homework, answer sheets, and student grades.
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	ACADEMIC ACCREDITATION COMMITTEE FOR THE DEPARTMENT OF BOTANY AND MICROBIOLOGY
REFERENCE NO.	
2/22/2026DATE	2/22/2026

1. Introduction to Plant Taxonomy

What is Taxonomy / Systematics ?

Q: Why we keep the stuffs of our home at the fixed place or arrange into some kinds of system?

Animal group	No. of species
Amphibians	6,199
Birds	9,956
Fish	30,000
Mammals	5,416
Reptiles	8,240
Subtotal	59,811
Insects	950,000
Molluscs	81,000
Crustaceans	40,000
Corals	2,175
Others	130,200
Total	1,203,375

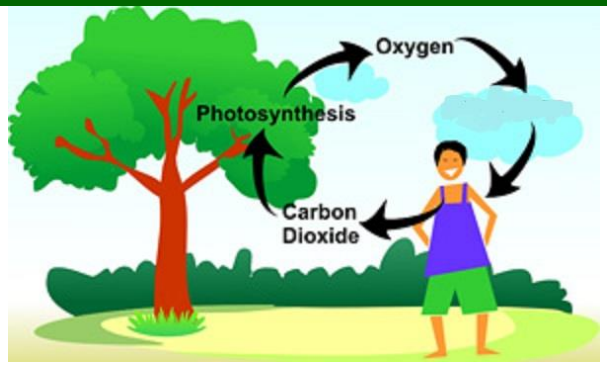
- Every Human being is a Taxonomist

Plants	No. of species
Mosses	15,000
Ferns and allies	13,025
Gymnosperms	980
Dicotyledons	199,350
Monocotyledons	59,300
Green Algae	3,715
Red Algae	5,956
Lichens	10,000
Mushrooms	16,000
Brown Algae	2,849
Subtotal	28,849
Total	1,589,361

- We have millions of different kind of plants, animals and microorganism. We need to scientifically identify, name and classify all the living organism.
- Taxonomy / Systematics is the branch of science deals with classification of organism.
- Q. What is Plant Taxonomy / Plant systematics

We study plants because:

❑ Plants produce oxygen. We breathe oxygen. We cannot live without oxygen.



❑ Plants convert Carbon dioxide gas into sugars through the process of photosynthesis.

❑ Every things we eat comes directly or indirectly from plants.

❑ Plants provide fibres for paper or fabric.

❑ Many chemicals produced by the plants used as medicine.

❑ Study of plants science helps to conserve endangered plants.

❑ Study of plants science helps to learn more about the natural world

❑ Plants can be a source of biofuels. Sugars, starches and cellulose can be fermented into ethanol. Ethanol is used as fuel.

❖ **We have millions of different kind of plants, animals and microorganism. We need to scientifically identify, name and classify all the living organism**

1. Introduction to Plant Taxonomy

- Plant taxonomy is the science of the identification, naming, and classification of plants.
- It provides a universal system for recognizing plant diversity.
- Taxonomy organizes plants into hierarchical categories such as family, genus, and species.
- It helps understand evolutionary relationships among plants.
- Taxonomy supports biodiversity conservation and ecological studies.
- Morphological characters traditionally formed the basis of classification.
- Modern taxonomy integrates molecular and genetic evidence.
- Herbarium specimens serve as permanent taxonomic references.
- Identification keys assist in recognizing unknown plants.
- Plant taxonomy forms the foundation of all botanical sciences.

Taxonomic Hierarchy

Carrolus Linnaeus first adopted the hierarchic system of taxonomy classification in 1753. The succession groups are as follow:

Species:

- **Organisms sharing a set of biological traits and reproducing only their exact kind.**
- **The lowest major group, representing plants and animals referred to as Species.**
- **Species is the fundamental unit in taxonomy**

Genus: Genus are the closely related species

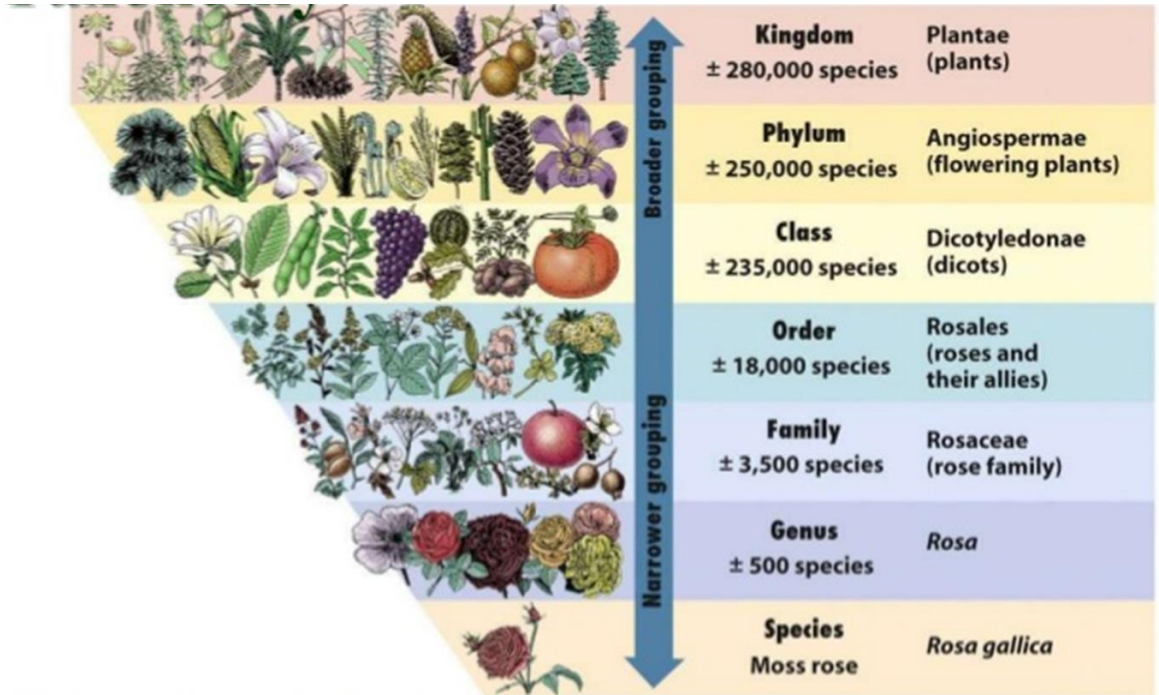
Family : Family is the closely related genera

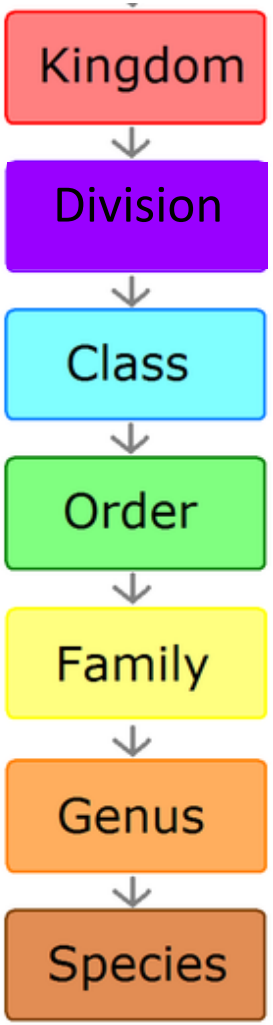
Order : Order is the closely related families

Class : Class are the closely related order

Division / Phylum: Division or Phylum is the related classes

Kingdom: Kingdom is the related Division / Phylum



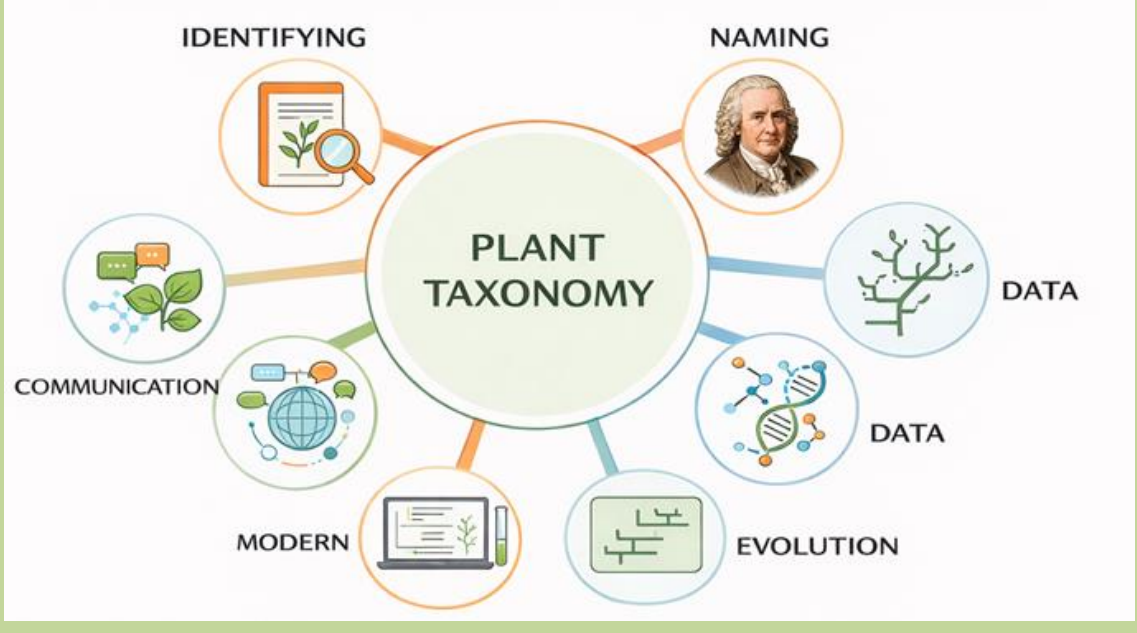


Objective / Goals / Aims of Plant Taxonomy

- To provide an inventory of plant taxa for local, regional or continental needs.
- To establish a suitable method for the identification, nomenclature, and description of plant taxa.
- Classification of organisms into classes, orders, Families, Genera, and species
- To provide significantly valuable information concerning wild and medicinal species, endangered species, unique plants, genetic and ecological diversity

Scope of Taxonomy

- Taxonomy is one of the oldest sciences.
- It provides thorough knowledge of living species and their various forms.
- All the branches of biology are dependent on taxonomy for the proper identification of the species.
- It has been proceeded further, incorporating data from phytochemistry and cytogenetics, supported by proper computation.



Basic components (Principles) of Plant Taxonomy / Plant Systematics

1) Plant Collection, Preservation, and Documentation

2) Plant Structure (Taxonomic Terminology, Taxonomic description of external and internal morphology)

3) Taxonomic Identification

4) Scientific Nomenclature / Botanical nomenclature: Nomenclature deals with the application of a correct name to a plant or a taxonomic group. Scientific names are necessary because the same common name is used for different plants in different areas of the world.

5) Taxonomic Classification (History and Systems of Plant Classification)

6) Taxonomic evidence / Source of data (Morphology, Anatomy, Embryology, Palynology, Micromorphology, Chemistry, DNA, etc.) in plant taxonomy

Basic components of Plant Taxonomy

***Phoenix dactylifera* L**

Taxonomic Identification

Stems solitary or clustered and then with few shoots, to 30 m tall, to 50 cm in diam., rough with persistent, diamond-shaped leaf bases. Leaves 3–5 m; sheath and petiole to 1 m; rachis 1–2 m; acanthophylls many per side of rachis; pinnae to 200 per side of rachis, linear, irregularly arranged and spreading in different planes; middle pinnae to 40 × 2 cm. Male inflorescences erect, to 1 m, with many rachillae, these ca. 30 cm; female inflorescences erect, becoming pendulous, to 2 m, with to 150 rachillae, these to 40 cm. Fruits variable in shape, usually oblong, to 7 × 3 cm, brown or black; endosperm homogeneous.

Taxonomic description (Plant Morphology)

Plant Classification

Kingdom: Plantae
Class: Angiosperms
Order: Arecales
Family: Arecaceae
Genus: *Phoenix*
Species: *Phoenix dactylifera*

Scientific name / Botanical Nomenclature

Types of Taxonomy / Taxonomic Studies / Plant Taxonomic Classification

From the various stages of classification, the types of taxonomy are defined: -

❖ **Alpha (α) Taxonomy / classical taxonomy:-**

It involves description and naming of organisms. It is the parent of other types of taxonomy.

❖ **Beta (β) Taxonomy: -**

In addition to morphological description, it also involves consideration of affinities and their inter-relationship between separate group of species.

❖ **Gama (ɣ) Taxonomy: -**

It is concerned with description, inter-relationship and evolution of one species from the other.

❖ **Omega (Ω) Taxonomy: -**

It is the modern experimental taxonomy in which the taxonomic activities have been enriched with data from ecology, phyto-chemistry, phyto-geography, cyto-genetics and physiology coupled with adequate computation.

Alpha (α) Taxonomy / classical taxonomy:

Plant collection, Preservation and Documentation

Herbarium: Plant collecting, Preservation and Documentation

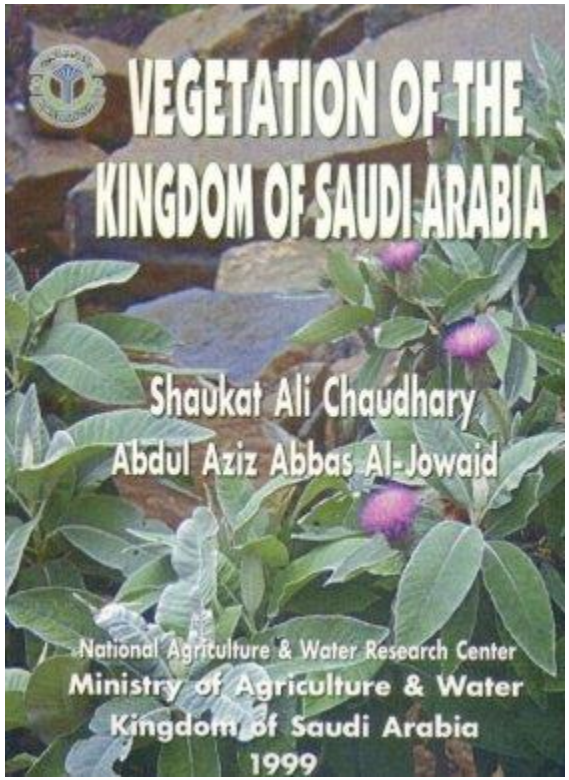
- **A HERBARIUM is a collection of dried plants systematically named and arranged for ready reference and study.**
- **To make a herbarium specimen, the plant is collected, and notes are made about it. The plant is then pressed until dry between blotters that absorb moisture and mounted onto a herbarium sheet with a suitable label, and stored in steel cabinet arranged into some system of classification.**
- **Herbarium techniques involve : (i) Collection, (ii) Drying, (iii) Poisoning, (iv) Mounting, (v) Stitching, (vi) Labelling, and (vii) Deposition.**



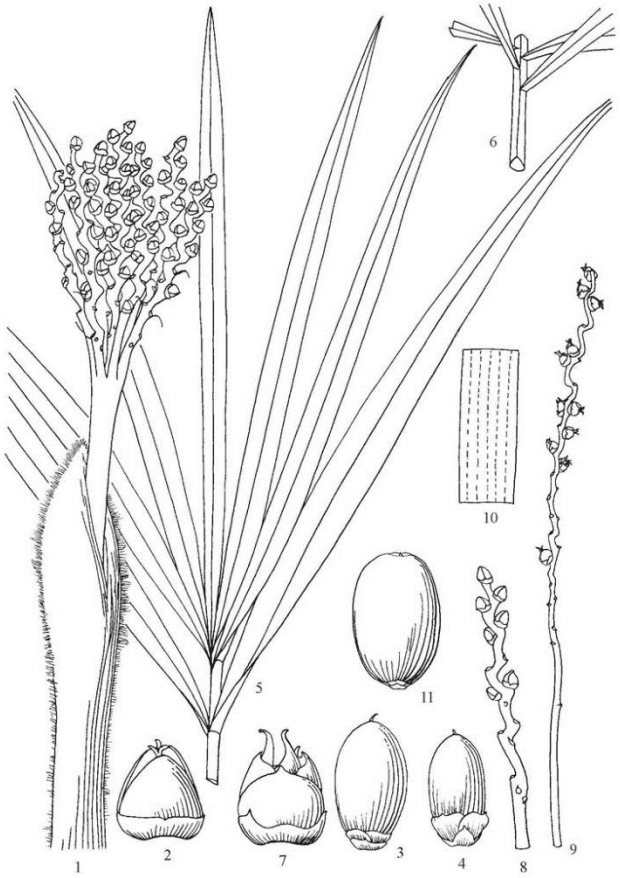




The FLORA is the main Resources of Taxonomic Information



Flora = it is the documentation of plants occurring in a particular region.



Description of plant need taxonomic terminology

Phoenix dactylifera Linnaeus, Sp. Pl. 2: 1188. 1753.

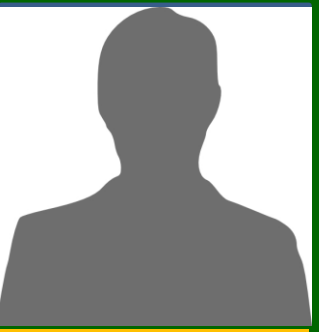
Stems solitary or clustered and then with few shoots, to 30 m tall, to 50 cm in diam., rough with persistent, diamond-shaped leaf bases. Leaves 3-5 m; sheath and petiole to 1 m; rachis 1-2 m; acanthophylls many per side of rachis; pinnae to 200 per side of rachis, linear, irregularly arranged and spreading in different planes; middle pinnae to 40 × 2 cm. Male inflorescences erect, to 1 m, with many rachillae, these ca. 30 cm; female inflorescences erect, becoming pendulous, to 2 m, with to 150 rachillae, these to 40 cm. Fruits variable in shape, usually oblong, to 7 × 3 cm, brown or black; endosperm homogeneous.

2. History of Plant Classification

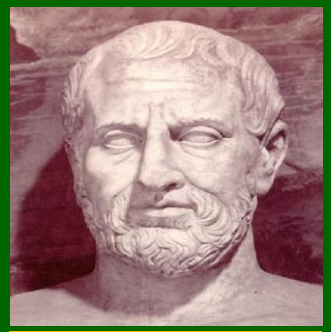
2. History of Plant Classification

- Early classification systems were artificial and based on habit or use.
- Theophrastus is considered the Father of Botany for early plant grouping.
- Linnaeus introduced the sexual system based on stamens and carpels.
- Natural systems were developed by Bentham and Hooker.
- Engler and Prantl proposed evolutionary classification systems.
- Hutchinson emphasized phylogenetic relationships among plants.
- Cronquist developed a widely used modern classification system.
- Takhtajan refined angiosperm phylogeny using morphology and anatomy.
- Molecular data revolutionized classification in the late 20th century.
- APG (Angiosperm Phylogeny Group) classification is based on DNA phylogeny.

SYSTEM OF PLANT CLASSIFICATION

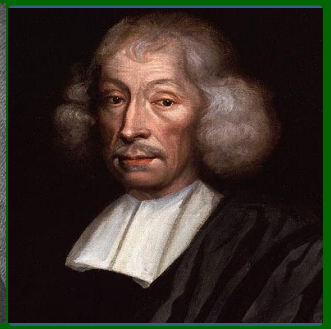


Preliterate Mankind / Folk taxonomies:



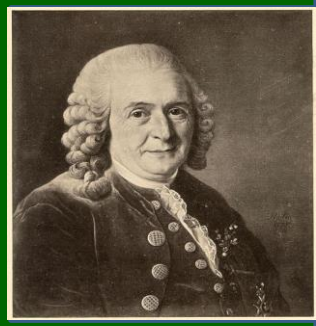
Theophrastus (372 BC to 287 BC):

Andrea Cesalpino (1519-1603)

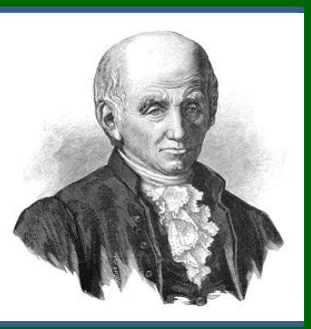


John Ray (1627-1705)

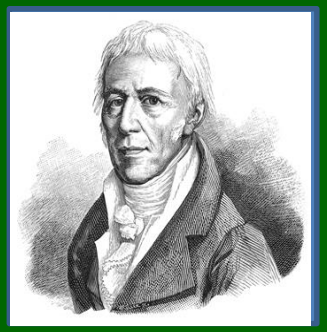
J. P. de Tournefort (1656-1708)



Carolus Linneaus (1753)



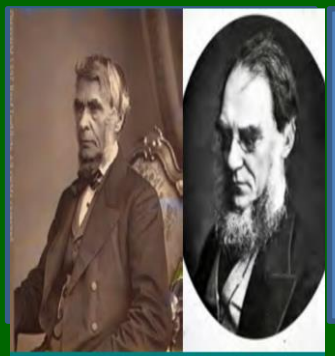
Michel Adanson (1727-1806)

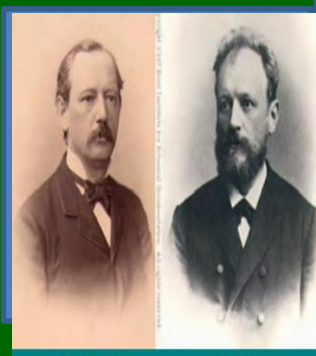


Jean B.P. Lamarck (1744-1829)

Antoine Laurent de Jussieu (1748-1836)

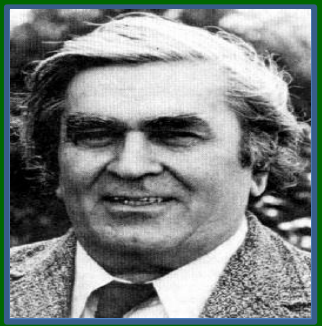
de Candolle (1778–1841)





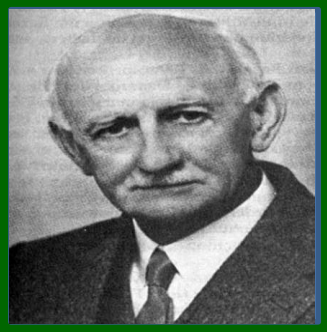
Charles E. Bessey (1845-1915)

Auther Cronquist 1968

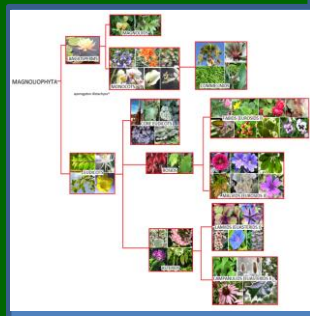


Armen Takhtajan 1969

Rolf Dahlgren (1932-87)



John Hutchinson (1884-1972)



APG Angiosperm Phylogeny Group (1998)

Binomial Nomenclature and Carolus Linneaus System of Plant Classification

- ❖ **Taxonomic Systems of Classification: Ideally our systems of classification should allow us to place similar species of plants together in the same category.**

- ❖ **There are two types of Classification Schemes:**

- ❑ **Artificial taxonomy was a system of grouping unrelated plant species by a common criteria (i.e. a flowers sexual organs)**
- ❑ **Natural classification reflects relationships among taxon**

- ➢ **Carolus Linneaus was a Swedish botanist.**

- ➢ **Carolus Linneaus traveled to Lapland (Blue Lake, CA) and collected large number of plants.**

- ➢ **Carolus Linneaus introduced Binomial Nomenclature.**

Binomial nomenclature = Uses two Latin words to indicate the genus and the species. The first word is the genus and the second word is the species. Example- the botanical name of dates is *Phoenix dactylifera*

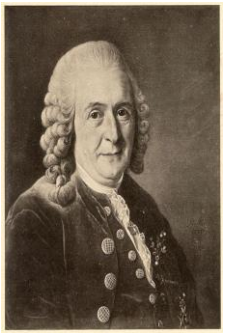
- ➢ **Carolus Linneaus published the book 'Species Plantarum' in 1753.**

- ➢ **Carolus Linneaus classified the plants based on the plant's method of reproduction and structure of reproductive parts.**

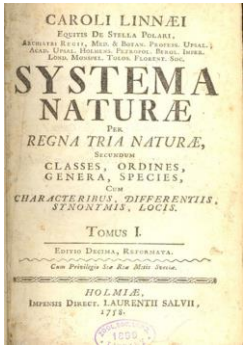
- ➢ **Produced his sexual system of classification (Artificial classification)**

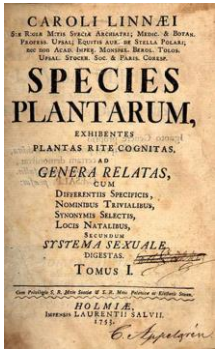
- ➢ **Carolus Linneaus divided plants into 24 classes. The Classes in the Linneaus is based largely on the amount, union and length of stamens**

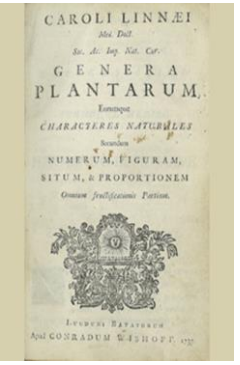
Classes



1. Monandria- stamen one
2. Diandria- stamens two
3. Triandria- stamens three
4. Tetrandria- stamens four
5. Pentandria- stamens five
6. Hexandria- stamens six
7. Heptandria- stamens seven
8. Octandria- stamens eight
9. Ennandria- stamens nine
10. Decandria- stamens ten
11. Dodecandria- stamens 11-19
12. Icosandria- stamens 20 or more, on the calyx
13. Polyandria- stamens 20 or more, on the receptacle
14. Didynamia- stamens didynamous; 2 short, 2 long
15. Tetradynamia- stamens tetradynamous; 4 long, 2 short
16. Monadelphia- stamens monadelphous; united in 1 group
17. Diadephia- stamens diadelphous; united in 2 groups
18. Polyadelphia- stamens polyadelphous; united in 3 or more groups
19. Syngenesia- stamens syngenesious; united by anthers only
20. Gynandria- stamens united with the gynoecium
21. Monoecia- plants monoecious
22. Dioecia- plants dioecious
23. Polygamia- plants polygamous
24. Cryptogamia- flowerless plants

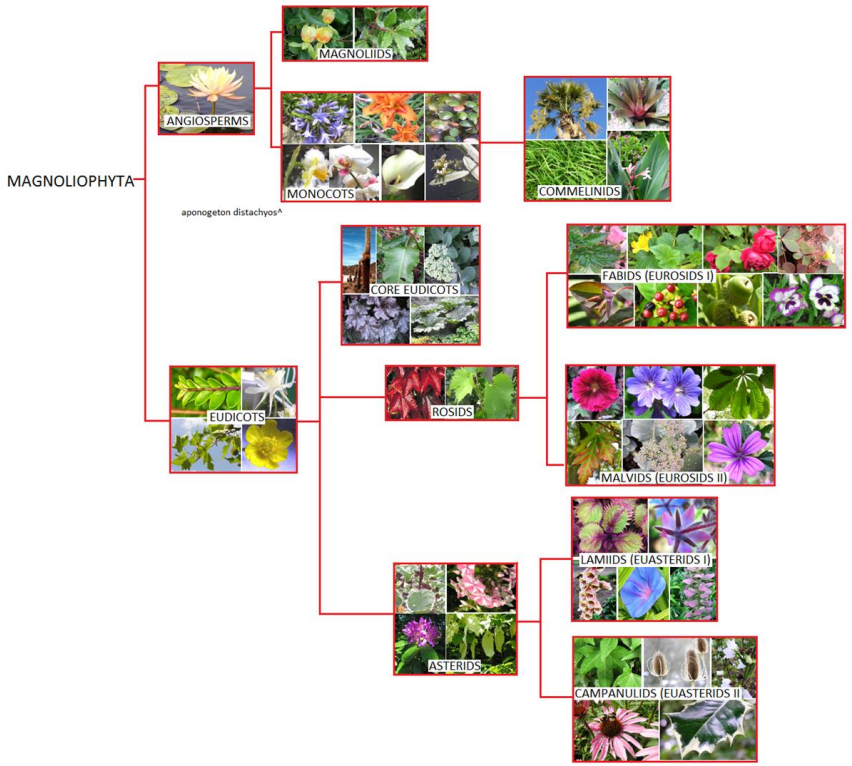






Angiosperm Phylogeny Group (APG)

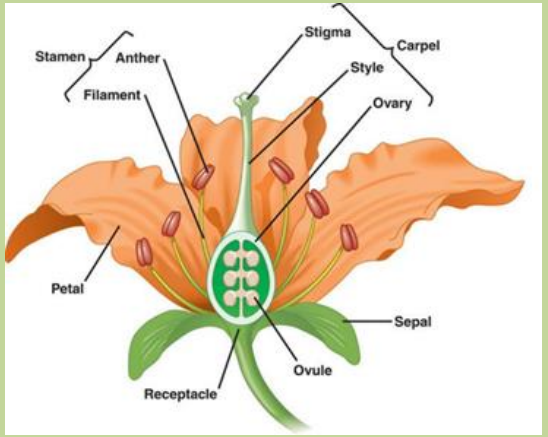
- The APG system of flowering plant classification is the modern, mostly molecular-based, system of plant taxonomy for flowering plants (angiosperms) being developed by the Angiosperm Phylogeny Group (APG).
- The APG was first published in 1998.
- Currently, the APG IV system recognizes a total of 64 angiosperm orders and 416 families.
- The families in APG classification have been grouped into 40 putative monophyletic orders under a small number of informal monophyletic higher groups: monocots, commelinoids, eudicots, core eudicots, rosids, eurosids I, eurosids II, asterids, euasterids I and euasterids II



3. Floral Variation and Scientific Terminology

3. Floral Variation and Terminology

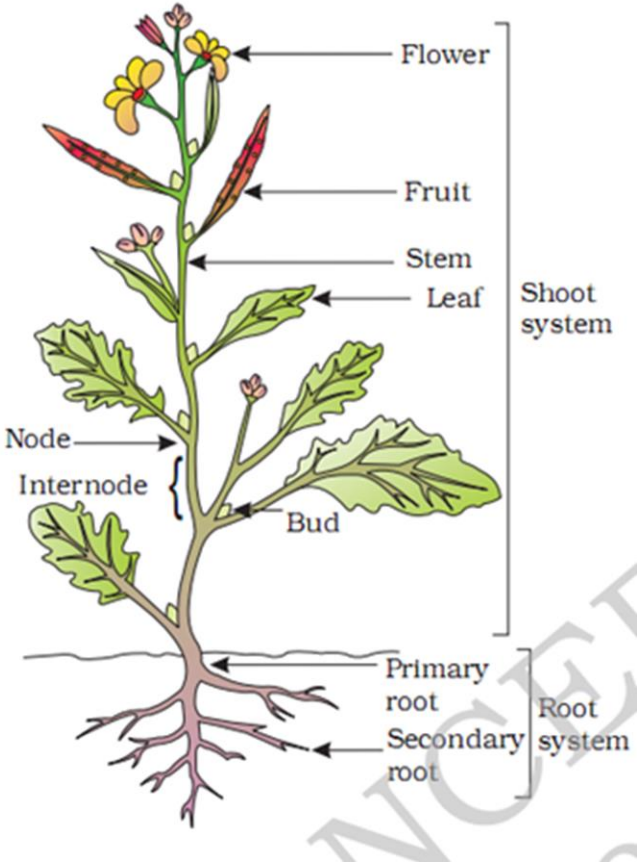
- Flower structure provides reliable characters for classification.
- Flowers show variation in symmetry such as actinomorphic or zygomorphic.
- Floral parts may be free (poly-) or fused (gamo-).
- Flowers may be complete or incomplete depending on whorls present.
- Floral sexuality may be bisexual or unisexual.
- Ovary position may be superior, inferior, or half-inferior.
- Aestivation describes arrangement of floral parts in buds.
- Floral terminology ensures precise scientific description.
- Modifications reflect evolutionary adaptations.
- Floral morphology is central to angiosperm taxonomy.

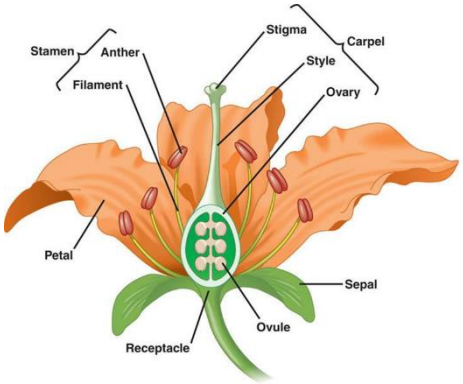


PLANT STRUCTURE
(MORPHOLOGY AND ANATOMY)

- Plant Morphology: Study of external structure of a plant
- Plant Anatomy: Study of Internal structure of a plant
- Flowering plants possess three kinds of vegetative (non-reproductive) organs: Roots, Stems, and Leaves
- The flower is the reproductive organ of the Angiosperms / Flowering plants.

Vegetative and Reproductive Parts of Plants





- **Root:**

In vascular plants, the root is the organ of a plant that typically lies below the surface of the soil. Root is meant for absorption of water and minerals from soil, and provide anchorage to plants.

- **Nodes :**

The nodes hold one or more leaves, as well as buds which can grow into branches (with leaves or inflorescences (flowers). Adventitious roots may also be produced from the nodes.

- **Internodes :**

The internodes distance one node from another.

- **Stem:**

The main body or stalk of a plant or shrub, typically rising above ground.

- **Leaf:**

A leaf is an organ of a vascular plant ,and is the principal lateral appendage of the stem,

- **Flower:**

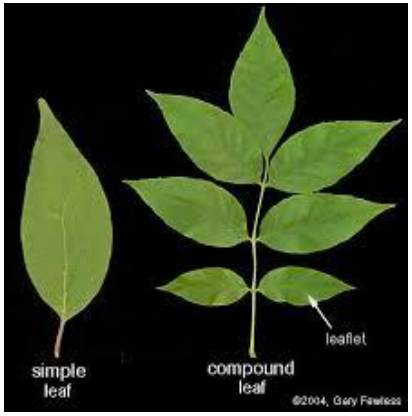
The seed-bearing part of a plant consisting of reproductive organs (stamens and carpels) that are typically surrounded by a brightly coloured corolla (petals) and a green calyx (sepals).

- **Fruit:**

A fruit is the seed-bearing structure in flowering plants formed from the ovary after flowering

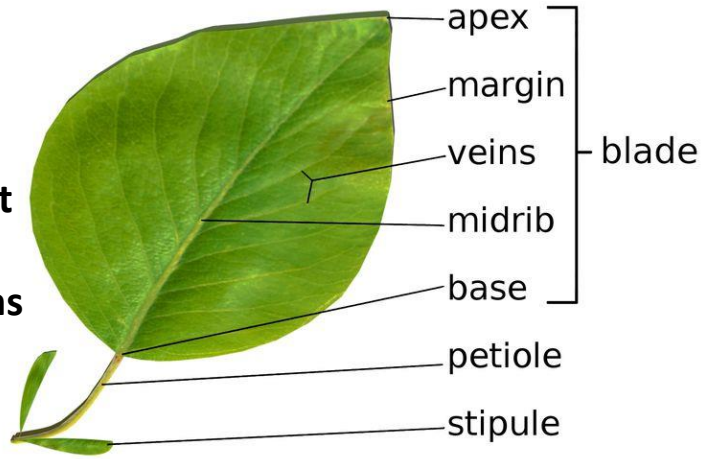
LEAVES

- **The leaf is the main photosynthetic organ of most vascular plants.**
- **Leaves generally consist of a flattened blade and a petiole, which joins the leaf to a node of the stem.**
- **Some plant species have evolved modified leaves that serve various functions. For example: climbing, pollinator attraction, storage, digestion, prevention of water loss, etc.**

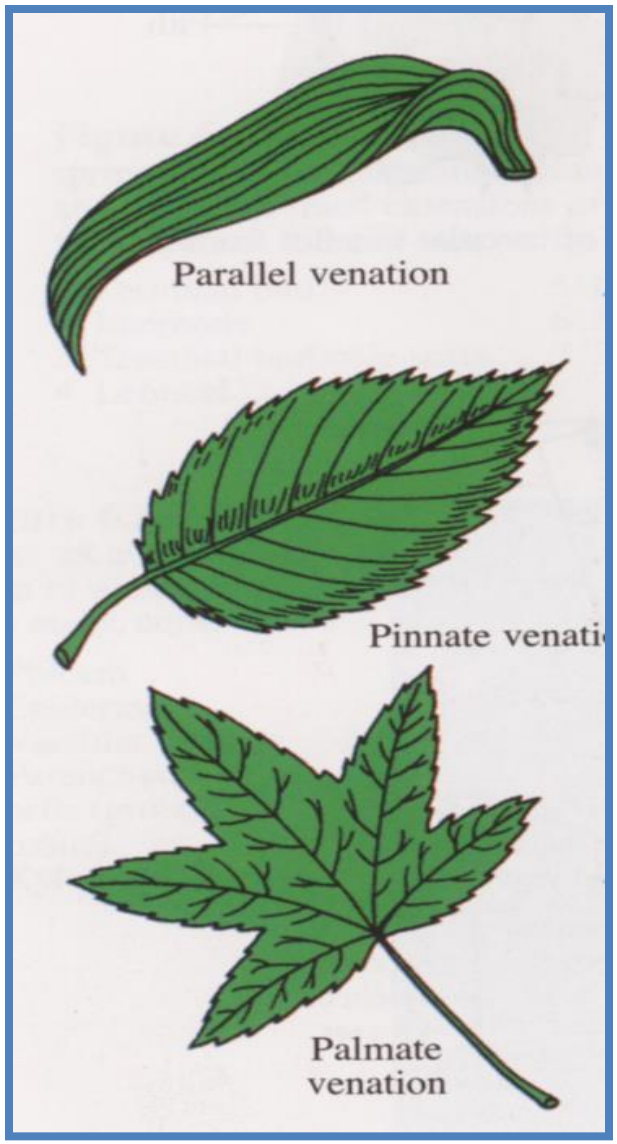


There are large number of terminology leaf based on:

- **Margin**
- **Apex**
- **Base**
- **Venation**
- **Arrangement**
- **Petiole**
- **Modifications**



Leaf Venation



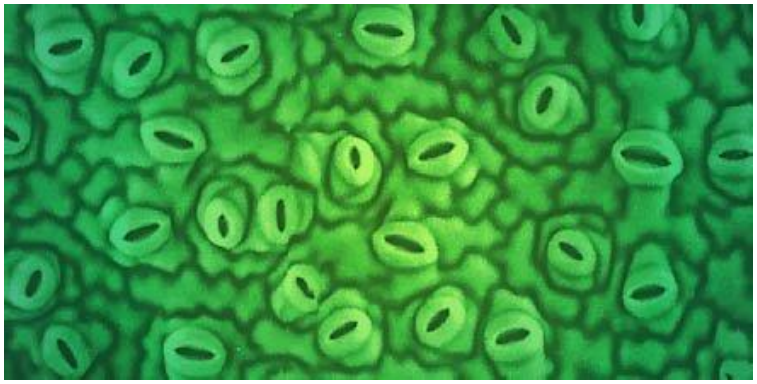
- **Parallel-** متوازي **veins extend the entire length of the leaf with little or no cross-linking**
- **Pinnate-** ريشي **leaves have one major vein from which others branch**
- **Palmate-** راحي **leaves have several veins which branch**

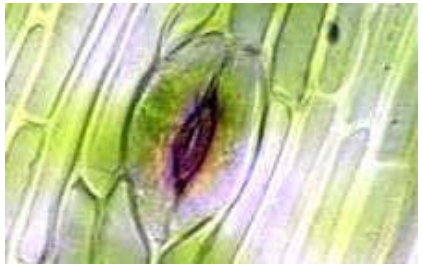
Dicot and Monocot Leaves

Reticulate
شبكي

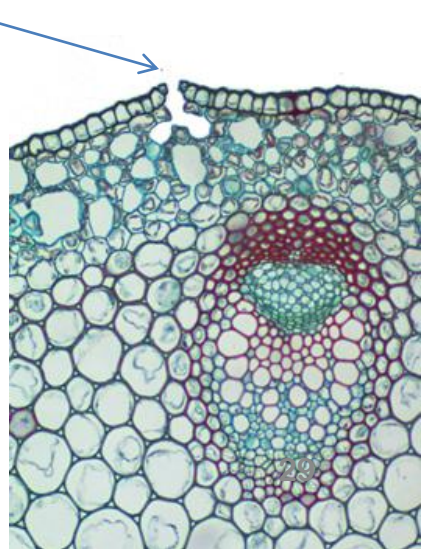
Parallel
متوازي

Dermal Tissue - Stomata

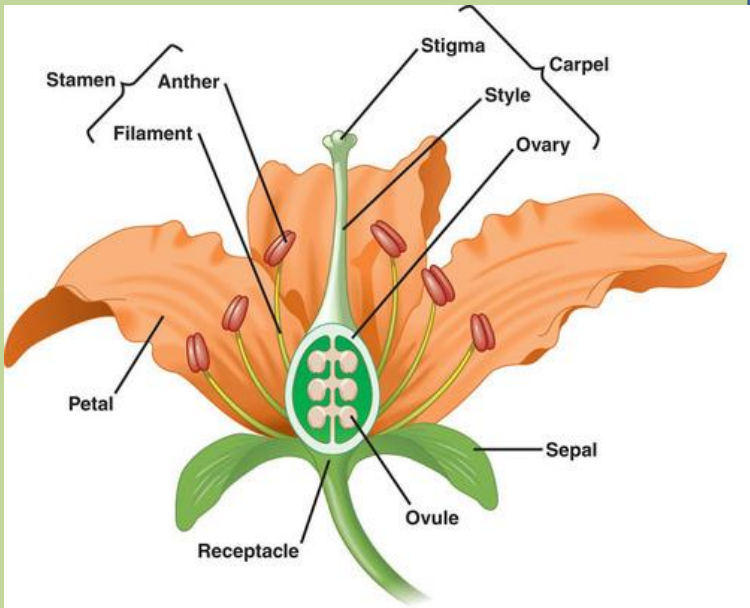




- **Openings in the epidermis on the underside of a leaf where gases are exchanged are called stomata.**



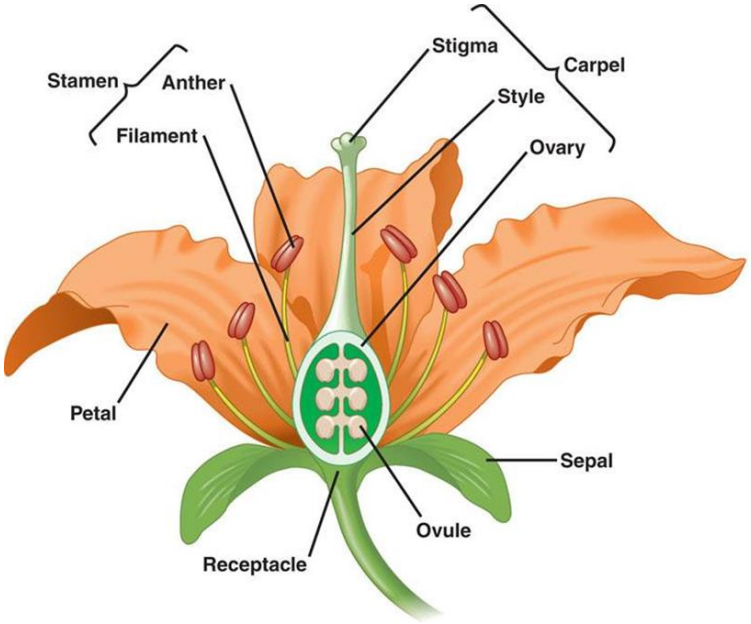
Floral Characters (Calyx, Corolla, Androecium, Gynoecium)



- Calyx consists of sepals protecting the floral bud.
- Corolla is formed by petals attracting pollinators.
- Sepals may be free or fused.
- Petals may show various shapes and colors.
- Androecium represents the male reproductive whorl.
- Stamens consist of filament and anther.
- Gynoecium represents the female reproductive whorl.
- Carpels may be free or fused.
- Ovary contains ovules for seed formation.
- Floral whorls provide key diagnostic characters.

Angiospermae
(Anthophyta – Flowering Plants)

- All Angiosperms produce flowers containing the sexual reproduction structures.
- The angiosperms (*angios*=covered, *sperm* = seed) produce fruits and seeds.
- There are presently 235,000 known living flowering plants species.



Parts of Angiospermic flowers

Peduncle: The stalk of a flower.

Receptacle: The part of a flower stalk where the parts of the flower are attached.

Sepal: The outer parts of the flower (often green and leaf-like) that enclose a developing bud.

Petal: The parts of a flower that are often conspicuously colored.

Stamen: The pollen producing part of a flower, usually with a slender filament supporting the anther.

Anther: The part of the stamen where pollen is produced.

Pistil: The ovule producing part of a flower. The ovary often supports a long style, topped by a stigma. The mature ovary is a fruit, and the mature ovule is a seed.

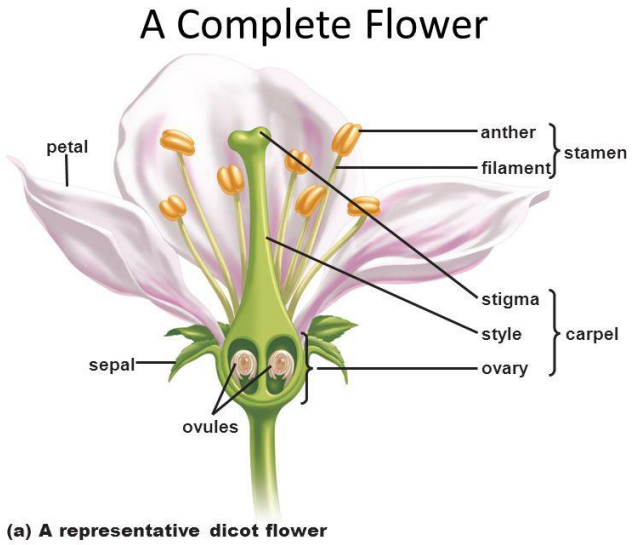
Stigma: The part of the pistil where pollen germinates.

Ovary: The enlarged basal portion of the pistil where ovules are produced.

Complete and incomplete flower

Complete flower:

- **A flower is said to be complete, when it has all the four whorls (calyx, corolla, androecium and gynoecium).**
- **Example: Hibiscus (Chinarose), Brassica (mustard) and Datura.**



Incomplete flower:

- **A flower is incomplete, when any one of the four whorl (calyx, corolla, androecium and gynoecium) is absent.**
- **Examples of these types of flowers are *Polyanthes* (calyx absent), *Beta* (corolla absent), *Cucurbita* male flower (gynoecium absent), female flower (androecium absent).**

Unisexual and Bisexual Flower

Bisexual or Hermaphrodite flower:

- **A bisexual flower is that, which contains both the male and female reproductive whorls, i.e., androecium and gynoecium.**
- **Examples: Hibiscus (Chinarose), Brassica (Mustard).**

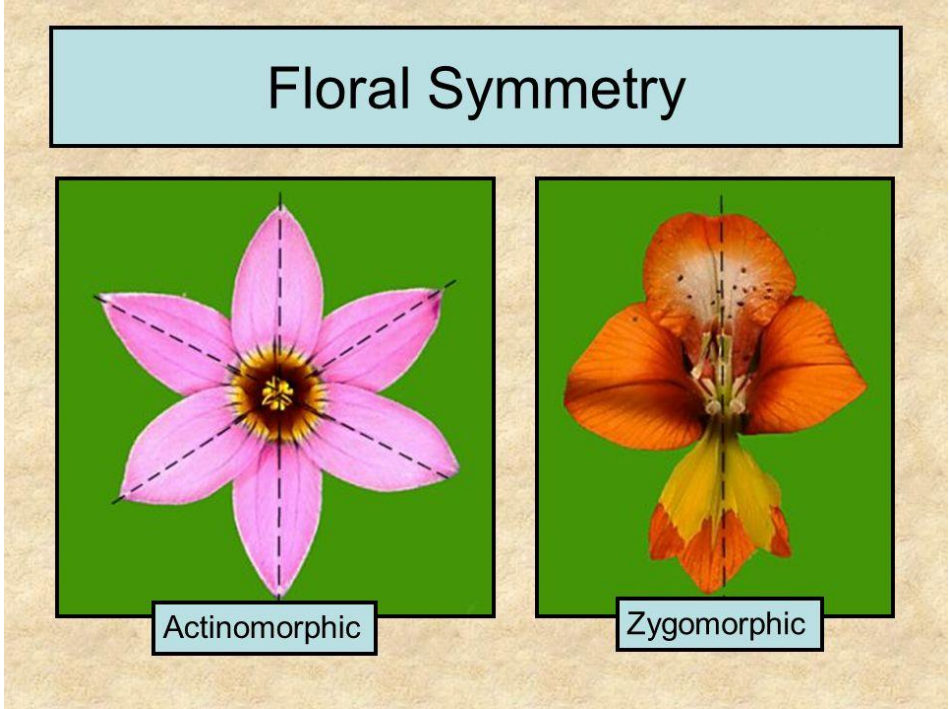
Unisexual flower:

- **A flower is unisexual, when either of the male or the female reproductive organ is absent.**
- **Examples of these types of flowers are staminate and pistillate flower of *Cucurbita* (gourd).**

Floral Symmetry

Regular or Actinomorphic flower:

A flower is said to be regular types of flowers, when all the floral members of the respective whorls (viz., sepals, petals, stamens, carpels) are having equal size and shape and are more or less equidistant from each other, hence the flower can be dissected into two equal halves at any plane, e.g., *Hibiscus* (Chinarose); *Datura*.



Irregular or Zygomorphic flower:

A flower is said to be irregular, when the floral members vary in their size and shape, and hence the flower can be cut into two equal halves through one plane only ; example *Pisum sativum* (Pea).

Cyclic and Acyclic Flower

Cyclic Flower:

Types of flowers are said to be cyclic, when all the four whorls (viz., sepals, petals, stamens and pistils) are arranged in whorled or verticellate manner.

Example, *Hibiscus* (Chinarose).

Acyclic Flowers:

Types of flowers are said to be acyclic, when the floral members are arranged spirally on the thalamus.

Example: *Paoenia*.

Spirocyclic, Nude and Neuter Flower

❖ **Spirocyclic flower:**

The floral members of a spirocyclic flower are both arranged spiral as well as in whorled manner example, *Nymphaea*, *Magnolia*.

❖ **Nude flower:**

The types of flowers are said to be naked, because neither calyx nor corolla is present, example Male flower within the cyathium of *Pedilanthus*.

❖ **Neuter flower:**

A flower is said to be neuter, when it is devoid of both male androecium and female gynoecium, as an example the Ray florets of sunflower.

Monochlamydous and Dichlamydous Flower

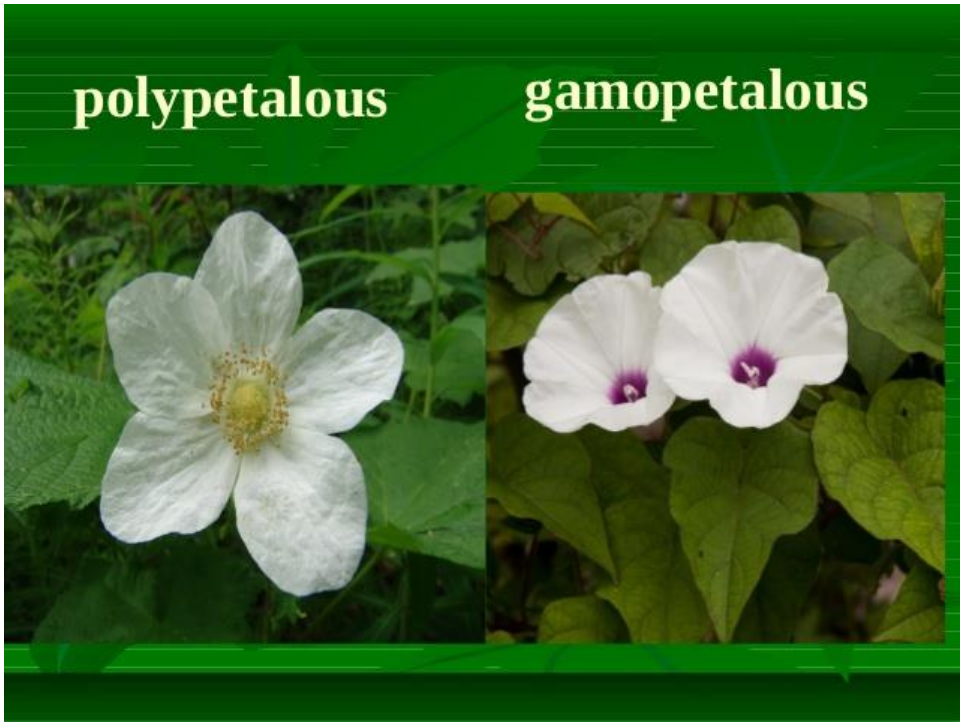
Monochlamydous flower:

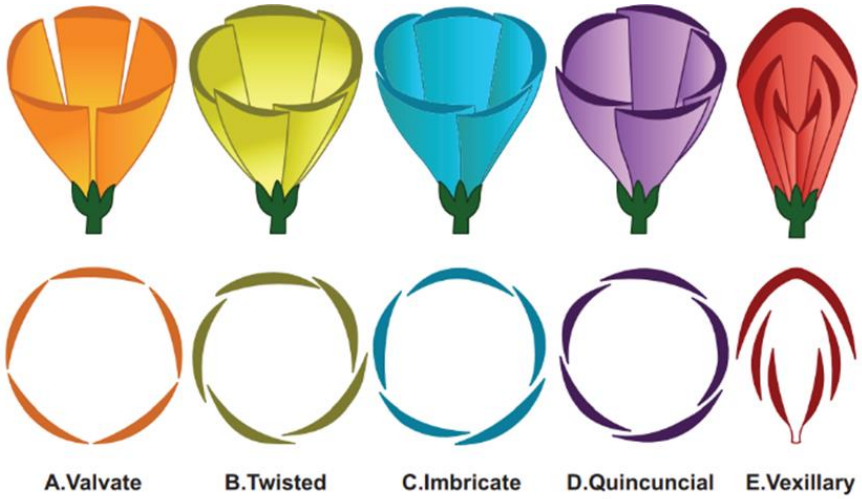
The types of flowers are said to be monochlamydous, when either calyx or corolla is present, e.g., *Polyanthes* (tuberose).

Dichlamydous flower:

A normal flower with both the accessory whorls, i.e., calyx and corolla is called dichlamydous. Example, *Hibiscus* (chinarose).

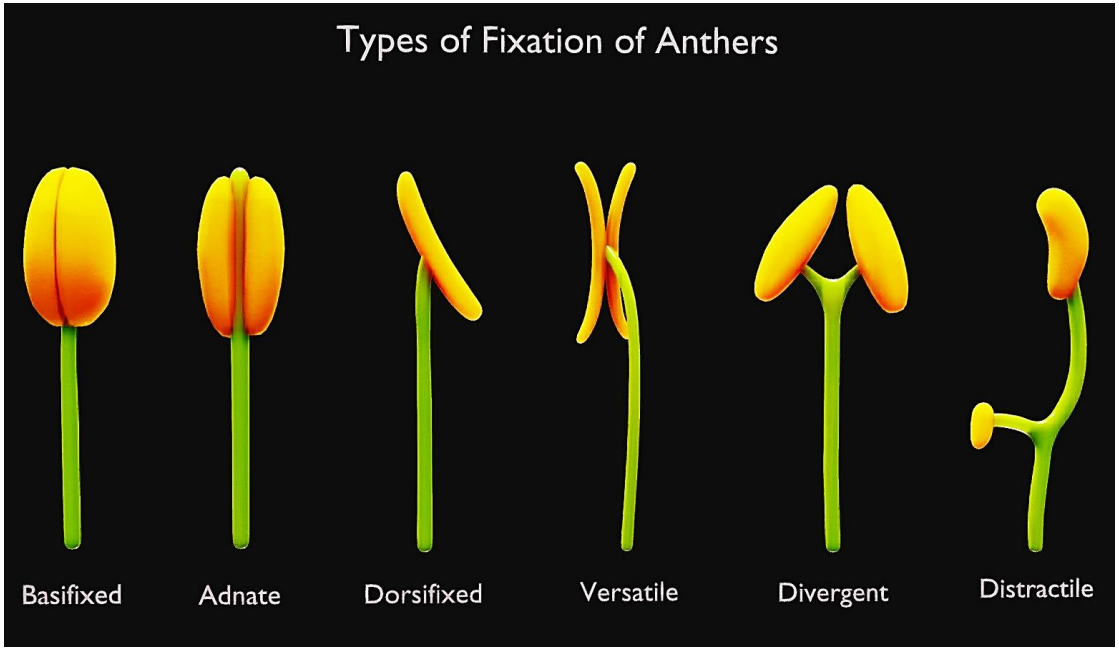
Polypetalous and Gamopetalous Flower



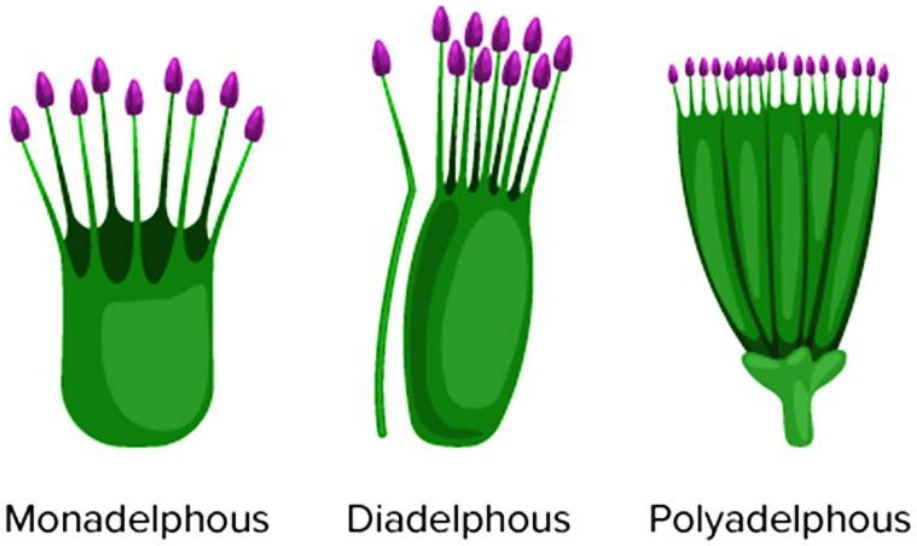


Polypetalous is having a corolla composed of distinct, separable petals.

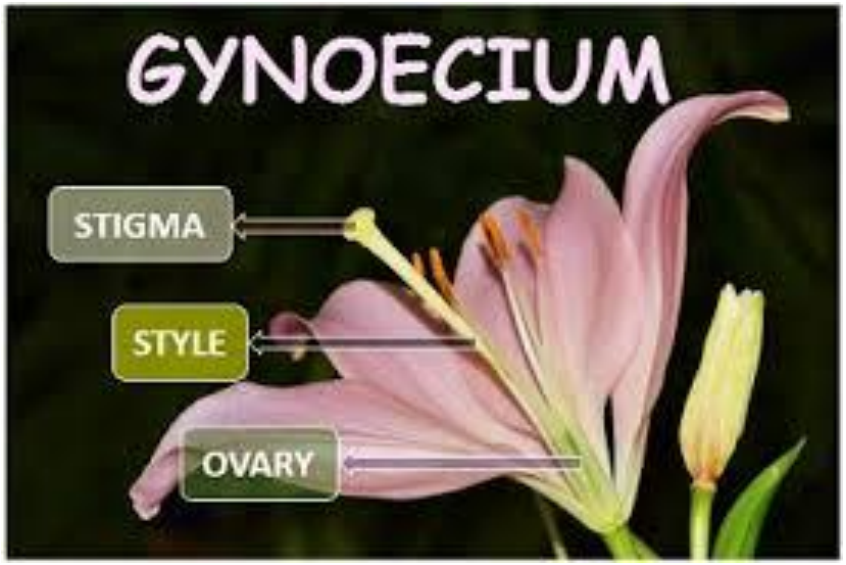
Gamopetalous having petals wholly or partially fused such that the corolla takes the form of a tube

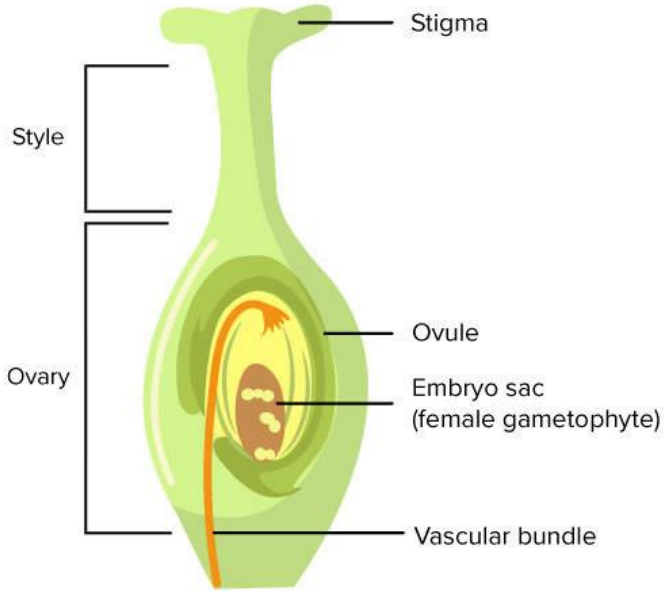


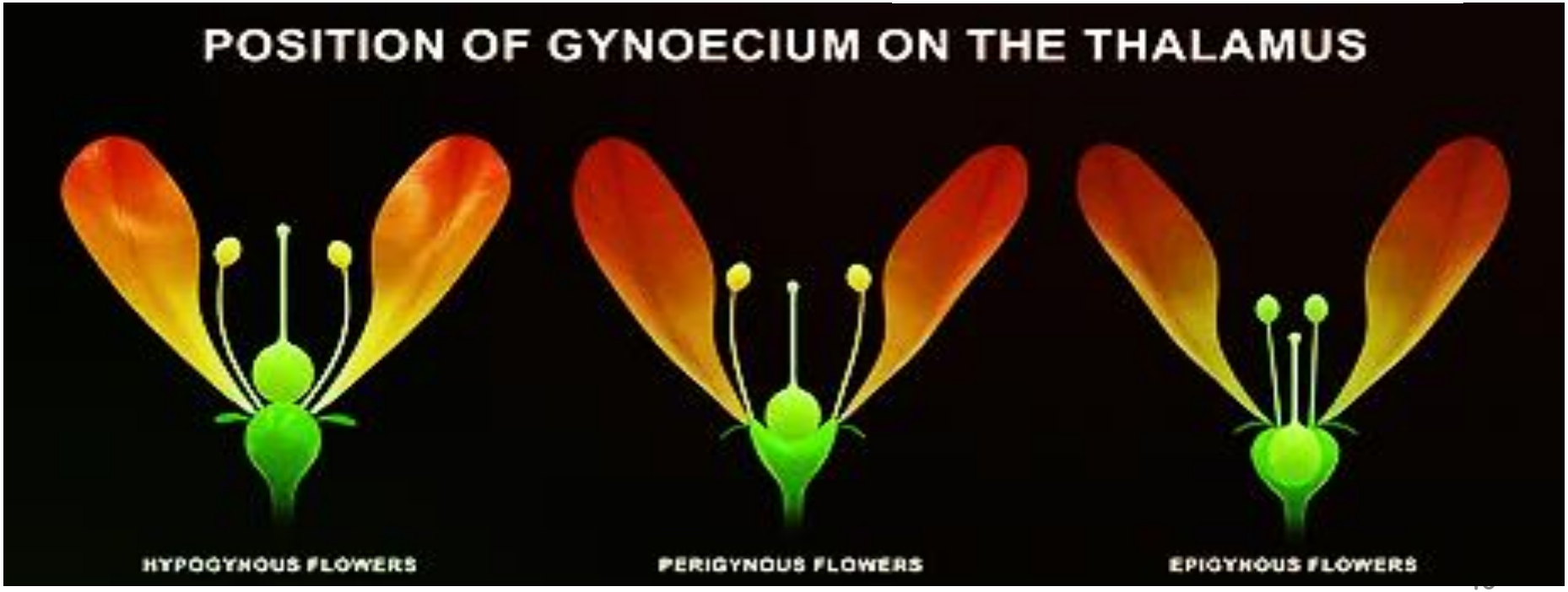
Adhesion



Cohesion of Stamens

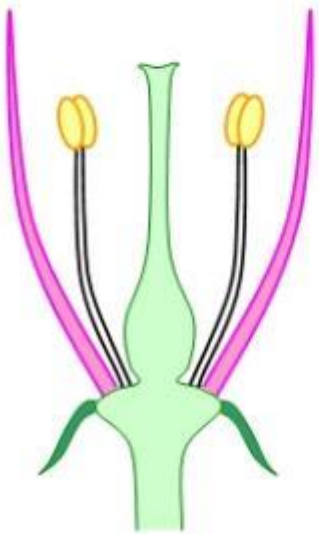

GYNOECIUM
STIGMA
STYLE
OVARY


Stigma
Style
Ovary
Ovule
Embryo sac
(female gametophyte)
Vascular bundle


POSITION OF GYNOECIUM ON THE THALAMUS
HYPOGYNOUS FLOWERS
PERIGYNOUS FLOWERS
EPIGYNOUS FLOWERS

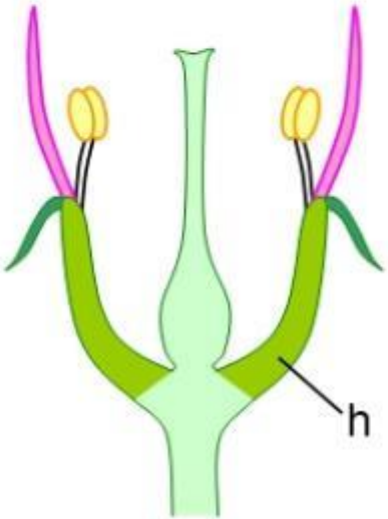
Relative Positions of Floral Appendages

Relative Positions of Floral Appendages



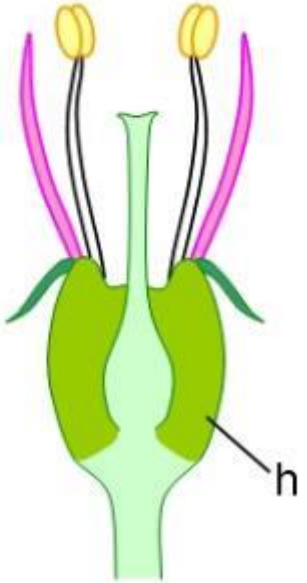
Hypogynous flower

Superior ovary (ovary above stamens which are above perianth). Stamens and perianth hypogynous.



Perigynous flower

Superior ovary. Stamens and perianth perigynous – i.e. their bases are united into a hypanthium (h) which holds them level with ovary.

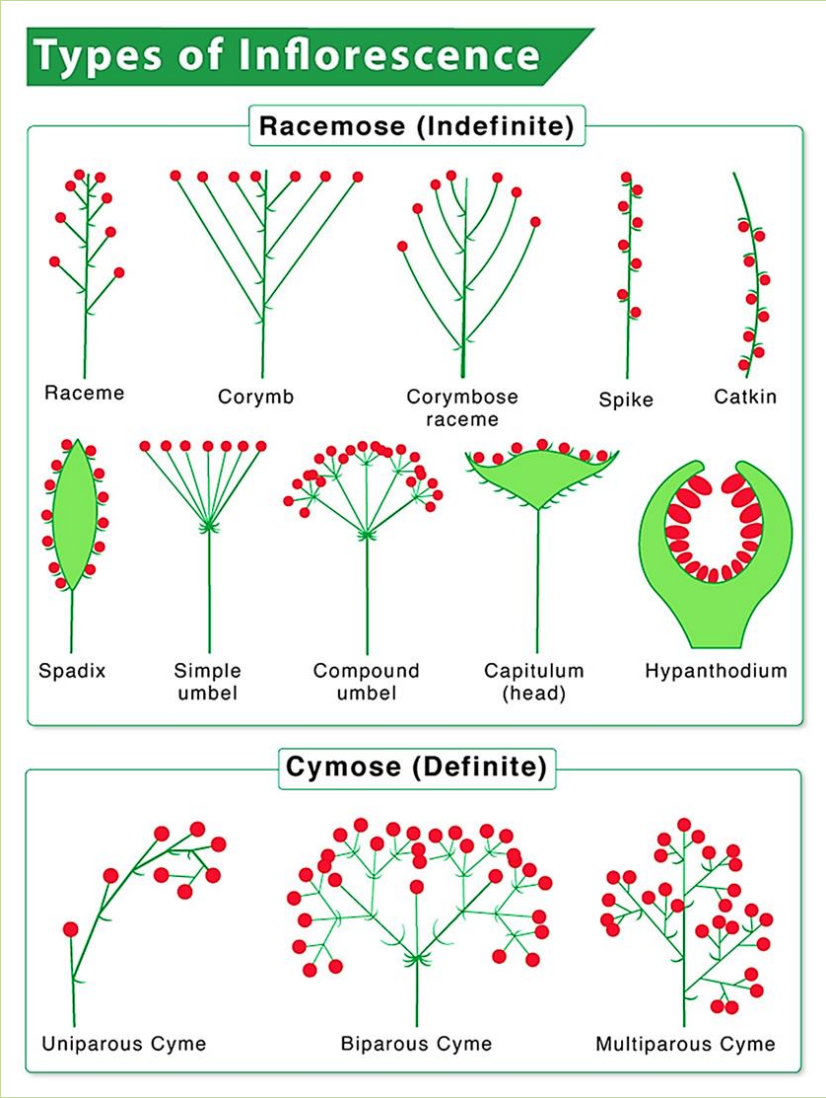


Epigynous flower

Inferior ovary. Stamens and perianth epigynous – i.e. positioned above the ovary on a hypanthium (h).

Inflorescences

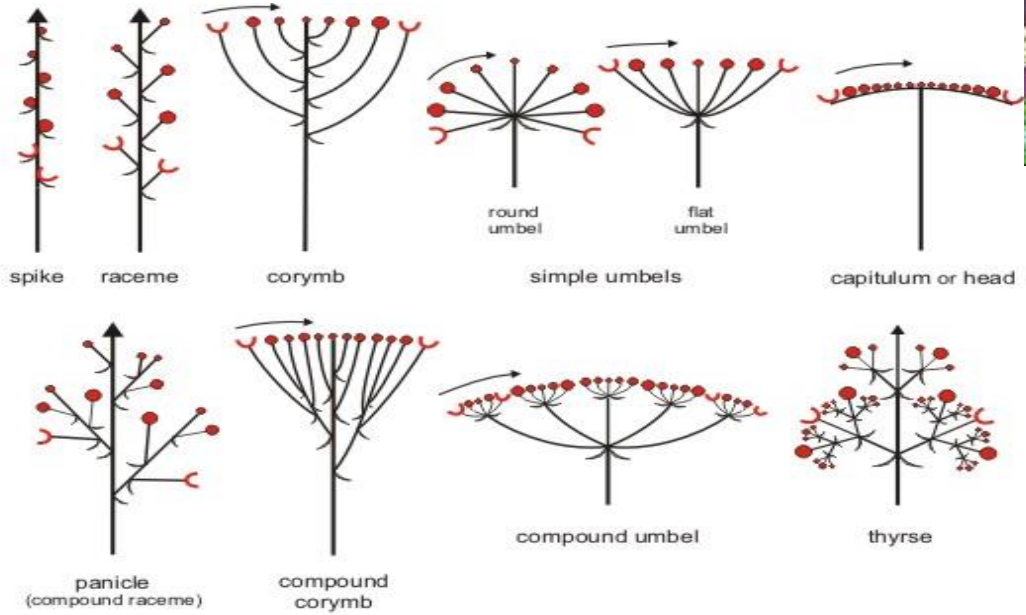
- Inflorescence is the arrangement of flowers on a plant axis.
- Racemose inflorescence shows indefinite growth.
- Cymose inflorescence shows determinate growth.
- Spike consists of sessile flowers on an axis.
- Raceme contains pedicellate flowers.
- Umbel has equal-length pedicels from one point.
- Capitulum occurs in Asteraceae.
- Panicle represents a branched raceme.
- Cyathium is characteristic of Euphorbia.
- Inflorescence types help in family identification.



Inflorescence

(An inflorescence is an arrangement of one or more flowers on a floral axis)

- **Inflorescence type determined by:**
  - **Number of flowers**
  - **Positional relationships**
  - **Degree of the development of their pedicels**
  - **Nature of their branching pattern**



Simple Inflorescences

- **Terminal: flower at the tip of a stem.**
- **Example: *Hibiscus coccineus***

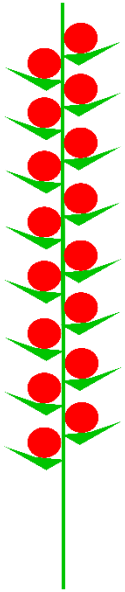
Scarlet rose-mallow (*Hibiscus coccineus*)

Compound Inflorescences

- Two or more flowers in every inflorescence
- Example: Sunflower

Compound Inflorescences

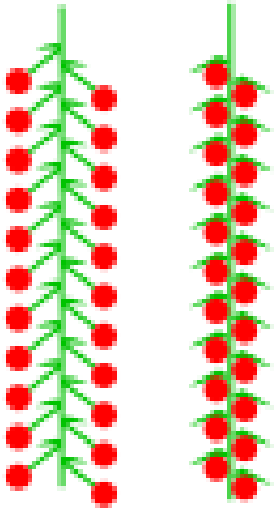
- **Spike**: elongate inflorescence; flowers are sessile, dense, or remote from one another



Spiked blazing star (*Liatris spicata*)

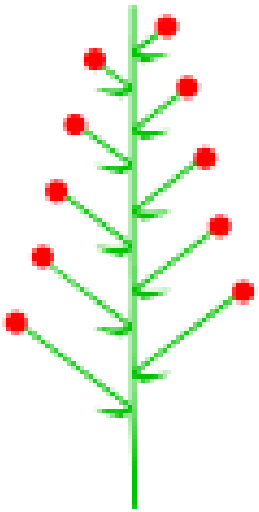
Compound Inflorescences

- **Catkin**: A spike like inflorescence of unisexual flowers; found only in woody plants.



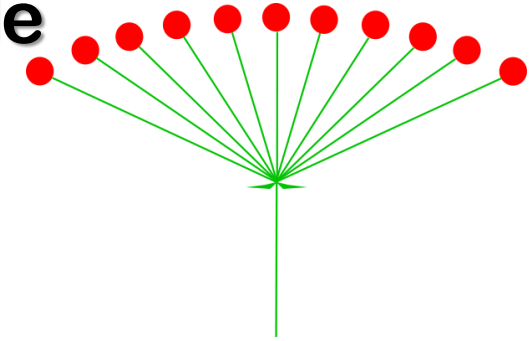
Compound Inflorescences

- **Raceme**: an elongate inflorescence of pedicellate flowers on an unbranched rachis



Compound Inflorescences

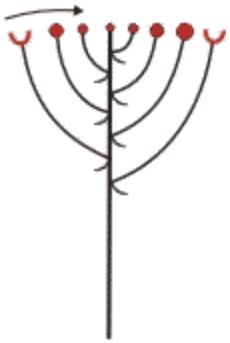
- **Umbel**: a flat-topped or somewhat rounded inflorescence in which all of the pedicels arise from a common point at the tip of the peduncle



Butterfly weed (*Asclepias* sp.)

Compound Inflorescences

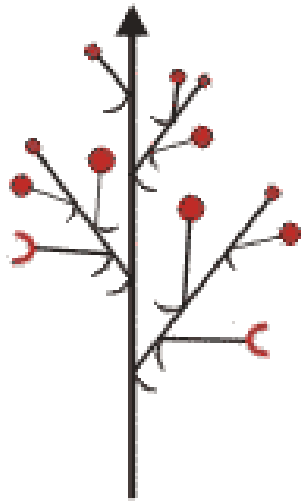
- **Corymb**: a flat-topped or somewhat rounded inflorescence in which the pedicels of varying length are inserted along the rachis



corymb

Compound Inflorescences

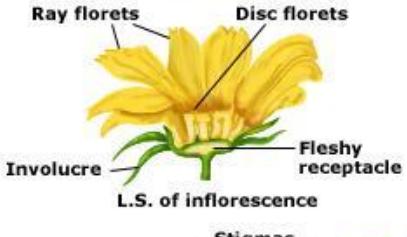
- **Panicle**: a much-branched inflorescence with a central rachis which bears branches which are themselves branched

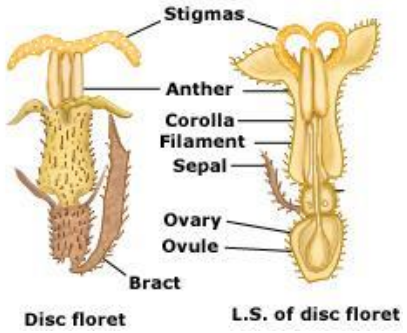


panicle
(compound raceme)

Compound Inflorescences

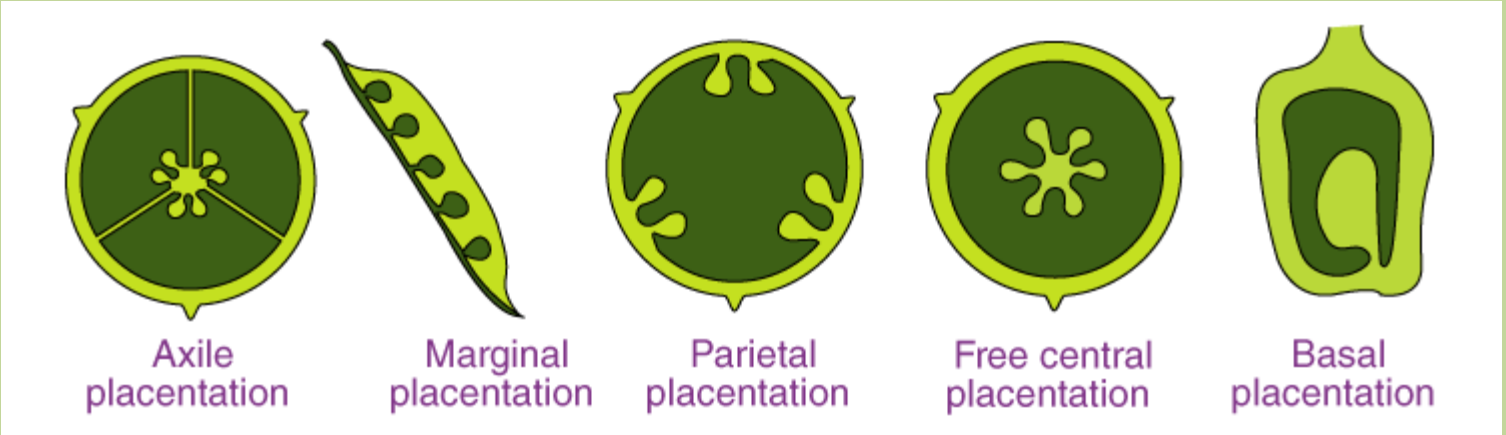
- **Head, (Capitulum) : is a short dense spike in which the flowers are borne directly on a broad, flat peduncle, giving the inflorescence the appearance of a single flower.**





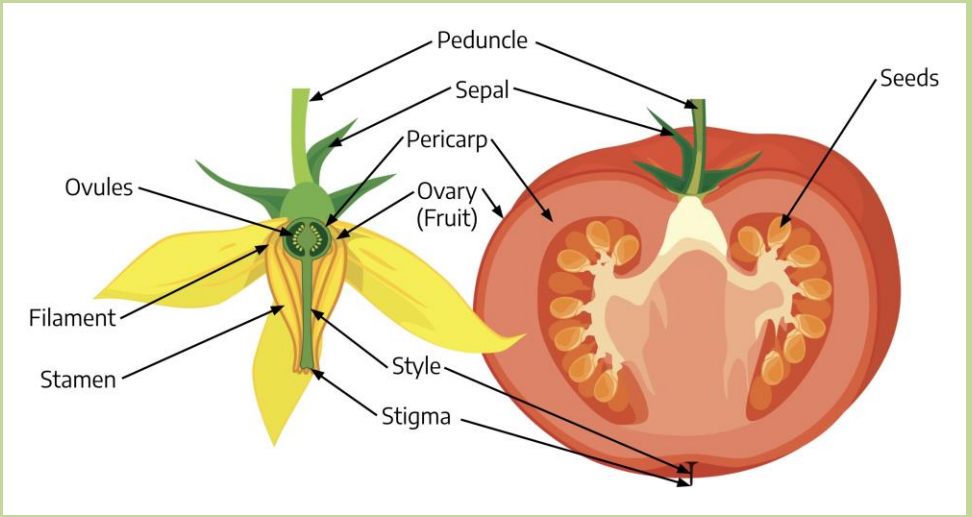
Placentation

- Placentation refers to ovule arrangement inside the ovary.
- Marginal placentation occurs in monocarpellary ovaries.
- Axile placentation occurs in multilocular ovaries.
- Parietal placentation occurs along ovary walls.
- Free central placentation lacks septa.
- Basal placentation has ovules at ovary base.
- Superficial placentation occurs on inner surfaces.
- Placentation assists in systematic classification.
- Ovary structure reflects evolutionary relationships.
- Placentation type is a stable taxonomic character.

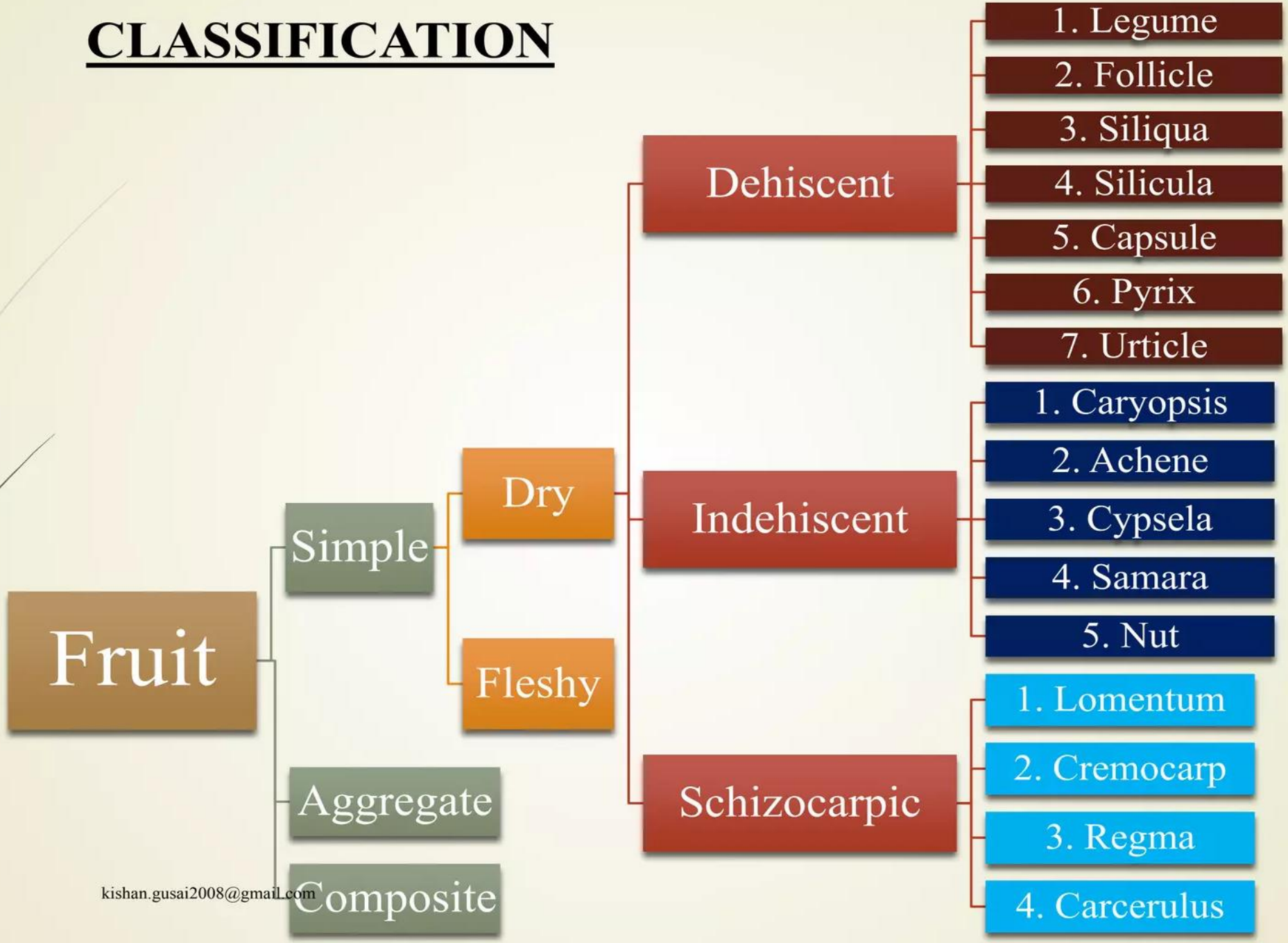


Fruits

- Fruit develops from the ovary after fertilization.
- Fruits protect and disperse seeds.
- Dry fruits may be dehiscent or indehiscent.
- Legume splits along two sutures.
- Capsule opens in various ways.
- Berry is a fleshy fruit with many seeds.
- Drupe contains a hard endocarp.
- Achene is a single-seeded dry fruit.
- Aggregate fruits arise from multiple ovaries.
- Fruit morphology is useful in classification.



CLASSIFICATION



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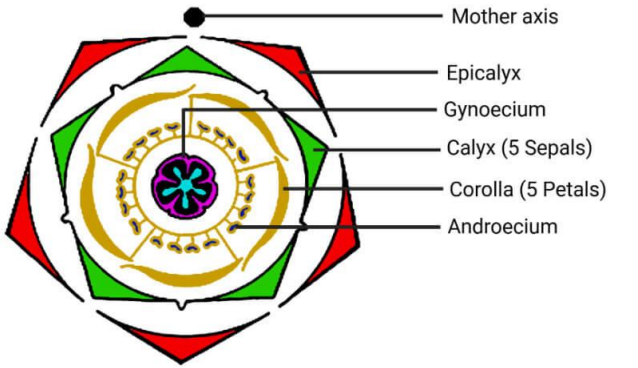
Floral Diagram and Floral Formula

- Floral diagram represents spatial arrangement of floral parts.
- Floral formula summarizes structure using symbols.
- Symbols indicate number of floral organs.
- Bract presence is shown by Br symbol.
- Symmetry is represented by specific signs.
- Fusion is shown by parentheses.
- Ovary position is indicated by a line above or below G.
- Floral diagrams assist comparative taxonomy.
- Floral formulas provide concise descriptions.
- Both tools aid rapid plant identification.

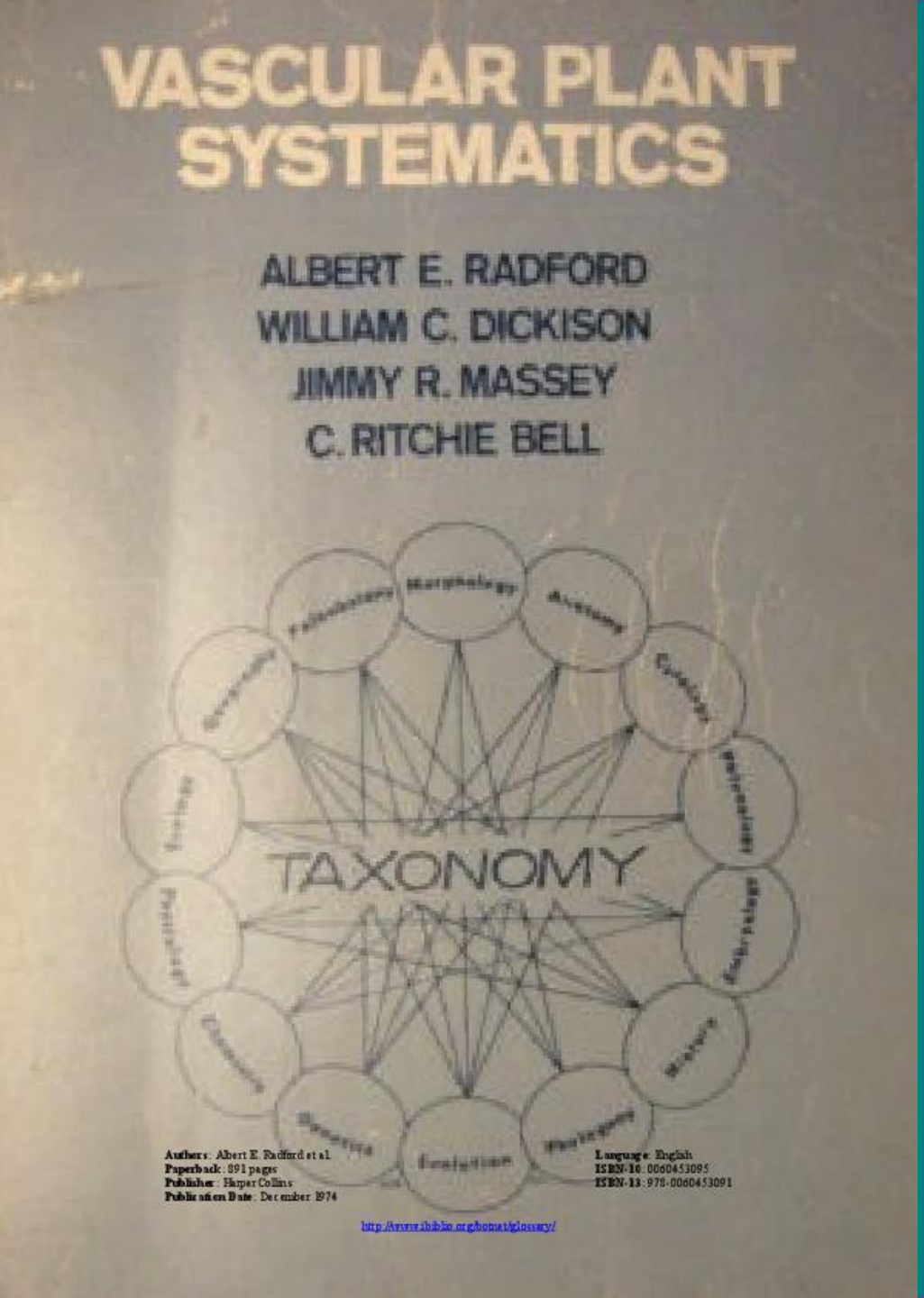
Family Malvaceae

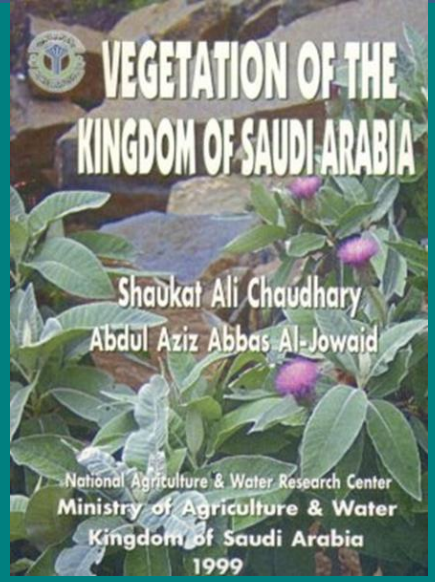
Malvaceae Floral Diagram

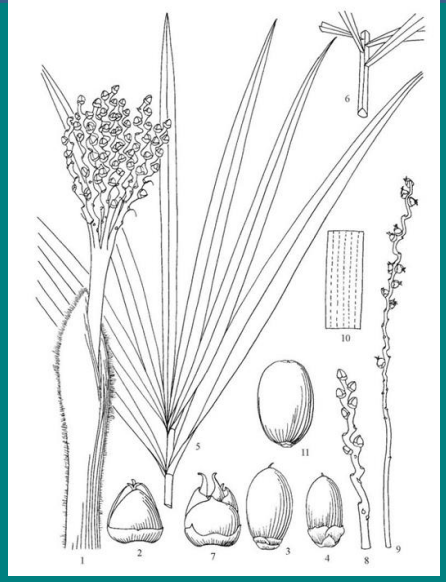


$\oplus \, ♂ \, Epi_{3\rightarrow8} \, K_{(5)} \, C_{(5)} \, A_{\infty} \, G_{(2\text{-}\infty)}$

Floral Formula of Malvaceae







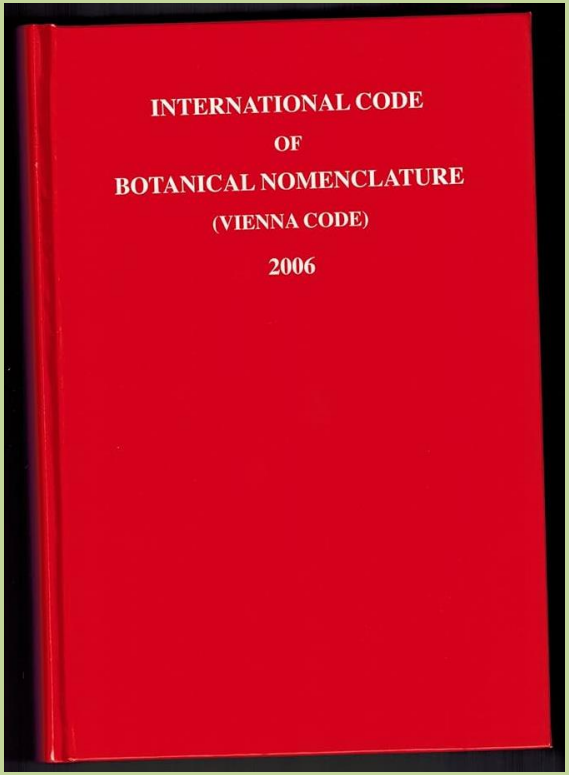
Phoenix dactylifera Linnaeus, Sp. Pl. 2: 1188. 1753.

Stems solitary or clustered and then with few shoots, to 30 m tall, to 50 cm in diam., rough with persistent, diamond-shaped leaf bases. Leaves 3-5 m; sheath and petiole to 1 m; rachis 1-2 m; acanthophylls many per side of rachis; pinnae to 200 per side of rachis, linear, irregularly arranged and spreading in different planes; middle pinnae to 40 × 2 cm. Male inflorescences erect, to 1 m, with many rachillae, these ca. 30 cm; female inflorescences erect, becoming pendulous, to 2 m, with to 150 rachillae, these to 40 cm. Fruits variable in shape, usually oblong, to 7 × 3 cm, brown or black; endosperm homogeneous.

4. Plant / Botanical Nomenclature

Plant Nomenclature

- Plant nomenclature follows rules of the International Code of Nomenclature (ICN).
- Scientific names are binomial consisting of genus and species.
- Genus names begin with a capital letter.
- Species epithets are written in lowercase.
- Scientific names are italicized or underlined.
- Type specimens define application of names.
- Priority rule gives validity to earliest published names.
- Synonyms arise from taxonomic revisions.
- Author citation indicates naming authority.
- Nomenclature ensures global communication among botanists.



Binomial Nomenclature and Carolus Linneaus System of Plant Classification

- ❖ **Taxonomic Systems of Classification: Ideally our systems of classification should allow us to place similar species of plants together in the same category.**

- ❖ **There are two types of Classification Schemes:**

- ❑ **Artificial taxonomy was a system of grouping unrelated plant species by a common criteria (i.e. a flowers sexual organs)**
- ❑ **Natural classification reflects relationships among taxon**

- ➢ **Carolus Linneaus was a Swedish botanist.**

- ➢ **Carolus Linneaus traveled to Lapland (Blue Lake, CA) and collected large number of plants.**

- ➢ **Carolus Linneaus introduced Binomial Nomenclature.**

Binomial nomenclature = Uses two Latin words to indicate the genus and the species. The first word is the genus and the second word is the species. Example- the botanical name of dates is *Phoenix dactylifera*

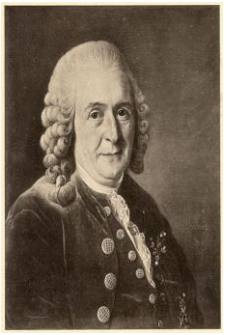
- ➢ **Carolus Linneaus published the book 'Species Plantarum' in 1753.**

- ➢ **Carolus Linneaus classified the plants based on the plant's method of reproduction and structure of reproductive parts.**

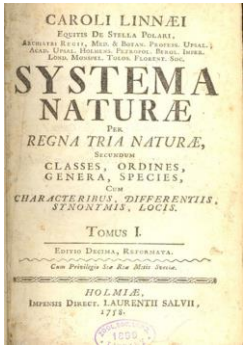
- ➢ **Produced his sexual system of classification (Artificial classification)**

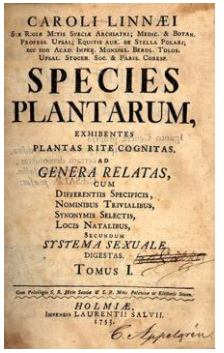
- ➢ **Carolus Linneaus divided plants into 24 classes. The Classes in the Linneaus is based largely on the amount, union and length of stamens**

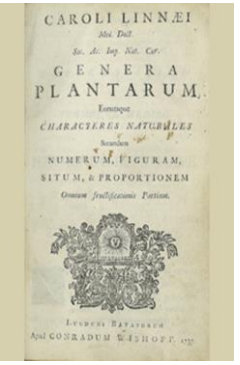
Classes



1. Monandria- stamen one
2. Diandria- stamens two
3. Triandria- stamens three
4. Tetrandria- stamens four
5. Pentandria- stamens five
6. Hexandria- stamens six
7. Heptandria- stamens seven
8. Octandria- stamens eight
9. Ennandria- stamens nine
10. Decandria- stamens ten
11. Dodecandria- stamens 11-19
12. Icosandria- stamens 20 or more, on the calyx
13. Polyandria- stamens 20 or more, on the receptacle
14. Didynamia- stamens didynamous; 2 short, 2 long
15. Tetradynamia- stamens tetradynamous; 4 long, 2 short
16. Monadelphia- stamens monadelphous; united in 1 group
17. Diadephia- stamens diadelphous; united in 2 groups
18. Polyadelphia- stamens polyadelphous; united in 3 or more groups
19. Syngenesia- stamens syngenesious; united by anthers only
20. Gynandria- stamens united with the gynoecium
21. Monoecia- plants monoecious
22. Dioecia- plants dioecious
23. Polygamia- plants polygamous
24. Cryptogamia- flowerless plants







Species Concept

- Species is the **basic unit of classification**
- **Plants of the same species consistently produce plants of the same types**

TAXONOMIC RANKS OF LAND PLANTS	ENDING	EXAMPLE TAXON
Kingdom	(various)	**Plantae**
Phylum [Division]	**-phyta**	**Magnoliophyta**
Subphylum [Subdivision]	-phytina	Magnoliophytina
Class	**-opsida**	**Asteropsida**
Subclass	-idae	Asteridae
Order	**-ales**	**Asterales**
Suborder	-ineae	Asterineae
Family	**-aceae**	**Asteraceae**
Subfamily	-oideae	Asteroideae
Tribe	-eae	Heliantheae
Subtribe	-inae	Helianthinae
Genus	(various)	***Helianthus***
Subgenus	(various)	*Helianthus*
Section	(various)	*Helianthus*
Series	(various)	*Helianthus*
Species [abbr. sp. (sing.), spp. (pl.)]	(various)	***Helianthus annuus***
Subspecies [abbr. subsp. or ssp. (sing.), subspp. or sspp. (pl.)]	(various)	*Helianthus annuus* ssp. *annuus*
Variety [abbr. var. (sing.), vars. (pl.)]	(various)	*Helianthus annuus* var. *annuus*
Form [abbr. f.]	(various)	*Helianthus annuus* f. *annuus*

The name of the plants must should be written in italics. For example *Phoenix dactylifera*

SCIENTIFIC NOMENCLATURE / BOTANICAL NOMENCLATE :

Nomenclature deals with the application of a correct name to a plant or a taxonomic group.

- **We have millions of species distributed in different geographical regions of the world.**

- **The Scientific names (Botanical name and Zoological name)of the living organism (Plants and Animals) are necessary because the same common name is used for different plants / Animals in different areas of the world.**

- **Swedish Botanist Carolus Linnaeus introduced Binomial Nomenclature.**

- **The Binomial nomenclature uses two Latin words to indicate the genus and the species. The first word is the genus and the second word is the species. Example- the botanical name of Dates is *Phoenix dactylifera***

International Code of Botanical Nomenclature (ICBN)

The current activity of botanical nomenclature is governed by the International Code of Botanical Nomenclature (ICBN) published by the International Association of Plant Taxonomy (IAPT).

The Code is divided into 3 divisions:

I. Principles
II. Rules and recommendations
III. Provisions for the governance of the Code

Principles of ICBN

1. Botanical Nomenclature is independent of Zoological Nomenclature. The Code applies equally to the names of taxonomic groups treated as plants whether or not these groups were originally so treated.

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

3. 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.

5. Scientific names of taxonomic groups are treated as LATIN, regardless of derivation.

6. The rules of nomenclature are Retroactive (taking effect from a date in the past.).

Names of Taxa

Rank	*Ending*	*Example*
Kingdom	-bionta	Chlorobionta
Division	-phyta	Magnoliophyta
	-mycota (Fungi)	Eumycota
Subdivision	-phytina	Pterophytina
	-mycotina (Fungi)	Eumycotina
Class	-opsida	Magnoliopsida
	-phyceae (Algae)	Chlorophyceae
	-mycetes (Fungi)	Basidiomycetes
Subclass	-opsidae	Pteropsidae
	-idae (Seed plants)	Rosidae
	-physidae (Algae)	Cyanophysidae
	-mycetidae (Fungi)	Basidiomycetidae
Order	-ales	Rosales
Suborder	-ineae	Rosineae
Family	-aceae	Rosaceae
Subfamily	-oideae	Rosoideae
Tribe	-eae	Roseae
Subtribe	-inae	Rosinae
Genus	*-us, -um, -is, -a, -on*	*Pyrus, Allium, Arabis, Rosa, Polypogon*
Subgenus		*Cuscuta* subgenus *Eucuscuta*
Section		*Scrophularia* section *Anastomosanthes*
Subsection		*Scrophularia* subsection *Vernales*
Series		*Scrophularia* series *Lateriflorae*
Species		*Rosa canina*
Subspecies		*Crepis sancta* subsp. *bifida*
Varietas		*Lantana camara* var. *varia*
Forma		*Tectona grandis* f. *punctata*

❖ **Generic Name:**

The Generic name is usually a noun and singular, which is spelled or written with a capital letter.

❖ **Specific Epithet:**

The specific epithet is often an adjective and it is written with a small initial letter.

❖ **In the hand written manner, both the generic names and specific epithet should be underlined, while if printed it should be in italics.**

TYPIFICATION

Type Specimen is the one representative of the taxon.

- **Holotype:**

A specimen designated by the author in the original publication (nomenclatural type).

- **Isotype:**

A duplicate specimen of the holotype collected at the same time and place (may be in other herbarium).

- **Lectotype:**

A specimen chosen from the author's original material when no holotype has been designated.

- **Neotype:**

A specimen selected when all original specimens have been destroyed

Author Citation, Effective Publication and Principle of Priority

Author Citation

- **For a name to be complete, it should be accompanied by the name of the author or authors who first published the name validly. The names of the authors are commonly abbreviated, Example L. for Carolus Linnaeus**
- ***Aizoon canariense* L.**
- ***Tribulus macropterus* var. *arabicus* (Hosni) Al-Hemaid & J. Thomas**

Basic structure of a taxonomic Research papers / Recent publication of a new species in taxonomic journal

Ann. Bot. Fennici 53: 37–39 ISSN 0003-3847 (print) ISSN 1797-2442 (online)
Helsinki 4 January 2016 © Finnish Zoological and Botanical Publishing Board 2016

Silene langshanensis (Caryophyllaceae), a new species from Inner Mongolia, China

Li-Qing Zhao[1,*], Zhi-Ming Xin[2] & Yi-Zhi Zhao[1]

[1] College of Life Science, Inner Mongolia University, Hohhot 010021, China (*corresponding author's e-mail: zhaofeiniu@126.com)
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Received 22 Apr. 2015, final version received 9 Oct. 2015, accepted 9 Oct. 2015

Zhao L.Q., Xin Z.M. & Zhao Y.Z. 2016: *Silene langshanensis* (Caryophyllaceae), a new species from Inner Mongolia, China. — *Ann. Bot. Fennici* 53: 37–39.

Silene langshanensis L.Q. Zhao, Y.Z. Zhao & Z.M. Xin *sp. nova* (Caryophyllaceae), is described and illustrated from Inner Mongolia, China. It appears to be most closely related to *S. scabrifolia* of *Silene* sect. *Holopetalae*. *Silene langshanensis* can be distinguished by the basally pubescent carpophore, petals with obtuse auricles, stems and leaves with dense, short hairs, and by the glabrous calyx.

In total, there are about 600 species of *Silene s. lato* (Caryophyllaceae) (Zhou *et al.* 2001). They are distributed mainly in the northern temperate regions, but occur also in Africa and South America (Zhou *et al.* 2001). Among these species, 110 are known from China, of which 67 are endemic. Twenty of the endemics (nine species of *Silene s. stricto*, nine of *Melandrium*, one of *Cucubalus* and one of *Lychnis*) are found in Inner Mongolia.

In September 2008 and later, in 2014, the authors Zhao and Xin collected specimens of *Silene* from Langshan in Bayannaoer (Inner Mongolia) from desert steppe communities on mountain slopes at 1150–1400 m a.s.l. After careful study, we concluded that the specimens represented an undescribed species of *Silene*.

Silene langshanensis L.Q. Zhao, Y.Z. Zhao & Z.M. Xin, *sp. nova* (Fig. 1)

HOLOTYPE: China. Inner Mongolia, Bayannaoer, Dengkou, Mt. Langshan, 40°43′58.4″N, 106°22′28.5″E, on stony mountain slopes, 1371 m a.s.l., 9 June 2014 *Li-Qing Zhao, Zhi-Ming Xin, Shuai Qin & Long Chen N14-001* (HIMC). — PARATYPES (all HIMC!): Same location as holotype, 9 June 2014 *Li-Qing Zhao, Zhi-Ming Xin, Shuai Qin & Long Chen N14-002, N14-003, N14-004*; Mt. Langshan, 40°39′27.7″N, 106°23′14.1″E, on stony mountain slopes, alt. 1185 m a.s.l., 10 September 2008 *Li-Qing Zhao & Zhi-Ming Xin N08-001*.

Herbs perennial, 20–50 cm tall. Roots robust, lignified. Plants cespitose with erect stems, multi-branched or sparsely branched, pubescent, upper parts glabrescent. Basal leaves oblanceolate, 20–60 × 2–6 mm, both surfaces pubescent, margins ciliate, base attenuate into a long petiole, apex acute; cauline leaves 3–7 pairs, linear-oblanceolate or linear-lanceolate, with short, axillary sterile branches or sometimes elongated flowering axillary branches. Flowers in a racemiform-like thyrse; cymes alternating (resulting from suppression of opposite cyme at same node) or opposite, 1-flowered (rarely 2), peduncles nearly equal or shorter than pedicels. Pedicel 2–6 cm, glabrescent; bracts ovate-lanceolate, ciliate, base connate, apex acuminate. Calyx tubular, green, sometimes violet, narrowly campanulate, slightly inflated in fruit, 10–13 × 4–5 mm, glabrous; calyx teeth broadly triangular-ovate, apex obtuse or acute, margin membranous, ciliate. Carpophore 2–3 mm, basally pubescent. Petals ca. 15 mm, claws cuneate, glabrous, auricles obtuse; limbs yellowish green, narrowly obovate, margin entire or emarginate, coronal scales absent. Stamens and styles prominently exserted; filaments glabrous. Styles 3. Ovary ovate-elliptic, ca. 5 mm long. Capsule 6-valved. Flowering and fruiting in June–September.

Silene langshanensis is placed in the section *Holopetalae*, of which five species are now known from China (Zhou *et al.* 2001). It resembles *S. scabrifolia* (*see* Shishkin 1936: 677) but can be distinguished by several characters (Table 1). The following key should be useful when identifying species of sect. *Holopetalae* in China.

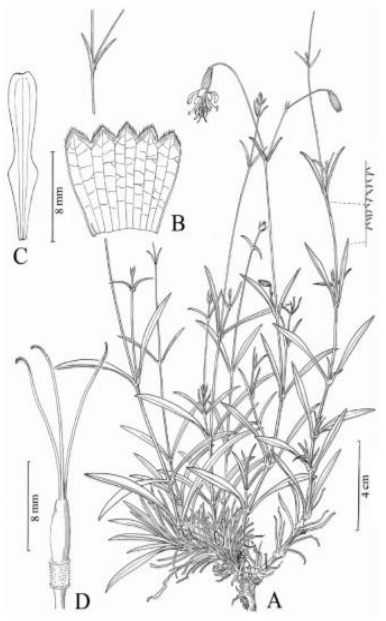

Fig. 1. *Silene langshanensis* (from the holotype, drawn by Ping Ma). — **A**: Habit. — **B**: Calyx. — **C**: Petal. — **D**: Pistil and carpophore.

Table 1. Main morphological differences between *Silene langshanensis* and *S. scabrifolia*.

Character	*S. langshanensis*	*S. scabrifolia* (= *S. komarovii*)
Stem	densely pubescent, upper part glabrescent when flowering	pubescent in lower part, glabrous and viscid above
Basal leaves	oblanceolate, 20–60 × 2–6 mm	spatulate or lanceolate, 60–80 × 5–10 mm
Cyme	1-flowered (rarely 2)	multiflowered
Pedicel	20–60 mm long, glabrescent	5–10 mm long, sparsely pubescent
Calyx	narrowly campanulate, 10–13 × 4–5 mm, glabrous	tubular-clavate, 8–12 × 2–3 mm, glabrous or sparsely villous
Carpophore	shortly pubescent	glabrous
Petal	with obtuse auricles	without distinct auricles
Limbs	yellowish green	yellowish white

1. Leaves ovate-lanceolate, 15–30 mm wide ..... *S. kungessana*
1. Leaves lanceolate or linear, 1.5–10 mm wide 2
2. Leaves linear, 10–30 × 1.5–3 mm ..... *S. holopetala*
2. Leaves oblanceolate or lanceolate, 30–80 mm long, usually more than 4 mm wide 3
3. Stems usually not branched; calyx 6–9 mm; petals pinkish abaxially ..... *S. pseudotenuis*
3. Stems branched; calyx 8–13 mm; petals yellowish green or yellowish white 4
4. Stem pubescent in lower part, glabrous and viscid above; cymes multiflowered; petals yellowish white, without obvious auricles; carpophore glabrous ..... *S. scabrifolia*
4. Stem with dense short hairs, upper part glabrescent when flowering; cymes 1-flowered (rarely 2); petals yellowish green, with obtuse auricles; carpophore basally pubescent ..... *S. langshanensis*

Acknowledgements

We are grateful to Ping Ma for the drawing. This study was financially supported by Natural Science Foundation of Inner Mongolia Autonomous Region (2014ZD02), National Key Basic Research Program of China (2014CB138802) and the Central Public-interest Scientific Institution Basal Research Fund (CAFYBB2014MA016).

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Effective publication in the journal, available to Botanist

Date of valid publication (principles of priority): If the same species will be published by some one else after this date then the publication will be not valid. (/Principles of Priority).

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Abstract / Summary / Synopsis.

Previously it was required to write in Latin.

In total, there are about 600 species of *Silene s. lato* (Caryophyllaceae) (Zhou *et al.* 2001). They are distributed mainly in the northern temperate regions, but occur also in Africa and South America (Zhou *et al.* 2001). Among these species, 110 are known from China, of which 67 are endemic. Twenty of the endemics (nine species of *Silene s. stricto*, nine of *Melandrium*, one of *Cucubalus* and one of *Lychnis*) are found in Inner Mongolia.

In September 2008 and later, in 2014, the authors Zhao and Xin collected specimens of *Silene* from Langshan in Bayannaoer (Inner Mongolia) from desert steppe communities on mountain slopes at 1150–1400 m a.s.l. After careful study, we concluded that the specimens represented an undescribed species of *Silene*.

Botanical name in Latin

Rank indicated

Silene langshanensis L.Q. Zhao, Y.Z. Zhao & Z.M. Xin, *sp. nova* (Fig. 1)

Type Specimen indicated

HOLOTYPE: China. Inner Mongolia, Bayannaoer, Dengkou, Mt. Langshan, 40°43′58.4″N, 106°22′28.5″E, on stony mountain slopes, 1371 m a.s.l., 9 June 2014 *Li-Qing Zhao, Zhi-Ming Xin, Shuai Qin & Long Chen N14-001* (HIMC). — PARATYPES (all HIMC!): Same location as holotype, 9 June 2014 *Li-Qing Zhao, Zhi-Ming Xin, Shuai Qin & Long Chen N14-002, N14-003, N14-004*; Mt. Langshan, 40°39′27.7″N, 106°23′14.1″E, on stony mountain slopes, alt. 1185 m a.s.l., 10 September 2008 *Li-Qing Zhao & Zhi-Ming Xin N08-001*.

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Taxonomic Description

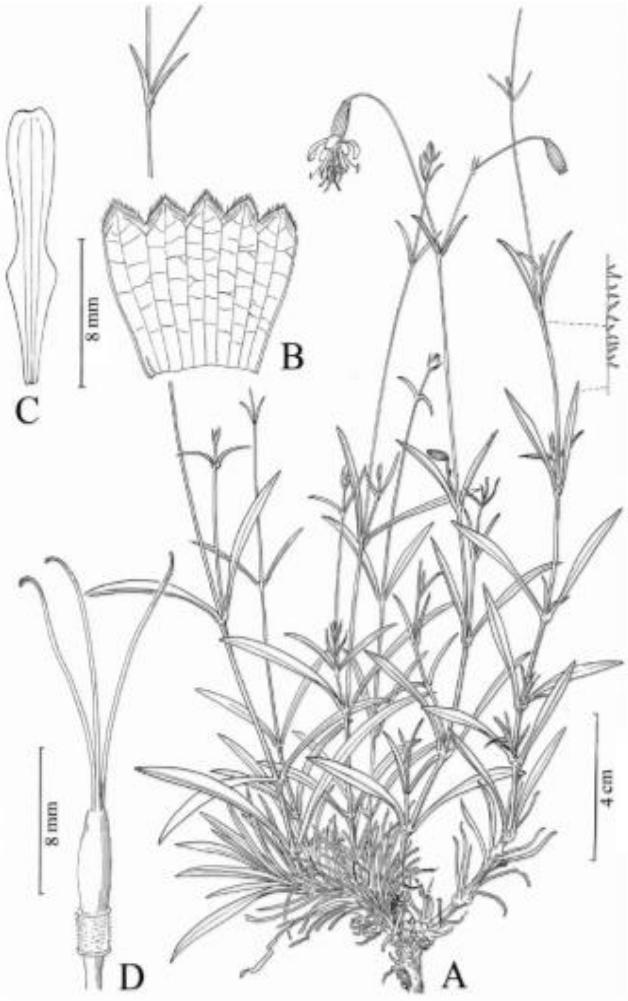

Fig. 1. *Silene langshanensis* (from the holotype, drawn by Ping Ma). — **A**: Habit. — **B**: Calyx. — **C**: Petal. — **D**: Pistil and carpophore.

sometimes violet, narrowly campanulate, slightly inflated in fruit, 10–13 × 4–5 mm, glabrous; calyx teeth broadly triangular-ovate, apex obtuse or acute, margin membranous, ciliate. Carpophore 2–3 mm, basally pubescent. Petals ca. 15 mm, claws cuneate, glabrous, auricles obtuse; limbs yellowish green, narrowly obovate, margin entire or emarginate, coronal scales absent. Stamens and styles prominently exserted; filaments glabrous. Styles 3. Ovary ovate-elliptic, ca. 5 mm long. Capsule 6-valved. Flowering and fruiting in June–September.

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Line drawing

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Carpophore	shortly pubescent	glabrous
Petal	with obtuse auricles	without distinct auricles
Limbs	yellowish green	yellowish white

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2. Leaves oblanceolate or lanceolate, 30–80 mm long, usually more than 4 mm wide 3
3. Stems usually not branched; calyx 6–9 mm; petals pinkish abaxially ..... *S. pseudotenuis*
3. Stems branched; calyx 8–13 mm; petals yellowish green or yellowish white 4
4. Stem pubescent in lower part, glabrous and viscid above; cymes multiflowered; petals yellowish white, without obvious auricles; carpophore glabrous ..... *S. scabrifolia*
4. Stem with dense short hairs, upper part glabrescent when flowering; cymes 1-flow… green, with … cent …

Taxonomic Key for Identification

Acknowledgements

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This article is also available at http://www.annbot.net and http://www.bioone.org/loi/anbf

Synonyms and Related Terminology

Synonyms:

- **A name rejected due to misuse or difference in taxonomic judgement.**

Basionym:

- **The basionym is the first name ever given to a taxon. Further studies and revisions may reject the basionym as the most correct one, but it still is useful as a nomenclatural reference for that species.**

- **Also, according to the priority rules of the ICBN, after a taxonomic revision that results in a species being reclassified in another genus, the specific epithet must remain the same as the one in the Basionym.**

- **A short example: Linnaeus classified the Tea Plant as *Thea sinensis*. Some decades later, Sweet noticed that the genus *Thea* was not really different from the genus *Camellia*, and renamed all the *Theas* as *Camellias*. *Thea sinensis* became *Camellia sinensis*, because he had to keep the specific epithet the same as the original name (Basionym) for that species, given by Linnaeus.**

Homonym:

A case in which two or more identical names are baed on different type , of which only one can be a legitimate name , is called as homonym.

Tautonym

A case in which name of genus and the name of the species is the same.

5. Major Plant Families (Diagnostic Characters)

Identifying Plant Families

Caryophyllaceae

- Herbs
- Leaves in opposite pairs, unlobed, untoothed
- Flowers usually have 5 petals
- Flowers usually have 5 sepals
- Flowers in cymes (group of flowers, terminal flower opens first
- Single capsule fruit

Brassicaceae

- Herbs
- Alternate leaves
- No stipules
- Flowers have 4 petals in a cross
- Flowers have 4 sepals
- Many cultivated vegetables

Identifying Plant Families

Apiaceae

- Herbs
- Leaves usually alternate with sheathing, inflated leaf-stalk bases
- Flowers have 5 separate petals
- Flowers small
- Umbels type of inflorescence

Lamiaceae / Labiatae

- Herbs
- Square stems
- Leaves opposite
- Leaves often toothed
- No stipules
- Tubular flowers
- Flowers usually have hood and prominent lower lip

Identifying Plant Families

Asteraceae / Compositae

- Largest family of flowering plants worldwide
- Herbs
- Leaves without stipules
- Flowers small in dense heads
- Petals always joined into a corolla-tube (petals fused together below forming a tube)

Cucurbitaceae

- Herbaceous vines
- Tendrils present
- Plants usually monecious
- Flowers 5-merous
- Ovary inferior
- Fruit usually a pepo

Identifying Plant Families

Asclepiadaceae

- Perennial herbs, vines, and shrubs with milky sap, some cactus-like
- Leaves opposite or whorled, simple, entire
- Flowers bisexual, actinomorphic, Stamens and carpels united into gynostegium
- Fruit a follicle
- seeds with a tuft of silky hairs

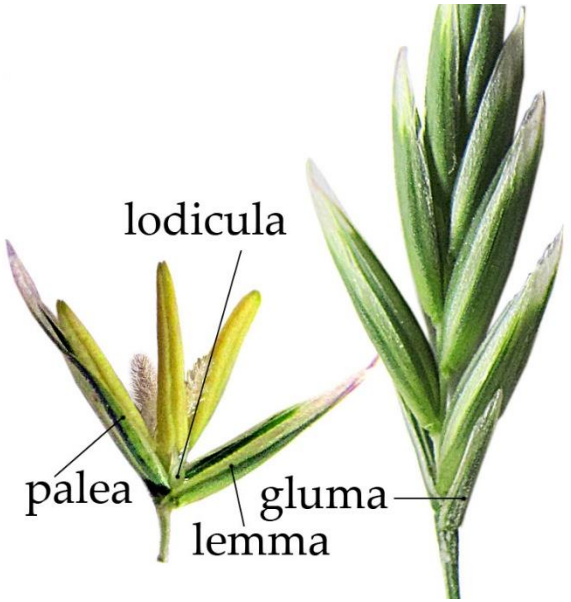
Euphorbiaceae

- Milky latex, cyathium inflorescence, tricarpellary ovary

Identifying Plant Families

Poaceae

- Hollow stem with nodes.
- Spikelet inflorescence.
- Caryopsis fruit.



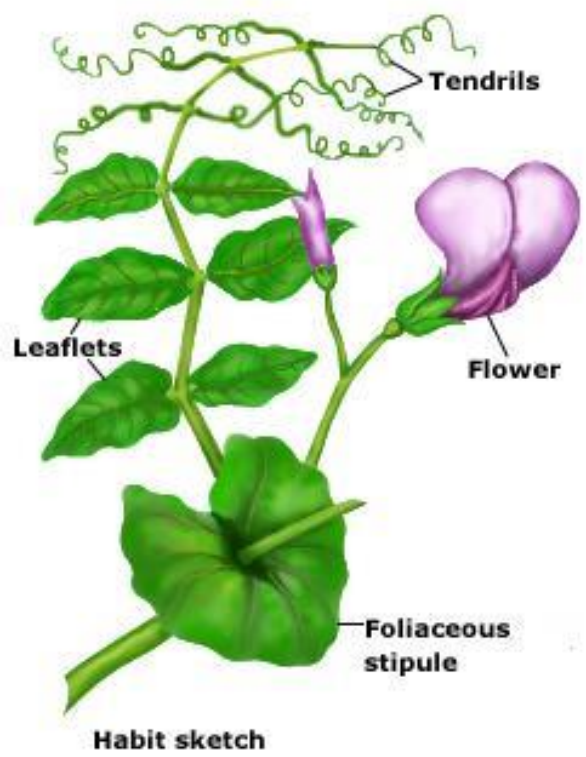
Solanaceae

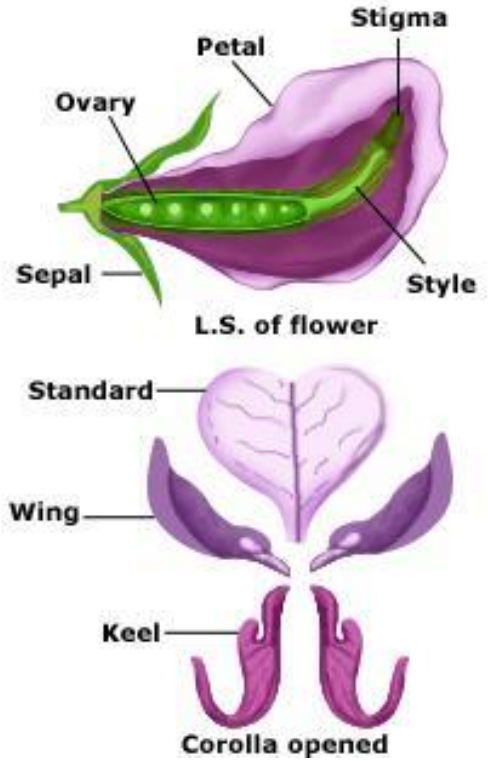
Actinomorphic flowers, five fused petals, berry/capsule fruit.

Identifying Plant Families

Fabaceae / Leguminosae

- Five-petalled flowers
- Leaves usually trifoliate or pinnate
- Wide standard petal at top
- 5 sepals forming calyx-tube (lower parts of sepals fused)
- Fruit an elongated pod

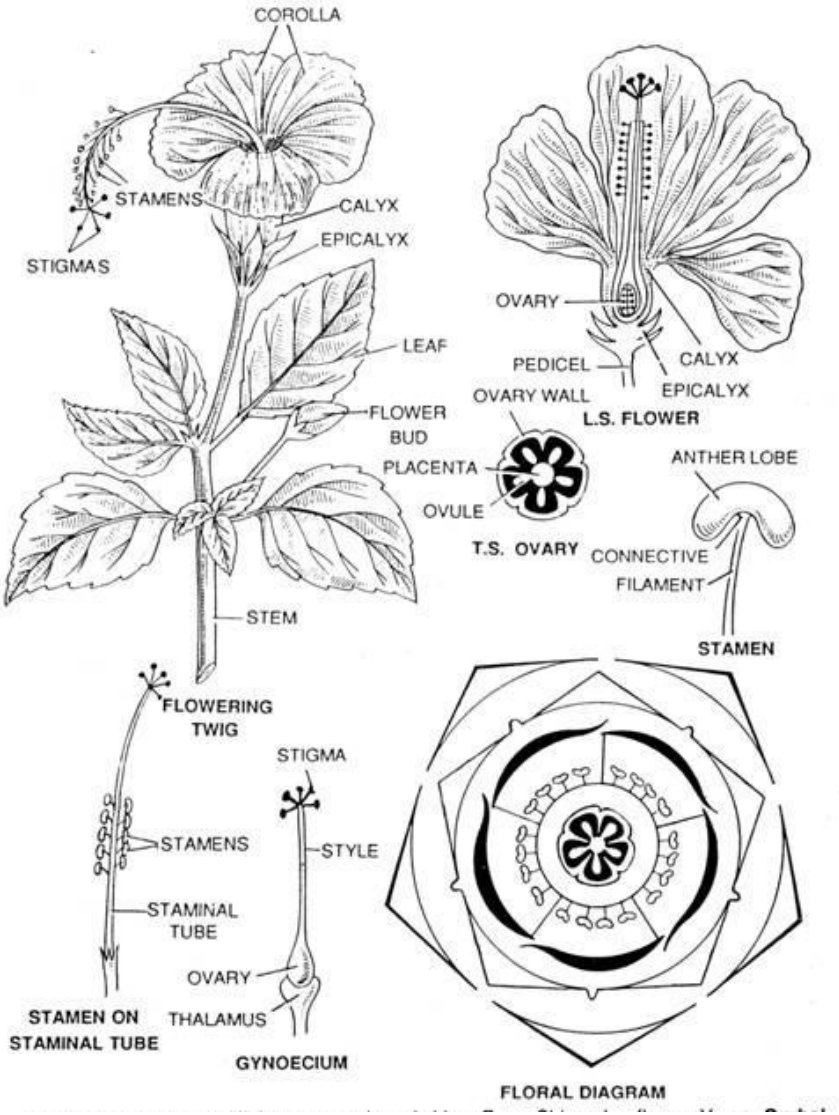




Identifying Plant Families

Malvaceae:

- Presence of epicalyx
- Petals with twisted aestivation
- Stamens indefinite and monoadelphous
- Anthers reniform and monothecous
- Ovary two- many carpels with axile placentation.

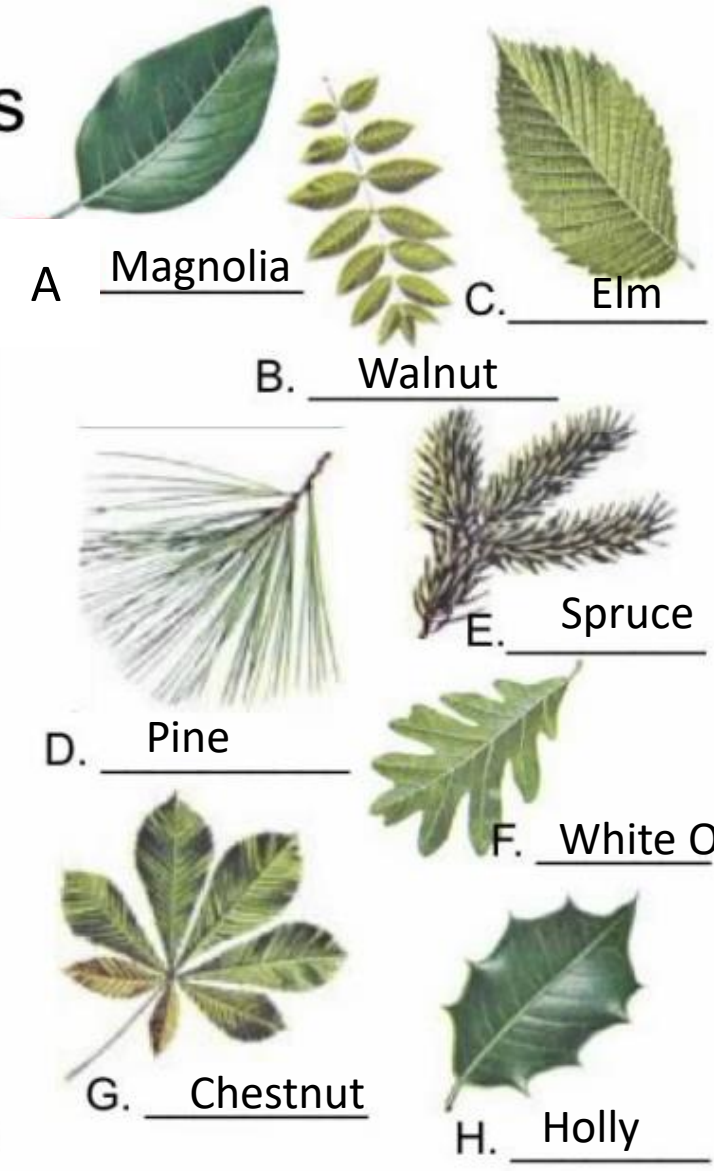


Taxonomic Key

An identification device, consisting of contrasting statements used to narrow down the identity of a taxon

Dichotomous Key For Leaves

1.	a. Needle leaves	go to 2
	b. Non-needle leaves	go to 3
2.	a. Needles are clustered	Pine
	b. Needles are in singlets	Spruce
3.	a. Simple leaves (single leaf)	go to 4
	b. Compound leaves (made of "leaflets")	go to 7
4.	a. Smooth edged	go to 5
	b. Jagged edge	go to 6
5.	a. Leaf edge is smooth	Magnolia
	b. Leaf edge is lobed	White Oak
6.	a. Leaf edge is small and tooth-like	Elm
	b. Leaf edge is large and thorny	Holly
7.	a. Leaflets attached at one single point	Chestnut
	b. Leaflets attached at multiple points	Walnut

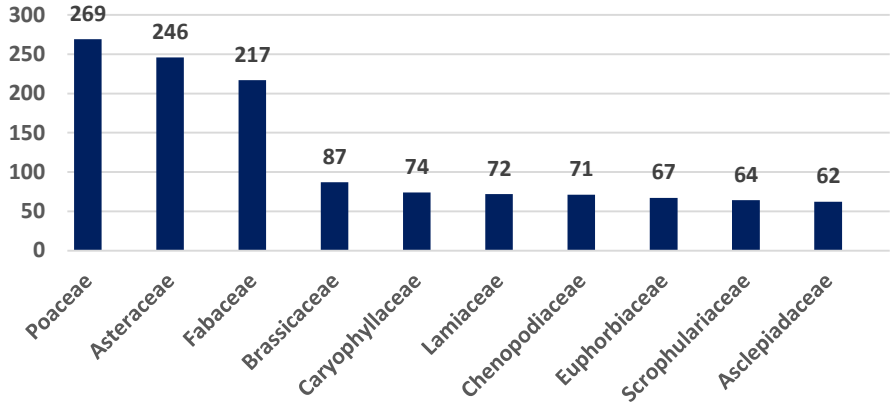


6. Plant Biodiversity and conservation

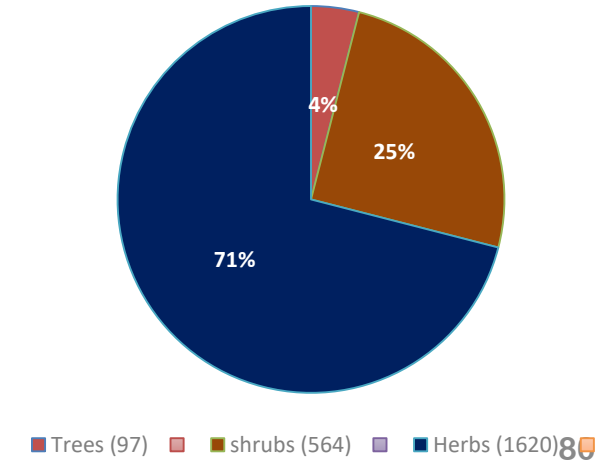
Plant Biodiversity of Saudi Arabia

- The flora of Saudi Arabia is somewhat a complex one, having affinities with the floras of East Africa, North Africa, the Mediterranean countries and the Irano-Turanian countries.
- Total number of species recorded: about 2300 species
- Gymnosperms: 9 species (*Juniperus phoenicea)*
- Pteridophytes : 27 species (Example: *Marsilea aegyptiaca)*
- Total number of families: 131
- Families represented by single species : 33
- 418 species belonging to 27 families are monocots
- 67 species are endangered (*Huernia saudi-Arabica)*
- 56 are endemic to the region (Example: *Aloe sheilae* Lavr.)

Major Families of Saudi flora



Percentage of Herbs, shrubs and Trees



Aromatic and Medicinal Plants of Saudi Arabia

Artemisia sieberi
(Family Compositae):

- Leaves are used as an anthelmintic.
- Anthelmintic is an antiparasitic drugs that expel parasitic worms

Ruta chalepensis
(Family Rutaceae)

- Leaves are used to cure rheumatism
- Rheumatism is the disease marked by inflammation and pain in the joints, muscles, or fibrous tissue

Withania somnifera
(Family Solanaceae)

- Leaves and roots are used as a poultice
- Poultice is the term used for "applied to the body to relieve soreness and inflammation"

Citrullus colocynthis
(Family Cucurbitaceae)

- Leaves, seeds and roots are used in insect bits

PLANT BIODIVERSITY AND CONSERVATION

- **Biodiversity** is the biological diversity which includes the variety of the whole species present on earth. It includes different animals, plants, micro-organisms)

- **Biodiversity conservation:**

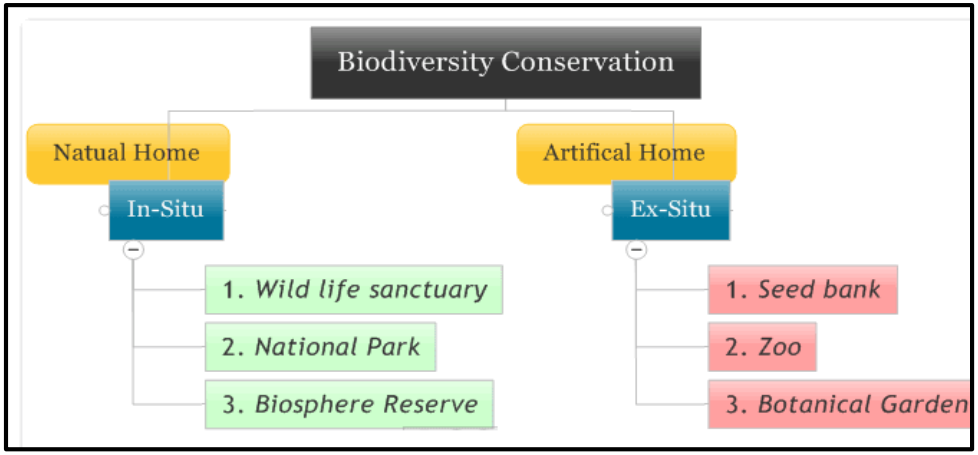
- Plant diversity is disappearing at an unprecedented rate as a direct impact of the way humankind uses the world's natural resources.
- Our flora is fundamentally important to human life as a source of food, shelter and medicine amongst many other things.
- The threats to plant diversity vary worldwide. These include habitat loss and degradation, invasive aliens, over-exploitation of resources, and even climate change.
- Species extinctions are on the rise.
- More than 80,000 seed-bearing plant species (20% of the total) are currently under threat.

- The biodiversity must should be conserve because of its benefit for example services and biological resources (medicine, food, wood products, fibers etc.) which are essential to live our life on earth.

- **In-situ conservation:** *In-situ* conservation means the conservation of species within their natural habitats. By *In-situ* biodiversity conservation method the biodiversity area may be covered in the form of natural park/ sanctuary/biosphere reserve etc.

- At present, Saudi Arabia has 15 protected areas. For example:

Area Name	Area Km^2	Declared Year
Harrat al Harrah	13,775	1987
Al Khunfah	20,450	1987
At Tubayq	12,200	1989



Ex-Situ conservation:

- Ex-situ conservation involves the conservation of biological diversity outside of their natural habitats.

- Ex-situ Biodiversity conservation can be done by forming Gene banks, seed banks, botanical garden, collections of In vitro plant tissue culture.

- Ex-situ biodiversity conservation strategy plays an important role in recovery programmes for endangered species.


Ochna inermis

Botanical Garden

- The botanic gardens are institutions holding documented collections of living plants for the purposes of studied botany, taxonomy and systematics, multidisciplinary scientific research, conservation, display and education.
- Botanical gardens are often run by universities or scientific research organizations.
- Recently botanic gardens have seen a revival as scientific institutions due to the emergence of the conservation movement.

List of some important botanic garden of world:

1. New York Botanical Gardens, New York, America
2. Royal Botanical Gardens Sydney, Sydney, Australia
3. Kirstenbosch National Botanical Garden, Cape Town, South Africa
4. Botanischer Garten München, Munich, Germany
5. Orto botanico di Padova, Padua, Italy
6. Hawaii Tropical Botanical Garden, Pāpa'ikou, Hawaii
7. Jardin Botanique de Montreal, Montreal, Canada
8. Longwood Gardens, Philadelphia, USA
9. Kew Royal Botanical Gardens, London, England
10. Oman Botanic garden, Oman (Botanical Garden for the Future)

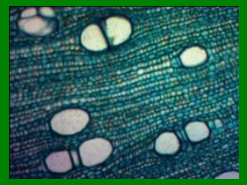
7. Taxonomic Evidences

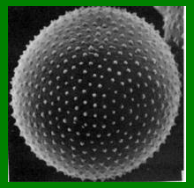
Taxonomic Evidences

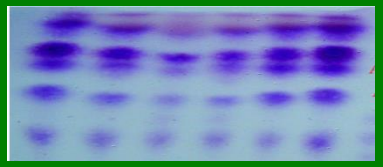
Taxonomic evidence for the establishment of classifications and phylogenies is gathered from a variety of sources

Morphology to Molecules

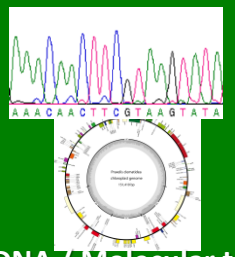

Morphology

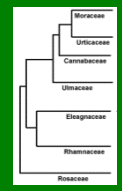

Anatomy


Pollen


Chemistry


Chromosomes





85

DNA / Molecular taxonomy

- Taxonomy relies on multiple sources of evidence.
- Morphological characters are primary taxonomic tools.
- Micromorphology (SEM) like leaf surface, pollen, seed surface
- Anatomical evidence supports internal structure analysis.
- Cytological data reveal chromosome behavior.
- Phytochemical compounds serve as chemical markers.
- Ecological evidence explains habitat adaptation.
- Geographical distribution supports species differentiation.
- Reproductive biology provides fertility information.
- Molecular data strengthen modern taxonomy.
- Integration of evidence ensures reliable classification.

TAXONOMIC EVIDENCES

- Taxonomic evidences are scientific data used to identify, classify, and establish relationships among plants.
- Morphological characters such as leaves, flowers, and fruits provide primary taxonomic evidence.
- Anatomical features including stomata, trichomes, and vascular tissues assist in plant identification.
- Cytological evidence based on chromosome number and structure helps explain evolutionary relationships.
- Palynological studies of pollen morphology serve as reliable diagnostic taxonomic characters.
- Embryological characters such as ovule and seed development contribute to classification.
- Chemotaxonomic evidence uses secondary metabolites like alkaloids and flavonoids for grouping plants.
- Molecular evidence derived from DNA sequencing provides objective and precise classification data.
- Ecological and geographical distribution patterns support taxonomic interpretation.
- Integrative taxonomy combines multiple evidences to achieve accurate and natural plant classification.

Molecular Systematics and Plant DNA Barcoding

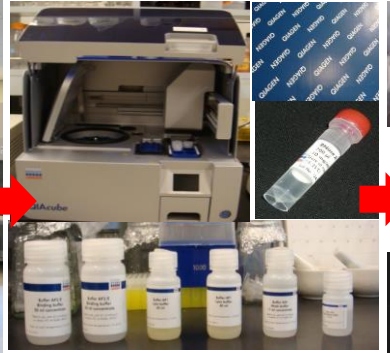
- Molecular systematics uses DNA, RNA, and protein sequences to study evolutionary relationships among plants.
- It provides objective taxonomic evidence independent of environmental influence on morphology.
- DNA sequencing allows accurate reconstruction of phylogenetic relationships.
- Molecular markers such as rbcL, matK, and ITS are widely used in plant systematics.
- Plant DNA barcoding identifies species using short standardized DNA regions.
- DNA barcodes function as unique genetic identifiers similar to commercial product barcodes.
- DNA barcoding helps detect cryptic, rare, and morphologically similar plant species.
- Molecular systematics supports revision and improvement of traditional classification systems.
- Barcoding plays an important role in biodiversity conservation, ecological monitoring, and medicinal plant authentication.
- Integration of molecular systematics with classical taxonomy forms the basis of modern integrative plant taxonomy.

Molecular systematics

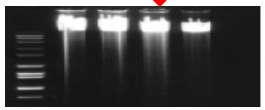
- Molecular systematics deals the utilization of nucleic acid data. As DNA sequence of a gene is constant in a species, hence advantage over morphological data for taxonomic studies.
- Taxonomist use molecular data from three different locations within a plant cell: chloroplast, mitochondrion and the nucleus.
- Molecular systematics involves following steps: (1) Sample collection, (2) DNA extraction, (3) Amplification using PCR –Polymerase chain Reaction, (4) DNA / Gene Sequencing, (5) Analysis of Sequence data.
- DNA barcoding can speed up identification of species. DNA barcoding helps in Wild plant identification / Medicinal plant authentication
- A DNA barcode is a short gene sequence taken from standardized portions of the genome, used to identify species

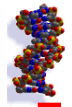

Collection of plant samples


A view of molecular biology laboratory



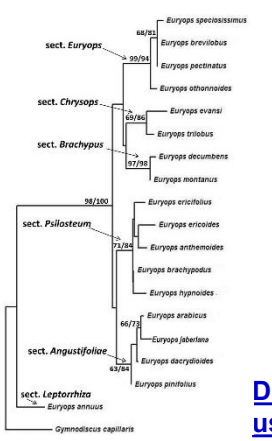
Gel electrophoresis



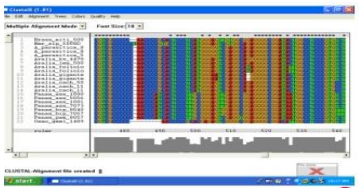


Molecular Biology

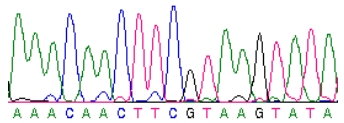
Doyle JJ, Doyle JL (1990) Isolation of plant DNA from fresh tissue. Focus 12:13–15

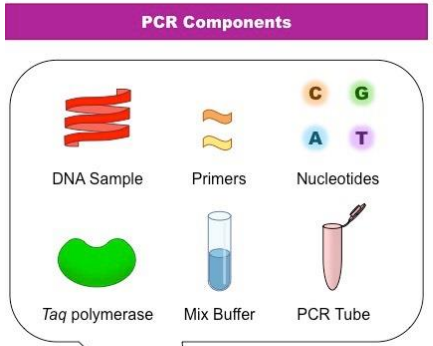


Building Tree



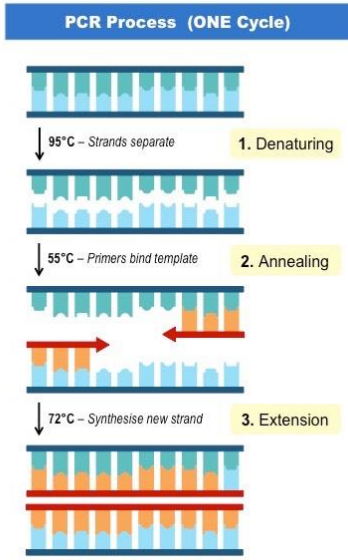
DNA sequence alignment using ClustalX

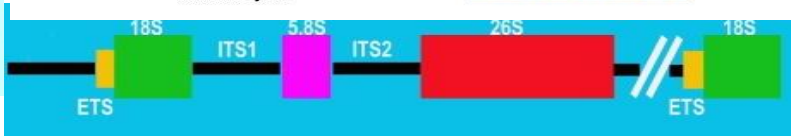


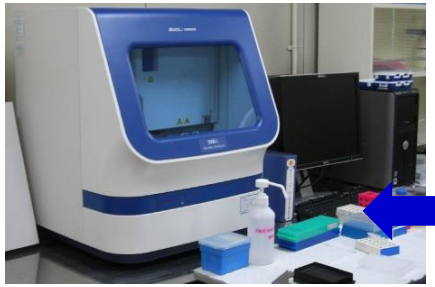


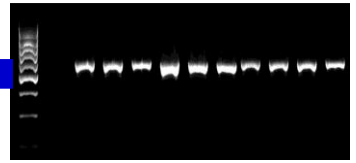

Thermal Cycler

PCR Cycle









Phylogenetic Implication of Molecular Genotyping of *Euryops jaberiana* Abedin & Chaudhary (Asteraceae)

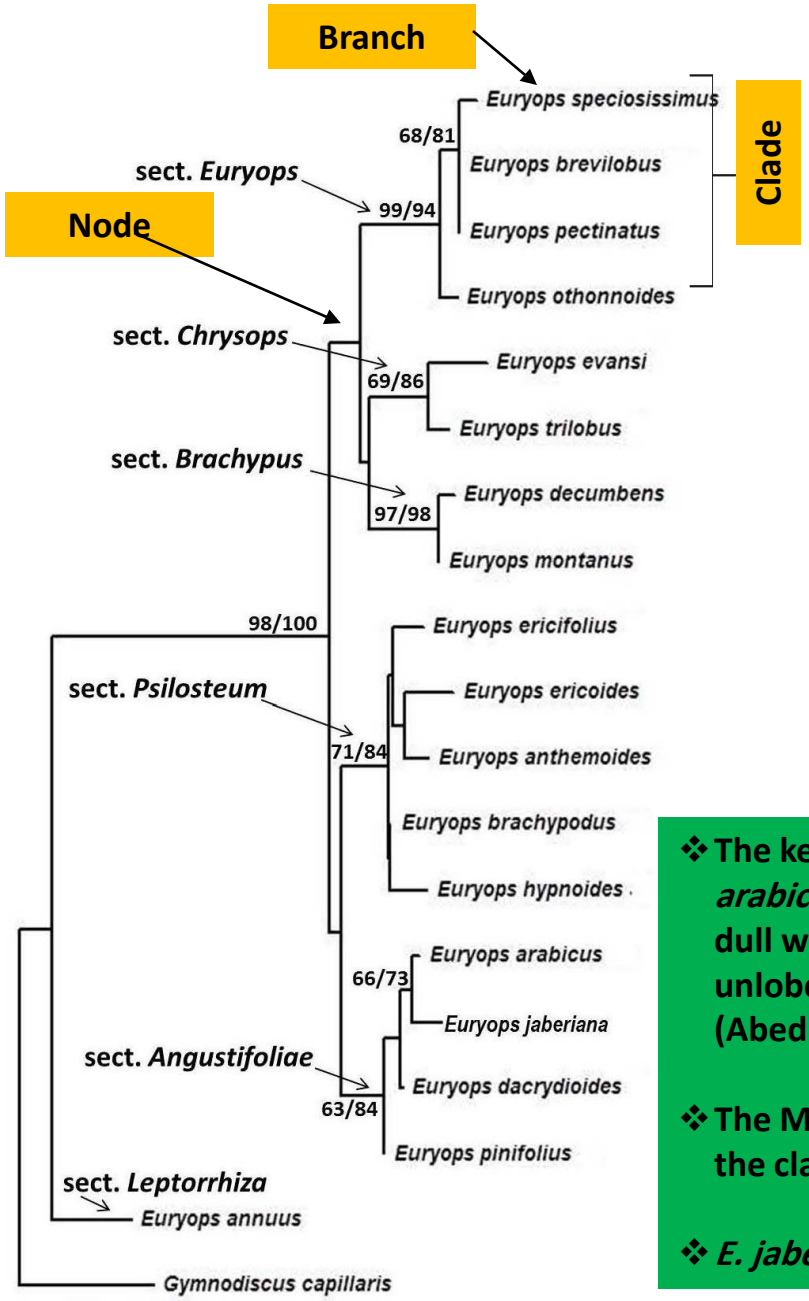
E. arabicus

- In Saudi Arabia, the genus *Euryops* (family Asteraceae) is represented by two species, *viz*. *E. arabicus* Steud. *ex* Jaub. & Spach, and *E. jaberiana* Abedin & Chaudhary.
- *E. arabicus* is is endemic to Arabian Peninsula, while *E. jaberiana* is endemic to northern Saudi Arabia.
- Morphologically *E. jaberiana* very closely resembles with *E. arabicus* / very narrow differences in m morphological characters (Abedin and Chaudhary, 2000).

E. jaberiana

- The taxonomic status of *Euryops jaberiana* Abedin & Chaudhary (tribe Senecioneae, was evaluated (Ali et al., 2016) based on molecular phylogenetic analyses of internal transcribed spacer sequence (ITS) of nuclear ribosomal DNA (nrDNA) in order to ascertain its position within the genus.

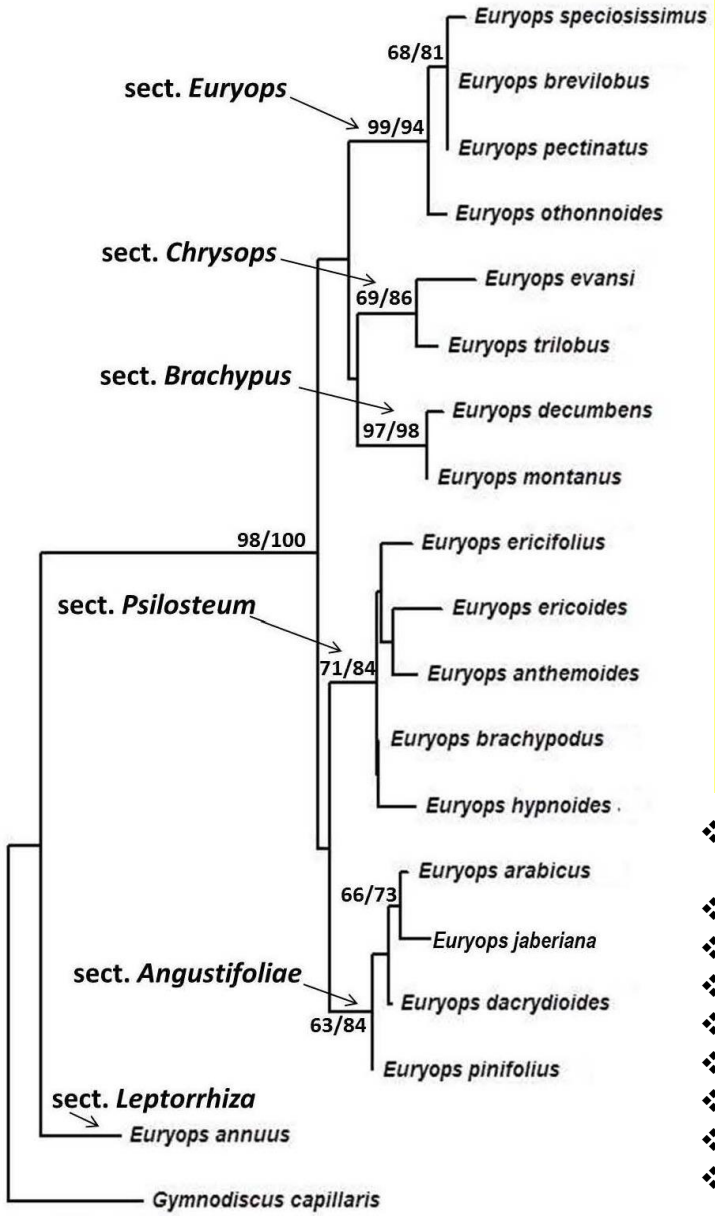
Phylogenetic Implication of Molecular Genotyping of *Euryops jaberiana* Abedin & Chaudhary (Asteraceae) Contd……

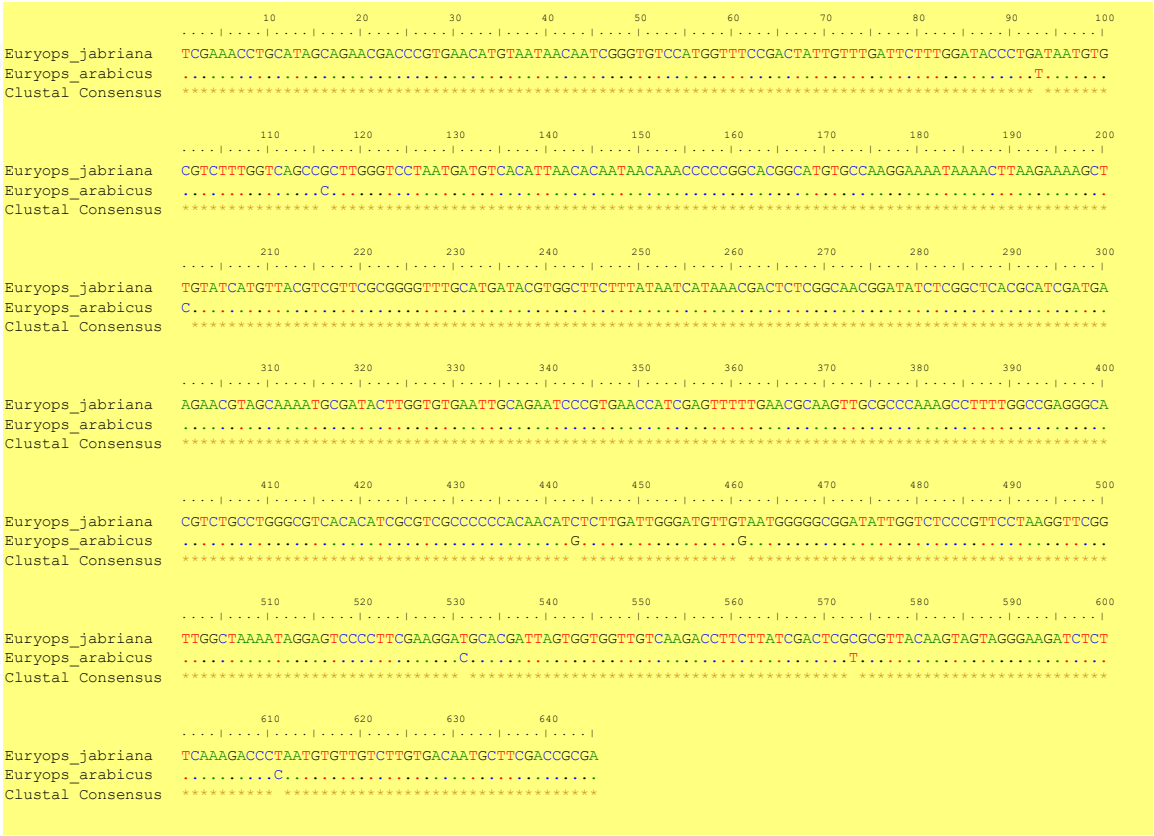


- In molecular taxonomic studies, the most convenient way of presenting taxonomic relationships among a group of organisms is the phylogenetic tree.
- Node: a branch point in a tree
- Branch: defines the relationship between the taxon
- Topology: the branching patterns of the tree
- Branch length: represents the number of changes that have occurred in the branch
- Clade: a group of two or more taxa closed together based on DNA sequences data analsysis
- Maximum parsimony is an optimality criterion under which the phylogenetic tree that minimizes the total number of character-state changes is to be preferred.
- Bootstrap: Bootstrapping is a procedure where DNA sequence data run for the phylogenetic analysis, and the reported value is the percentage of bootstrap replicates, for examples 100 means that the node is well-supported, it showed in all tress.

- The key morphological features which differentiate *E. jaberiana* from *E. arabicus* are: leaves 3-lobed at the tips, pappus hairs transparent or rarely dull white, and achenes glabrescent, while in *E. arabicus*, the leaves are unlobed, pappus hairs are dull white and achene densely lanate hairy (Abedin and Chaudhary, 2000).
- The Maximum Parsimony analyses reveals that *E. jaberiana* nested within the clade of the section *Angustifoliae.*
- *E. jaberiana* shows proximity with *E. arabicus* (66% bootstrap support.

Phylogenetic Implication of Molecular Genotyping of *Euryops jaberiana* Abedin & Chaudhary (Asteraceae) Contd……





- A total of eight specific nucleotide differences were detected between *E. jaberiana* and *E. Arabicus i.e.* at the alignment position:
- 93 (A →T)
- 116 (G → C)
- 201 (T → C)
- 443 (C → G)
- 461 (T → G)
- 531 (T → C)
- 573 (C → T)
- 611 (T → C)

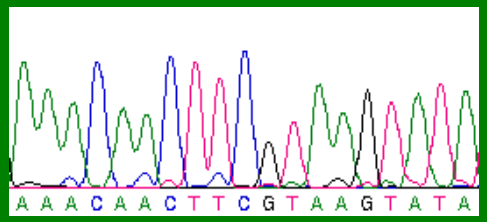
Thus on the basis of phylogenetic relationships of *E. jaberiana* within the genus and nucleotide differences, Ali et al. (2016) recognized *E. jaberiana* as a distinct species and different from *E. arabicus.*

8. Plant DNA Barcoding

Plant DNA Barcoding

- **Molecular markers such as rbcL, matK, and ITS are widely used in plant systematics.**
- **Plant DNA barcoding identifies species using short standardized DNA regions.**
- **DNA barcodes function as unique genetic identifiers similar to commercial product barcodes.**
- **DNA barcoding helps detect cryptic, rare, and morphologically similar plant species.**
- **Molecular systematics supports revision and improvement of traditional classification systems.**
- **Barcoding plays an important role in biodiversity conservation, ecological monitoring, and medicinal plant authentication.**
- **Integration of molecular systematics with classical taxonomy forms the basis of modern integrative plant taxonomy.**

NCBI



Applications of Plant DNA Barcoding

- DNA barcoding enables rapid and accurate identification of plant species, including unknown or fragmentary samples.
- It is widely used for authentication of medicinal plants and detection of adulteration in herbal products.
- DNA barcoding helps in biodiversity assessment and monitoring of endangered plant species.
- It assists in identifying invasive species and supports ecological and environmental management programs.
- DNA barcoding is applied in forensic botany, agriculture, and conservation genetics for species verification.

ONLINE RESOURCES OF PLANT TAXONOMY

- World Checklist of Selected Plant Families
- Tropicos — **nomenclatural, bibliographic, and specimen data**
- Global Biodiversity Information Facility
- The New York Botanical Garden Virtual Herbarium
- National Center for Biotechnology Information
- GenBank — Nucleotide
  Alphabet of Life
- Biodiversity Heritage Library
- Wikispecies
- Catalogue of Life
- African Plant Database
- JSTOR Plant Science
- Herbarium Catalogue
  Royal Botanic Gardens, Kew
- Encyclopedia of Life
- Royal Botanic Gardens, Kew
  Plant information portal
- Google Images

LITERATURE OF PLANT TAXONOMY

Records: Library and Herbarium

Publications:

Monograph - covers a specific group of plants: family, genera, etc. (Revisions, Synopses)

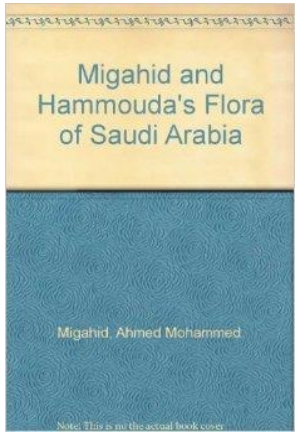
Flora - Treatment of plants in a defined geographical area

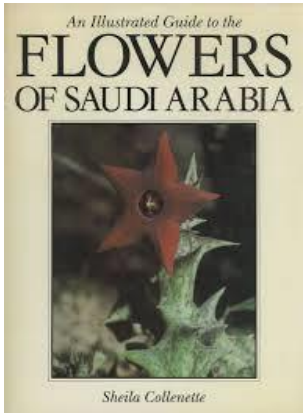
Taxonomic journals

- **American Journal of Botany** (http://www.amjbot.org)
- **Annals of the Missouri Botanic Garden** (http://www.mbgpress.org/)
- **Australian Journal of Botany** (http://www.publish.csiro.au/nid/65.htm)
- **Botanical Journal of the Linnaean Society** (http://www.blackwellpublishing.com/jnl_default.asp)
- **Botanical Review** (http://sciweb.nybg.org/science2/BotanicalReview.asp)
- **Brittonia** (http://www.nybg.org/bsci/brit/)
- **Canadian** Journal of Botany (http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_desc_e?cjb)
- **Fieldiana** (Botany) http://www.fortsasbooks.com/publish.htm
- **Grana** (http://www.tandf.co.uk/journals/titles/00173134.asp)
- **International Journal of Plant Sciences** (http://www.journals.uchicago.edu/IJPS/home.html)
- **Molecular Biology & Evolution** (http://mbe.oupjournals.org)
- **Molecular Phylogenetics & Evolution (**http://www.elsevier.com)
- **Nordic Journal of Botany** (http://www.nathimus.ku.dk/bot/b_nordic.htm)
- **Novon**(http://www.mbgpress.org/)
- **Smithsonian Contributions to Botany** (http://www.sipress.si.edu/the_press/press_main.html)
- **Systematic Biology** (http://systbiol.org)
- **Systematic Botany** (http://www.sysbot.org/)
- **Taxon** (http://www.botanik.univie.ac.at/iapt/s_taxon.php)

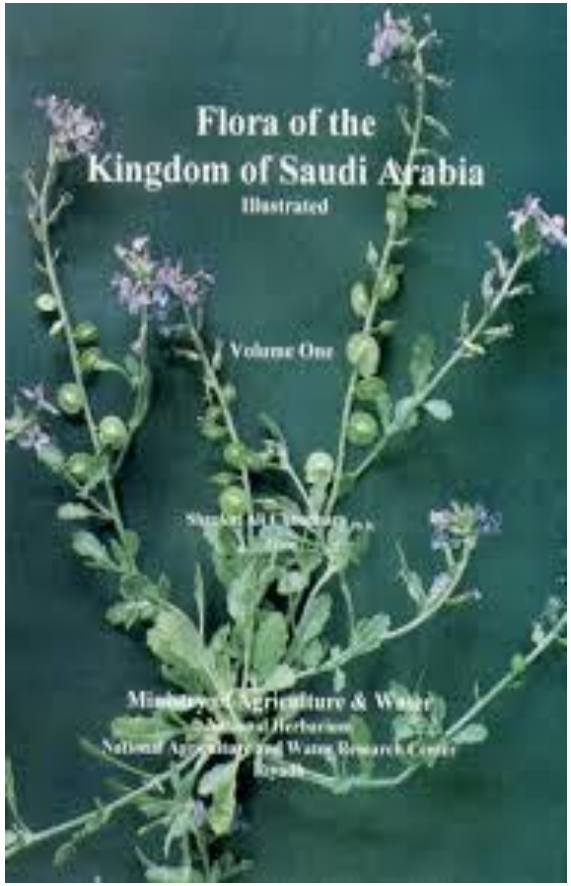
History of Botanical Studies in Saudi Arabia

- Musil (1909) and Philby (1917) were studied plants of arbian peninsula region during early 19th century.
- E. Blatter (1919-1936) compiled most of the major and minor collections of the previous visitors and published a detailed checklist of the wild plants of Arabia (Flora Arabica).
- The collections of DeMarco (DeMarco & Dinelli, 1974), as part of the work of Italconsult Company for the survey of Agriculture Development, and Mandaville (Saudi Aramco during 1960's) were also remarkable. These collections were deposited in the British Herbaria.





- A.M. Migahid, A.El-Sheikh, U. Bairele, P. Kong, H.M. Hassan, H.A. Abulfatih were also collected plant from different region of Saudi Arabia . The collections are deposited in the Herbarium (KSU) of Botany & Microbiology, King Saud University. The flora of Saudi Arabia appeared in 1974, 1978 and 1988-1990.
- S. Collenette (1972-1999) : Collections are deposited in the Royal Botanic Gardens (E), Edinburgh and RBG, Kew (K), a set of which is also deposited at the National Herbarium (RIY) of the Ministry of Agriculture.
- The floristic wealth of Saudi Arabia was enumerated approximately 15 years ago in the three volumes of ‘Flora of Saudi Arabia’ (by S. Chaudhary).



History of Botanical Studies in Saudi Arabia Contd....

- Kitab al Nabat by A.H. Dinawari (895 A.D.): A comprehensive knowledge of the agriculture and medicinal practices of the Bedouins.

- Discussion about Arabian plants is available in the manuscript Istakhri (915-919 A.D.), Idrisi (11153 A.D.), A.Al-Fida (1331 A.D.).

- Peher Forsskal (1736-1763): Stay in the southern parts of the Arabian Peninsula, and collected a significant number of plants from Yemen and Jizan Region. Some of these plants were described as new in the posthumous publication "Flora Aegyptiaca-Arabica" by Niebuhr (1775).

FLORA
ÆGYPTIACO-ARABICA.
SIVE
DESCRIPTIONES
PLANTARUM,
QUAS
PER
ÆGYPTUM INFERIOREM
ET
ARABIAM FELICEM
DETEXIT, ILLUSTRAVIT
PETRUS FORSKÅL.
PROF. HAUN.

POST MORTEM AUCTORIS
EDIDIT
CARSTEN NIEBUHR.

ACCEDIT
TABULA ARABIÆ FELICIS GEOGRAPHICO-BOTANICA.

HAUNIÆ, 1775.
EX OFFICINA MÖLLERI, AULÆ TYPOGRAPHI.
PROSTAT APUD HEINECK ET FABER.

- Ehrenberg (1825) visited some of the Red Sea Islands, and Studied mainly microorganisms.

- There were some further visitors too in the Arabian Peninsula region but their collection are not available in any Herbarium), like Ehrenberg (1820-26), Aucher-Eloy (1830), Kotschy and Schimper (1836), Anderson (1859), Pelley (1865), Balfour (1880), Schweinfurth (1888), Deflers (1893).

- J.R. Wellsted (1833) traveled along the southern coast of Arabia and collected some plants.

- E. Combes and M.O. Tamisier in the middle of the 19th century accompanied an Egyptian expedition team to the mountains of Asir. Their records were published in the "Voyage en Abssinie et 1` Arabie" in 1851.

THANKS