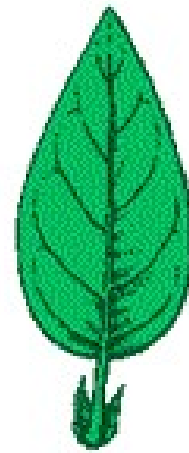


Leaves: Types, Phyllotaxy, and Modifications

Dr. Irani Biswas

Types of Leaves

- 1. Simple Leaf:
 - Single lamina, may be lobed or unlobed.
 - Examples: Mango, Guava.
- 2. Compound Leaf:
 - Lamina divided into leaflets.
 - Types: Pinnately compound (Neem), Palmately compound (Cotton).



Simple



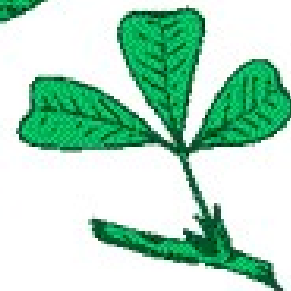
Pinnately Compound



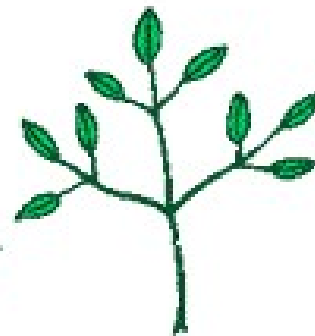
Twice Pinnately Compound



Palmately Compound



Trifoliolate



Ternate

Phyllotaxy

- Arrangement of leaves on the stem or branch:
- 1. Alternate: Single leaf at each node (e.g., Sunflower).
- 2. Opposite: Two leaves opposite each other at a node (e.g., Guava).
- 3. Whorled: More than two leaves at a node forming a whorl (e.g., Alstonia).



Modifications of Leaves

- Leaves may be modified to perform special functions:
- 1. Tendrils: For climbing (e.g., Pea).
- 2. Spines: For protection (e.g., Cactus).
- 3. Storage leaves: Store food/water (e.g., Onion, Aloe).
- 4. Insectivorous leaves: Trap insects for nutrition (e.g., Pitcher plant).
- 5. Phyllodes: Flattened petiole takes over photosynthesis (e.g., Australian Acacia).

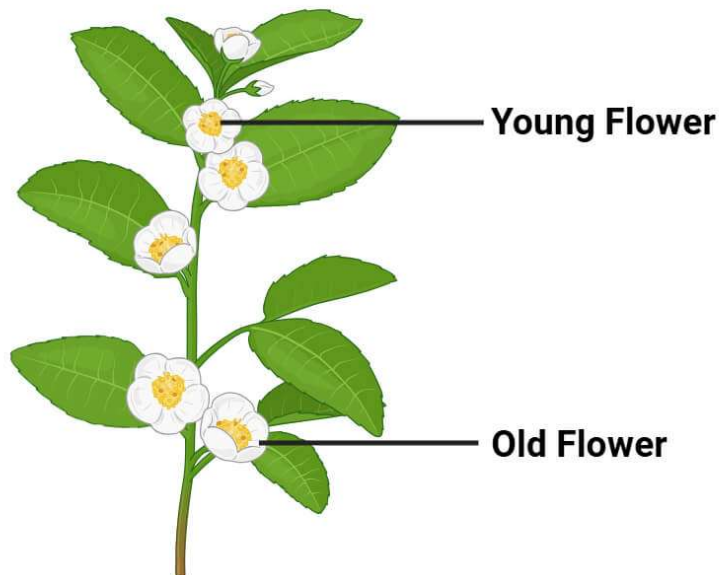
Inflorescence: Types and Evolution

Dr. Irani Biswas

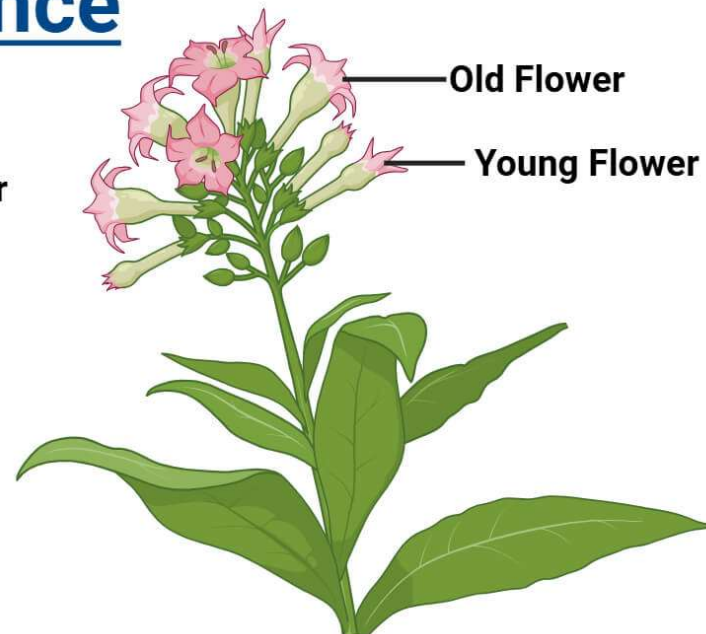
Introduction to Inflorescence

- Inflorescence refers to the arrangement and pattern of flowers on a plant. It is an important taxonomic feature in plant identification.
- Three main categories: Racemose (indeterminate), Cymose (determinate), and mixed

Inflorescence



Racemose Inflorescence

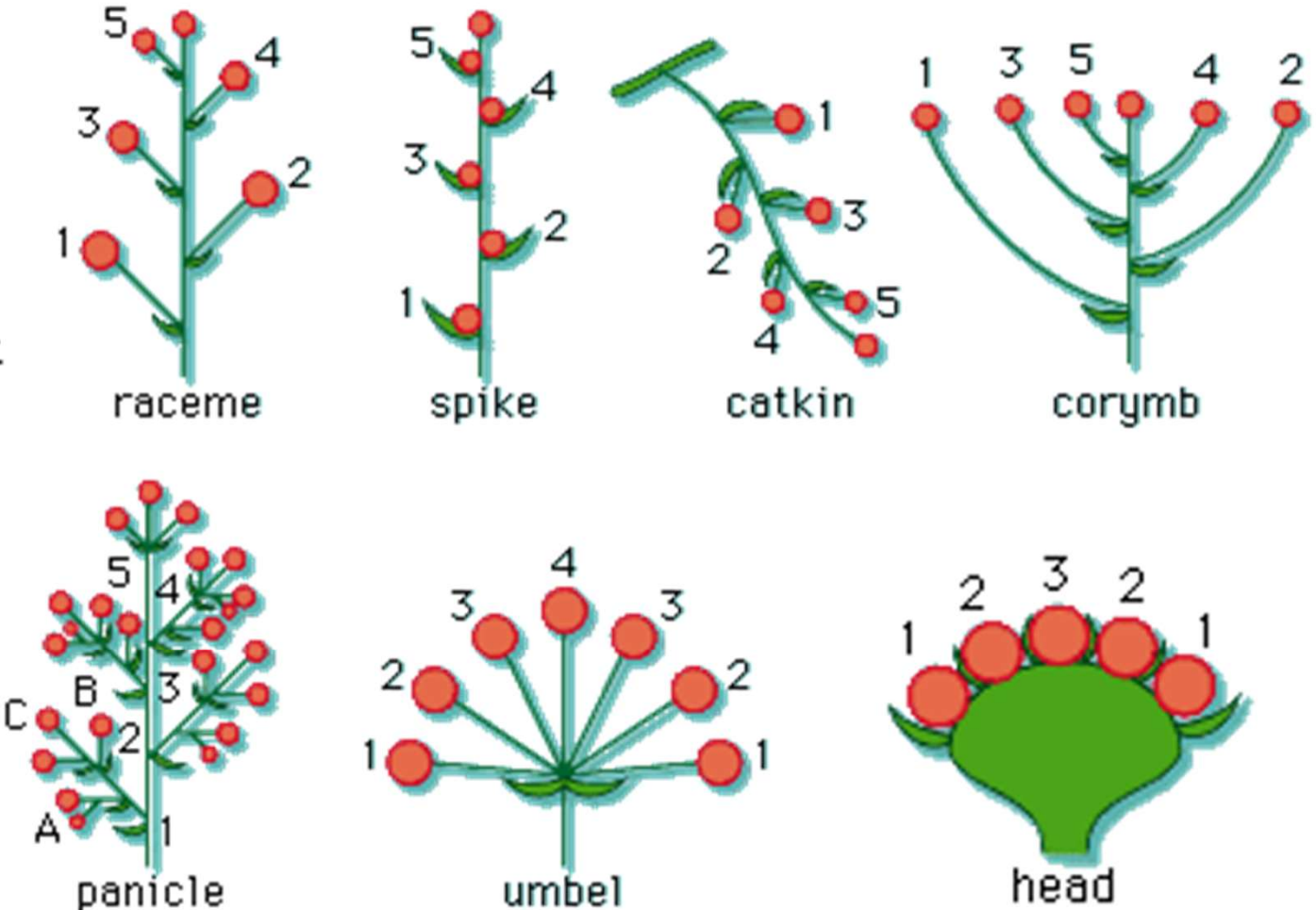


Cymose Inflorescence

Racemose Inflorescence

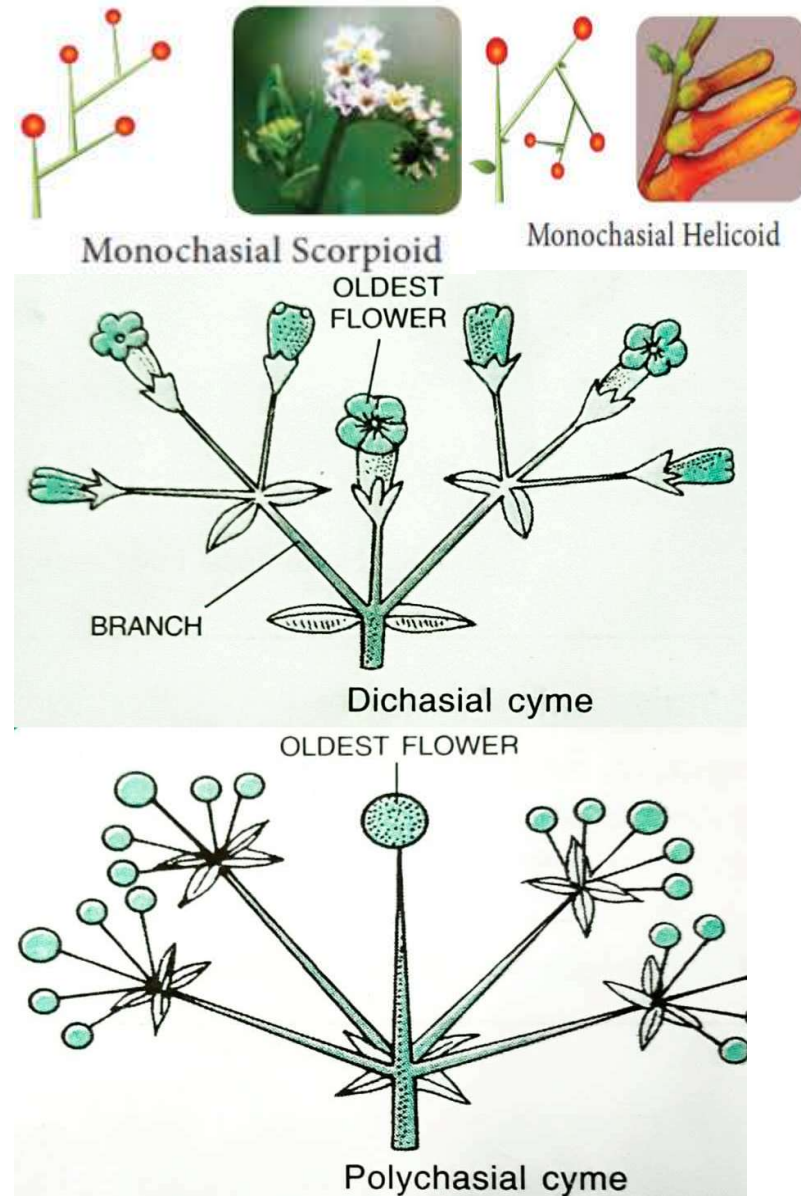
- Characteristics:
 - Main axis grows continuously.
 - Flowers are arranged in acropetal succession (older at base, younger at top).
- Types: Raceme, Spike, Catkin, Corymb, Umbel, Spadix, Capitulum.

Flowers are represented by circles, and their order of development is indicated in numerical sequence: in each inflorescence, flower 1 is the oldest in the group. The letters A, B, and C in the diagram of the panicle depict the sequence of flower development in one of the lowest branches.



Cymose Inflorescence

- Characteristics:
 - Main axis terminates in a flower.
 - Flowers are arranged in basipetal succession (younger at base, older at top).
- Types: Monochasial cyme, Dichasial cyme, Polychasial cyme.



Mixed Inflorescence

In this category of inflorescence, the axis begins as a racemose inflorescence and exhibits branching in a cymose fashion. There are following types beneath this:

Thyrus:

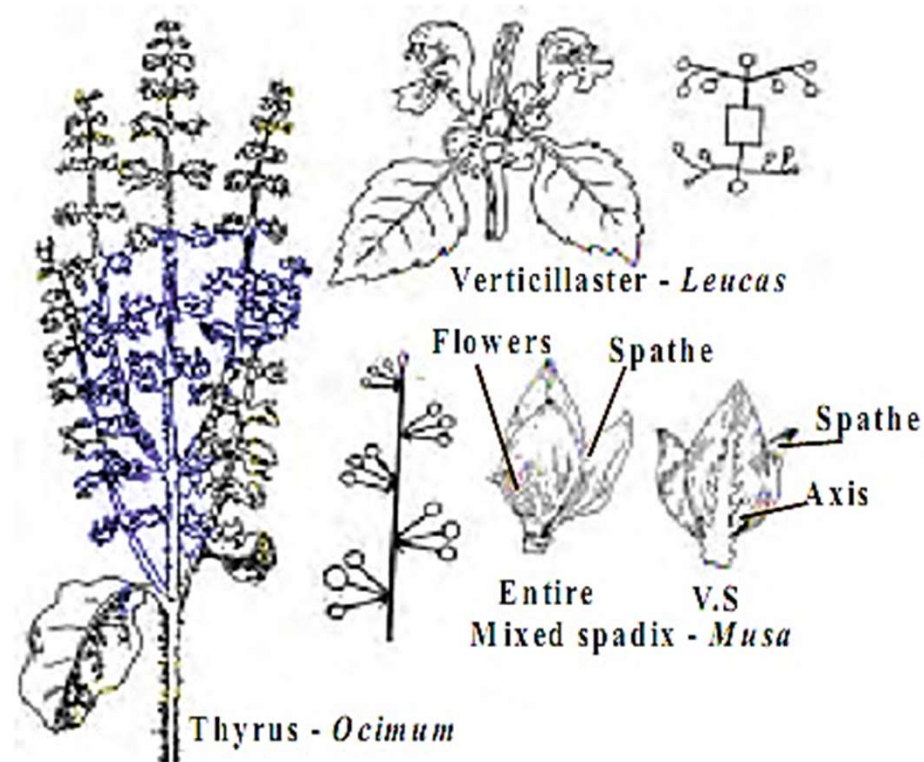
The major axis of the inflorescence exhibits a number of simple dichasial cymes arranged in a racemose way, example: *Ocimum*.

Verticillaster:

The pair of dichasial cymes occurs from the axils of opposite flowers. Later such grow as monochasial scorpioid cymes just about the stem, example: *Leucas*.

Mixed Spadix:

In *Musa* many cymose clusters are arranged on the swollen inflorescence axis from base to the apex. Each cymose cluster is enclosed by a big bract termed as spathe.



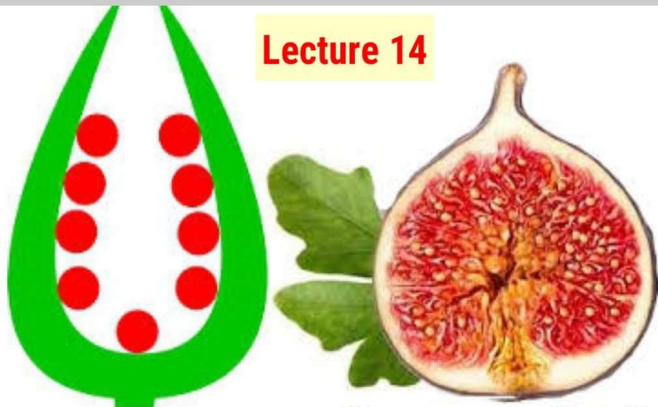
Special Types of Inflorescence

Modified forms adapted for specific functions:

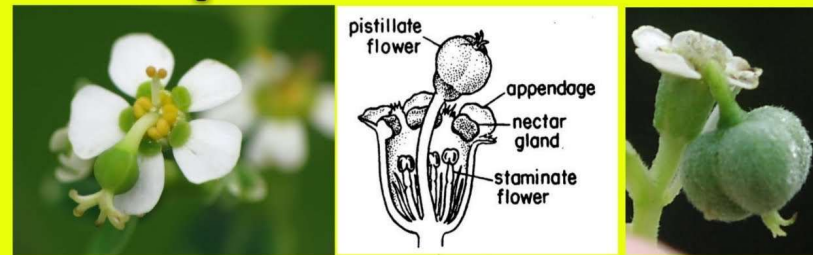
- Hypanthodium (e.g., Ficus).
- Cyathium (e.g., Euphorbia).
- Coenanthium (e.g., Dorstenia)

Hypanthodium Inflorescence

Lecture 14



Cyathium Inflorescence Euphorbiaceae

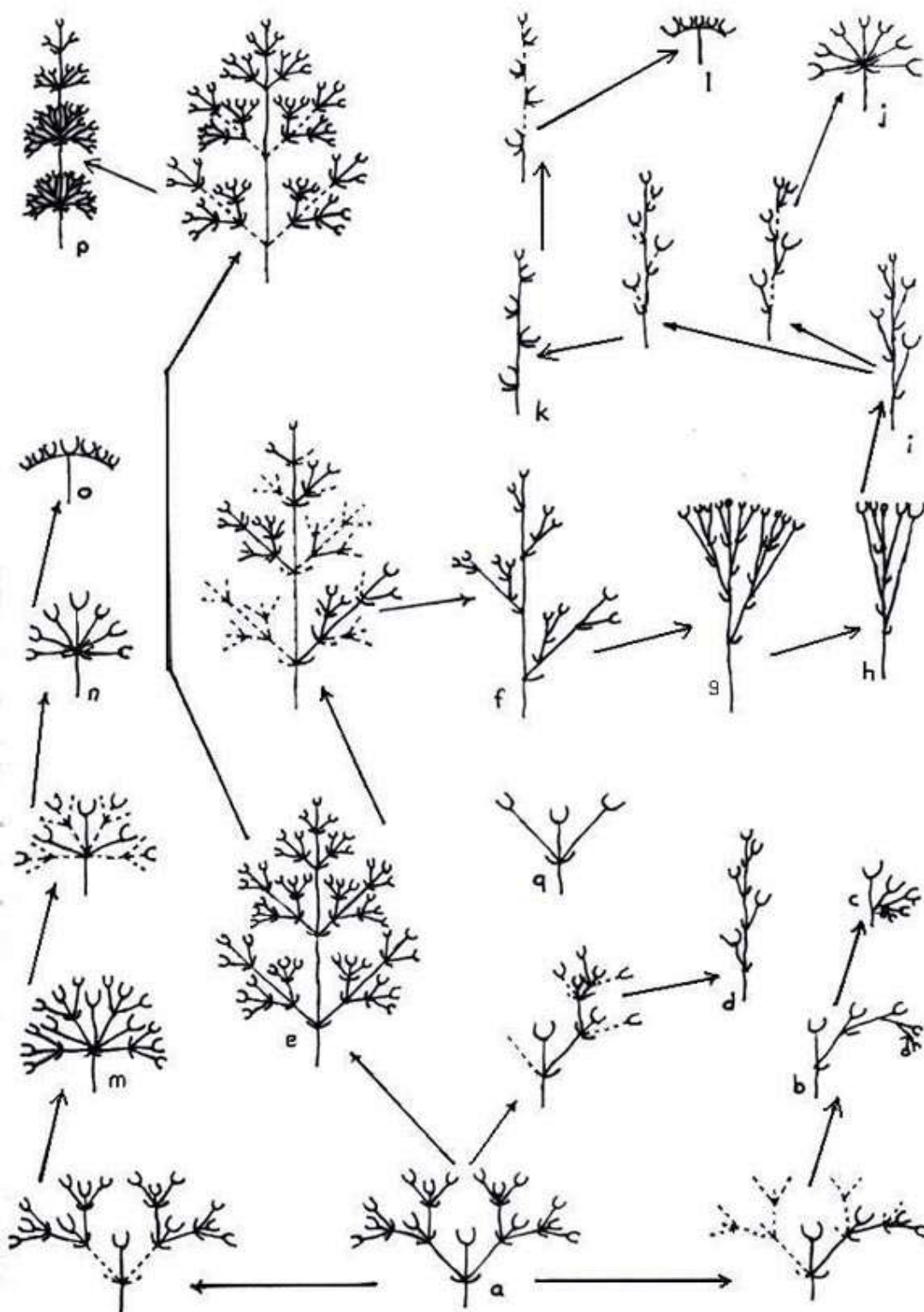


Dorstenia

Evolution of Inflorescence

Evolutionary trends in inflorescences:

- Primitive forms: Solitary flowers, racemose types.
- Advanced forms: Compound and highly specialized inflorescences.
- Evolution linked to pollination strategies and efficiency in reproductive success.



Schematic diagrams of hypothetical evolution of inflorescence types:
a. compound dichasium; b. helicoid cyme; c. cincinnus;
d. scorpioid cyme; e. thyrses; f. panicle;
g. compound corymb; h. simple corymb;
i. raceme;
j. indeterminate umbel; k. spike; l. indeterminated head;
m. cyme; n. determinate umbel; o. determinate head;
p. verticillate inflorescence; q. simple dichasium.

Lawrence

Summary

- Inflorescence is the arrangement of flowers on a plant.
- Two major types: Racemose (indeterminate) and Cymose (determinate).
- Special types and evolutionary trends show adaptation for reproductive efficiency.

Flower Morphology and Related Concepts

Dr. Irani Biswas

The Flower as a Modified Shoot

Flowers are modified shoots specialized for reproduction.

- Floral organs (sepals, petals, stamens, carpels) are homologous to leaves.
- Ensure protection of reproductive organs and aid pollination.
- Origin explained by the 'Floral Theory' of Goethe.

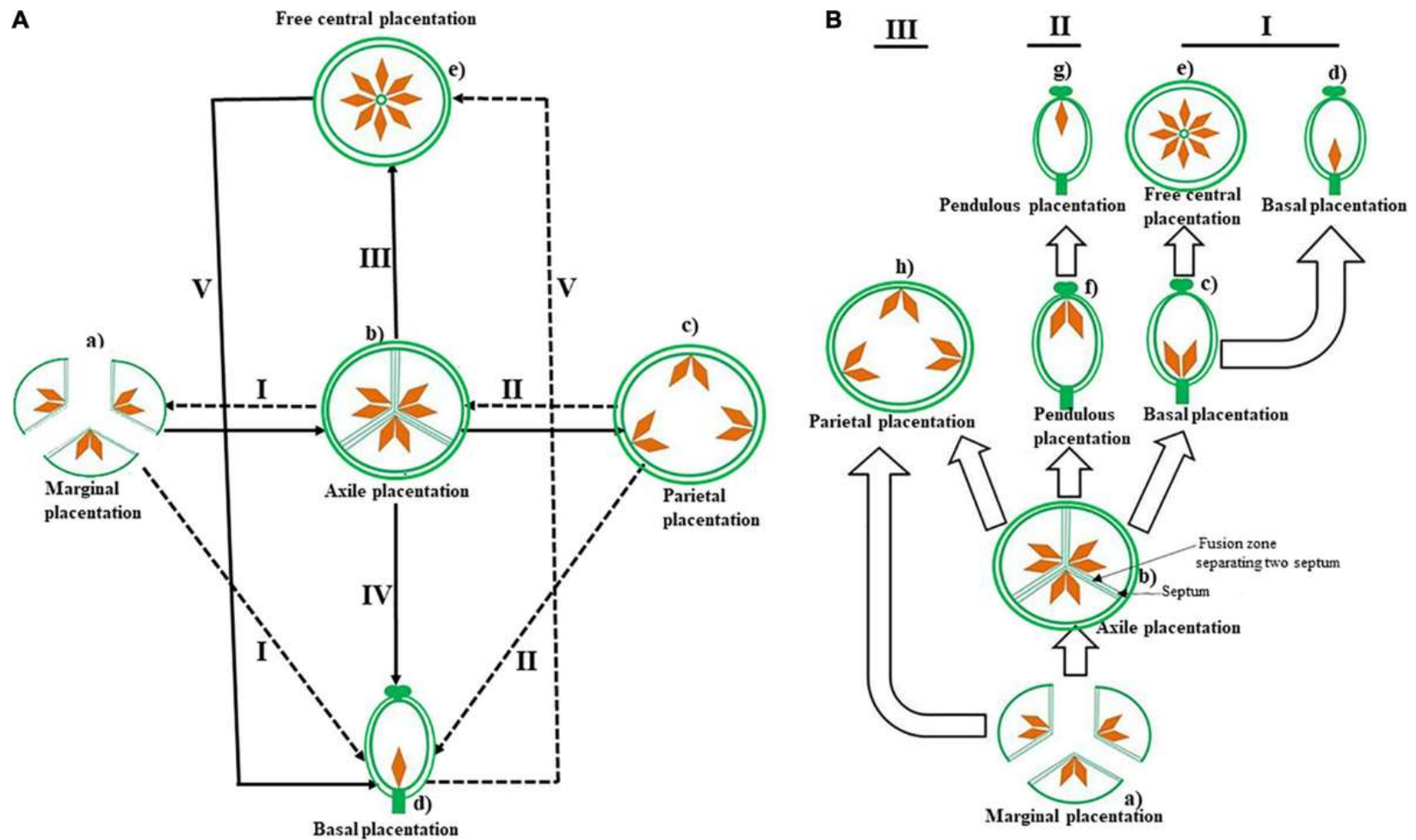
Aestivation

- Arrangement of sepals or petals in a flower bud before it opens:
- 1. Valvate: Margins just touch (e.g., Calotropis).
- 2. Twisted: One margin overlaps the next (e.g., Hibiscus).
- 3. Imbricate: Irregular overlapping (e.g., Cassia).
- 4. Vexillary: Standard overlaps wings, wings overlap keel (e.g., Pea).

Placentation and Its Evolution

- Arrangement of ovules within the ovary:
 1. Marginal (primitive type).
 2. Axile (common in multicarpellary syncarpous ovaries).
 3. Parietal.
 4. Free-central.
 5. Basal and Apical.

Evolution: Transition from simple marginal types to complex arrangements to optimize ovule number and seed dispersal.



The schematic diagram of the evolutionary trend and relationship of various placentation types in the angiosperm flower as proposed by [Puri \(1952\)](#) (**A**) and [Stebbins \(1974\)](#) (**B**). Transverse section of ovary with different placentation types is also shown in the figure: (**A**-a) marginal placentation, (b) axile placentation, (c) parietal placentation, (d) basal placentation, and (e) free central placentation; (**B**-a) apocarpous gynoecium, (b) axile placentation, (c,d) basal placentation, (e) free central placentation, (f,g) pendulous placentation, and (h) parietal placentation. The different pathways within author's proposed scheme are given in roman numbers (I, II, III, IV, and V). Dotted arrows indicate possibilities of evolution, but these have yet to be proved.

Floral Formulae

Symbol	Description
1. Br	Bracteate flower
2. EBr	Ebracteate flower (bract absent)
3. K	Calyx
4. K_n	Polysepalous calyx
5. $K_{(n)}$	Gamosepalous calyx
6. C	Corolla
7. C_n	Polypetalous
8. $C_{(n)}$	Gamopetalous
9. P	Perianth
10. A	Androecium
11. G	Gynoecium
12. $\underline{G}$	Superior ovary
13. $\overline{G}$	Inferior ovary
14. ♂	Male flower
15. ♀	Female flower
16. ♂ ♀	Bisexual flower
17. ⊕	Actinomorphic flower
18. % or †	Zygomorphic flower

Family	Floral formula
Cruciferae	$EBr \oplus \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} K_{2+2} C_4 A_{2+4} \underline{G}_{(2)}$
Compositae	$EBr \% \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} K_{\text{pappus}} C_{(5)} A_0 \underline{G}_{(2)}$ (Ray floret)
	$Br \oplus \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} K_{\text{pappus}} \overbrace{C_{(5)}} A_5 \underline{G}_{(2)}$ disc floret
Solanaceae	$EBr \oplus \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} K_{(5)} \overbrace{C_{(5)}} A_5 \underline{G}_{(2)}$
Gramineae	$Br / Br \% \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} P_{2(\text{lodicules})} A_3 \underline{G}_1$
Leguminosae	$Br \% \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} K_{(5)} \overbrace{C_{1+2+(2)}} A_{1+(9)} \underline{G}_1$
Malvaceae	$Br \oplus \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} Epi? K_{(5)} \overbrace{C_{(5)}} A_{(w)} \underline{G}_{(5)}$
Liliaceae	$Br \oplus \begin{matrix} \text{♂} \\ \text{♀} \end{matrix} \overbrace{P_{(3+3)}} A_{3+3} \underline{G}_{(3)}$

Floral Diagram

- Graphical representation showing number, arrangement, and fusion of floral parts in transverse section.
- Depicts position of bracts, sepals, petals, stamens, carpels.
- Useful in plant taxonomy.



Figure 4.38: (a) *Hibiscus rosa-sinensis*

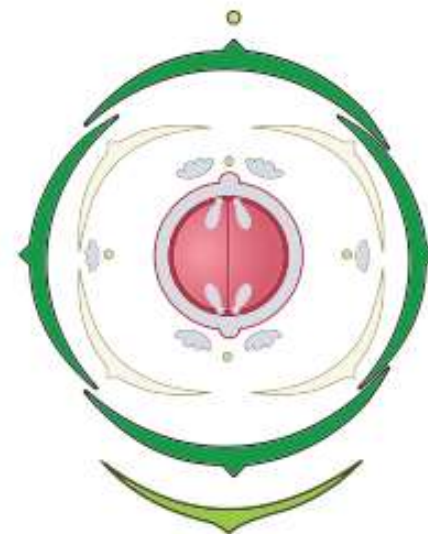
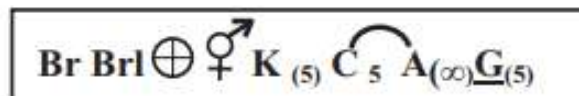
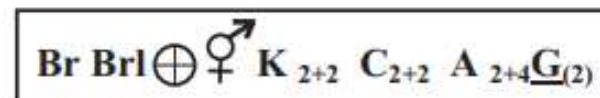


Figure 4.38: (b) *Brassica campestris*



Adhesion and Cohesion of Floral Parts

- Cohesion: Fusion of similar floral parts (e.g., petals fused into a gamopetalous corolla).
- Adhesion: Fusion of dissimilar floral parts (e.g., stamens attached to petals = epipetalous).
- Fusion can enhance structural strength, pollination efficiency, and reproductive success.

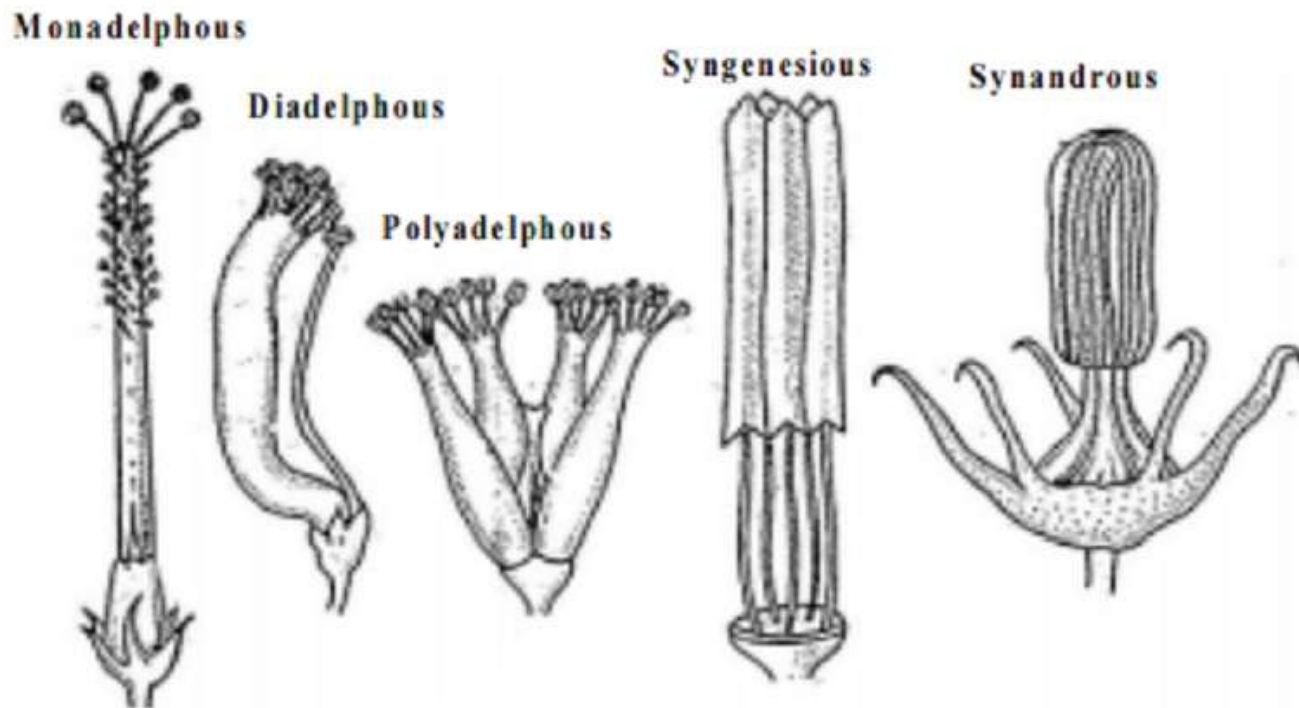


Fig : Cohesion of stamens

Summary

- Flowers are specialized shoots with modified leaves for reproduction.
- Aestivation describes arrangement of petals/sepals in buds.
- Placentation evolved for optimal ovule arrangement.
- Floral formulae and diagrams are key tools in taxonomy.
- Adhesion and cohesion shape floral morphology.

Fruits: Definition and Types

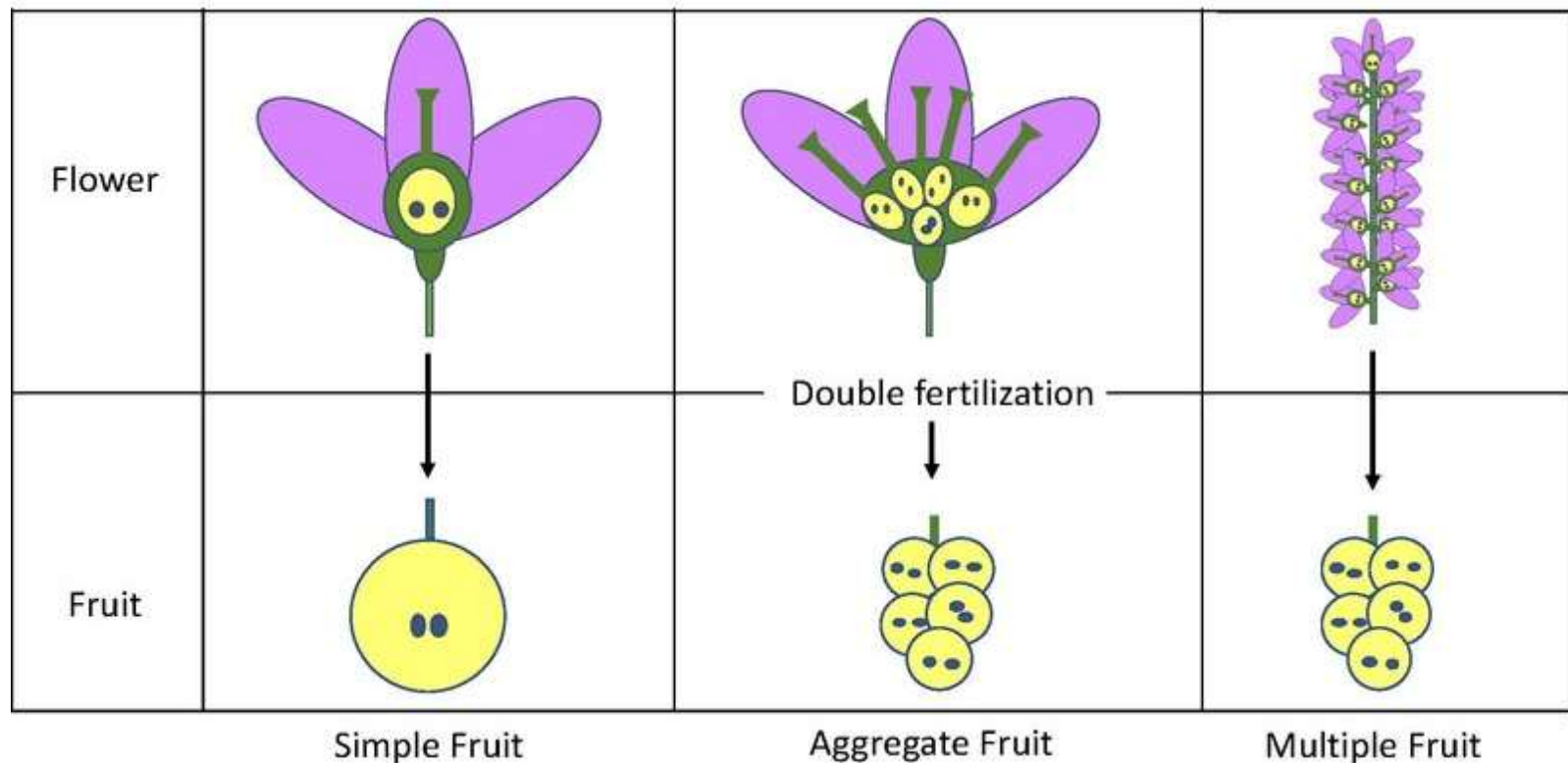
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Definition of Fruit

- • A fruit is a mature or ripened ovary, developed after fertilization, usually containing seeds.
- • Fruits protect seeds and aid in their dispersal.
- • In some cases (parthenocarpic fruits), fruits develop without fertilization (e.g., banana).

Broad Classification of Fruits

- Fruits are classified into three main types based on their origin and development:
- 1. Simple Fruits
- 2. Aggregate Fruits
- 3. Multiple or Composite Fruits



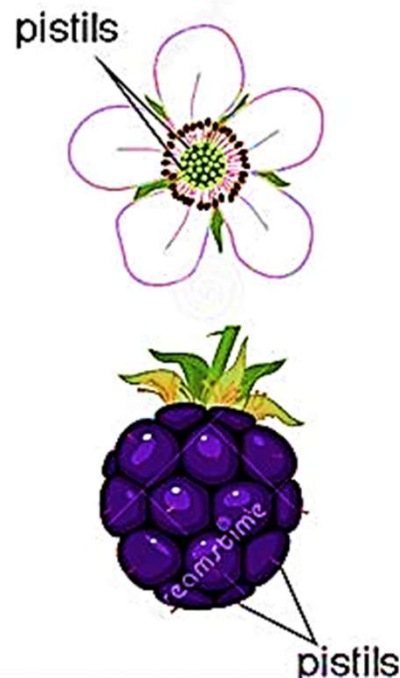
Simple Fruits

- Develop from a single ovary of a single flower.
- Types:
 1. Dry Simple Fruits: Dehiscent (e.g., pea, mustard) and Indehiscent (e.g., sunflower, maize).
 2. Fleshy Simple Fruits: Berry (e.g., tomato), Drupe (e.g., mango), Pome (e.g., apple).

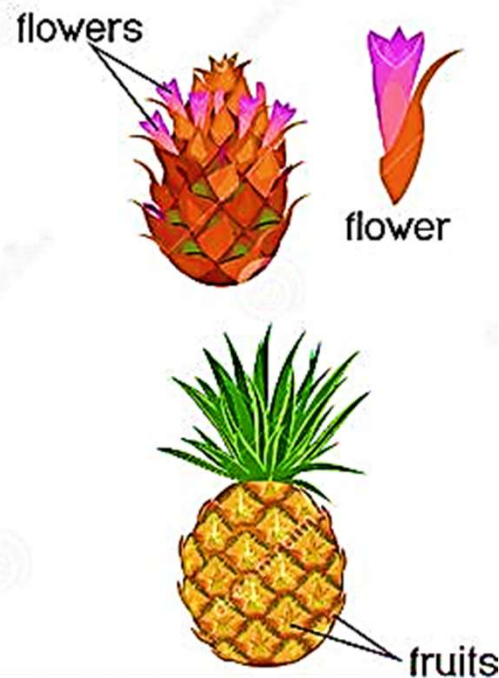
Simple fruit



Aggregate fruit



Multiple fruit



Aggregate Fruits

- • Develop from multiple ovaries of a single flower (apocarpous gynoecium).
- • Each ovary develops into a small fruitlet; all fruitlets form an aggregate fruit.
- • Examples: Strawberry, raspberry, custard apple.



Multiple or Composite Fruits

- Develop from the ovaries of multiple flowers (inflorescence).
- Flowers contribute to a single mass of fruit.
- Examples: Pineapple (sorusis), fig (syconus), mulberry.

(1) Sorosis



(2) Syconus



Summary

- • Fruits are ripened ovaries, protecting seeds and aiding dispersal.
- • Classified into Simple, Aggregate, and Multiple types.
- • Each type has unique developmental origins and examples.

Dispersal of Fruits and Seeds

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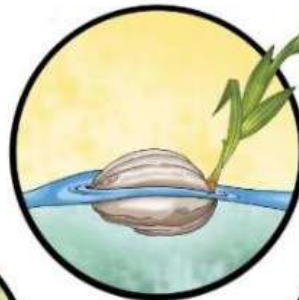
Introduction

- Dispersal is the process by which fruits and seeds are spread away from the parent plant.
- Ensures species survival, reduces competition, and allows colonization of new areas.
- Dispersal is aided by various agents like wind, water, animals, and mechanical forces.

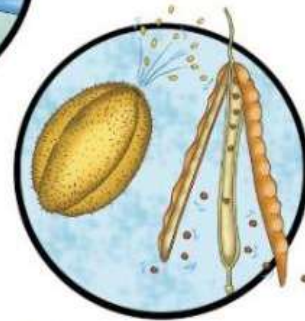
ANIMAL DISPERSAL
(ZOOCHORY)



WATER DISPERSAL
(HYDROCHORY)



MECHANICAL DISPERSAL
(AUTOCHORY)



HUMAN DISPERSAL
(ANTHROPOCHORY)



WIND DISPERSAL
(ANEMOCHORY)



Dispersal by Wind (Anemochory)

Fruits and seeds are light, small, and may have wings, hairs, or other adaptations to float in air.

Examples:

- 1. Winged fruits – e.g., maple (samara).
- 2. Hairy seeds – e.g., cotton, Calotropis.
- 3. Very light seeds – e.g., orchids.

Seed Dispersal by Wind



Gliders



Parachutes



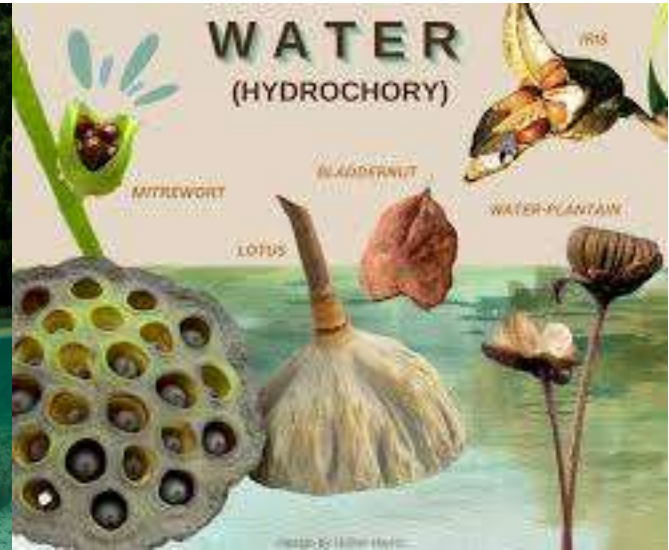
Helicopters



Flutterers

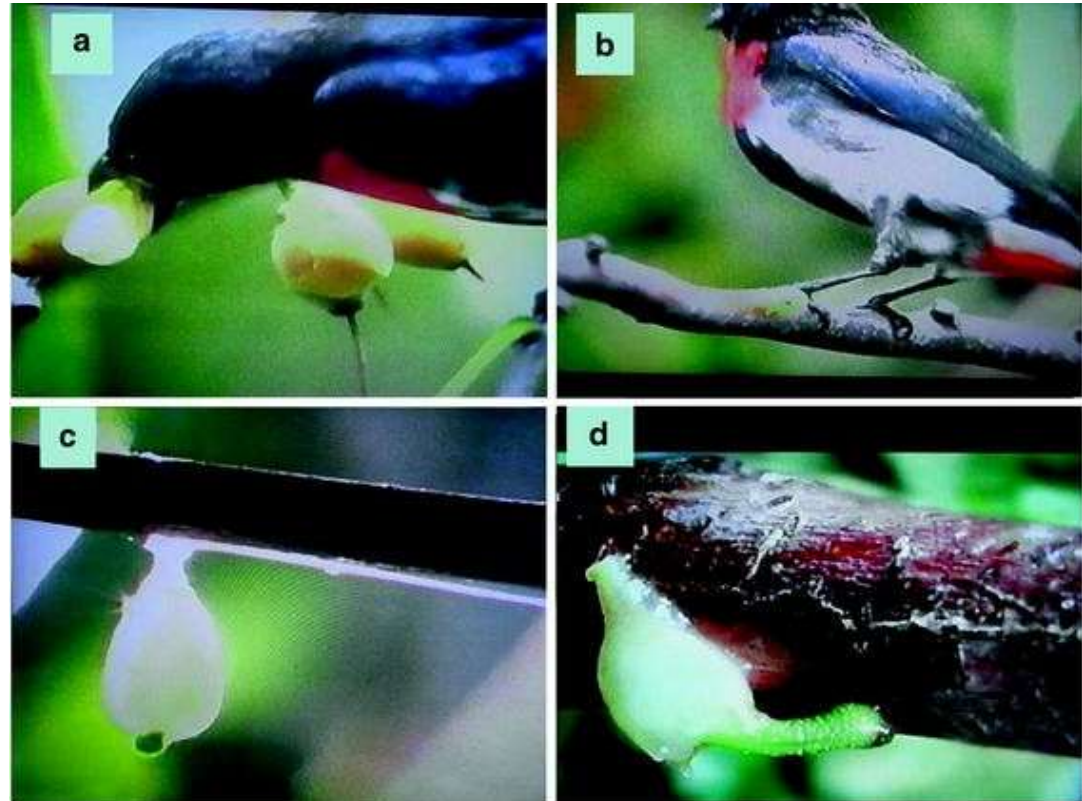
Dispersal by Water (Hydrochory)

- Adapted to float on water with fibrous husks or air-filled cavities.
- Examples:
 1. Coconut – fibrous mesocarp aids floating.
 2. Lotus – seeds remain viable in water for long periods.



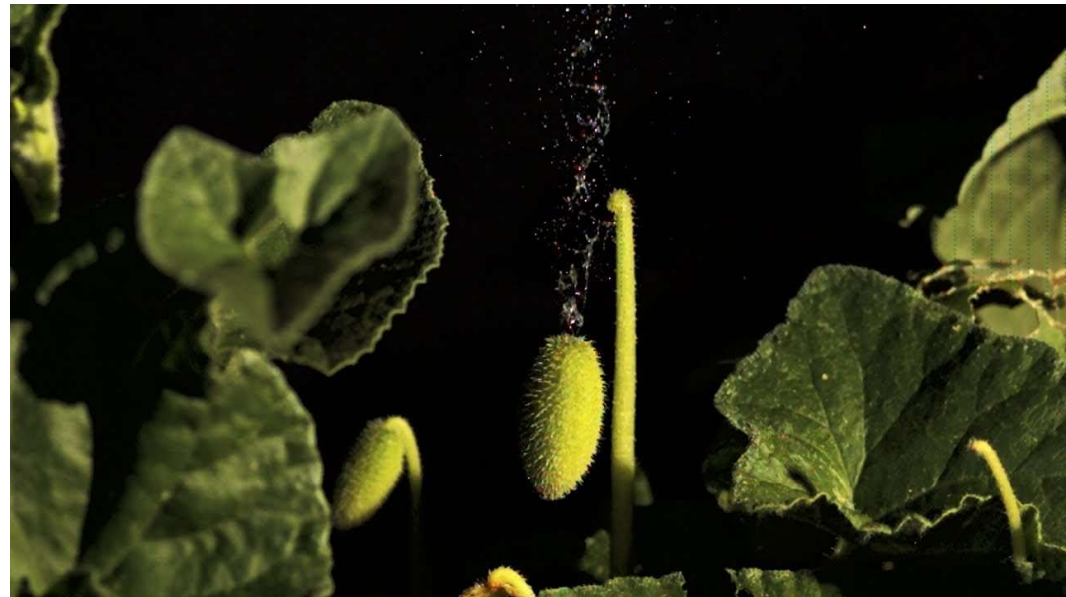
Dispersal by Animals (Zoochory)

- Seeds and fruits have adaptations to attach to animals or to be eaten and later excreted.
- Examples:
 1. Hooks and spines – e.g., Xanthium, burdock.
 2. Fleshy edible fruits – e.g., mango, guava, tomato.



Mechanical Dispersal (Autochory)

- Fruits burst open when dry, scattering seeds by mechanical force.
- Examples:
 1. Pea, bean – pods split open (dehiscence).
 2. Balsam – fruit bursts and throws seeds away.



Summary

- • Dispersal mechanisms: Wind, water, animals, and mechanical forces.
- • Adaptations in fruit/seed structure help in effective dispersal.
- • Dispersal ensures plant survival, diversity, and colonization of new habitats.

THANK YOU