TAXONOMY, UTILISATION OF PLANTS. PALYNOLOGY & EMBRYOLOGY

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ACHARYA NAGARJUNA UNIVERSITY

CENTRE FOR DISTANCE EDUCATION

NAGARJUNA NAGAR,

GUNTUR

ANDHRA PRADESH

B.Sc. Botany :: Third Year

Unit-I

Lesson 1

I N T R O D U C T I O N

OBJECTIVES

To study about the identification, nomenclature and classification of Angiospermic plants.

CONTENTS

1.1.1 INTRODUCTION

Plant taxonomy is a branch of botany which deals with the identification, nomenclature and classification of different kinds of plants. This term was introduced first by A.P. de Candolle in 1813. It means lawful arrangement of things and is derived from Greek (Taxis = arrangement; Nomos = Law or rule). Most authors have a opinion that "**taxonomy**" is synonymous with "**Systematic Botany**". Some authors prefer to differentiate between them. Systematic Botany is defined as 'the study and description of variation in organisms, the investigation of causes and consequences of this variation, and the manipulation of the data obtained to produce a system of classification'.

Taxonomy plays an important role in the study of all other branches of Botany. Modern taxonomy depends on different branches of Botany like morphology, anatomy, embryology, palynology, cytology, phytochemistry, genetics, physiology etc. for information and data.

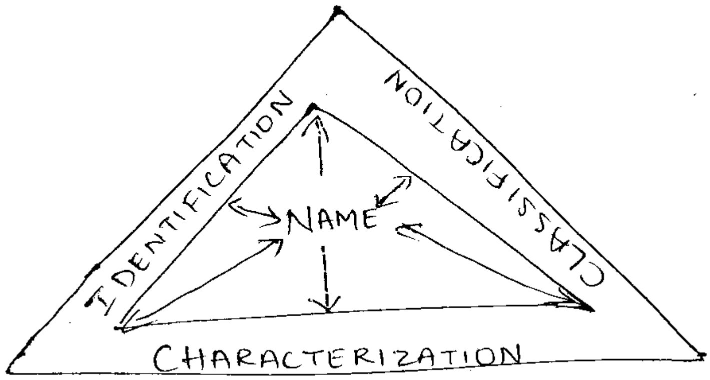

Fig. 1.1 Taxonomic fundamentals

1.1.2 FUNCTIONS OF TAXONOMY

Taxonomy has three basic functions namely; identification, nomenclature and classification.

A. **Identification:** Identification is recognising an unknown specimen with an already known taxon, and assigning a correct rank and position in an extant classification.

B. **Nomenclature:** Nomenclature deals with determination of a correct name for a taxon using rules and recommendations of the International code of Botanical Nomenclature (ICBN).

C. **Classification:** The placing of plants into a hierarchy of ranks or categories such as species, genera, family and so on is known as classification. There are basically three kinds of classifications: artificial, natural and phylogenetic.

1. **Artificial Systems:** These are the systems based on one or few comparable characters like morphology, nutritional habits etc. The classification of plants into trees, shrubs, herbs is an artificial one. Sexual system of Linnaeus in which floral characters are given importance for the first time is an artificial one.

2. **Natural systems:** These are the systems in which plants are grouped on the basis of their natural relationships taking into consideration all possible morphological characters. E.g: Classifications of de Jussieu, de Candolle & Bentham and Hooker.

3. **Phylogenetic systems:** These are the systems proposed after the publication of 'Origin of Species' and the announcement of 'theory of evolution' by Charles Darwin. Hence they are also called 'Post-Darwinian classifications'. They reflect the genetic and evolutionary relationships among the taxa and show them in the form of a phylogenetic tree. Classifications made by Eichler, Engler and Prantl, Bessey, Hutchinson and others come under this category. More recent classifications made by Takhtajan (1980), Cronquist (1981), and Thorne (1992) have used data from different branches of Botany apart from the vegetative and floral characters. Hence they are also known as 'Multi disciplinary systems'.

1.1.3 UNITS OF CLASSIFICATION

Any system of classification is made up of different units, which are arranged in hierarchial sequence. Irrespective of its rank in the sequence every unit is called '**taxon**'.

'**Species'** is the basic unit of classification. All those plants which are identical in all respects are regarded as one species. Different species with related characters are grouped into one '**genus'**. Different genera with common characters are grouped into a '**family'**. Different families with similar characters are grouped into an **'order'**. Different orders which are related to each other are grouped into a **'series'**. A group of related series is considered as a '**class**'. Different classes with similarities are grouped into a **'division'**. A group of divisions constitutes the '**Kingdom'** which is the largest taxon occupying the top most position in the taxonomic hierarchy. Every unit of classification can be subdivided as sub-class, sub order etc.

For example the systematic position of *Gossypium herbaceum* (cotton) is as follows:

Kingdom	:	Plant Kingdom
Division	:	Phanerogamae
Sub-division	:	Angiospermae
Class	:	Dicotyledonae
Sub class	:	Polypetalae
Series	:	Thalamiflorae
Order	:	Malvales
Family	:	Malvaceae
Genus	:	Gossypium
Species	:	Herbaceum

1.1.4 AIMS OF TAXONOMY

The following are the aims of taxonomy.

1. To provide a convenient method for identification and communication.
2. To provide an inventory of the worlds flora.
3. To detect evolution at work, discovering its process and interpreting its results.
4. To provide a system of classification which depicts evolution within the group.
5. To provide an integrating and unifying role in the training of biology students.
6. To provide new concepts, reinterpret the old, and develop new procedures for correct determination of taxonomic affinities, in terms of phylogeny and phenetics.

1.1.5 PRINCIPLES OF TAXONOMY

Cronquist (1968) have formulated certain basic principles which are as follows:

i. Taxa should be established only on the basis of multiple correlation of characters. This principle states that no character of a taxon should be considered singly for the establishment of its relationships with other taxa. It should always be considered along with other characters.

ii. Taxonomic importance of a character should be determined, by how well it correlates with other characters. A character with no obvious correlation with other characters is not taxonomically important.

iii. Taxonomy has its predictive value.

1.1.6 PRIMITIVE AND ADVANCED CHARACTERS

	PRIMITIVE CHARACTER		ADVANCED CHARACTER
1.	Trees, Shrubs	1.	Herbs
2.	Perennials	2.	Biennials and Annuals
3.	Spiral Phyllotaxy	3.	Opposite and Whorled leaves
4.	Simple leaves	4.	Compound leaves
5.	Solitary flowers	5.	Inflorescence
6.	Bisexual flowers	6.	Uni sexual flowers
7.	Monoecious condition	7.	Dioecious condition
8.	Spirally arranged floral parts	8.	Floral parts in whorls (cyclic flowers)
9.	More number of members in floral whorls	9.	Less number of members in floral whorls
10.	Actinomorphic flowers	10.	Zygomorphic flowers
11.	Hypogynous flowers	11.	Perigynous and epigynous flowers
12.	Dichlamydeous flowers	12.	Monochlamydeous and Achlamydeous flowers
13.	Polypetalous corolla	13.	Gamopetalous corolla
14.	Free stamens	14.	United stamens
15.	Free carpels (Apocarpous)	15.	Fused carpels (syncarpous)
16.	Superior ovary	16.	Inferior ovary
17.	Simple fruit	17.	Multiple fruit
18.	Presence of endosperm (endospermic seed)	18.	Absence of endosperm (Non-endospermic seed)

1.1.7 MODEL QUESTIONS

1) Write short notes on functions of Taxonomy.
2) What are the units of classification?
3) What are the aims of taxonomy?
4) Describe the principles of taxonomy.
5) Write short notes on classification.
6) Distinguish between:
   a) Genus and Species
   b) Division and Class
   c) Identification and nomenclature
   d) Taxonomy and Classification

1.1.8 REFERENCES

1. **Plant Systematics** – Gurcharan Singh, Oxford and IBH Publishing Co. Pvt. Ltd.
2. **Taxonomy of Angiosperms** – V. Singh & D.K. Jain, Rastogi Publications.

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M. Sudha

Unit-I

Lesson 1A

HISTORICAL BACKGROUND OF PLANT – CLASSIFICATION

OBJECTIVES

To study a detailed account of historical background of plant classification.

CONTENTS

1A.1 INTRODUCTION

Plant taxonomy, the science of classifying and naming the plants antedate recorded history.

One of the earliest Indian works dealing with plants in a scientific manner is **Vrikshayurveda**. It was compiled by **Parasara** perhaps before the beginning of the Christian era. In this work a system of classification was also provided which was based on a study of comparative morphology of plants. According to **Majumdar** (1946) this system of classification was more advanced than the ones developed in Europe before the 18th century. In **Vrikshayurveda** several families, known as **ganas**, are very clearly distinguished and are easily recognisable even today.

Historical development of classification has passed through 3 distinct approaches, beginning with artificial system of classification to the latest phylogenetic systems incorporating all phenetic information.

Various attempts made to classify the plants fall in one of the following three categories:
1) Artificial systems
2) Natural systems
3) Phylogenetic systems

1A.2. ARTIFICIAL SYSTEM OF CLASSIFICATION

The earliest systems of classification were artificial systems and the systems of this nature remained dominant from 300B.C. upto about 1830. Since very little information was available about the plants, these systems were based on one or few characters. The artificial systems propounded by early herbalists were based on habit (trees, shrubs, herbs etc.), and the linnaeus sexual system on floral characters (particularly the number of stamens and carpels).

Theophrastus (370-285B.C.), a Greek naturalist who is called as the father of botany, was a disciple of **Plato** and **Aristotle**. Two of his botanical works have survived intact, however, and are available in English translations: **Enquiry into Plants** (1916) & **The Causes of Plants** (1927). He described about 500 kinds of plants, classified into four major groups: trees, shrubs, under shrubs and herbs. He recognised differences between flowering plants and non flowering plants, superior ovary and inferior ovary, free and fused petals and fruit types. He gave names and described the 500 kinds of plants in his **Historia Plantarum**, the oldest botanical work in existence. Because of wide use, his names received general recognition and some of them still appear as generic names in modern classification, e.g., daukan (*Daucas*) and aspharagos (*Asparagus*).

Parasara (250B.C. to 120 B.C.), **Indian Scholar** Parasara was an Indian Scholar who compiled **Vrikshayurveda** (Science of Plant life), one of the earliest works dealing with plant life. The book has separate chapters on morphology, properties of soil, forest types of India and details of internal structure. Plants were classified into numerous families (ganas) on the basis of morphological features. Samiganyan (Leguminosae) were distinguished by hypogynous flowers, five petals of different sizes, gamosepalous calyx and a fruit, actually a legume. Svastikaganyan (cruciferae) similarly has a calyx resembling a swastika, ovary superior, 4 free sepals and petals each, six stamens, of which 2 are shorter, and 2 carpels forming a bilocular fruit. Unfortunately, this great scientific advance did not reach Europe at that time where scientific knowledge was just making its debut.

Caius Plinius Secundus (23-79A.D.), a Roman naturalist, compiled **Historia Naturalis** (77A.D.) where in he described some 1,000 plants such as medicinal plants, timber trees, etc.

Pedanion Dioscorides (62-128A.D.), a physician of Asia Minor, described about 600 medicinal plants mainly from Mediterranean in his book **Materia Medica**, written in Greek. The book gives the common names of plants in Greek and in many cases names applied in Latin, Egyptian, Gallic, etc. Though this work has no taxonomic significance as compared with modern systems, there are certain series of related plants indicating that Dioscorides had some sense of relationship.

Andrea Caesalpino (1519-1603A.D.) - the first plant taxonomist. An Italian botanist who studied botany under Luca Ghini and became the Director of the Botanical Garden and later professor of botany and medicine at Bologna. He prepared a herbarium of 768 well mounted plants in 1563, which is still preserved in the Museum of Natural History at Florence. His work **De Plantis libri** in 16 volumes appeared in 1583 and contained descriptions of 1520 species of plants grouped as herbs and trees and further differentiated on fruit and seed characters.

Joachin Jung (1587-1657) – The first terminologist. A brilliant teacher in Germany, he succeeded in defining several terms such as nodes, internodes, simple and compound leaves, stamens, styles, capitulum composed of ray and disc florets.

Gaspard (Caspar) Bauhin (1560):- A swiss botanist, he travelled extensively and formed a herbarium of 4000 specimens. He published **Phytopinax** (1596), **Prodromustheatri botanici** (1620) and lastly **Pinax theatri botanici** (1623) containing a list of 6000 species of plants and introducing **binomial nomenclature** for several species.

John Ray (1628-1705A.D.) was a British botanist and he produced a three volume work, **Historiaplantarum** (1686-1704) which contains an improved version of his system of classification originally proposed in **Methodus Plantarum Nova** (1682). His classification represented a notable advancement and was an approach towards the natural system. Although he retained the old grouping into herbs and trees, he was the first to divide these groups into Dicotyledons and Monocotyledons on the basis of presence of two and one cotyledon respectively. His major groups are as follows:-

(1) Herbae (Herbs)
- Imperfectae (flowerless plants)
- Perfectae (flowering plants)
  - Dicotyledons
  - Monocotyledons

(2) Arborae (Trees and shrubs)
- Monocotyledons
- Dicotyledons

J.P.de Tourne fort (1656-1708) – **Father of the genus concept**:- A French botanist who later became the Director of de Jardin des plantes in Paris. He published **Elements de botanique** in 1694, including 698 genera and 10,146 species. This work was enlarged and published in Latin as **institutions rei herbariae** in 1700. He was the first to provide characterization of genera. His system of classification, was useful for identification in recognizing petaliferous and apetalous flowers, free and fused petals, and regular and irregular flowers.

Rudolf Camerarius (1665-1721) was Director of Botanical Garden at Tubingen, Germany. He was the first to recognize sex in flowering plants and he also established through his researches that Pollen was necessary for seed formation.

Carolus Linnaeus (1707-1778), a great Swedish naturalist is rightly known as the 'father of modern botany'. He was born on 23 May, 1707 at Rashult, a small village of Southern Sweden.

While he was a student at the University of the Uppsala, he published his first paper on the sexuality of plants in 1729 under the guidance of Professor Olof Rudbeck. In 1730 he published **Hortus Uplandicus** where in he enumerated the plants of the Uppsala Botanical Garden growing at that time. In Holland, his **Systema Naturae** appeared in 1735, the publication of which was financed by the famous Dutch botanist J.F. Gronovius. Later, in 1737 he published his famous **Hortus Cliffortianus**, and **Genera Plantarum**. His **species plantarum** was published in 1753, a work where some 7,300 species are described and arranged according to his sexual system of classification.

Linnaeus first outlined his system in **Systema Naturae**, which classified all known plants, animals and minerals. In his **Genera Plantarum** he listed and described all plant genera known to him. In **Species Plantarum** he listed and described all species of plants. For each species there was:

i. a generic name
ii. a polynomial descriptive phrase or phrase name commencing with generic name and of up to twelve words, intended to serve as description of the species.
iii. a trivial name or specific epithet on the margin.
iv. synonyms with reference to important earlier literature.
v. habitats and countries.

The generic name followed by trivial name formed the name for each species. Linnaeus thus established the *binomial nomenclature,* first started by Casper Bauhin and the generic concept, started by Tourne fort.

Linnaeus system of classification is though artificial, he was the first to recognise the significance of flower and fruit structure. He largely emphasised the numerical relationships of the sex organs. He recognised 24 classes determined on the basis of the number, size and union of stamens. The classes were subdivided into orders based, not on characters, but on his idea of their relationships. Twenty four classes of Linnaeus are as follows:

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 eleven to nineteen)
12) Icosandria (Stamens twenty or more, attached to the calyx)

13) Polyandria (Stamens twenty or more, attached to the receptacle)
14) Didynamia (Stamens didynamous)
15) Tetradynamia (Stamens tetra dynamous)
16) Monadelphia (Stamens monadelphous)
17) Diadelphia (Stamens diadelphous)
18) Polyadelphia (Stamens polyadelphous)
19) Syngenesia (Stamens syngenesious)
20) Gynandria (Stamens adnate to the gynoecium)
21) Monoecia (Plants monoecious)
22) Dioecia (Plants dioecious)
23) Polygamia (Plants polygamous)
24) Cryptogamia (Flowerless plants)

The system of Linnaeus which largely depended on the number of stamens and carpels in the flower was very simple and convenient and became very popular. It remained dominant for over 75 years until it was replaced by the systems of de Jussieu and de Candolle.

1A.3. NATURAL SYSTEM OF CLASSIFICATION

Linnaeus system was the last among the artificial systems of classification. The natural systems were based on natural affinities. de Jussieu and de Candolle made significant contribution in this direction. The natural systems remained dominant before the idea of evolution was accepted. The most important and the last of the natural systems was by Bentham and Hooker (1862-1883) which although appeared after the publication of the Darwin's theory of evolution, is pre evolutionary in conception.

Michel Adanson (1727-1806), a French botanist, published a two volume work, **Families de Plantes** (1763), where in he arranged genera in 58 families according to his system of classification. Present day Numerical taxonomy is based on the idea conceived by Adanson and now developed into Neo-Adansonian principles.

Jean B.P. Lamarck (1744-1829). A French naturalist, he authored **Flore Francaise** (1778), which in addition to a key for identification of plants, contained principles concerning natural grouping of species, orders and families. He is better known for his evolutionary theory, *Lamarckism*.

de Jussieu (1686-1758), a French botanist, made significant contribution to systematic botany. He never published his system and it was left to his nephew Antoine Laurent de Jussieu (1748-1836) to publish this system of classification in **Genera Plantarum** (1789).

An outline of the classification is presented below:

1. Acotyledones (Plants with out cotyledons)
2. Monocotyledones (Plants with one cotyledon)

3. Dicotyledones (Plants with two cotyledons)
   i) Apetalae
   ii) Monopetalae
   iii) Polypetalae
   iv) Diclines irregulares

In this classification, the plants were divided into three groups, further divided on corolla characteristics and ovary position to form 15 classes and 100 orders. **Acotyledones** in addition to cryptogams contained some hydrophytes whose reproduction was not known then. **Diclines irregulares** contained Amentiferae, Nettles, Euphorbias and also the Gymnosperms.

de Candolle (1778-1841), a French botanist, was born and carried most of his work in Switzerland. He published his views on classification in his classic work, **Theorie elementaire de la botanique**, published in 1813 in Paris. In this work he set forth the principles of a natural systems of classification and further developed morphological approach to classification.

The system of de Candolle was similar to that of de Jussieu in many respects but it was certainly an improvement over that of the latter particularly in the treatment of the Dicotyledons. He divided the Dicotyledons into two groups on the basis of presence or absence of petals.

Outline of classification proposed by A.P. de Candolle is as follows:

I. Vasculares (Vascular bundles present)

Class (1) Exogenae (dicots)

(A) Diplochlamydeae (flowers with a double whorl of perianth)
- Thalamiflorae
- Calyciflorae
- Corolliflorae

(B) Monochlamydeae (flowers with a single whorl of perianth) (also including Gymnosperms)

Class (2) Endogenae (Monocots)

(A) Phanerogamae (flowers present)

(B) Cryptogamae (flowers absent)

II. Cellulares (no vascular bundles)

Class (1) Foliaceae (Mosses, Liverworts)

Class (2) Aphyllae (Algae, Fungi, Lichens)

One of the serious drawback of the decandolle's system was the inclusion of vascular cryptogams among Monocotyledons.

Stephan Endlicher (1805-1849), an Austrian botanist, made a significant contribution to the plant classification. He divided the plant kingdom into Thallophytes (algae, fungi and lichens) and Cormophytes (mosses, ferns and seed plants). His classification of angiosperms begins with a group without Petals, in contrast to his predecessors who commence with the groups with well developed petals.

George Bentham (1800-1884) and **Sir J.D. Hooker** (1817-1911):- These two English botanists jointly produced the most elaborate natural system of classification in their three volume work **Genera Plantarum** (1862-83), a classification of seed plants recognising Dicotyledons, Gymnosperms and Monocotyledons as distinct groups. In all 202 natural orders (now treated as families) were recognised grouped into cohorts (now orders) and series.

Genera plantarum, through published after the *Origin of species* by Darwin, is pre-Darwinian in concept. The descriptions were accurate, authentic and no doubt the system is still useful and followed in several major herbaria of the world.

The following is the summary of Bentham and Hooker's system:

(A) Dicotyledons

(1) Polypetalae

Series I Thalami florae
It includes 6 orders starting from
Ranales and ending with Malvales.

Series II Disciflorae
It includes 4 orders starting from
Geraniales and ending with Sapindales

Series III Calyciflorae
It includes 5 orders starting from
Rosales and ending with Umbellales

(2) Gamopetalae

Series I Inferae
It includes three orders starting from
Rubiales and ending with campanales.

Series II Heteromerae

The 3 orders which are included in this series start from Ericales and end with Ebenales.

Series III Bicarpellatae
It includes 4 orders which starts from Gentianales and ends with Lamiales.

(3) Monochlamydae: It includes 8 series

Series I	Curvembryeae
Series II	Multiovulatae aquaticae
Series III	Multiovulatae terrestries
Series IV	Microembryeae
Series V	Daphnales
Series VI	Achlamydosporeae
Series VII	Unisexuales
Series VIII	Ordines anomali

(B) Gymnospermae

It includes Gnetaceae, coniferae and cycadaceae.

(C) Monocotyledones: It includes 7 series

Series I Microspermae
Series II Epigynae
Series III Coronarieae
Series IV Calycinae
Series V Nudiflorae
Series VI Apocarpeae
Series VII Glumaceae

1A.4 PHYLOGENETIC SYSTEM OF CLASSIFICATION

The evolutionary theory 'Origin of Species' proposed by Darwin and Wallace in 1858 influenced taxonomy in various ways. The systems of this period are based on the course of evolutionary descent and they tried to reflect the genetic and phylogenetic relationships. The authors of most of these systems have emphasised on certain pre-selected characters which they considered of phylogenetic importance. The most widely known systems are those of Engler, and Hutchinson and two modern systems, Takhtajan and cronquist published in fully documented form.

A.W. Eichler (1839-1887): A German botanist, proposed a system of classification based exclusively on morphological data. The plant kingdom was divided into two sub groups: Cryptogamae and Phanerogamae. The phanerogamae was further subdivided into Gymnospermae and Angiospermae and the latter was divided into 2 classes: Monocotyledons and Dicotyledons. Only two groups Chloripetalae and Sympetalae were recognised in Dicotyledons.

Adolph Engler (1844-1930) and **Karl Prantl** (1849-1893). Engler and Prantl, the two German botanists, developed a system of classification based on Eichler and differing in details. The monumental work **Die naturlichen pflanzenfamilien** (1887-1915) in 23 volumes covered the whole plant kingdom. The seed plants (Embryophyta Siphonogama) were divided into Gymnospermae and Angiosperms. The Angiosperms were divided into Monocotyledons and Dicotyledons. The two sub classes of dicots were named as Archichlamydeae (petals absent or free) and Meta chlamydeae (petals fused).

Embryophyta Siphonogama

Angiosperms　　Gymnosperms

Dicotyledons　　Monocotyledons

Archichlamydeae　　Metachlamydeae

Charles Edwin Bessey (1845-1915):- He was the first American to make a major contribution to plant classification, and the first botanist to develop intentional phylogenetic classification. He based his classification on Bentham and Hooker’s system of classification. His system of classification appeared in the **Annals of the Missouri Botanical Garden** (1915) under the title **“The Phylogenetic taxonomy of Flowering Plants**”. He considered angiosperms to have evolved monophyletically from Cycadophyta belonging to implied bennetlitalean ancestry.

He divided the Anthophyta (Angiosperms) into two groups, Oppositifoliae (Dicotyledons) and Alternifoliae (Monocotyledons). Bessey believed in the strobiloid theory of origin of the flower. The flower having originated from a vegetative shoot, of which some are modified to form sterile perianth, fertile stamens and carpels. Two evolutionary lines from such a flower formed **Strobiloideae** (Ranalian line) with connation of like parts and **Cotyloideae** (Rosalian line) with connation of unlike parts.

The Ranales were considered by him to be the most primitive angiosperms from which Monocotyledons and other groups of Dicotyledons have evolved.

Outline of the classification of Angiosperms proposed by Charles Bessey (1915)

Division: Anthophyta (flowering plants)

Class Alternifoliae
(Monocotyledons)

Subclass (1) Strobiloideae
(5 orders)

(2) Cotyloideae
(3 orders)

Class Oppositifoliae
(Dicotyledons)

Subclass (1) *Strobiloideae*
Superorder (i) Apopetalae – polycarpellatae
(7 orders)
(ii) Sympetalae - polycarpellatae
(3 orders)
(iii) Sympetalae - dicarpellatae
(4 orders)

Subclass (2) *Cotyloideae*
Superorder (i) Apopetalae (7 orders)
(ii) Sympetalae (3 orders)

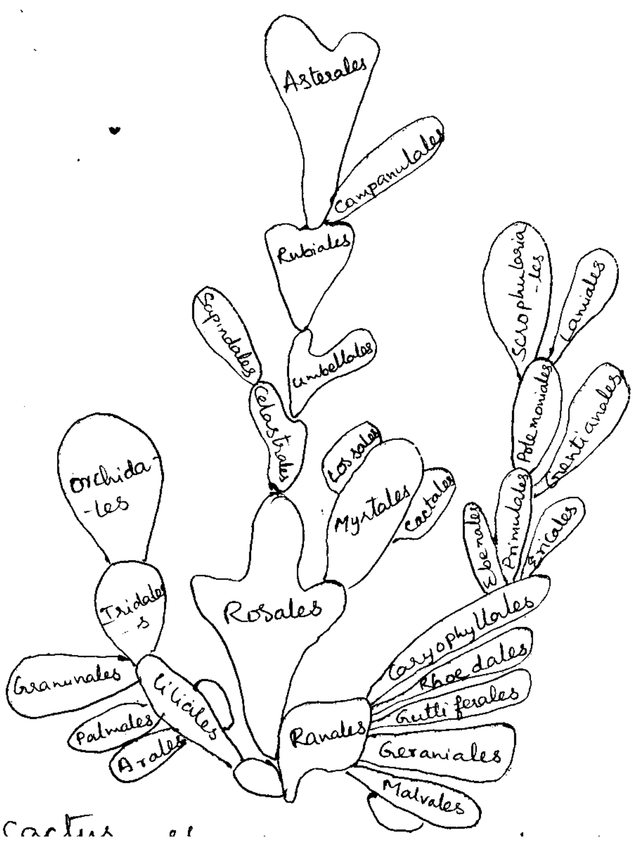

Fig. 1A.1 Besseyan cactus showing relationship of orders recognised by Bessey

John Hutchinson (1884-1972). A British botanist associated with the Royal Botanic Gardens at kew, he developed a system of classification which appeared in its final form in **The Families of Flowering Plants** (1973). Dicots are considered more primitive than monocots, and divided into two groups: *Lignosae* and *Herbaceae*. Magnoliales are considered to be the most primitive dicots. The division of dicots into woody and herbaceous lines has received wide criticism. Several closely related families have been separated and placed in distant groups.

Hutchinson's classification is briefly tabulated as under:

Flowering Plants
(Phanerogams)
2 Phyla

- Angiosperms — 2 Subphyla
  - Monocotyledons (29 orders) — 3 Divisions
    - Calyciflorae (12 orders)
    - Corolliflorae (14 orders)
    - Glumiflorae (3 orders)
  - Dicotyledons (75 orders) — 2 Divisions
    - Lignosae (54 orders)
    - Herbaceae (28 orders)
- Gymnosperms

Robert Thorne (1920): An American plant taxonomist put forward his classification in 1968. He incorporated the role of phytochemistry in realignment of taxa. He divided them into two sub classes: *Dicotyledonae* (*Annonidae*) and *Monocotyledonae* (*Lillidae*) Nineteen super orders are recognised in dicots and Nine in monocots.

Rolf Dahlgren (1932-1987): A Danish botanist who first proposed his classification by illustrating an angiosperm system as an imaginary phylogenetic shrub in 1974. In this system, the *angiosperms* (*Magnoliopsida*) represent a class divisible into two sub classes, *Magnoliidae* for dicots and Lillidae for monocots. The system includes 25 super orders in dicots and 8 in monocots.

Arthur Cronquist (1919-1992): Cronquist recognised 6 subclasses in dicots and 5 in monocots. His classification closely resembles Takhtajan in placing angiosperms in Division *Magnoliophyta* divided similarly into *Magnoliopsida* (dicots) and *Liliopsida* (Monocots). Super orders are not recognised. Dicots are divided into 64 orders and 318 families, monocots into 19 orders and 65 families.

Armen Takhtajan (1910-1997): A Russian botanist who developed a classification system of flowering plants, which were periodically revised, the last version being published in 1997. He placed angiosperms in Division *Magnoliophyta* divided into two classes *Magnoliopsida* (dicots) and *Liliopsida* (monocots), divided in turn into sub classes. In 1997 he finally recognised 11 sub classes in dicots and 6 in monocots. These are further divided into super orders (ending in-anae), orders and families, 56 super orders, 175 orders and 459 families are included in dicots, where as monocots include 16 super orders, 58 orders and 133 families.

1A.5 MODEL QUESTIONS

1) What is the difference between artificial and natural systems of classification? Briefly give an outline of artificial system of Linnaeus.

2) Write a brief account of phylogenetic systems of classification.

3) Give a brief outline of classification of angiosperms after A.P. de Candolle.

4) Give a synoptical lay out of the system of classification of flowering plants by Bentham and Hooker.

5) Give an account of Bentham and Hooker's system of classification of dicotyledons. In what respect does this system differ from that of Engler and Prantl.

6) Give outlines of Bentham and Hooker's, Hutchinson's and Engler and Prantl's systems of classifications. How do they differ from each other.

1A.6 REFERENCE BOOKS

1. **Plant Systematics –** Gurcharan Singh, Oxford & IBH Publishing Co. Pvt. Ltd.
2. **Taxonomy of Angiosperms** – V. Singh and D.K. Jain, Rastogi Publications.

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M. Sudha

Unit-I

Lesson 2

COMPARITIVE ACCOUNT OF BENTHAM AND HOOKER, AND ENGLER AND PRANTL SYSTEMS OF CLASSIFICATION

OBJECTIVES

To know about the comparative account of Bentham & Hooker & Engler & Prantl systems of classification in detail.

CONTENTS

2.1 INTRODUCTION TO BENTHAM AND HOOKER

The system of classification of seed plants presented by Bentham and Hooker, two English botanists, represented the most well-developed natural system. The classification was published in a three volume work **Genera Plantarum** (1862-83). George Bentham wrote many important monographs on families such as Labiatae, Ericaceae, Scrophulariaceae and Polygonaceae. He published **Handbook of British Flora** (1858) and Flora Australiensis in 7 volumes (1863-78). Sir J.D. Hooker (1817-1911), who was the Director of the Royal Botanic Gardens in kew, England published **Flora of British India** in 7 volumes (1872-97), **Student's Flora of the British Isles** (1870) and also revised later editions of **Handbook of British Flora**, which remained a major British Flora until 1952.

The Genera Plantarum of Bentham and Hooker provided the classification of seed plants, describing 202 families and 7569 genera. They estimated the seed plants to include 97,205 species.

The system divided Phanerogams or seed plants into three classes: *Dicotyledons, Gymnospermae and Monocotyledons*.

Dicotyledons were further subdivided into three sub classes: *Polypetalae, Gamopetalae, and Monochlamydae* based on the presence or absence of petals and their fusion. These were further subdivided into series, orders (called cohorts by the two authors) and families (called natural orders). No orders were recognised within Monochlamydeae and Monocotyledons, the series being directly divided into families.

Table 1. Bentham & Hooker's system of classification

Phanerogamae (Flowering Plants)

Dicotyledonae	Gymnospermae	Monocotyledonae
	(1) Gnetaceae	(1) Microspermae
	(2) Coniferae	(2) Epigynae
	(3) Cycadaceae	(3) Coronariae
		(4) Calycinae
		(5) Nudiflorae
		(6) Apocarpae
		(7) Glumaceae

Dicotyledonae

Polypetalae	Gamopetalae	Monochlanydeae
(1) Thalami florae	(1) Inferae	(1) Curvembryae
(2) Disciflorae	(2) Heteromerae	(2) Multiovulatae aquaticae
(3) Calyciflorae	(3) Bicarpellatae	(3) Multiovulatae terrestris
		(4) Microembryeae
		(5) Daphnales
		(6) Achlamydosporeae
		(7) Unisexuales
		(8) Ordines anomali

2.2 BENTHAM AND HOOKER'S SYSTEM OF CLASSIFICATION

Phanerogams or seed plants

Class (A) Dicotyledons – 14 series, 25 orders, 165 families

Subclass (1) *Polypetalae* (Corolla of distinct petals)

Series (I) *Thalami florae* (Petals and Stamens hypogynous)

It includes the following 6 orders.

1) Ranales
2) Parietales

3) Polygalineae
4) Caryophyllineae
5) Guttiferales
6) Malvales

Series (II) *Disciflorae* (Petals and Stamens hypogynous and a nectariferous disc surrounds the base of the ovary). It includes 4 orders.

1) Geraniales
2) Olacales
3) Celastrales
4) Sapindales

Series (III) *Calyciflorae* (Petals and Stamens perigynous or sometimes epigynous). It includes 5 orders.

1) Rosales
2) Myrtales
3) Passiflorales
4) Ficoidales
5) Umbellales

Subclass (2) *Gamopetalae* (corolla of united petals)
Series (I) *Inferae* (ovary inferior). It includes 3 orders.

1) Rubiales
2) Asterales
3) Campanulales

Series (II) *Heteromerae* (ovary superior, stamens as many or twice as many as corolla lobes, carpels more than two). The three orders are:

1) Ericales
2) Primulales
3) Ebenales

Series (III) *Bicarpellatae* (Ovary superior, stamens as many as the corolla lobes or fewer, carpels usually two) It has the following 4 orders:

1) Gentianales
2) Polemoniales
3) Personales
4) Lamiales

Subclass (3) *Monochlamydae* (petals absent)

Series I *Curvembryeae* (embryo curved round the endosperm, ovule usually one).
Series II Multiovulatae aquaticae (aquatics with numerous ovules).
Series III Multiovulatae terrestris (terrestrial plants with numerous ovules)
Series IV Microembryeae (embryo very small in copious endosperm)
Series V Daphnales (ovary usually with one carpel and single ovule)
Series VI Achlamydosporeae (ovary usually inferior, unilocular and one to three ovuled)
Series VII Unisexuales (flowers unisexual)
Series VIII Ordines anomali (The families of uncertain relationship were placed here)

Class (B) *Gymnospermae*

They include Gnetaceae, Coniferae and Cycadaceae

Class (C) *Monocotyledons*

Series I Microspermae (ovary inferior, seeds very small)
Series II Epigynae (ovary inferior, seeds large)
Series III Coronarieae (perianth petaloid, ovary superior)
Series IV Calycinae (perianth sepaloid, ovary superior)
Series V Nudiflorae (perianth mostly lacking, ovary superior)
Series VI Apocarpae (carpels free)
Series VII Glumaceae (perianth small, scale like)

Merits

1) The system has great practical value for identification of plants.

2) The system is widely followed for the arrangement of specimens in the herbaria of many countries including Britain and India.

3) Unlike de Candolle, the Gymnosperms are not placed among dicots but rather in an independent group.

4) Although the system is not a phylogenetic one, Ranales are placed in the beginning of Dicotyledons. The group Ranales is generally regarded as primitive by most of the leading authors.

5) Dicotyledons are placed before the Monocotyledons, a position approved by all present day authors.

6) The description of families and genera are precise.

7) The arrangement of taxa is based on overall natural affinities decided on the basis of morphological features, which can be easily studied with the naked eye or with a hand lens.

8) Heteromerae is rightly placed before Bicarpellatae.

Demerits

1) The system does not incorporate phylogeny, although it was published after Darwin's evolutionary theory.

2) *Gymnosperms* are placed between Dicotyledons and Monocotyledons, where as their position is before the Dicotyledons, as they form a group independent from angiosperms.

3) *Monochlamydeae* is an unnatural assemblage of taxa and the creation of this group has resulted in the separation of many closely related families.

4) In Monocotyledons, *Liliaceae and Amaryllidaceae* are generally regarded as closely related and often included in the same order. But in this system they are placed under different series, Amaryllidaceae under *Epigynae* and Liliaceae under C*oronarieae*.

5) *Unisexuales* is a loose assemblage of diverse families, which share only one major character, i.e. unisexual flowers.

6) Many large families, e.g. *Urticaceae, Euphorbiaceae and Saxifragaceae*, are unnatural assemblages and represent polyphyletic groups. These have rightly been split by sub sequent authors into smaller, natural and monophyletic families.

7) *Orchidaceae* is an advanced family with inferior ovary and Zygomorphic flowers, but the family is placed towards the beginning of Monocotyledons.

8) In Gamopetalae, Inferae with an inferior ovary is placed before the other two orders having a superior ovary. The inferior ovary is now considered to have been derived from a superior ovary.

2.3 ENGLER AND PRANTL SYSTEM OF CLASSIFICATION

This is a system of classification of the whole plant kingdom, proposed jointly by two German botanists: **Adolph Engler** (1844-1930) and **Karl A.E. Prantl** (1849-1893). The classification was published in a monumental work *Die Naturlichen Pflanzen familien* in 23 volumes (1887-1915). The system provided classification and description down to the genus level, incorporating information on morphology, anatomy and geography.

The system had significant improvements over Bentham and Hooker: *Gymnosperms* were placed before *angiosperms*, group *Monochlamydeae* was abolished and its members distributed along with their polypetalous relatives, and many large unnatural families were split into smaller natural families. The placement of monocots before dicots, did not get subsequent support. The placement of the so called group *Amentiferae* comprising families Betulaceae, Fagaceae, Juglandaceae, etc. in the beginning of dicots, did not find much support.

In this scheme of classification the plant kingdom was divided into 13 divisions of which the first 11 dealt with thallophytes, the 12th *Embryophyta Asiphonogama* (embryo formed, no pollentube) included Bryophytes and Pteridophytes, while the 13th and last division *Embryophyta Siphonogama* (embryo formed, pollentube developing) included seed plants. This Embryophyta siphonogama was divided into *Gymnosperms and Angiosperms*. Angiosperms were traditionally divided into *Monocotyledons and Dicotyledons*. The Dicotyledons were further distinguished into *Archichlamydae and Metachlamydae*. The Archichlamydae includes the polypetalous forms or petals absent where as the *Metachlamydae* includes the gamopetalous forms.

Outline of the system of classification of Engler and Prantl.

Plant Kingdom

$\left.\begin{array}{l}\text{Division 1}\\ \\ \text{Division 11}\end{array}\right\}$ Thallophytes

Division 12. Embryophyta Asiphonogama
- Subdivision (1) Bryophyta
- Subdivision (2) Pteridophyta

Division 13. Embryophyta Siphonogama
- Subdivision (1) Gymnospermae - 7 orders
- Subdivision (2) Angiospermae
  - Class (1) Monocotyledoneae - 11 orders, 45 families
  - Class (2) Dicotyledoneae - 44 orders, 258 families
    - Subclass (1) Archichlamydae (Petals absent or free) - 33 orders, 201 families.
    - Subclass (2) Metachlamydae (Petals united) – 11 orders, 57 families.

Merits

The classification of Engler and Prantl has the following improvements over that of Bentham and Hooker.

1) This was the first major system to incorporate the ideas of organic evolution, and the first major step towards phylogenetic systems of classification.

2) The classification covers the entire plant kingdom and provides description identification keys down to the level of family, genus and even species for large number of families.

3) Gymnosperms are separated and placed before angiosperms.

4) Many larger families of Bentham and Hooker have been split into smaller and natural families.

5) Abolition of Monochlamydae has resulted in bringing together several closely related families. Family Illecebraceae is merged with Caryophyllaceae.

6) Compositae in dicots and Orchidaceae in monocots are advanced families with inferior ovary, Zygomorphic and complex flowers. These are rightly placed towards the end of dicots and monocots respectively.

7) The Gamopetalous condition is considered as advanced over polypetalous condition.

8) The terms cohort and natural order have been replaced by the appropriate terms order and family respectively.

9) The classification being thorough has been widely used in text books, floras and herbaria around the world.

Demerits

The major drawbacks of the system include:

1) The system is not a phylogenetic one in the modern sense. Many ideas of Engler are now out dated.

2) Monocotyledons are placed before Dicotyledons. It is now widely agreed that Monocotyledons evolved from the primitive Dicotyledons.

3) The placement of the so called group *Amentiferae* comprising families Betulaceae, Fagaceae, Juglandaceae, etc. in the beginning of dicots were considered as primitive because of the presence of reduced unisexual flowers, having few floral members and borne in catkins.

4) Dichlamydeous forms (distinct calyx and corolla) were considered to have evolved from the monochlamydeous forms (single whorl of perianth). This view is not tenable.

5) Helobieae (including families Alismaceae, Butomaceae and Potamogetonaceae) is a primitive group, but in this classification placed after Pandanales, which is a relatively advanced group.

6) Ranales are now considered a primitive group with bisexual flowers, spirally arranged floral parts and numerous floral members. In this classification they are placed much lower down, after Amentiferae.

2.4 COMPARISON OF BENTHAM AND HOOKER WITH THAT OF ENGLER AND PRANTL SYSTEMS OF CLASSIFICATION

Bentham and Hooker		Engler and Prantl	
1.	Published in Genera Plantarum in 2 volumes (1862-83).	1.	Published in Die Naturalichen pflanzen-familien in 23 volumes (1887-1915).
2.	This system is based on the de candolle system.	2.	This system is based on Eichlers system.
3.	It is an artificial system and was never intended to express a phylogenetic scheme of classification.	3.	It is a phylogenetic system.
4.	Includes only seed plants.	4.	Includes the whole plant kingdom.
5.	Gymnosperms placed in between Dicotyledons and Monocotyledons.	5.	Gymnosperms separated and placed before the Angiosperms.
6.	Dicotyledons placed before Monocotyledons.	6.	Dicotyledons placed after Monocotyledons.
7.	Dicotyledons divided into 3 sub classes: Polypetalae, Gamopetalae and Monochlamydae.	7.	Dicotyledons divided into 2 subclasses: Archichlamydae and Metachlamydae.
8.	Sub classes are further subdivided into series, cohorts (representing orders) and natural orders (representing families).	8.	Sub classes are further sub divided into orders and families, series not recognised.
9.	Monocotyledons include 7 series and 34 natural orders.	9.	Monocotyledons include 11 orders and 45 families.
10.	Pre Darwinian in concept.	10.	Post Darwinian in concept.
11.	Dicotyledons start with Ranales having bisexual flowers.	11.	Dicotyledons start with verticillatae with unisexual flowers.

	Bentham and Hooker		Engler and Prantl
12.	Monocotyledons start with Microspermae including Orchidaceae.	12.	Monocotyledons start with Pandanales. Microspermae are placed towards the end of monocotyledons.
13.	Closely related families caryophyllacease, Illecebraceae and Chenopodiaceae are kept apart, the first under polypetalae and the other two under Monochlamydae.	13.	Family Illecebraceae is merged with caryophyllaceae. Chenopodiaceae and Caryophyllaceae placed in the same order, centrospermae.
14.	Closely related families Amaryllidaceae and Liliaceae placed in separate series Epigynae and Coronarieae respectively.	14.	Liliaceae and Amaryllidaceae placed in the same order, Liliiflorae.
15.	Many larger families, eg., Urticaceae, Saxifragaceae and Euphorbiaceae are unnatural heterogeneous groups.	15.	Several larger families of Bentham and Hooker split into smaller homogeneous families. Urticaceae split into Urticaceae, Ulmaceae and Moraceae.
16.	The Monocotyledons end with the Graminae which is the correct position of the family form the phylogenetic stand point.	16.	The Monocotyledons end with the orchidaceae a family sufficiently advanced, but certainly not advanced over grasses.
17.	They recognised 200 families of flowering plants.	17.	They recognised 280 families of flowering plants.

2.5 MODEL QUESTIONS

1) Give a synoptical lay out of the system of classification of flowering plants by Bentham and Hooker. Mention the merits and demerits of the system.
2) Give an account of Bentham and Hooker's system of classification of dicotyledons. In what respect does this system differ from that of Engler and Prantl.
3) Give a synoptical lay out of the system of classification of flowering plants by Engler and Prantl. Mention the merits and demerits of the system.
4) Compare Bentham and Hooker's & Engler and Prantl's systems of classification.

2.6 REFERENCE BOOKS

1. **Plant Systematics –** Gurcharan Singh, Oxford & IBH Publishing Co. Pvt. Ltd.
2. **Taxonomy of Angiosperms –** V. Singh and D.K. Jain, Rastogi Publications.

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M. Sudha

Unit-I

Lesson 3

PLANT NOMENCLATURE

OBJECTIVES

To study about the detailed account of naming the angiospermic plant.

CONTENTS

3.1 INTRODUCTION TO PLANT NOMENCLATURE

Nomenclature may be defined as the system of naming objects, particularly those of biological origin. Plants are known by common, vernacular or local names given to them. It has been observed that same plant has several common names in different parts of the country or the same common name has been applied for several different plants. Plants growing in a particular area are named in their own language. Such names are called vernacular names or common names. This necessitated the need for assigning scientific names to the plants. The current activity of botanical nomenclature is governed by the International Code of Botanical Nomenclature (ICBN) published by the International Association of Plant Technology (IAPT). The code is revised after changes at each International Botanical Congress.

3.2 BINOMIAL NOMENCLATURE

The Binomial system of Nomenclature was employed by Linnaeus in the first edition of his **Species Plantarum** published in 1753 although this system was first introduced by Gaspard Bauhin as early as 1623. According to the binomial system of nomenclature the name of a plant consists of two Latin words, the first (generic epithet) representing the genus and the second (specific epithet) the species. For example, the botanical name of mango is *Mangifera indica*. The first or the generic name (Mangifera) always starts with a capital letter and the second or the specific name (indica) starts with a small letter.

3.3 INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE (ICBN)

Professional botanists have gradually adopted a definite system of naming plants and plant groups according to international agreements reached at meetings. However, these meetings held previously are known as International Congresses and the rules adopted and published by them are known as the International Code of Botanical Nomenclature.

It was not until the 5th International Botanical Congress at Cambridge (1930) that the differences were finally resolved and a truly International Code evolved, accepting the concept of type method, rejecting the tautonyms, making Latin diagnosis mandatory for new groups and approving conserved generic names. The code has since been constantly emended at each International Botanical Congress. The rules of nomenclature adopted at the Cambridge Congress were subjected to some changes and refinement from time to time and the current International Code of Botanical Nomenclature as appeared in 1978 was adopted by the Twelth International Botanical Congress held in Leningrad (U.S.S.R) in August, 1975. The following information is based on this edition of the code.

The code is divided into three parts **– Principles, Rules and Recommendations**.

3.4 PRINCIPLES

The principles from the basis of the system of botanical nomenclature. The six principles given in this section are:

1) Botanical Nomencalture is independent of zoological nomenclature.
2) The application of names of taxonomic groups is determined by means of nomenclature types.
3) The nomenclature of taxonomic groups is based upon priority of publication.
4) Each taxonomic group can bear only one correct name, the earliest that is in accordance with the Rules, except in specific Cases.
5) Scientific names of taxonomic groups are treat as Latin regardless of their derivation.
6) The Rules of nomenclature are retro active unless expressly limited.

The Rules give detailed prescriptions on all the points connected with the naming of plants. The names contrary to the rules cannot be maintained.

3.5 SOME IMPORTANT RULES

1) The rank of taxa

The word taxa signify "taxonomic groups of any rank". The rank of species is basic and the relative order of the ranks of taxa are: species, genus, family, order, class, division and kingdom.

2) The type method (Typification)

This is a modification recently introduced in the code. The application of names of taxa of the rank of family or below is determined by means of nomenclature types. The following terms are used in the nomenclature of types:

i) Holotype

It is the one specimen used or designated by the author as the nomenclatural type.

ii) Isotype

It is a duplicate of holotype from the same collection with the same locality, date and number as the holotype. For example, if several herbaceous plants are collected at the same time, all belonging to the same new species, one may be selected as the holotype and the rest are isotypes.

iii) Paratype

It is a specimen cited with the original description other than the holotype or isotype. For example, if the new taxon is gathered with flowers and fruits in one season and without flowers and fruits in another season, these two collections will bear two different field numbers. However, the author will select one collection for holotype and isotype for describing the new taxon and the other gathering will from the paratype.

iv) Syntype

It is any one, two or more specimens cited by the author when no holotype was designated or any one of two or more specimens simultaneously designated as types.

v) Lectotype

It is a specimen or other element selected from the original material by any worker to serve as a nomenclatural type when no holotype was designated at the time of original publication or it is missing.

vi) Neotype

It is the specimen or other element selected by any author to serve as nomenclatural type as long as the whole material on which the name of the taxon is based gets lost.

3) Priority

Botanists have universally agreed to the principle of priority in order to avoid confusion and duplication in the names of taxa. Each taxon can bear only one correct name and the correct name is the earliest legitimate one except in case of limitation of priority by conservation. The principle of priority does not apply to names of taxa above the rank of family. Botanists have unanimously agreed for the date of valid publication of names of plants to hold Linnaeus *Species Plantarum* (1753) as the starting point for the angiospermic names.

4) Names of families

The name of the family is formed by adding the suffix *aceae* of a legitimate name of an included genera, e.g. Rosaceae from *Rosa* and Cucurbitaceae from *Cucurbita*. However, there are exceptions for the following eight families where alternative names are also permitted ending in -aceae.

Palmae	(Arecaceae)
Graminae	(Poaceae)
Cruciferae	(Brassicaceae)
Leguminosae	(Fabaceae)
Guttiferae	(Clusiaceae)
Umbelliferae	(Apiaceae)
Labiatae	(Lamiaceae)
Compositae	(Asteraceae)

5) Name of species

The name of species is a binary combination consisting of the name of the genus followed by the specific epithet. If an epithet consists of two or more words, these are to be united or hyphened (e.g. *Hibiscus rosa-sinensis*).

The specific epithet should not be exactly the generic name, e.g., names like *Linaria linaria* and *Phragmites Phragmites*, where specific epithet exactly repeats the generic name are known as *tautonyms*. Tautonyms are treated as illegitimate in botanical nomenclature.

6) Names of infraspecific taxa

An infraspecific taxon (taxon below the rank of the species) when containing the nomenclatural type of next higher taxon cannot be indicated by epithets such as typicus, originalis etc. Article 26 requires that in such cases, the specific epithet should be repeated unaltered in infraspecific taxon. For example, the combination *Lobelia spicata* var. Originalis McVaugh which includes the type of *Lobelia spicata* should be named as *Lobelia spicata* Lam. var. spicata.

7) Effective and valid publication of new taxa

The publication is effective only when printed matter is distributed to the general public or atleast to botanical institutions with libraries accessible to botanists. It is not effective by communication of new names at a public meeting, by placing of names in collections or gardens open to the public. The date of effective publication is the date on which the printed matter become available.

The following are important conditions attached for valid publication of names of new taxa:

i) Publication must be effective.

ii) There must be a description of the new taxon or a reference to a previously published description.

iii) It must be accompanied by a Latin description or with reference to a previously published Latin description.

iv) A nomenclature type is to be indicated for a new taxon of the rank of family.

8) Names of Plants in Cultivation

Plants brought from the wild into cultivation retain original names. For example, forms of *Chrysanthemum Parthenium* brought into cultivation are not to be renamed *Matricaria eximia*.

9) Retention of names of taxa which are divided

When a genus is divided into two or more genera, the original generic name must be retained for the genus including the type species.

Similarly, when a species is divided into two or more species, the original specific name must be retained for the species containing the type. For example, *Lychnisdioica* L. was divided by Miller into two species which were named as L. *dioica* L. emend Mill. and L. *alba* Mill.

10) Changes in names of taxa

Changes in the names of taxa may be required (a) by transference of the taxon, or (b) by its union with another taxon of the same rank, or (c) by a change of its rank.

a) Retention of names of taxa on transference

When a subdivision of a genus is transferred to another genus without change of rank, its original name (if legitimate) must be retained. For example, when *Saponaria* sect. *Vaccaria* DC was transferred to *Gypsophila* it became *Gypsophila* sect. Vaccaria DC.

When a species is transferred to another genus without change of rank, the original name (if legitimate) must be retained. For example, *Hydrocotyle asiatica* L. when transferred to the genus *Centella* must be called *Centella asiatica* L.

b) Choice of names when taxa of the same rank are united

When two or more taxa of the same rank are united into one, the oldest legitimate name is retained for the combined taxon. If the names of the taxa are of the same date, the author who first unites them has the right to choose any one of the names, and his choice must be followed. For example, K. Schumann united the three genera *Sloanea* L. (1753), *Echinocarpus* Blume (1825) and *Phoenicosperma* Miq. (1865) and he has rightly adopted the name *Sloanea* L. for the resulting genus which is the oldest of the three generic names.

c) Choice of names when the rank of a taxon is changed

When the rank of a genus or a taxon below the rank of genus is changed, the correct name is the earliest legitimate one available in the new rank. For example, *Magnolia virginiana* var. *foetida* L. (1753) when raised to specific rank, its correct name should be *Magnolia grandiflora* L. (1882), not M. *foetida* L.

3.6 MODEL QUESTIONS

1. What is plant nomenclature? Give a brief account of binomial nomenclature.
2. Give a concise account of International Code of Botanical Nomenclature.
3. Give a brief account of some important rules of the code.
4. Write Short Notes on:
   i) Typification
   ii) Effective and valid publication of new taxa
   iii) Plant nomenclature
   iv) Names of families
5. Differentiate between:
   i) Genus & species
   ii) Isotype & Paratype
   iii) Syntype & Lectotype
   iv) Lectotype & Neotype

3.7 REFERENCE BOOKS

1. **Plant Systematics –** Gurcharan Singh, Oxford and IBH Publishing Co. Pvt. Ltd.
2. **Taxonomy of Angiosperms –** V. Singh & D.K. Jain, Rastogi Publications.

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M. Sudha

Unit-I

Lesson 4
A BRIEF ACCOUNT OF CURRENT CONCEPTS IN TAXONOMY

OBJECTIVE

To study different concepts like cytotaxonomy, numerical taxonomy etc.

CONTENTS

One of the principle aim of taxonomy is to provide a system of classification of living organisms based on Evolutionary relationships.

Morphological characters of plants have been used extensively both for producing classification and for diagnostic purposes, this is known as classical or orthodox or Alphataxonomy and are still indispensable to the taxonomist. However, external morphological study is not adequate and other branches of study are of considerable value in proper assessment of the systematic status of a taxon and its phylogeny. Recent researches have shown that contributions to systematics can come from any branch of Botany. The modern trend in taxonomy have evolved sustained accumulation of data from several fields like Anatomy, cytology, embryology, palynology, genetics, physiology, ecology, plant geography and various others. The newer aspects of taxonomy like cytotaxonomy, chaemotaxonomy, numerical taxonomy, biosystematics etc., have greatly clarified confusion in the systems derivesed by classifical taxonomy. Taxonomy now may be regarded as an inter disciplinary science and is called omega taxonomy.

4.1 CYTOTAXONOMY

Cytotaxonomy utilizes cytological characters in solving taxonomical problems. Most of the cytotaxonomic studies are based on two nuclear chromosomal characters. They are:

1. Number, size, and shape of chromosomes.
2. Behaviour of chromosomes during mitosis and meiosis.

The chromosomes are the carriers of genetic information and as such have a considerable significance in evolutionary studies.

4.1.1 Chromosome number

Chromosomal number is usually constant in a species and the makes it an important taxonomic character. The lowest chromosomal number is found in *Haplopappus gracillus* (2n = 4) and highest in *Poa litorosa* (2n = 265). Similarly among lower plants spirogyracylindrica (Alga) has n=2 lowest and ophioglossum reticulatum (Pteridophyta) n = 1260 highest.

Sometimes the chromosomal number is constant through out the whole group. e.g. Pinus and Quescus and other members of Fagaceae have the same basic number n = 12. In such cases, chromosomal number is not of any help in distinguishing various taxa with in the group.

When chromosome numbers in various members of a taxon are in the proportion of exact multiples, the series is describes as euploidy. Several such examples can be found in the flowering plants and ferns. In Malvaceae for instance, the somatic number in various species range from 10, 15, 20, 25 . . . . . . 40 from 12, 18, 24 to 30; from 14, 28, 42, 56 to 84 and so on. In the genus Taxa Xacum (Asteraceae), there are species with 2n = 16, 24, 32, 40 and 48 chromosomes. Various members of such an euploid series may be unified by a basic number of X which is the gametic number of a diploid species and other species can be described triploid (3x), tetraploid (4x), hexaploids (6x) . . . . Polyploids (nx). Thus one of the series in Malvaceae has X = 5 while the others have X = 6, 7 etc. This Taxa xacum the basic number is X = 8.

If the chromosome numbers found within a group bear no simple numerical relationship to each other, than the series is termed as an aneuploid series or simply aneuploidy.

In nature a large number of plant groups are known to exhibit aneuploidy. Various species of Carex (Cyperaceae) show a wide range of chromosome numbers from n = 6 to 112 with multiples of 5, 6, 7 and 8. The genus Iseilema also shows aneuploidy. Iseilema antephoroides is having n=5, *I. venkateswarlui* n = 4, *I. lubbardu* n = 3.

Cytological studies, especially the karyotype data, have been shown to be useful in taxonomy at all levels up to that of family and even above, but most involve species and groups of species.

4.1.2 Chromosome morphology

In addition to variation in number, chromosome vary in form, size, volume and in the amount of distribution of Heterochromatin. Usually monocotyledons have large chromosomes than the dicotyledons and herbaceous plants have larger chromosomes than their woody plants.

The individual chromosomes of some taxa show marked difference in shape and size at mitotic metaphase. They are characterised by the relative length of the arms. Position of the centromere and presence of satellite make further difference. A karyotype consists of chromosomes similar to each other in size and with median, submedian, centromeres may be considered as a symmetrical one, whereas asymmetrical karyotype possesses many chromosomes with subterminal centromeres or great difference in size between the largest and the smallest or both.

4.1.3 Chromosome behaviour during meiosis

A study of chromosomal behaviour at meiosis can provide some valuable information about the relationship of populations and species. Meiotic abnormalities such as non-pairing, crossing over and subsequent changes such as chromosome size, translocation, lagging chromosomes, bridge formation, non-disjunction and several others can be easily detected and interpreted. These changes can be observed during microsporogenesis.

4.1.4 Cytological variation at family level

Cytological evidence is of considerable importance in interpreting a classification and establishing relationships.

An Ranunnculaceae, chromosome number and chromosome morphology have provided basis for natural arrangement of genera and tribe. In Ranunnculaceae Engles and Prantle recognised two main tribes namely Halleboraceae and Anemoneae. These tribes have genera with basic chromosome number 7, 8 and 9 and have large and small chromosomes.

The subdivision of the family Brassicaceae as recognised by Schutz on traditional characters are also distinct karyotypically in having different base chromosome numbers as has been shown by the studies of Honton (1932).

The major subdivision of the family Gramineae as recognised currently are characterised by the number and size of the chromosomes.

The genera Agave and Yucca were placed in the separate families, Amaryllidaceae and Lilliaceae respectively by some early workers have 5 long and 25 short chromosomes but their karyotype morphology is also similar. Thus in the light of the above evidence and other morphological characters, these two genera were placed in the same family Agavaceae.

4.1.5 Variation at genetic level

There are several examples where chromosome number support generic status. A classical example can be seen in crepsis cymbogon's and youngia of the compositeae. In crepsis, various species have X = 7, 6, 5, 4, 3 chromosomes, while in other genera X = 8 or X = 9.

The genus Cistus (Cistaceae) was previously included in Helianthemum. The former has been chromosome number 8 and latter 9. This supports the recognition of cistas as a separate genus.

The two genera of the Brassicaceae, physaria and Lesquerella were recognised by many as a single genus. Cytological evidence, however, suggests these two genera should remain separated.

Chromosome morphology has been effectively used in dilimiting and in taxonomy of some genera such as Nicotiana and Crepis, which are extensively investigated cytologically.

4.1.6 Cytological variation at specific and intraspecific level

A great deal of cytological variation occurs at specific and intraspecific level. There is an exhaustic literature on this aspect.

Monotropa hypopitys (Monotropaceae) was formerly treat a single species with two varieties var hisuta and var glabra.

On the cytological examination of the former was found to be a haxaploid with 2n = 48, later a diploid with 2n = 16. Hexaploid was retained as the species *H. hypopitys* and *H. glabra* was raised to specific rank as *H. hypogea*.

It is clear from the examples quoted above and many others, that karyotype data can support conclusions based on the other data at all levels of taxonomic heirarchy. However, it has also been noted that karyotype variation or variation in chromosome number is not correlated with morphological features. There is particularly so in the case of aneuploids and their related diploids.

4.2 NUMERICAL TAXONOMY

Organisms are classified on the evidence obtained from their characters, therefore it becomes necessary to employ all the characters for the ideal or a natural classification. But since each individual may possess thousands of characters, so it is difficult or becomes impracticable to use all characters. This naturally leads to the problem of selection of suitable characters.

The use of as many characters as possible or ideally all the characters for classification was proposed by Adanson (1763).

The branch of Botany that uses mathematical methods to evaluate observable differences and similarities between taxonomic groups is known as Numerical taxonomy or taximetries. Sikal and Sneath (1963) gave the first comprehensive explanation to this subject.

Numerical taxonomy is based on phenetic evidence as judged from an organisms phenotype rather than from its supposed phylogeny. It includes two basic aspects.

1. Construction of taxonomic groups
2. Discrimination of taxonomic groups

4.2.1 Construction of taxonomic groups

First individuals are selected and their observable characters are spotted out. There is no limitation to the number of characters to be considered. The larger, the number of characters, better is the approach for generalization of the taxa. Later the resemblances among the individuals are established on the basis of characters analysed.

4.2.2 Discrimination of taxonomic groups

When the taxonomic groups chosen for the study show overlapping of characters, discrimination is made between them by using analysis techniques.

Steps to the consideration of taxonomic groups

Two major bases have been recommended to design a natural system of classification.

(1) Phenetic (2) Clasdistic

(1) **Phenetic –** Phenetic classification is the similarity (relationship) (characters related to the appearance) characters. This phenotypic relationship expressed in terms of similarity does not embody any relationship through ancestry.

(2) **Cladistic –** This relationship is expressed in terms of correlation amongst individuals with regard to their evolutionary history. The relationship means common ancestry. The work cladistic means study of evolutionary sequence and pathway followed by individuals and the origin of branches from evolutionary tree. The evolutionary tree with anastomosing branches leading to various taxa are termed as cladograms.

In the construction of taxonomic groups, the following steps are used.

1. Operational taxonomic units
2. Unit characters
3. Selection of unit characters
4. Estimation of similarities

5. Similarity matrix

1. Operational taxonomic units

Operational taxonomic unit is the basic unit of study in numerical taxonomy (OTU). It can be an individual, species, genus, family, order or class. Since the taxonomic units employed in numerical taxonomy are not always comparable to formal taxonomic units, they are termed as operational taxonomic units. Comparison is made only between OTUs of equal rank. For e.g. when genera are compared they should be represented by different species. Similarly, when families are compared, they should be represented by different genera.

2. Unit characters

The characters used in numerical taxonomy are known as unit characters. A unit character is that one which cannot be subdivided logically. According to Sokal and Sneath (1963), unit characters is defined as taxonomic characters which exists in one or more status. Only phenotypic characters are used as unit characters e.g. presence or absence of an awn in a grass spikelet.

There are two types of unit characters.

(a) Those unit characters which exist in two states are called **binary characters**. This is the simplest form of coding where characters are divided into + and – or as 1 and 0. The positive characters are recorded as + or 1 and negative characters as – or 0. In case, the organ passing a character, the character is recorded as NC, which means no comparison.

(b) Those unit characters, which exists in more than two states, are called multistate characters. The multistate characters may be:

(i) qualitative such as, the colour f the flower. The colour of the flower could be in any number of states – white, red, yellow, violet, blue, etc.

(ii) quantitative such as the length of the leaf, it could be – 1 cm, 2 cm, 3 cm, 4 cm etc., light of the plant or amount of pubescence on a leaf etc.

3. Selection of unit characters

Sneath and Sokal suggested the following points for proper selection of unit characters.

1. They should be come from all parts of the organism.
2. They should belong to all the stages of the life cycle of the organism.
3. Variable characters within the group be used.
4. Due attention should be given to characters related to morphology, physiology, ecology and distribution of organism.

4. Estimation of similarities

There are 3 methods of estimating phonetic resemblance between the taxonomic groups, namely:

a) Coefficient of association
b) Coefficient of correlation
c) Measurement of taxonomic Di

a) Coefficient of association - It is measured by following formula.

$$S = \frac{N_S}{N_S + N_d}$$

Where S = Simple matching index or coefficient

N_S = The number of positive features shared by any two OTUS.

N_d = The number of positive features in one OUT and the number of negative features in the other OUT.

In the conventional 2 x 2 frequency table, the most common model for qualitative characters, the number of the four possible combinations of matches (or agreements) and mismatches (or disagreements) of the characters states of two OTUs is shown.

OTU.2	OTU 1			
		+		
	+	a	b	a + b
	-	c	d	c + d
		a + c	b + d	

n = a + b + c + d

a, b, c, d are the numbers of the four combinations and total number of four combinations

n = a + b + c + d. Number of matches

m = a + d and number of mismatches u = b + c them m + 4 = n

The following table gives a numerical examples with 20 characters

OTU.2	OTU 1			
		+	-	
	+	12	3	15
	-	1	4	5
		13	7	n = 20

$$S = \frac{Ns}{Ns + Nd} = \frac{m}{m + u} = \frac{m}{m} = \frac{a + d}{a + b + c + d}$$

$$= \frac{(12 + 4)}{12 + 3 + 1 + 4} = \frac{16}{20} = 0.80$$

simple matching coefficient (s) = 0.80

(b) Coefficient of correlation:- It is measured by the following formula.

$$rjk = \frac{E^n [(x_{ij} - x_i)(x_{lk} - x_k)]}{\sqrt{\{[E^n(x_{ij} - x_j)^2] \ [En(x_{ik} - x_k)^2]\}}}$$

Where j and k stand for two unit characters (OTUs)

x_{ij} = value of character i in unit j

x_{ik} = value of character i in unit k

x_i and x_k = means value of all the characters in unit j and k.

E^n = Total number of characters studied

(c) Measurement of taxonomic distance between OTUS

It is an expression of the relationship between individuals or taxa in terms of multi-dimensional space with one dimension for each character.

Taxonomic distance (d) =

$$d_{jk} \sqrt{\{E^n (x_{ij} - x_{ik})\frac{2}{n}}$$

where x_{ij} = value of characters (in unit) (OTU)
x_{ik} = value of characters i in unit k (OTU)
E^n = sum over n characters
d = Taxonomic distance

The value of taxonomic distance (d) is the distance in a phenetic space divided by $\sqrt{n}$

5. Similarity matrix

The similarity matrix is the basic evidence available for finding taxonomic structure. After calculating all, the indices of the OTU's, the similarities are arranged in a t x t table.

A typical 10 x 10 similarity matrix for 10 OTU's is given below in the table.

Similarity Matrix

1	A	1.0									
2	B	0.9	1.0								
3	C	0.6	0.5	1.0							
4	D	0.5	0.6	0.5	1.0						
5	E	0.9	0.8	0.6	0.5	1.0					
6	F	0.6	0.6	0.8	0.5	0.6	1.0				
7	G	0.6	0.6	0.8	0.5	0.5	0.8	1.0			
8	H	0.5	0.5	0.5	0.9	0.5	0.5	0.5	1.0		
9	I	0.8	0.9	0.6	0.5	0.9	0.6	0.6	0.6	1.0	
10	J	0.6	0.6	0.7	0.6	0.6	0.8	0.8	0.5	0.6	1.0
		A	B	C	D	E	F	G	H	I	J

Advantages

1. It helps in integrating data from a wide variety f sources such as morphology, physiology, chemistry, DNA strands, aminoacid sequence etc. This is very difficult to do by conventional taxonomy.
2. This method being quantitative, gives better, classifications and keys.
3. It led to the re-interpretation of a number of biological concepts.

Disadvantages

1. Selection of character is difficult

There are the some admissible unit characters.

a) It cannot be subdivided.
b) It must show variation among the taxa under comparison.

c) It should be inherent in the organisms.
d) It should not be susceptible to environmental or experimental conditions
e) It must be of some diagnostic value

2. The "numerical species" recognized by this method is unacceptable unless some "genetic" or crossability evidence are incorporated..

4.2.3 Anatomy in relation to taxonomy

The first attempt to use anatomy in plant classification was made by Bureau (1864). Anatomical characters of vegetative and floral parts of flowering plants have been successfully employed to solve taxonomic problems and for the elucidation of phylogenetic relationships. Solereder (1899) emphasized the importance of xylem structure in plant classification. Bailey (1951) and Metcalfe and Chalk (1950) have listed numerous anatomical features that can be made use in taxonomy.

Some of the basic evidentary anatomical characters of well established value are discussed below:

4.3 VEGETATIVE ANATOMY

a) Leaf anatomy: Leafy characters especially epidermal characters and stomatal characters are very much useful in taxonomy. They include:

i) Nature and thickness of epidermis
ii) Nature of trichomes
iii) Structure and types of mesophyll
iv) Pattern of Sclerenchyma
v) Chloroplast structure

Stomata accompanied by 6 subsidiary cells consisting of two lateral pairs parallel to the long axis of the pore and two polar cells and second lateral pair as long as the stomatal complex. Similarly the shape of the guard cells are also useful in plant classification. For example – stomata with bean shaped guard cells are met with Dictoyledons while stoma with dumble – shaped cells are seen in Poaceae. In Cyperaceae redangula guard cells can be seen.

Trichomes are epidermal outgrowths. They exhibit great variation in structure and function and thus are of much taxonomic value. Schulz (1936) used the type of hairs as the major criterion in the subdivision of the family Crucifereae into tribes and genera.

Ramayya (1969, 1972), Ramayya and Rajgopal (1968, 1971) studied the nature of trichomes in distinguishing the families – Compositeae, protulacaceae and Aizoaceae.

b) Stem Anatomy

Stem anatomical characters help in separation Dictoyledons and Monocotyledons and also in the separation of various species of the genus. The following anatomical characters are useful as diagnostic tooles.

a) Degree of elevation of stem ridges
b) Distribution of Collenchyma
c) Pattern of Collenchyma thickenings
d) Shape an size of Sclerechyma
e) Arrangement and type of vascular bundles

Ayensu (1970) found anatomy useful in separating *Dioscorea rotunda* and *D. cayennensis*, which are closely related, on the basis of arrangement of vascular bundles in the stem.

Stem anatomy has been studied in the herbaceous members where it has proved to be of some diagnostic value. In the stem of *Ranunculus repens* there is relatively little strengthening tissue and is correlated with the creeping habit of the plant. While the closely related species, *R. acris*, intrafascicular tissue is sclerified and therefore an erect habit is possible.

c) Petiole Anatomy: Howard (1963) suggested that the petiole anatomy is also of taxonomic significance. Some of the important characters useful are –

1) Position of the petiole on the stem
2) Pressure and absence of stipules
3) Out tine of the petiole
4) Number of traces
5) Vascularisation pattern

d) Nodal anatomy: Sinnot (1914) gave a classification of nodal types in megaphyllous plants. In general there are: 3 major types of node – Unilacunan, trilacular and multilacunas.

Trilacunar nodes occur in the majority of Dicotyledons, multilacunas nodes in the primitive orders such as Magnoliales, piperales, trochodendraly and advanced orders such as umbellales, piperales and Asterales and unilacunar nodes in laurales, Caryophyllales, Ericales, Ebenales, Prisnulales, Myrtales and majority of families of Asteridae.

e) Wood Anatomy

The most important anatomical features that have been used in taxonomy and phylogeny are those of secondary wood. This is because of their conservative nature. Wood anatomy can be used at all taxonomic leader. In Quescus (Fagaceae), different subgenera and sections can be delimited with the help of anatomical evidence. The placement of genus Myrishca and the related genera close to hauraceae is supported by the evidence of wood structure (Eames-1961), while in the same basis Myristicaceae are considered unrelated to Annonaceae and Eupomaliceae. Similarly placing of calycarthaceae in or near rosales is not supported by wood structure.

f) Floral anatomy

Floral anatomy has a wide application in determination of status of high ranking groups such as genera and species.

Separation of the genus Paeonia from Rannunculaceae and its inclusion under separate family – the Paeoniaceae and also separation of genus trapa from Onagraceae and included under a new family of its own trapaceae. Inclusion of Solonaceae and scrophulariaceae under one single order, scrophulariales due to uniformity in floral structure. Placement of Cyperaceae and Poaceae in two separate orders Cyperales and Poales respectively by Hutchinson (1978).

Fruit wall and seed coat anatomy have also come to the help of taxonomists in many cases. Seed coat morphology has yielded valuable taxonomic information. Seed coat anatomy has also been used for systematic purposes.

4.4 MODEL QUESTIONS

Essay Questions

1. Write an essay on Cytotaxonomy.
2. Write a brief account of current concepts in taxonomy.
3. Write an essay on numerical taxonomy.
4. Briefly explain the modern trends in taxonomy.
5. Write briefly on Anatomy in relation to taxonomy.

Short Notes

1. Cytotaxonomy
2. Numerical taxonomy
3. Anatomical evidences

4.5 REFRENCE BOOKS

1. **Plant Systematics –** Gurcheran Singh, Oxford and IBH Publishing Co. Pvt. Ltd.
2. **Taxonomy of Angiosperms –** V. Singh & D.K. Jain, Rastogi Publications.
3. **Taxonomy of Vascular Plants –** George H.M. Laurence, 1973, Oxford & IBH Publishing Co., New Delhi.

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Dr. D. SOMESWARI

Unit-II

Class : **Dicotyledons**
Subclass **: Polypetalae**
Series **: Thalamiflorae**
Order **: Ranales, Parietales & Malvales**

Lesson 5.1

TAXONOMY AND ECONOMIC IMPORTANCE OF THE FAMILIES BELONGING TO THE ORDERS RANALES, PARIETALES AND MALVALES IN SERIES THALAMIFLORAE AND SUBCLASS POLYPETALAE

OBJECTIVES

⇒ To study the vegetative and floral characters of the plants belonging to the families in orders Ranales, Parietales and Malvales.
⇒ To know the similarities and differences between the families of orders Ranales, Parietales and Malvales.
⇒ To know the economic importance of the families in the orders Ranales, Parietales and Malvales.

STRUCTURE

5.1 General characters of Polypetalae
5.2 Annonaceae
5.3 Capparidaceae
5.4 Malvaceae

Sub-Class: **Polypetalae**

5.1.1 Characteristic feature of Sub-class Polypetalae
1. Flowers with both calyx and corolla
2. Petals are distinct and free

5.1.2 Classification: Sub-class Polypetalae has three series:
(a) Thalamiflorae
(b) Disciflorae
(c) Calyciflorae

Series : **Thalamiflorae**

1. Flowers regular, bisexual
2. Hypogynous flowers
3. Ovary superior
4. Orders included → a) Ranales, b) Parietales, c) Malvales.

(a).Order : **Ranales**

1. Stamens usually numerous
2. Carpels free and embryo minute
3. Family included → **Annonaceae**

(b).Order : **Parietales**

1. Stamens definite or numerous
2. Carpels united into a unilocular ovary with parietal placentation
3. Family included → **Capparidaceae**

(c).Order : **Malvales**

1. Stamens numerous, monoadelphous
2. Ovary 3-many locular, axile placentation
3. Family included → **Malvaceae**.

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5.2 ANNONACEAE
The Custard Apple Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Polypetalae
Series	Thalamiflorae
Order	Ranales
Family	Annonaceae

2) Distribution:

A family of 120 genera and 1,200 species widely distributed in the tropics, chiefly the Old World. In India, the family is represented by 26 genera and about 200 species mostly confined to the peninsular India.

3) Familiar Plants:

1. *Annona muricata* (Laxmanaphalam)
2. *Annona reticulata* (Ramaphalam)
3. *Annona squamosa* (Sithaphalam)
4. *Artabotrys odoratissimus* (Teega Sampenga)
5. *Cananga adorata* (Chettu Sampenga)
6. *Desmos chinensis*
7. *Monodora myristisa*
8. *Polyalthia longifolia* (Naramamidi)
9. *Unona discolor*
10. *Xylopia aromatica*

4) Vegetative characters:

They are usually aromatic trees or shrubs, or sometimes woody climbers such as species of *Oxymitra* and *Melodorum*.

5) Root: Tap root

6) Stem:

Errect, woody or climbing, branched. Branching monopodial (*Polyalthia*) or sympodial (*Artabotrys*).

7) Leaves:

The leaves are alternate, exstipulate, simple and entire, Oil passages are present in stems and leaves.

8) Inflorescence:

The flowers are often solitary axillary, terminal or leaf opposed or sometimes fascicled. Some species of *Polyalthia* (*P. fragrans* and *P. simiarum*) are cauliflorous where flowers are borne on old axis or woody tubercles.

9) Flowers:

The flowers are usually ebracteate, pedicellate, complete, actinomorphic, bisexual (unisexual in *Stelechocarpus*), hypogynous and conical thalamus.

10) Calyx:

The calyx has three sepals which are free or united at the base or into a three lobed cup in *Cyathocalyx.* The aestivation is valvate.

11) Corolla:

The corolla has usually six petals in two whorls (inner whorl is absent in some species of *Unona),* both whorls are similar or inner smaller as in *Cananga.* The petals are free or basally connate and show imbricate or valvate aestivation.

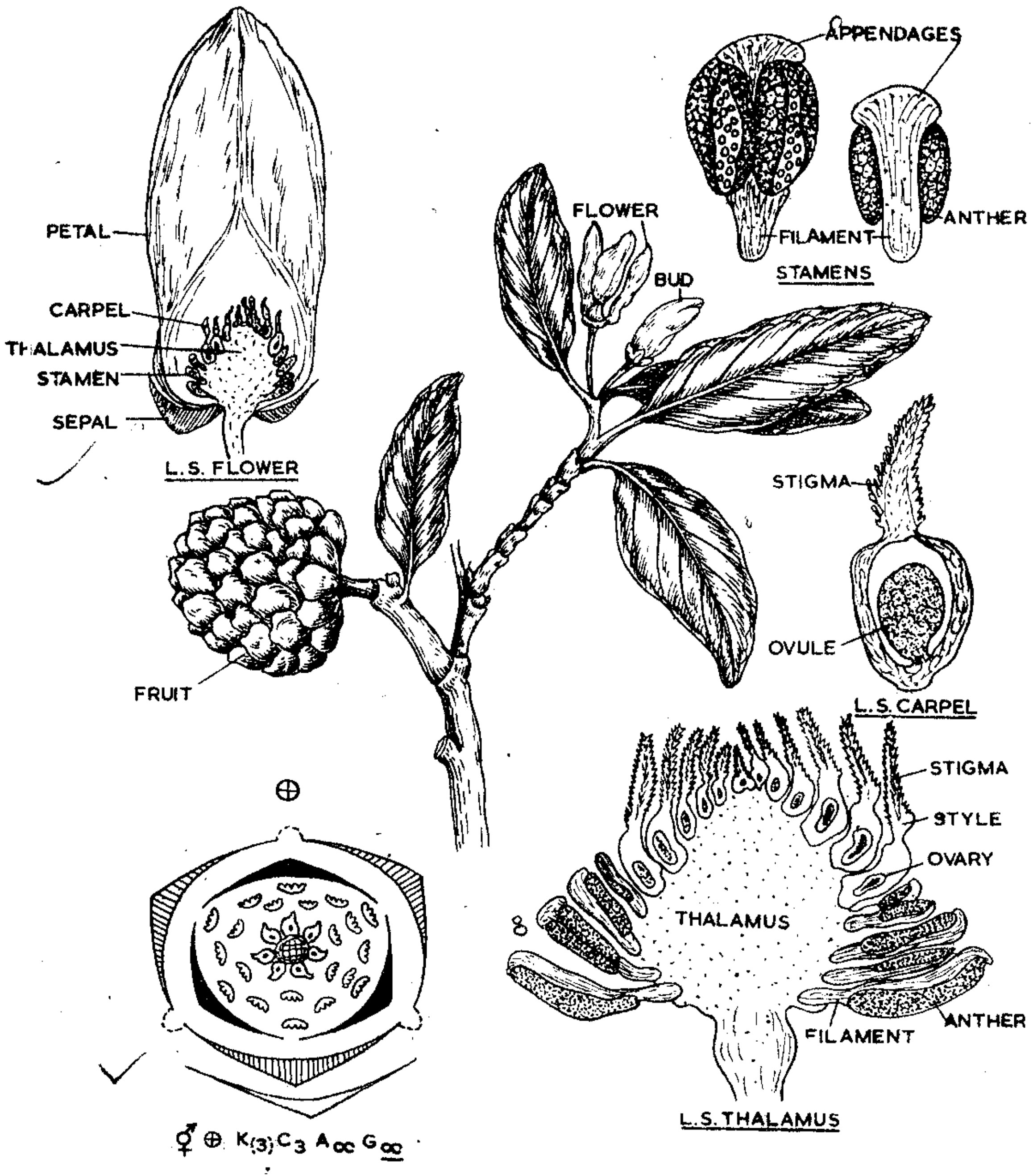

Fig.5.1 *Annona squamosa* (Sitaphal)

12) Androecium:

The androecium consists of numerous free stamens which are spirally arranged on a large convex receptacle. The filaments are short and thick and the anthers are adnate, dithecous and extrorse. The connective is produced into an oblong, dilated or truncate head above the anthers.

13) Gynoecium:

The gynoecium has one to indefinite carpels which are spirally arranged on the receptacle above the stamens. There are one to three carpels in *Cyathocalyx,* few to many in *Artabotrys* and indefinite in *Polyalthia.* The carpels are free but in *Annona,* they are subconnate with distinct stigmas. The ovary is superior, unilocular with many anatropous ovules in two rows on the ventral suture of the carpel. The placentation is parietal, basal or subbasal as in *Polyalthia* which has one or two ovules. The style is short or the stigma is sessile.

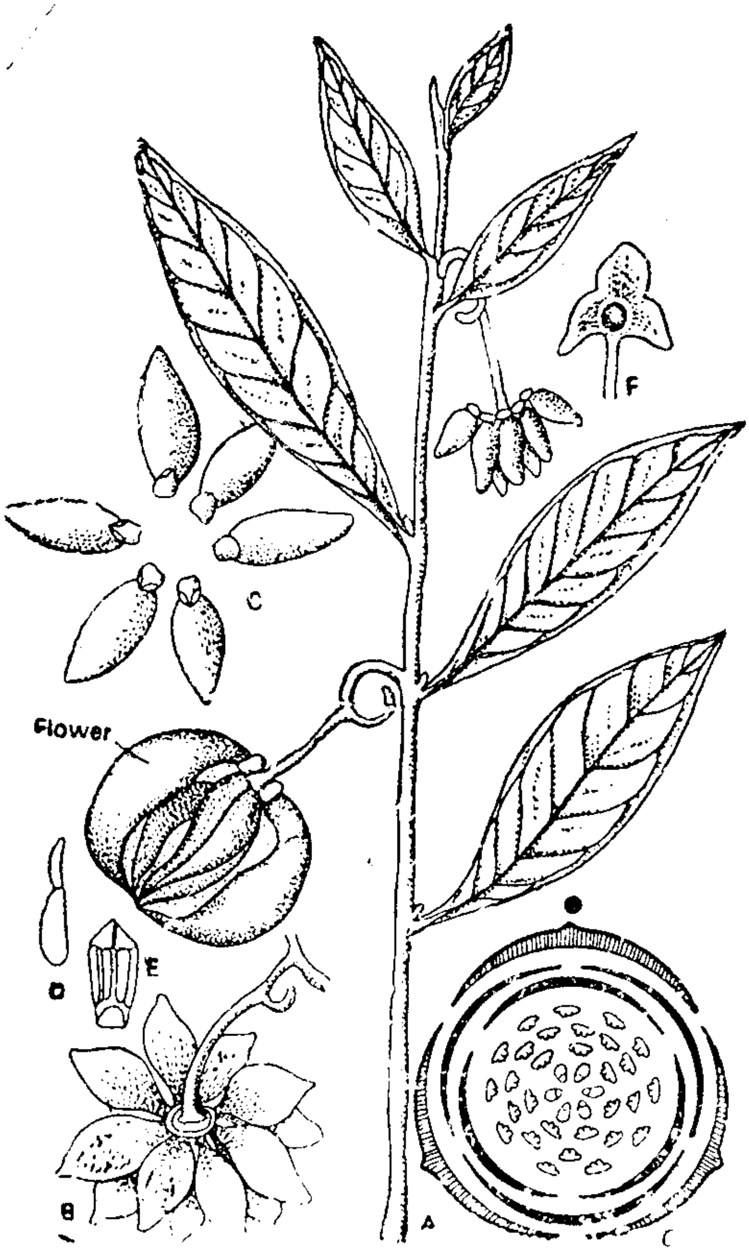

Fig. 5.2 Annonaceae – *Artabotrys odoratissimus*

14 & 15) Fruit and Seed:

The fruit is often an aggregate of berries. In *Annona,* the berries become confluent with each other and with the receptacle to form a globose or ovoid many seeded fleshy fruit. However, in *Polyalthia longifolia,* the berries do not confluent to each other and remain separate. The seeds are large with a small embryo and dense ruminate endosperm.

16) Pollination:

The flowers are often fragrant due to the presence of oil sacs and are pollinated by flies.

17) Dispersal:

The seeds are usually dispersed by birds and bats. The fleshy fruits of *Annona* are generally dispersed by mammals. The seeds of *Artabotrys* and *Polyalthia* are drifted by sea.

18) Floral Formula:

Ebrl ⊕ ⚥ K_3 C_{3+3} A_α $G_{\underline{\alpha}}$

19) Economic Importance:

The members of the family provide edible fruits, ornamentals, timbers and essential oils.

I. Edible Fruits:

Many species yield edible fruits, e.g., *Annona squamosa*, *A. reticulata* and *Cananga odorata*.

II. Ornamentals:

The following species are grown as ornamentals for their fragrant flowers and attractive leaves.

(i) *Artabotrys odoratissimus* is a strong climbing or scrambling shrub with greenish or yellowish and very fragrant flowers.
(ii) *Cananga odorata* is a medium sized tree with long acuminate leaves and very fragrant greenish to yellowish flowers.
(iii) *Polyalthia longifolia* and *P. pendula* are lofty trees with drooping branches and beautiful green foliage. They form one of the most beautiful avenue trees.

III. Essential oils:

Flowers of *Cananga odorata* and *Artabotrys odoratissimus* yield an essential oil which is used in high class perfumery and toilet preparations.

IV. Timbers:

Species of *Cananga, Sageraea, Miliusa* and *Polyalthia* provide useful timber.

V. Other uses:

1. Inner bark of *Unona pannosa* affords a strong fibre which is used for cordage and for paper making.
2. Seeds of *Anona squamosa* possess insecticidal properties and are used for killing insects and lice.

20) Distinguishing features:

1) Exstipulate simple leaves.
2) Oil passages in stem, leaves and flowers.
3) Long, elongated or conical thalamus.
4) Trimerous perianth.
5) Numerous, free stamens and carpels.
6) Very short filament (stamens), hooded connective.
7) Aggregate fruit
8) Ruminate endosperm.

21) Questions:

1. Describe the vegetative and floral characters of the family Annonaceae. Write the Botanical names of 4 plants and their economic importance.
2. Write short notes on:
   (i) Essential organs of Annonaceae.
   (ii) Economic importance of Annonaceae.

22) Reference Books:

i) **Angiosperms (Systematics & Life Cycle) –** G.L. Chopra, Pradeep Publications, Jalandhar.
ii) **Taxanomy of Angiosperms –** B.P. Pandey, S.Chand & Co. Ltd., New Delhi.
iii) **Introductory Taxonomy (Angiosperms) –** Dr. B.S.Trivedi & Dr. B.B.Sharma, Kithab Mahal, Allahabad.

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Ch. E. USHA RANI

5.3 CAPPARIDACEAE
The Capers Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dictoyledonae
Sub-class	Polypetalae
Series	Thalamiflorae
Order	Parietales
Family	Capparidaceae

2) Distribution:

The family includes 42 genera and over 900 species distributed in tropical and warm temperate regions of the world. In India, the family is represented by 7 genera and about 53 species occurring mostly in the western and south India and a few in the tropical Himalayas.

3) Familiar Plants:

1. *Cadaba indica*
2. *Capparis aphylla*
3. *Capparis spinosa* (Capers)
4. *Cleome gynandra*
5. *Cleome viscosa* (Kukka vaminta)
6. *Crataeva religiosa*
7. *Maerua areneria*
8. *Roydsia suaveolens*

4) Vegetative characters:

The family includes herbs (*Cleome*), shrubs (*Cappairs*), trees (*Crataeva*) and occasionally woody climbers (*Maerua*). They contain a watery sap.

5) Root: Tap root

6) Stem

Ariel usually erect, branched, woody (*Capparis*) or herbaceous (*Cleome gynandra*) The plants may have an offensive smell. Stem is covered with glandular hair.

7) Leaves

The leaves are alternate, stipulate or exstopulate and simple (*Capparis*) or palmately compound (3-9-foliate) as in *Cleome gynandra*. The stipules are foliaceous (*Cleome*) or spinose (*Capparis*). In *Capparis decidua* leaves are present for a very short durationand later the plants become leafless and the function of photosynthesis is taken over by green branches which develop palisade like layers in the outer cortex.

8) Inflorescence:

The flowers are solitary or in fascicles of three or four as in some species of *Capparis*, but more commonly they are racemose (*Cleome gynandra* and *C. viscosa*).

9) Flowers:

The flowers are bracteate, complete, usually hermaphrodite, actinomorphic (zygomorphic in *Capparis*), tetramerous and hypogynous.

10) Calyx:

The calyx is usually of four sepals which are free or basally connate with valvate (*Maerua*) or imbricate aestivation. The four sepals are arranged in two series. The posterior sepal forms a hood-like structure in *Capparis*.

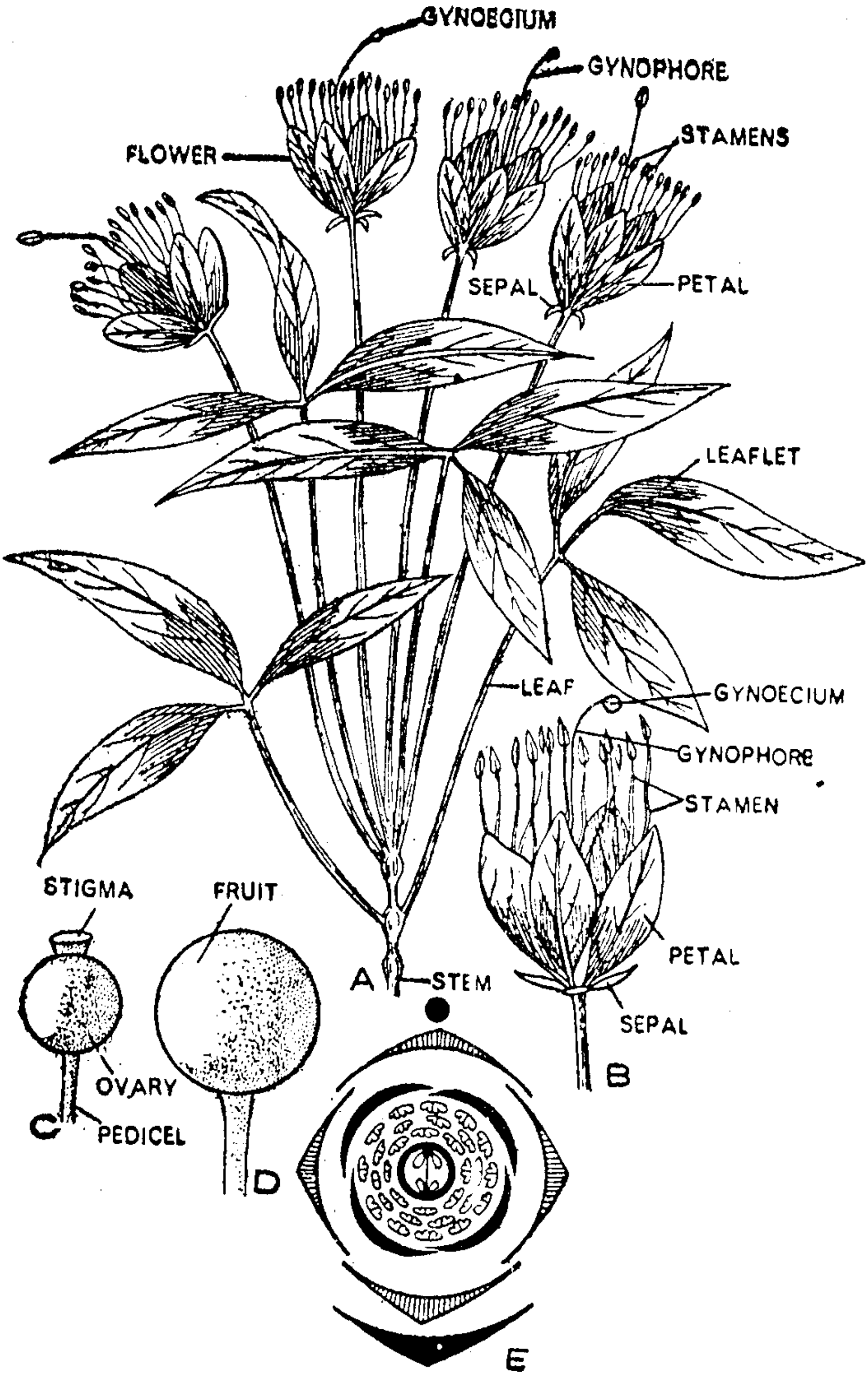

Fig. 5.3 Capparidaceae – *Crataeva* Sp. **A**, twig; **B**, flower

11) Corolla:

The corolla is of four, free petals but occasionally the petals are two (*Cadaba*) or altogether absent (*Roydsia*). The petals are diagonal, often clawed and valvate (*Crataeva*) or imbricate.

12) Androecium:

The androecium is of four to numerous free stamens. There are only four stamens alternating with the petals in *Cleome tetrandra* but other species of *Cleome* have six stamens. There are indefinite stamens in *Capparis* and *Crataeva* arranged in several whorls. The anthers are dithecous, introrse and dehiscing longitudinally. In some species of *Cleome* (e.g. *C. gynandra)* the stamens are raised on an androphore, formed by the development of internode between petals and stamens. Usually a disc occurs between petals and stamens which is thicker on the posterior side.

13) Gynoecium:

The gynoecium is usually bicarpellary and syncarpous, the ovary is sessile or elevated on a short or long gynophore (development of an internode between stamens and carpels), unilocular with two or rarely four (Capparis) parietal placentae or sometimes divided into two or more loculi by in growth of the placentae. The ovules are few to many on each placenta. The style is usually short with a bilobed or capitate stigma.

14) Fruits:

The fruit is capsule dehiscing by two valves (*Cleome*) or a berry (*Capparis*) or drupaceous (*Roydsia*).

15) Seeds:

The seeds are usually reuniform, non-endospermic and with an incurved embryo.

16) Pollination:

The pollination is brought about by the agency of insects which visit flowers for nectar secreted by the disc.

17) Dispersal:

The fruits are dispersed by water current (*Crataeva*) or by cattles by adhesion due to viscid exudation.

18) Floral Formula:

Br Ebrl $\oplus$ ⚥ K_{2+2} C_4 $A_{6-\alpha}$ $\underline{G}_{(2)}$

19) Economic Importance:

Economically, the family is of little importance.

I. Medicines:

(i) The seeds of *Cleome gynandra* syn. are employed internally for expelling round worms.
(ii) The roots of *Maerua arenaria* are used as a tonic and stimulant.
(iii) The bark and leaves of *Crataeva religiosa* is diuretic.

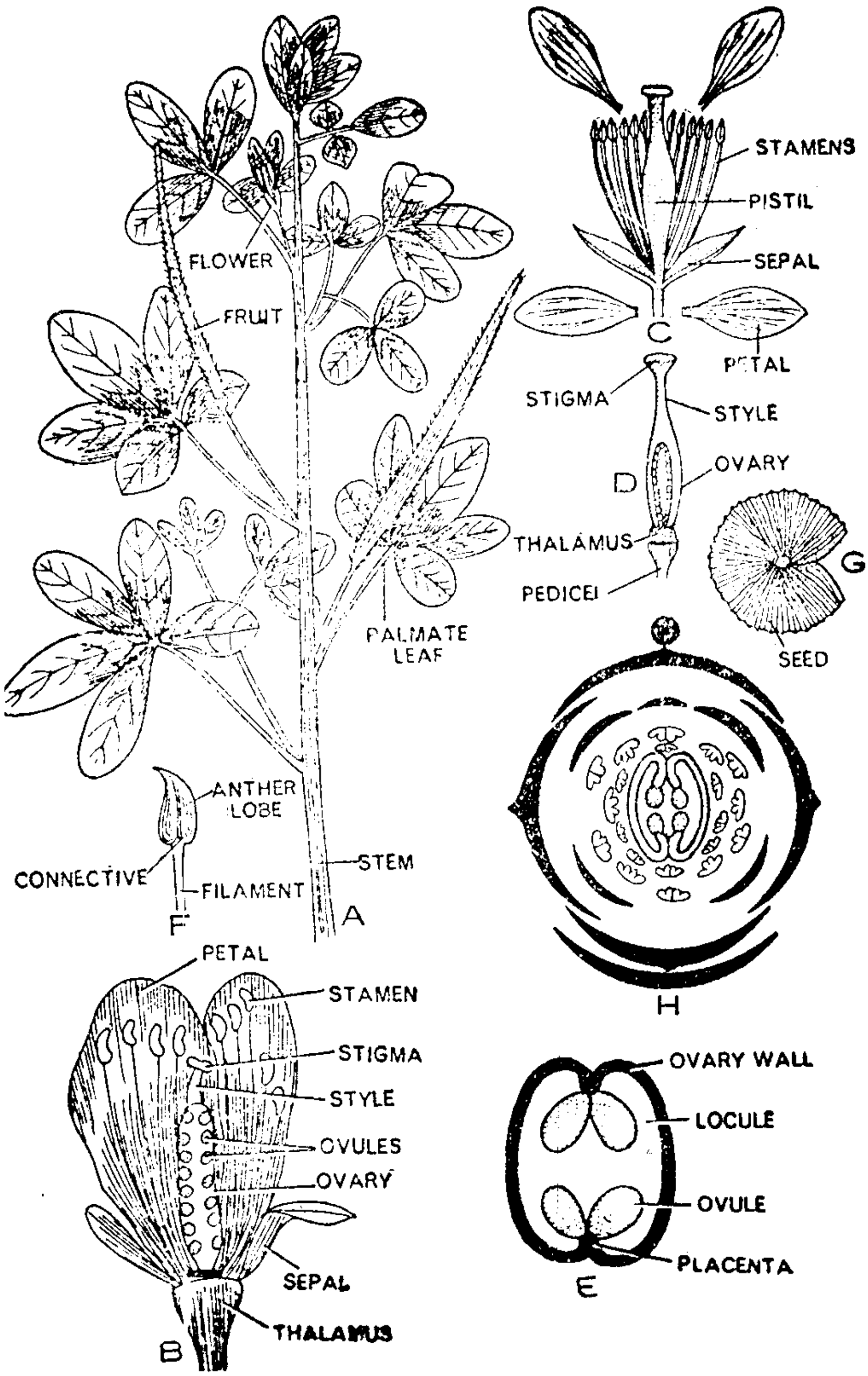

Fig. 5.4 Capparidaceae – *Cleome viscosa* Linn. **A**, twig; **B**, L.S.

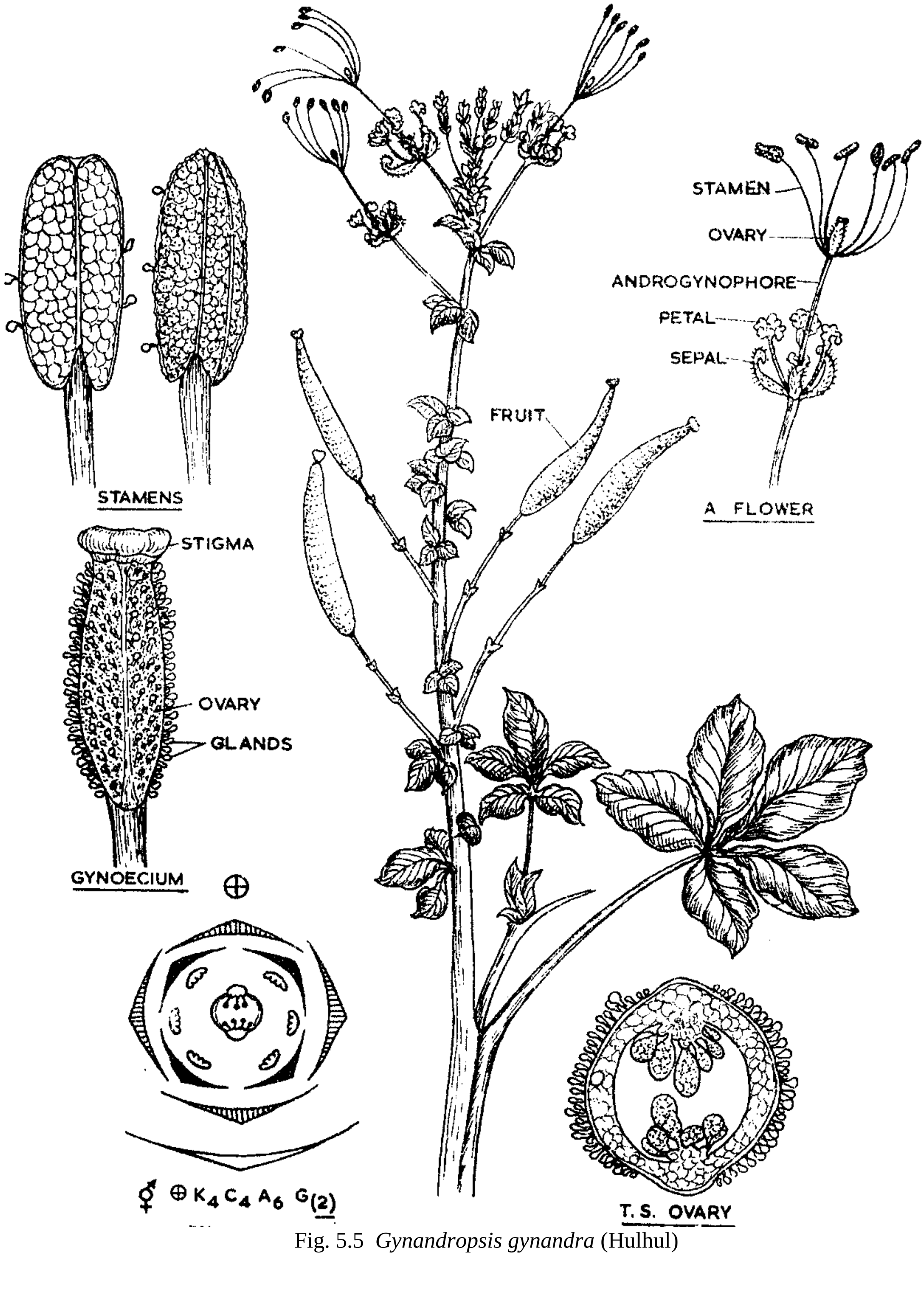

Fig. 5.5 *Gynandropsis gynandra* (Hulhul)

II. Ornamentals:

Few species such as *Cratoeva adansonii*, *Cleome spinosa* and *Capparis spinosa* are gown as ornamentals.

III. Other uses:

(i) The flower buds of *Capparis spinosa* (Caper plant) are the capers used in flavouring of foods.
(ii) The fruits of some species of *Capparis* such as *C. zeylanica* and *C. decidua* are pickled.

20) Distinguishing Features:

1. Herbs, shrubs or rarely trees, with a watery sap.
2. Stipulate leaves, simple or compound.
3. Corymbose inflorescence.
4. Bracteate, tetramerous flowers with clawed petals.
5. Presence of androphore or gynophore or both.
6. Stamens 4-6 or many.
7. Ovary superior, bicarpellay, unilocular, parietal placentation.
8. Fruit siliqua or berry.

This family is closely related to Cruciferae, in the presence of bicarpellary ovary with parietal placentation and siliquose fruit. However, it differs from it in having.

1. Stipulate leaves.
2. Bracteate flower.
3. Absence of tetradynomous condition.
4. Presence of unilocular ovary.

Engler and Prantl placed this family in the order Rhoedales together with Cruciferae.

21) Questions:

1. Describe the characters of the family Capparidaceae.
2. Write short notes on:
   (a) Economic importance of Capparadiaceae.
   (b) Characters of Capparidaceae.

22) Reference Books:

i) Introductory Taxonomy (Angiosperms) – Dr. B.S. Trivedi & Dr.B.B.Sharma, Kithab Mahal, Allahabad.
ii) Taxonomy of Vascular Plants – George H.M. Lawrence – Oxford & IBM Publishing Co., New Delhi.

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CH.E. USHA RANI

5.3 Family : MALVACEAE
The Cotton Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Polypetalae
Series	Thalamiflorae
Order	Malvales
Family	Malvaceae

2) Distribution:

The family includes 75 genera and over 1,000 species, mostly confined to the tropical and subtropical regions of the world. In India, the family is represented by 22 genera and about 110 species occurring mostly in the warmer parts.

3) Familiar Plants:

1. *Abelmoschus esculentus* (Benda)
2. *Abutilon indicum* (Erribenda)
3. *Althaea rosea*
4. *Bombax ceiba*
5. *Ceiba pentandra*
6. *Gossypium herbaceum* (Patti)
7. *Hibiscus cannabinus* (Tella gongura)
8. *Hibiscus rosa-sinesis* (Mandara)
9. *Malva sylvestris*
10. *Sida acuta*

4) Vegetative characters:

The members of the family are mostly annual or perennial herbs (*Sida, Malvastrum).* However, some species of the tropics are shrubs *(Hibiscus rosa-sinensis)* or soft wooded trees *(Kydia* and *Bombax).* The plants are mucilaginous and rarely they contain acid juice.

5) Root: Tap root.

6) Stem:

The stem is erect, cylindrical, jointed, branched, solid and hairy. Generally, the upper younger parts of the stem are herbaceous and the lower mature parts are woody. The herbaceous portions are often covered with stellate hairs.

7) Leaves:

The leaves are cauline, alternate, stipulate, simple, entire or more or less palmately divided or digitate *(Bombax).* The venation is multicostate reticulate. The stipules are free and often caducous.

8) Inflorescence:

The flowers are borne on various types of inflorescences. Generally, the flowers are solitary axillary or terminal. Sometimes (as in *Kydia),* the inflorescence is a panicle.

9) Flowers:

The flowers are bracteate, bracteolate, pedicellate, complete, cyclic, hermaphrodite (rarely unisexual or polygamous as in *Kydia),* actinomorphic, pentamerous and hypogynous.

10) Calyx:

The calyx is frequently subtended by an involucre of bracteoles which forms the epicalyx. The epicalyx has three to many, free or connate bracteoles (there in *Malva,* five in *Urena* and many in *Hibiscus).* Epicalyx is, however, absent in *Sida* and *Abutilon.*

The calyx is usually of five, free or connate sepals which show valvate aestivation in bud.

11) Corolla

The corolla has five petals which are often large and showy, free or basally connate with the staminal column as in *Hibiscus.* The petals show twisted or imbricate aestivation.

12) Androecium:

The androecium consists of numerous monadelphous stamens. The filaments are united to form a staminal column around the ovary and style. The staminal column is divided at the apex and bears reniform monothecous extrorse anthers which open by longitudinal slits. In *Bombax,* the stamens are pentadelphous, the five staminal bundles are opposite the petals. The pollen grains are covered by spines.

13) Gynoecium:

The gynoecium is of five to many fused carpels which are arranged in a whorl around the central axis. The ovary is superior with as many locules as the number of carpels. One or more anatropous ovules are present in each locule on axile placentation. The styles are connate below or throughout their length. The stigmas are as many or twice as many as the carpels.

14) Fruit:

Various types of fruits are found in the family. The fruit is a loculicidal capsule *(Hibiscus* and *Gossypium).* In *Sida, Malva* and *Aubutilon* it is a schizocarp and a fleshy berry in *Malvaviscus.* In several species of *Urena* the fruits are covered with hooked bristles.

15) Seeds:

The seeds are reniform or oboviod with a scanty endosperm which is often mucilaginous, and a curved embryo. They are often pubescent or densely clothed with woodly hairs as in *Gossypium.*

16) Pollination:

The flowers are mostly insect pollinated. The insects are attracted by the large size and right colours of the flowers. The nectar is secreted at the bases of the sepals or petals. Extrafloral nectaries are present in many species of *Gossypium.* The humming birds are common pollinators in *Abutilon* and *Gossypium. Malva rotundifilia* is self pollinated.

17) Dispersal:

The seeds of *Gossypium* and *Bombax,* which have a hairy covering are dispersed by wind. The seeds of several species of *Malva* are buoyant and this favours their dispersal by water. In some species such as *Urena lobata,* the seeds have hooked spines and they are dispersed by adhesion to animals and humans. Ants help in dispersal of seeds in *Sida* and *Abutilon.*

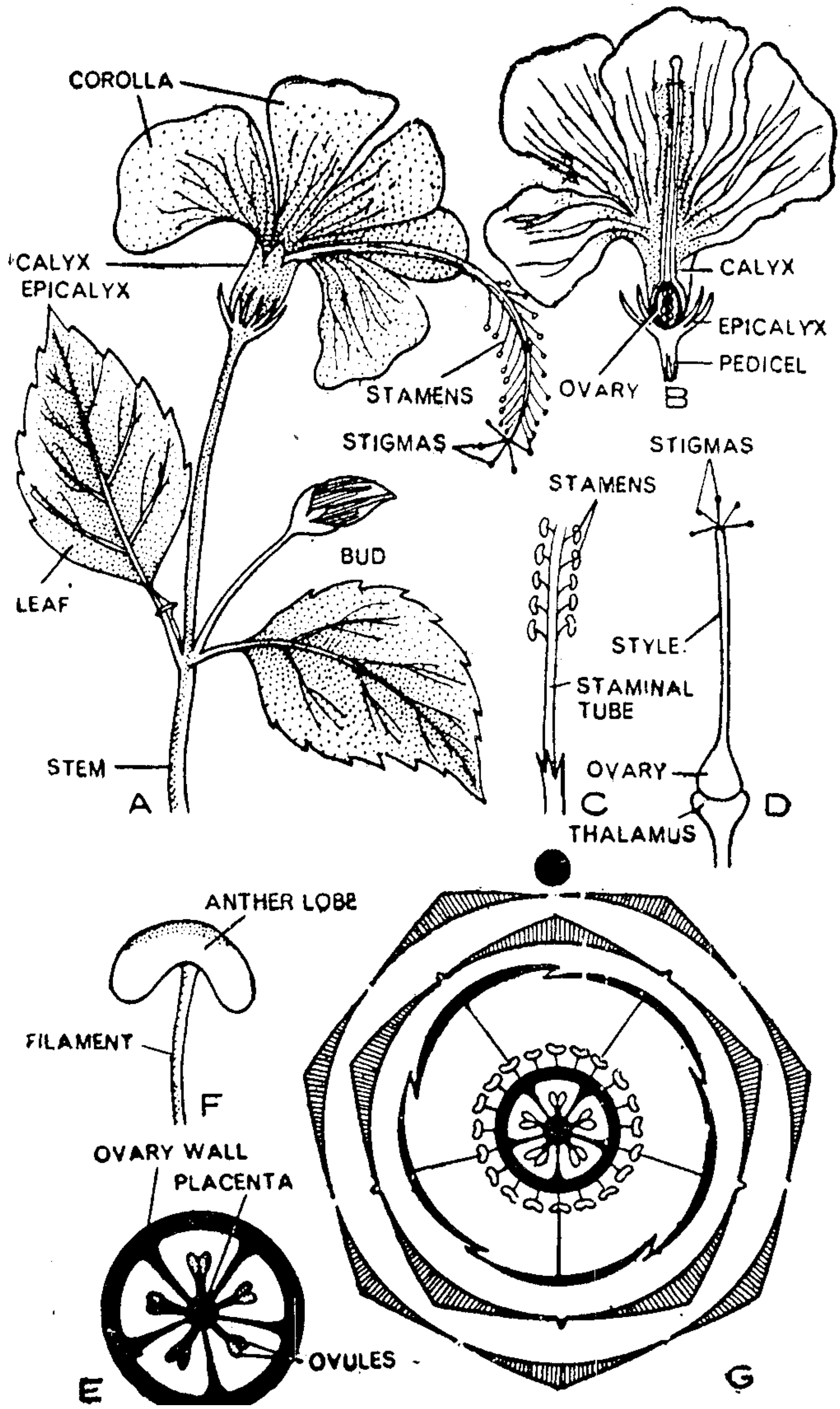

Fig. 5.6 Malvaceae – *Hibiscus rosa-sinensis* Linn.

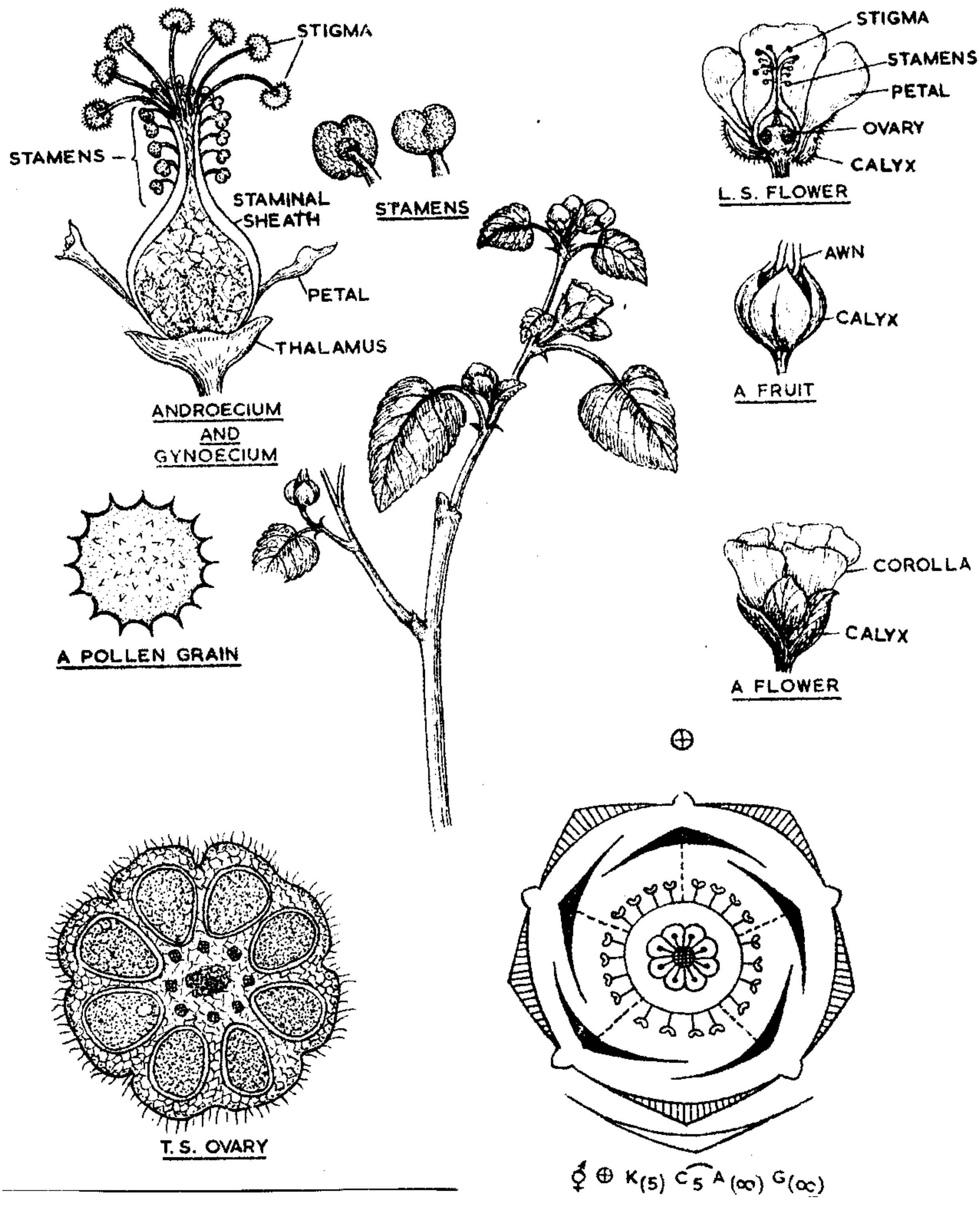

Fig. 5.7 *Sida cordifolia*

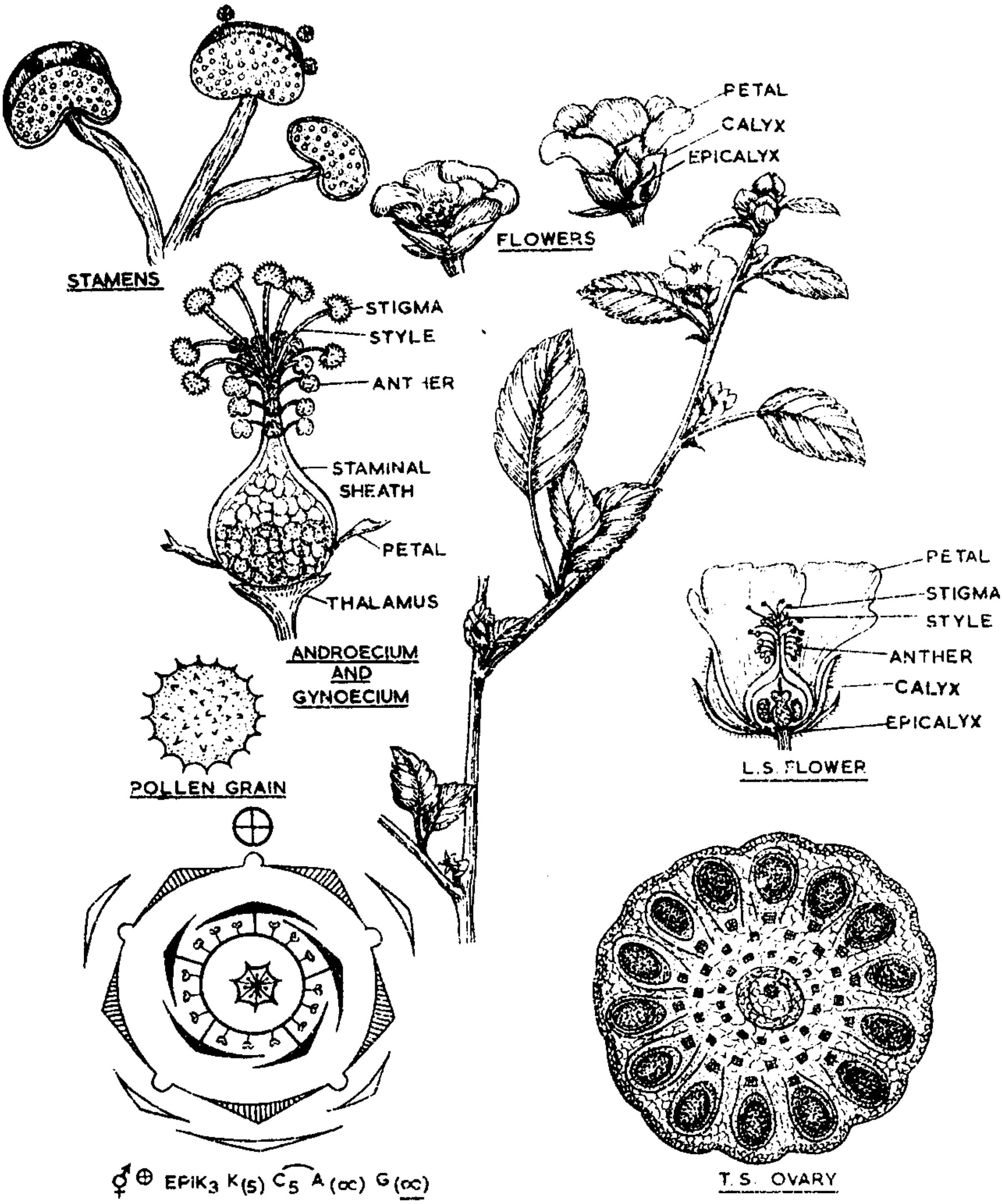

Fig. 5.8 *Malvastrum coromandelianum*

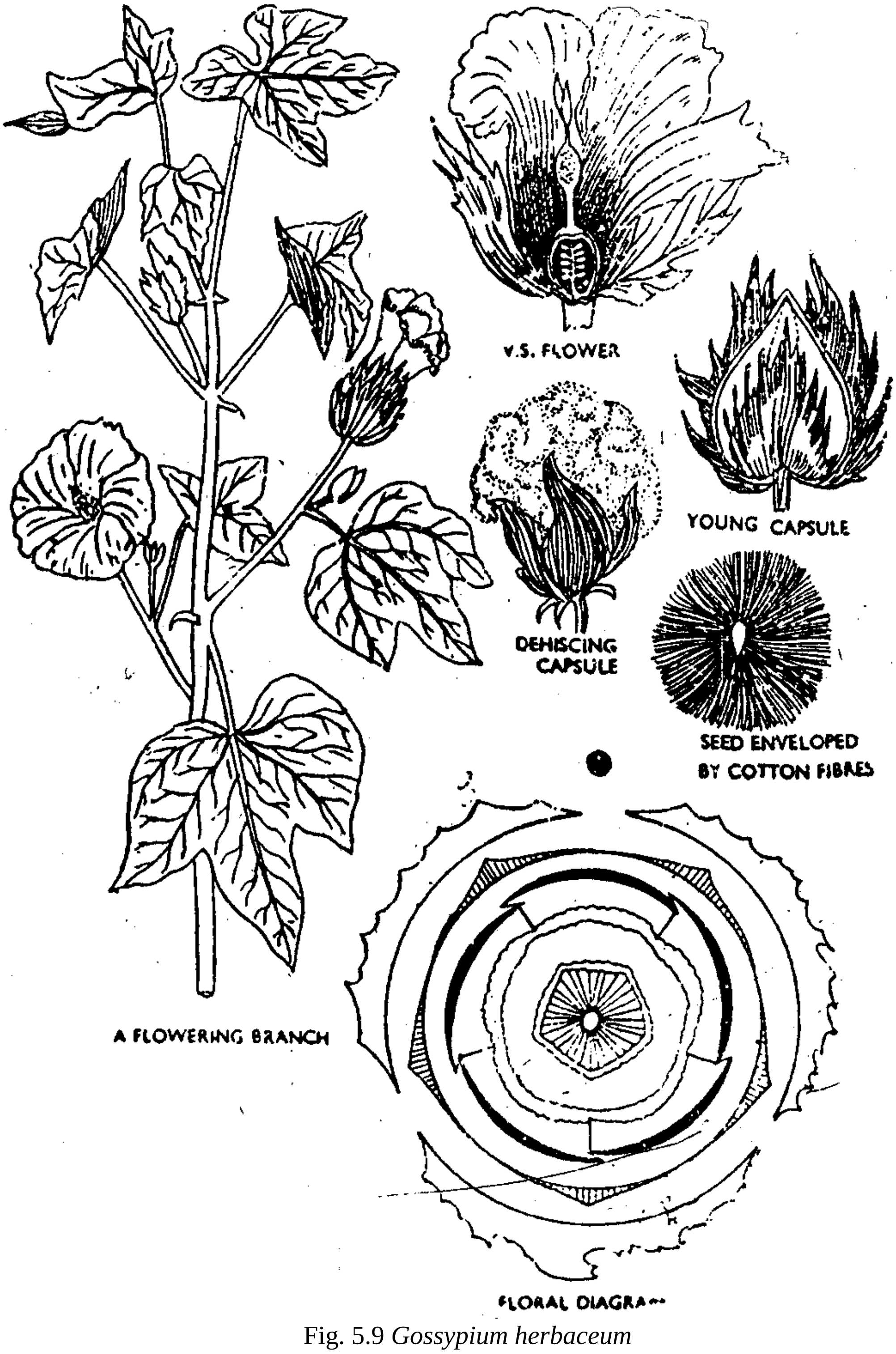

Fig. 5.9 *Gossypium herbaceum*

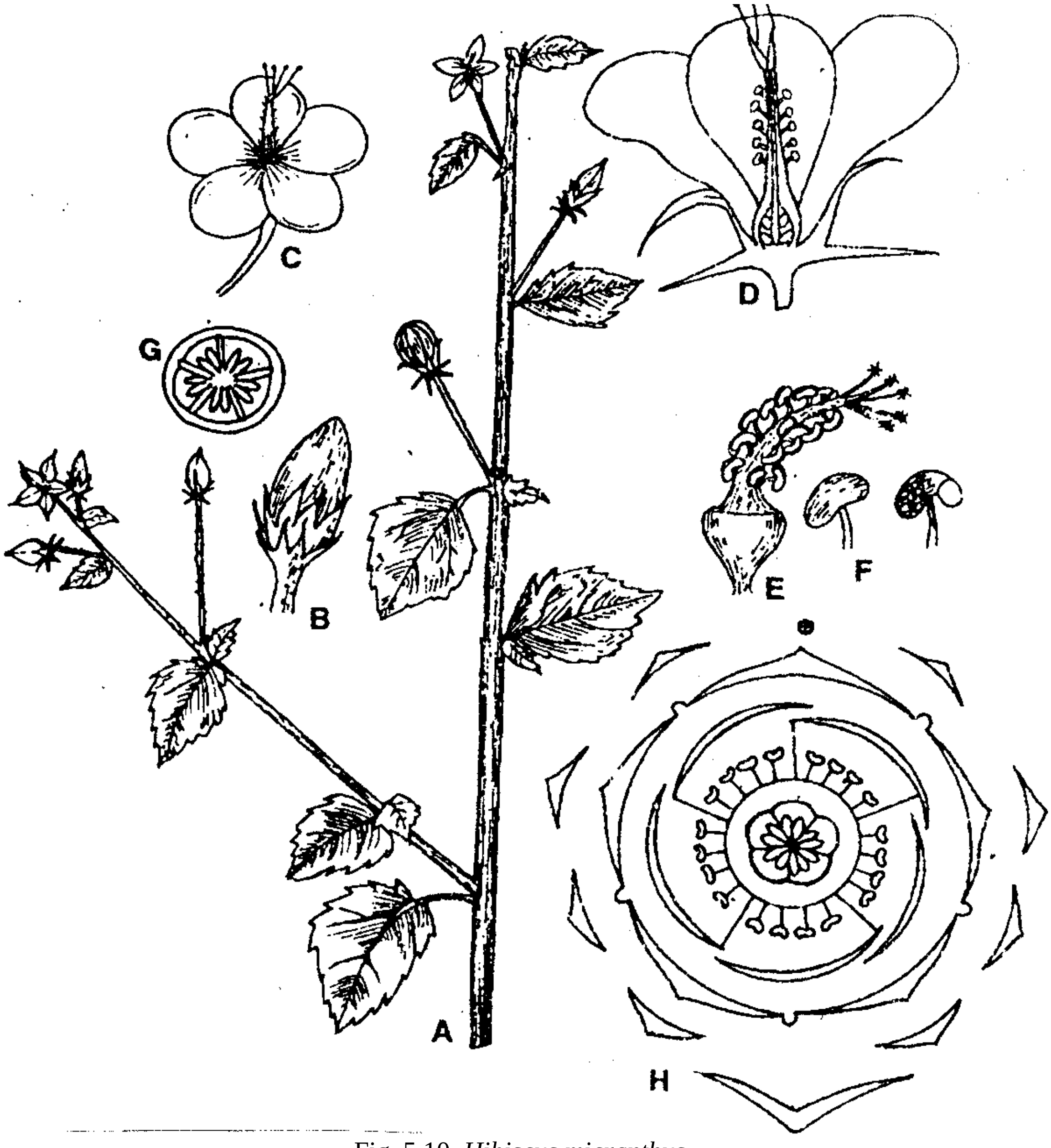

Fig. 5.10 *Hibiscus micranthus*

A. Twig; **B.** Bud, **C**. Flower, **D**. L.S. of flower, **E**. Androecium, **F**. Stamen, **G**. T.S. of ovary, **H**. Floral diagram

18) Floral Formula:

Hibiscus : Br $\oplus$ ♀⚦ Epi_{α} $K_{(5)}$ $C_{(5)} \leftarrow A_{(\alpha)}$ $\underline{G}_{(5)}$

Malva : Br $\oplus$ ♀⚦ Epi_{3} $K_{(5)}$ $C_{5} \leftarrow A_{(\alpha)}$ $\underline{G}_{(\alpha)}$

Sida : Br or Ebr $\oplus$ ♀⚦ $K_{(5)}$ $C_{(5)}$ $A_{(2)+(2)+1}$ G_{0}

19) Economic Importance:

The plants of this family are important source of vegetables, fibres, oils and medicines. Many species are grown in gardens for their attractive flowers.

I. Vegetables:

The tender fruits of *Abelmoschus esculentus* (Lady's finger) and floral buds of *Bombax ceiba* (Silk cotton tree) are used as vegetable.

II. Fibers:

Several plants of the family are important source of fibres. Some important fibre yielding species are as follows:

(i) The seeds of several species of *Gossypium* (Cotton) are densely clothed with long hairs which are the source of cotton.

(ii) The cortical fibre of *Hibiscus cannabinus* is used widely for cordage, ropes, coarse sackings, floor coverings, etc.

(iii) A woolly outgrowth from the pericarp of fruits of *Bombax ceiba* (Silk cotton tree) is the source of Kapok.

III. Oils:

The seeds of *Gossypium* are the source of a fatty oil, the cotton seed oil, which is edible and also used for the manufacture of soaps, lubricants, protective coatings, etc. The oil cake, which is very rich in protein makes an excellent cattle feed.

IV. Ornamentals:

Several species of Malvaceae are grown as ornamentals for their large showy flowers. The notable among them are:

1) *Hibiscus rosa-sinensis*
2) *H. mutabilis*
3) *Althoea rosea*
4) *Malva sylvestris*
5) *Thespesia populnea*
6) *Adansonia digitata*
7) *Bombax ceiba*

5. Medicines:

(i) The roots and bark of *Urena lobata* are used as a cure for hydrophobia.
(ii) The roots of *Malva verticillata* are used for whooping cough and the ash of dried leaves is given in scabies.

6. Other uses:

(i) The roots of *Pavonia odorata* are used in Indian perfumery an enter into the composition of a well known perfume, Hina.
(ii) The mucilaginous bark of *Kydia calycina* (Pula) and the stems of *Abelmoschus moschatus* (Musk mallow) are used for clarifying sugar.

20) Distinguishing features:

1) Presence of stellate hairs and mucilage juice on vegetative parts.
2) Leaves alternate, simple, stipulate, multicostate reticulate venation.
3) Flowers regular, bisexual, pentamerous with an epicalyx.
4) Sepals valvate, free or united.
5) Corolla free, twisted or imbricate.
6) Stamens numerous,monadelphous, anthers monothecous.
7) Carpels 3-5, syncarpous, superior, multilocular, axile placentation.
8) Fruit a capsule or schizocarpic, carcerulus.

21) Questions:

1. Describe the characters of the family Malvaceae?
2. Write short notes on:
   (a) Economic importance of Malvaceae.
   (b) Flower in Malvaceae.
3. Distinguish between Malvaceae and Annonaceae.

22) Reference Books:

i) **Taxonomy of Vascular Plants** – George H.M. Lawrence – Oxford & IBM Publishing Co., New Delhi.
ii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr.B.B.Sharma, Kithab Mahal, Allahabad.

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Ch. E. USHA RANI

Unit-II

Class : **Dicotyledons**
Subclass **: Polypetalae**
Series **: Disciflorae & Calyciflorae**
Order **: Geraniales & Rosales**

Lesson 6

TAXONOMY AND ECONOMIC IMPORTANCE OF FAMILIES BELONGING TO THE SERIES DISCIFLORAE AND ORDER GERANIALES, SERIES CALYCIFLORAE AND ORDER ROSALES

OBJECTIVES

⇒ To study the vegetative and floral characters of the plants belonging to the families in the orders Geranials & Rosales.
⇒ To know the similarities and differences between the families in Geranials & Rosales.
⇒ To know the economic importance of the families in Geranials & Rosales.

CONTENTS

6.1 Series disciflorae and calyciflorae
6.1.1 Characteristic feature of series disciflorae and calyciflorae

<u>Disciflorae</u>

1. Conspicuous disc is present at the base of the ovary
2. Ovary superior
3. Order included → Geraniales

Order → **Geraniales**

1) Carpels several, syncarpous
2) Ovules one or two in each locule, ascending or pendulous
3) Family included → **Rutaceae**

Calsiflorae

1) Flowers perigynous and epigynous
2) Disc rarely present
3) Order included → Rosales

Order : **Rosales**

1) Flowers bisexual, regular or zygomorphic
2) Gynoecium of 1 - more carpels
3) Styles usually distinct
4) Family included → Leguminoceae

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6.2 Family : RUTACEAE
(The Orange family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Class	Spermatophyta
Sub-class	Angiospermae
Class	Dicotyledonae
Sub-class	Polypetalae
Series	Disciflorae
Order	Geraniales
Family	Rutaceae

2) Distribution:

There are 150 genera and 900 species, widely distributed in the tropical and temperate regions, especially in the South Africa and Australia. In India, the family is represented by 23 genera and over 480 species occurring mostly in the tropical and subtropical Himalayas and the Western Peninsular India.

3) Familiar Plants:

1. *Aegle marmelos* (Maredu)
2. *C. maxima*
3. *C. medica* (Madiphalam)
4. *C. nobilus* (Kamala)
5. *C. sinensis* (Bathai)
6. *Citrus aurantium* (Narinja)
7. *Citrus limon*
8. *Feronia lemonia* (Velaga)
9. *M. honigii* (Curry leaf)
10. *Murraya paniculata* (Puvelaga)

4) Vegetative Characters:

The members of the family are herbs *(Boenninghausenia),* undershrubs *(Ruta graveolens),* shrubs *(Murrayapaniculata)* or trees *(Citrus, Aegle marmelos, Feronia limoni).* A characteristic feature of the family is the presence of pellacid glands filled with essential oils. The plants are spinous in *Citrus* and *Aegle.*

5) Root: Tap root.

6) Stem:

Usually erect, woody, branched, armed with spines. Young shoot are gland dotted.

7) Leaves:

The leaves are opposite or alternate and simple or compound. For example, the leaves are pinnately compound in *Murraya* and digitate in *Aegle.* In *Citrus*, the leaves are unifoliate with a joint at the junction of the blade and winged petiole. The stipules are absent. The leaves are mostly gland-dotted.

8) Inflorescence:

The flowers are usually borne in axillary or terminal cymes or panicles, sometimes they form racemes as in *Dictamnus.* In some species of *Citrus,* the flowers are axillary solitary or fascicled.

9) Flowers:

The flowers are bracteate, bracteolate, usually hermaphrodite (unisexual) and polygamous as in *Zanthoxylum),* actinomorphic (zygomorphic in *Dictamnus).* Pentamerous (tetramerous in some species of *Ruta)* and hypogynous. A fleshy nectariferous disc is present between the stamens and ovary.

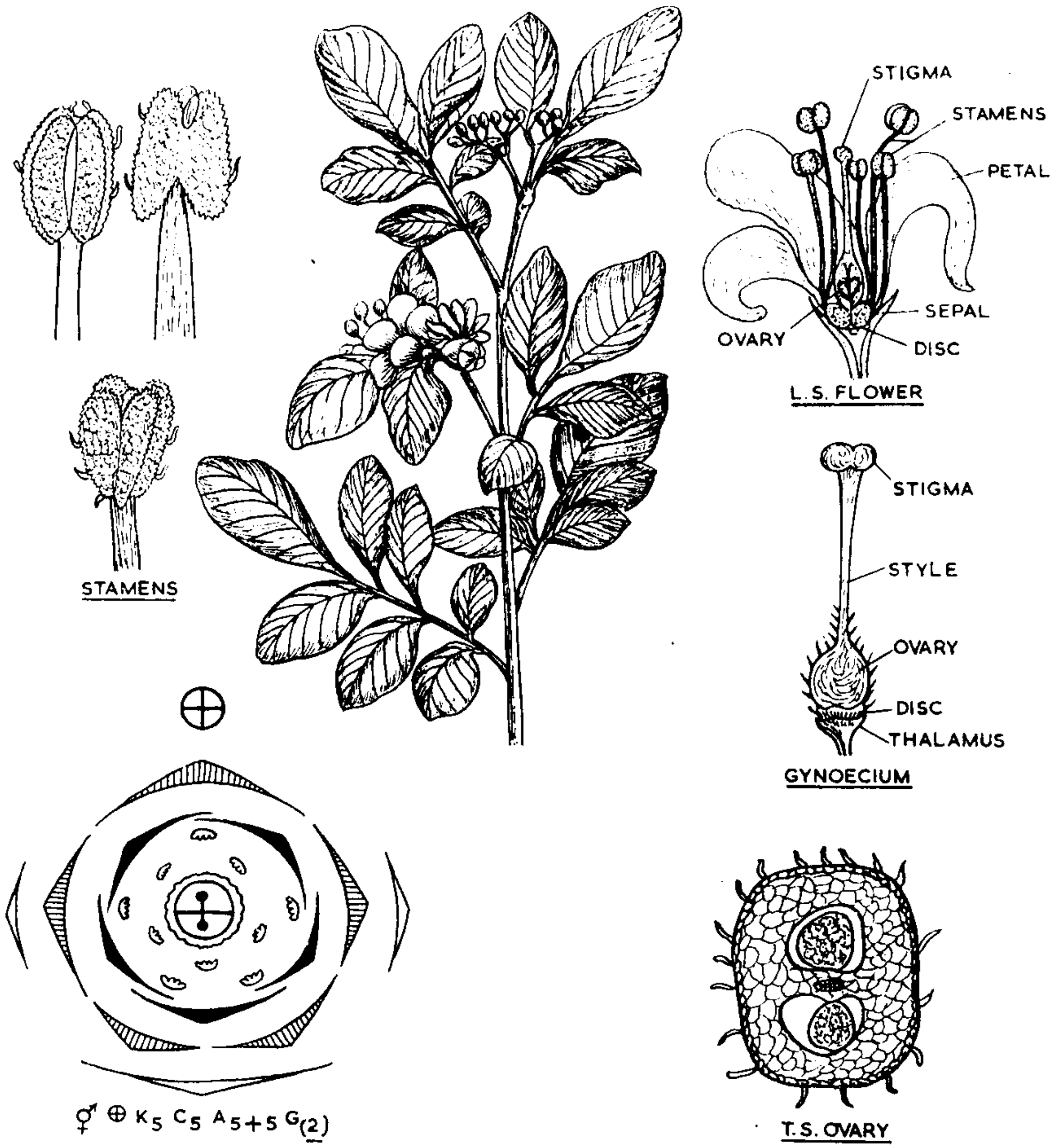

Fig. 6.1 *Murraya paniculata*

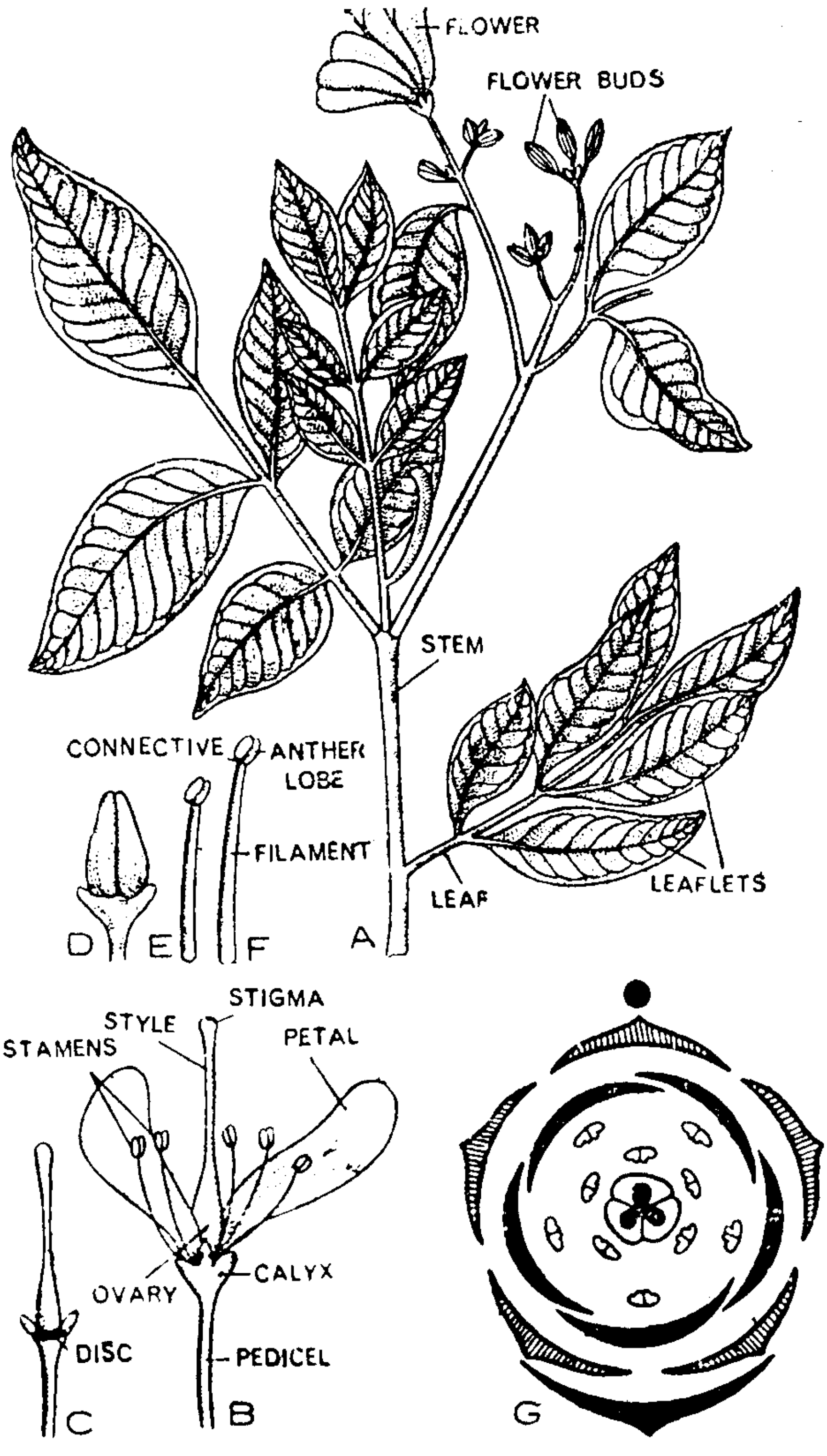

Fig. 6.2 Rutaceae – *Murraya exotica* Spreng.

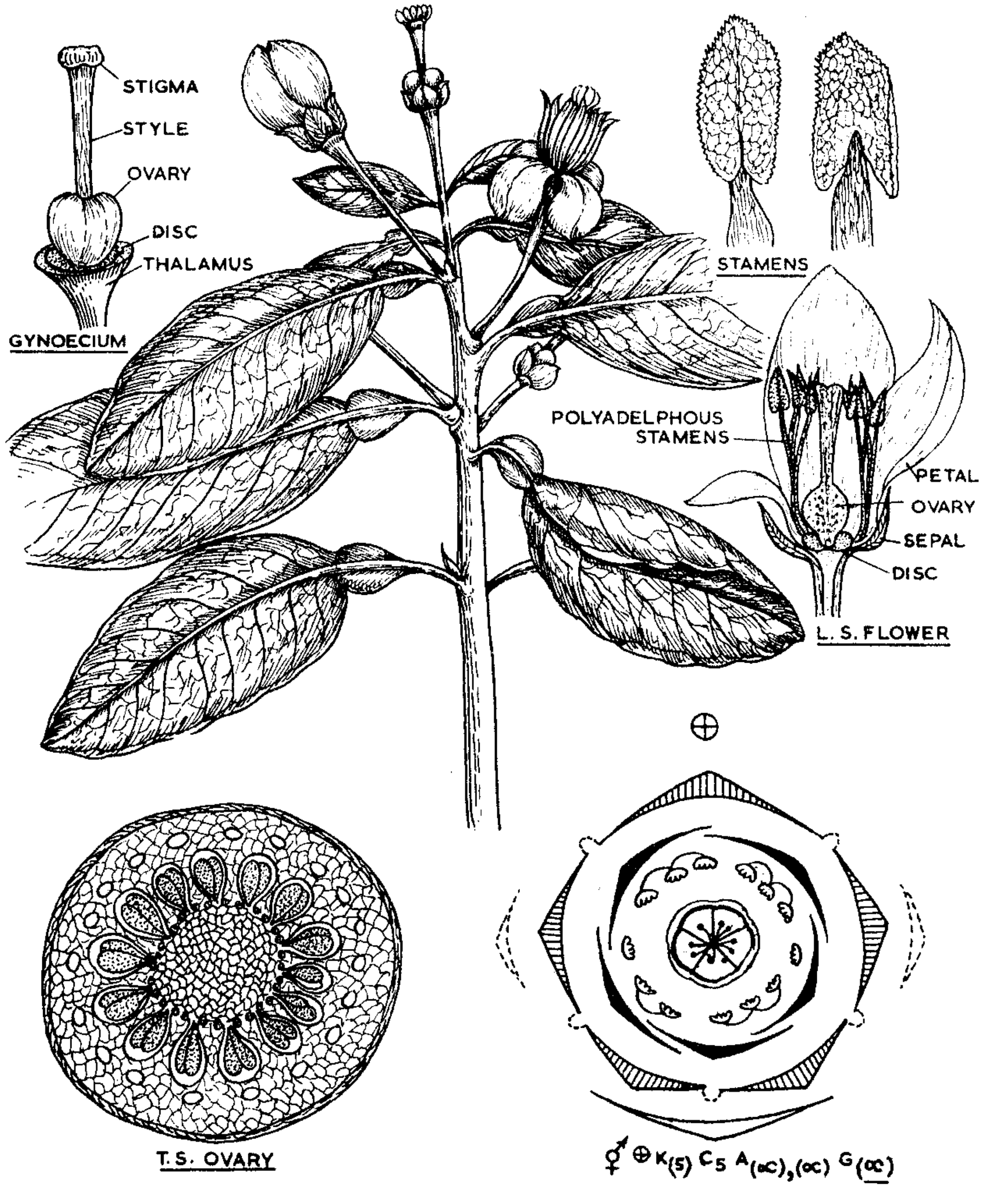

Fig. 6.3 *Citrus aurantium* (the lemon)

10) Calyx:

The calyx is of four or five sepals which are free or more often show various degrees of connation. In *Citrus,* the calyx is cupular or urceolate. The sepals are imbricate in bud. In *Peganum,* the sepals are foliaceous pinnatifid and persistent. Rarely, sepals are absent as in some species of *Zanthoxylum.*

11) Corolla:

The corolla is composed of four or five free petals which are valvate or imbricate in bud. In *Dictamnus,* where the corolla is zygomorphic, the four upper petals are in pairs and are ascending, whereas the lower one is declinate.

12) Androecium:

The stamens are as many as or twice the petals or sometimes they are numerous as in *Citrus* and *Aegle.* When the stamens are equal to the number of petals, they are arranged in an antesepalous whorl (*Zanthoxylum).* More frequently, the stamens are double, the number of petals and then they are obdiplostemonous. The filaments are usually free but in *Citrus,* the filaments of numerous stamens are united in several bundles (polyadelphous condition). The anthers are dithecous, introrse and dehiscing longitudinally. The connective is usually glandular at the apex.

13) Gynoecium:

The gynoecium is of two to five carpels which are completely united or sometimes the carpels are free towards the base and the ovary is deeply lobed as in *Peganum, Dictamnus* and other related genera. The ovary has as many locules as the number of carpels with two to many or sometimes one anatropous ovule in each locule on axile placentation. In *Feronia,* the ovary is unilocular with parietal placentation. The styles are as many as the carpels, free or variously united. The stigmas are terminal, entire or lobed.

14) Fruit:

The fruit is a capsule *(Ruta),* a drupe *(Skimmia)* or a berry. In *Citrus,* juicy emergences arise from the inner layer of pericarp which form the edible part of the fruit. The berry of *Citrus* is known as hesperidium. The berry has a woody rind in *Feronia* and *Aegle.*

15) Seed:

The seeds may or may not contain endosperm and the embryo is straight or curved. Polyembryony is fairly common in some species of *Citrus.*

16) Pollination:

The Rutaceae are adapted for insect pollination. The flowers are conspicuous and often fragrant and the nectar secreted by a fleshy disc situated beneath the ovary is quite exposed and freely accessible. All possibility of self-pollination is excluded as the stigma ripens after all the stamens have withered.

17) Dispersal:

Seeds are dispersed largely by animals, and also by the human agency.

18) Floral Formula:

Citrus : Br brl $\oplus$ ⚥ $K_{(5) \text{ or } (4)}$ $C_{5 \text{ or } 4} \leftarrow A_{\alpha \text{ (Polyadel)}}$ $\underline{G}\ (\alpha)$

Murraya : Br brl $\oplus$ ⚥ $K_{(5)}$ C_5 A_{5+5} $\underline{G}$ (2)

19) Economic Importance:

The family is the source of several important fruits, medicines and few ornamentals.

I. Fruits

The family is important for the citrus fruits which are the richest source of vitamin C.

(i) *Citrus medica*
(ii) *Citrus lemon*
(iii) *Citrus aurantium* var. *aurantium* (Narinja)
(iv) *Citrus sinensis* (Sweet, orange) - Battai
(v) *Citrus paradisi* (Loose skinned orange)

II. Medicines and Spices:

(i) The root bark of *Toddalia asiatica* is a potent antimalarial drug. It is also used for the treatment of cough and influenza.
(ii) The leaves of *Murraya kokenigii* are aromatic which are used for flavouring curries.

III. Ornamental plants:

The following species are grown as ornamentals:

(i) *Murraya paniculata* syn. *Murraya exotica* (Orange jasmine)
(ii) *Ruta graveolens*
(iii) *Skimmia arborescens*
(iv) *Dictamnus albus*
(v) *Glycosmis pentaphylla*

20) Distinguishing Features:

1. Plants predominently shrubs and trees.
2. Leaves compond, exstipulate, gland dotted.
3. Flowers bisexual, regular, hypogynous, pentamerous. A large honey disc is present below the ovary.

4. Calyx and Corolla with 4-5 parts.
5. Stamens 8-10, many, polyandrous, polyadelphous or monadelophous, Obdiplostamonous.
6. Carpels 5 to many, ovary superior, multilocular, with axile placentation.
7. Fruit a characteristic hesperidium.

21) Questions:

1. Describe the characters of the family Rutaceae and discuss its economic importance.
2. Write short notes on:
   (i) Economic importance of Rutaceae.
   (ii) Vegetative characters of Rutaceae.

22) Reference Books:

i) **Taxonomy of Angiosperms –** B.P. Pandey, S.Chand & Co. Ltd., New Delhi.

ii) **Taxonomy of Vascular Plants –** George H.M. Lawrence – Oxford & IBM Publishing Co., New Delhi.

iii) **Introductory Taxonomy (Angiosperms) –** Dr. B.S.Trivedi & Dr. B.B.Sharma, Kithab Mahal, Allahabad.

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CH.E. USHA RANI

6.3 Family : LEGUMINOSAE
The Pea Family

Sub-class : POLYPETALAE
Series : CALYCIFLORAE
Order : Rosales

Order *Rosales* includes nine families and being one of the largest orders of flowering plants, there are as many as 15,000 species included in the various families of which it is composed. Among these are plants of great value of agricultural and horticultural purposes. Plants range from herbs, shrubs and trees. Flowers cyclic, perfect, actinomorphic and zygomorphic, polypetalous, pentamerous, hypo-peri to epigynous. Stamens indefinite usually free, rarely adelphous, carpels a few to many, free or united.

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	: Spermatophyta
Sub-division	: Angiospermae
Class	: Dicotyledonae
Sub-class	: Polypetalae
Series	: Calyciflorae
Order	: Rosales
Family	: Leguminosae

This is the third largest family of the flowering plants. Bentham and Hooker divided the family into three subfamilies, Papilionaceae, Caesalpinieae and Mimoseae. Most of the recent taxonomists treat them as three distinct families, Paipilionaceae, Caesalpiniaceae, and Mimosaceae respectively.

Subfamily : PAPILOIONACEAE

2) Distribution:

This subfamily contains about 482 genera and 7,200 species cosmopolitan in distribution but abundant in the tropical and subtropical regions. In India, the family is represented by 100 genera and over 748 species occurring chiefly in the Peninsular India and the Himalayas.

3) Familiar Plants:

1. *Abrus precatorius* (Gurivinda)
2. *Arachis hypogaea* (Verusenaga)
3. *Butea monosperma*
4. *Cajanus cajan* (Kandulu)
5. *Crotalaria juncea* (Janumu)
6. *Dolichos lablab* (Chikkudu)
7. Glycine max (Soyabean)
8. *Phaseolus* spp (Beans)
9. *Pisum sativum* (Batani)
10. *Trigonella foenum-graecum* (Menthi)

4) Vegetative Characters:

They are predominantly herbs (*Melilotus*, *Medicago*) or herbaceous climbers (*Pisum sativum*). Some are climbing shrubs (*Abrus*) or trees (species of *Erythrina* and *Dalbergia*). In most climbers (*Clitoria*), twinning stem is found, but some such as *Vicia* and *Lathyrus*) climb by leaf tendrils.

5) Root:

Tap root. Lateral roots of most of the plants have nodules which contain Nitrogen fixing bacteria (Rhizobium).

6) Stem:

The stem is usually erect, branched, solid and hairy. The climbing stems are weak and they possess tendrils.

7) Leaves:

The leaves are usually alternate, simple (as in some species of *Crotalaria* and *Alysicarpus*), pinnately (*Sesbania, Abrus, Dalbergia*) or digitately compound (*Trifolium, Melilotus, Parochetus*). In some genera, such as *Lathyrus, Pisum* and *Vicia*, the terminal leaflet and sometimes others are modified into tendrils. In *Lathyrus aphaca* all the leaflets are reduced to tendrils and the function of photosynthesis is taken up by the foliaceous stipules. The leaves are stipulate and the stipules are free or sometimes adnate (*Trifolium*). The leaflets are often stipellate. The leaf base is usually pulvinous.

The leaves of several genera such as *Phaseolus, Trifolium* and *Desmodium* perform sleep movements where the leaflets assume a vertical position at night. *Desmodium montarium* (Telegraph plant) exhibits continuous spontaneous movements.

8) Inflorescence:

The inflorescence is commonly as axillary, leaf opposed or terminal raceme. Sometimes, the flowers are arranged in panicles (*Dalbergia*) or dense axillary heads (*Trifolium*) or they are solitary as in some species of *Lathyrus*.

9) Flowers:

The flowers are often bracteate and bracteolate. Sometimes the bracts are foliaceous and persistent as in *Flemingia*. They are complete, zygomorphic, hermaphrodite, pentamerous and hypogynous or perigynous.

10) Calyx:

The calyx is composed of usually five sepals which are more or less united into a tube. The odd sepal is usually anterior. They show valvate or imbricate aestivation in bud.

11) Corolla:

The corolla is papilionaceous. The five petals are unequal and have bilateral symmetry. The posterior (outer most) petal which is largest is called standard. The lateral pair of petals (one on either side of the standard) is often clawed and are called the wings. The two anterior petals are united to form the keel which encloses the stamens and carpel. The petals show descending imbricate aestivation. In *Amorpha* wings and keel are absent and in some species of *Lespedeza* the lowers are apetalous.

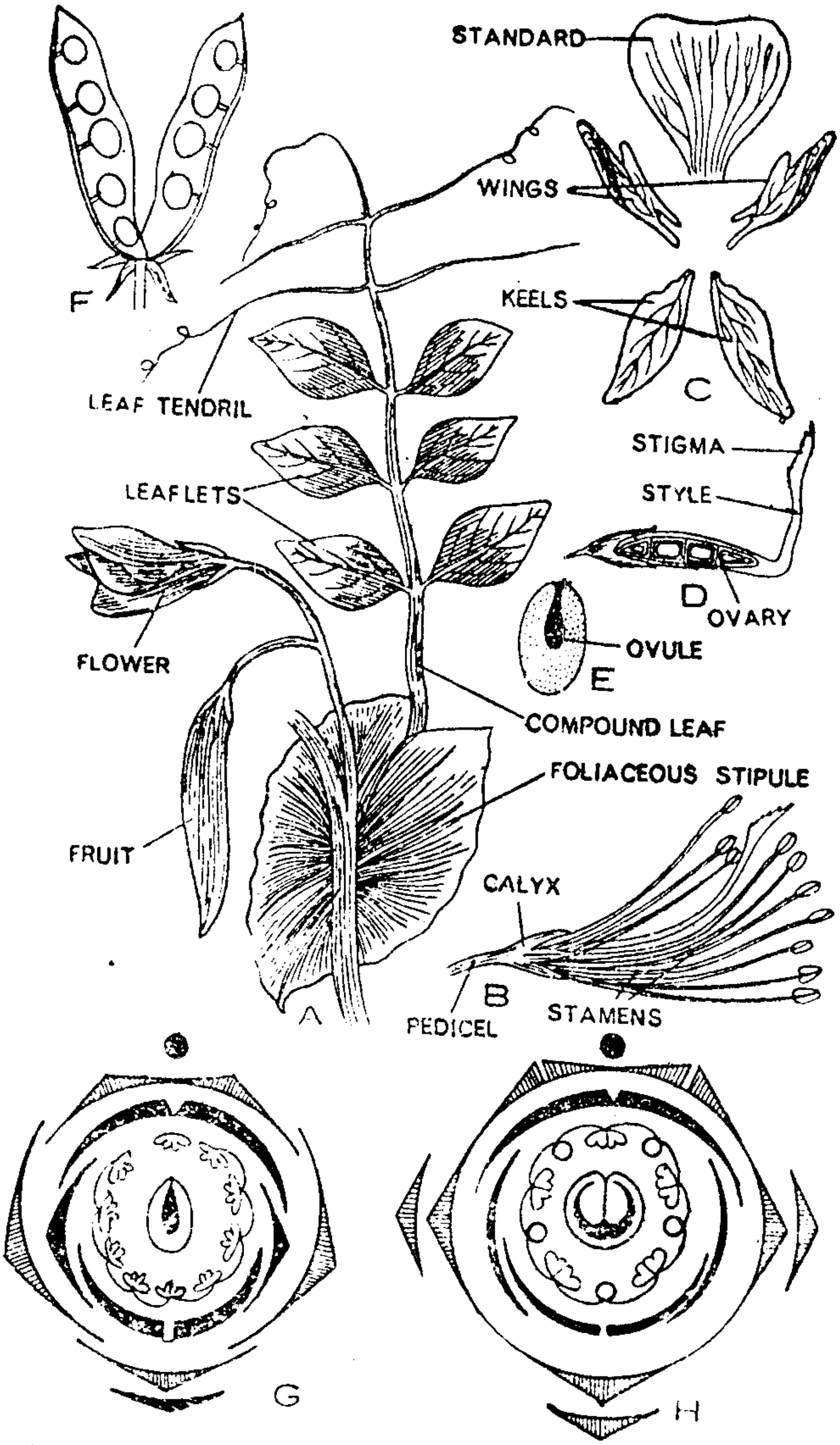

Fig. 6.4 Papilionaceae (Leguminosae) – *Pisum sativum*

12) Androecium:

Androecium is composed of ten stamens which are arranged in a single whorl in mature flower. The stamens are usually diadelphous. The filaments of nine stamens are united into a long tube which encloses the ovary and the tenth posterior stamen remains free. Sometimes stamens are monadelphous *(Crotalaria* and *Pongamia)* or they are all free (polyandrous, e.g., *Sophora).* The anthers are dithecous, introrse and dehisce longitudinally.

13) Gynoecium:

The gynoecium is monocarpellary with a superior or partly inferior unilocular ovary. The ovules are many to several (solitary in *Lespedeza)* on the ventral suture and placentation is marginal. The style is simple and the stigma is capitate or terminal.

14) Fruit:

The fruit is a legume or pod dehiscing by one or both the sutures into two valves or it is indehiscent (*Dalbergia* and *Pongamia)* or sometimes it is jointed separating into one-seeded parts *(Alysicarpus).* The fruits of *Arachis hypogaea* (Groundnut) develop underground. After fertilization the flowers in the axils of lower leaves turn downward and get buried into the soil.

15) Seeds:

Seeds are non-endospermic or with a scanty endosperm and with a large curved embryo.

16) Pollination:

The Papilionaceae are generally pollinated by bees or sometimes they are self pollinated. The necter is secreted on the inner sides of the stamen bases and it accumulates in the space between the stamens and the ovary. Bees are attracted by the conspicuous corolla and visit the flowers for easily accessible necter. In the absence of insects, self pollination occurs in *Pisum* and some other genera.

17) Dispersal:

Seeds are usually dispersed by birds, animals and human agency.

18) Floral Formula:

Br brl % ⚥ $K_{(5)}$ $C_{1+(2)+(2)}$ $A_{(9)+1}$ $\underline{G}_1$

19) Economic Importance:

The Papillonaceae are of great economic importance and provide important foodstuffs, valuable fodder, fatty oils, useful fibres, timbers, dyes, gums and several beautiful ornamental plants.

I. Pulses:

The seeds of several species are rich source of starch and proteins and form an important part of our food. The widely used species include:

(i) *Cajanus cajan* (Kandulu)
(ii) *Cicer arietinum* (Sanaga)
(iii) *Glycine max* (Soybean)
(iv) *Pisum sativum* (Batani)
(v) *Vigna mungo* (Minumulu)
(vi) *Vigna radiata* (Pesalu)

II. Vegetables:

The pods of the following species are used as vegeatble:

(i) *Phaseolus vulgaris* (Kidney bean)
(ii) *Cyamopsis tetragonoloba* (Cluster bean) – Goru chikkudu

III. Oils:

(a) The fatty oil from the seeds of *Arachis hypogaea* (Groundnut) is edible and is extensively used in the manufacture or Vanaspati by hydrogenation. It is also used in the manufacture of soaps, cosmetics, artificial leather and as a lubricant. The oil cake is a valuable cattle feed and a good organic nitrogenous fertilizer.

(b) The seeds of *Pongamia pinnata* (Pongam oil tree) yield a useful oil used for leather dressing, soap making, lubrication and illumination.

IV. Fibres:

The bast fibres obtained from the stem of *Crotalaria juncea* (Sunhemp) are used for making ropes and gunny bags.

V. Fodder:

The Papilionaceae provide several pasture and hay plants, such as Clovers (*Trifolium alexandrinum, T. repens, T. hydribum, T. pratense, T. resupinatum*) and Alfalfa or Lucerene (*Medicago sativa*).

VI. Timbers:

The following species provide valuable timbers.

(a) *Dalbergia latifolia* (East Indian rosewood)
(b) *Pterocarpus dalbergioides* (Andaman redwood)
(c) *Pterocarpus marsupium* (Indian kino tree)
(d) *Pterocarpus santalinus* (Red sanders)

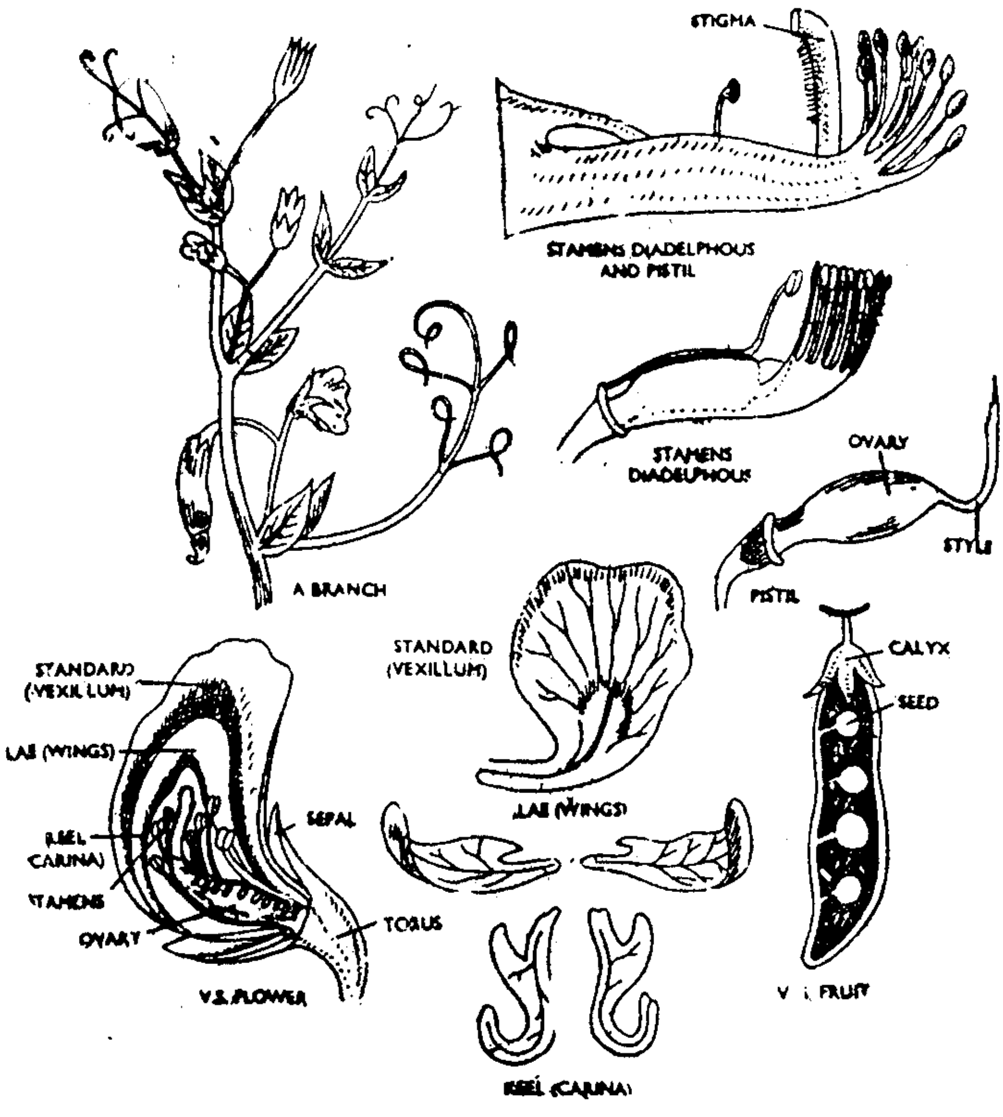

Fig. 6.5 *Lathyrus oderatus* (Sweet pea)

VII. Dyes:

(a) *Indigofera tinctoria* (Indigo) and some other species of the genus such as *I. suffruticos* and *I. sumatrama* are the source of Indigo dye which finds use in dyeing and printing cotton and rayon and in preparation of pigments for paints and printing ink.

(b) *Pterocarpus santalinus* (Red sandalwood). Wood contains red resinous Santalin used for dyeing silk and cotton.

VIII. Gum:

Some species are the source of gums, which are used in food and in paper and textile industries.

(a) *Astragalus gummifer* is the source of the commercially important gum Tragacanth which is used as emulsifier, in confectionery and cosmetic preparations and in textile industry as a sizing material.
(b) *Cyamopsis tetragonoloba* (Cluster bean, Gwar). The seeds are the source of Gwar gum used in food, paper and textile industries.

IX. Medicines:

Several plants are the source of drugs:

(a) The seeds of *Psoralea corylifolia* are used in indigenous medicine as laxative and are also recommended for the treatment of leucoderma and leprosy.
(b) The decoction of leaves and roots of *Abrus precatorius* (Rati) is used for cough and cold.
(c) *Uraria logopodioides* is an ingredient of Dasamoola, an ayurvedic medicine, employed in remittent fever and chest inflammation.

X. Ornamentals:

The family provides a large number of beautiful ornamentals. The notable amongst them are:

(i) *Clitoria ternatea* (Butterfly pea)
(ii) *Pongamia pinnata* (Pongam oil tree)
(iii) *Sesbania sesban* (Common sesban, Jait)

20) Distinguishing features:

1) Herbs, shrubs or trees.
2) Presence of root nodules.
3) Leaves alternate, stipulate, simple or compound usually trifoliate.
4) Stipules and leaflets modified into tendrils.
5) Pulvinous leaf base.
6) Flowers bisexual, Zygomorphic and perigynous.
7) Papilionaceous corolla, with vexillary aestivation.
8) Stamens 10, monadelphous or diadelphous (1+9).
9) Carpel one, Unilocular, Ovules many, marginal placentation.
10) Fruit a legume or Pod.

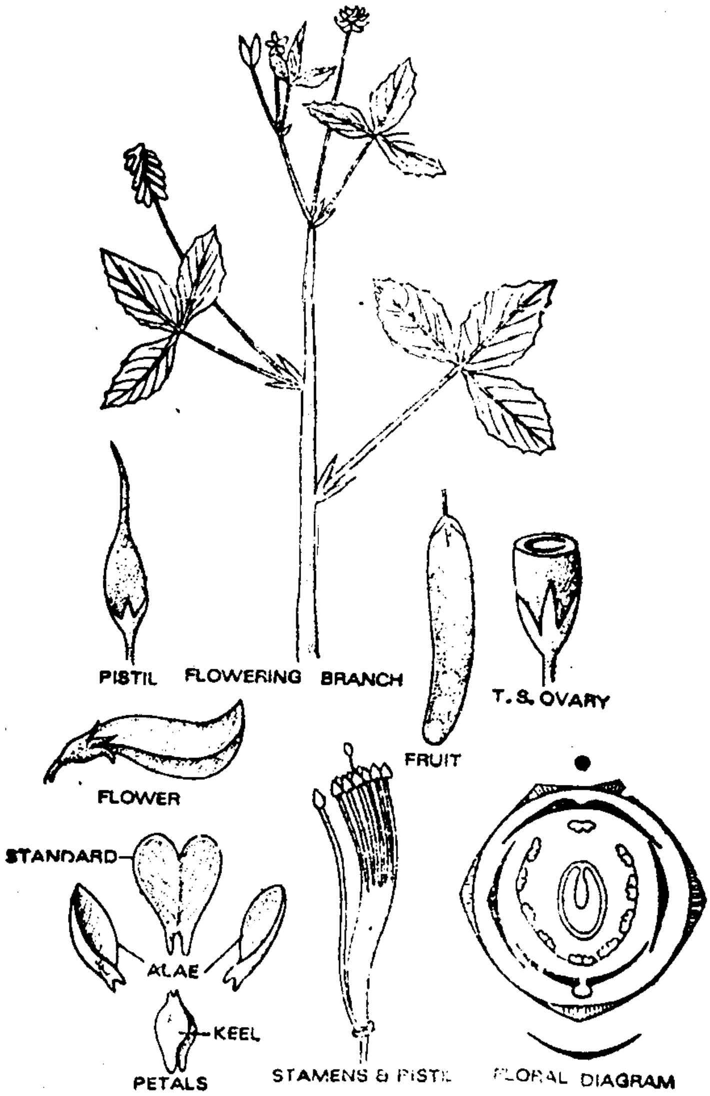

Fig. 6.6 *Trigonella fornum-graceum*

21) Questions:

1. Describe the characteristic features of the family Fabaceae. Add a note on its economic importance.
2. Write short notes on:
   (a) Pollination mechanism in Fabaceae
   (b) Economic importance of Fabaceae.
   (c) Characters of Fabaceae.

22) Reference Books:

i) **Angiosperms (Systematics & Life Cycle)** – G.L. Chopra, Pradeep Publications, Jalandhar.

ii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr. B.B.Sharma, Kithab Mahal, New Delhi.

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Ch.E. USHA RANI

6.4 Subfamily : CAESALPINIEAE

(The Casia family)

STRUCTURE

1. Systematic position
2. Distribution
3. Familiar Plants
4. Vegetative characters
5. Root
6. Stem
7. Leaves
8. Inflorescence
9. Flower
10. Calyx
11. Corolla
12. Androecium
13. Gynoecium
14. Fruit
15. Seed
16. Pollination
17. Dispersal
18. Floral Formula
19. Economic importance
20. Distinguishing Features
21. Questions
22. Reference Books

1) Systematic position:

Division	: Spermatophyta
Sub-division	: Angiospermae
Class	: Dicotyledonae
Sub-class	: Polypetalae
Series	: Calyeiflorae
Order	: Rosales
Family	: Leguminosae
Sub-family	: Caesalpiniaceae

2) Distribution:

This subfamily includes about 152 genera and 2,800 species distributed in both tropical and subtropical regions. In India, it is represented by 23 genera and 80 species chiefly in the Western Peninsular India and tropical Eastern Himalayas.

3) Familiar Plants:

1. *Bauhinia rocemosa*
2. *Caesalpinia bonducella* (Gacha poda)
3. *Caesalpinia pulcherimma* (Ratnagandhi; Chitti Kesari)
4. *Cassia fistula* (Rela)
5. Delonix *regia* (Royal Poinciana or Gulmohar – Erra turai)
6. *Hardwickia binata* (Yepi chettu)
7. *Parkinsonia aculiata* (Jeelugu)
8. *Saraca indica* (Asokamu)
9. *Senna occidentalis* (Cassia)
10. *Tamarindus indica* (Chinta)

4) Vegetative characters:

They are mostly trees *(Tamarindus indica, Cassia fistula)* or shrubs (e.g. *Parkinsonia)* or rarely herbs (some species or *Cassia,* e.g. *C. tora* and C. *absus).* Occasionally they are woody climbers such as *Caesalpinia bonducella,* climbing with the help of sharp prickles and *Bauhinia vahlii,* climbing by stem tendrils. The climbing species of *Bauhinia* show peculiar secondary growth and thus the stems become flat or corrugated.

5) Root:

Tap root.

6) Stem:

Erect, cylindrical, woody and mostly glabrous. Sometimes weak and climbing with the help of tendrils or sharp prickles. Tannin sacs and gum passages are present in many species.

7) Leaves:

The leaves are usually alternate, stipulate and are uniinnate *(Cassia)* or bipinnate *(Tamarindus, Delonix).* The leaves of *Bauhinia* are simple and bilobed. The stipules are free and of various types. The stipels are mostly absent. The leaf base is often swollen. In *Parkinsonia,* the leaf rachis is flat and ends in a sharp point. When minute leaflets are fallen or do not develop, the rachis resembles the phyllode of acacia.

8) Inflorescence:

The flowers are arranged usually in racemes or panicles or rarely the inflorescence is a cymose. In some species of *Cassia* there are only one or two flowers in a leaf axil.

9) Flowers:

The flowers are mostly large and showy, bracteate, complete, zygomorphic, bisexual, pentamerous and hypogynous.

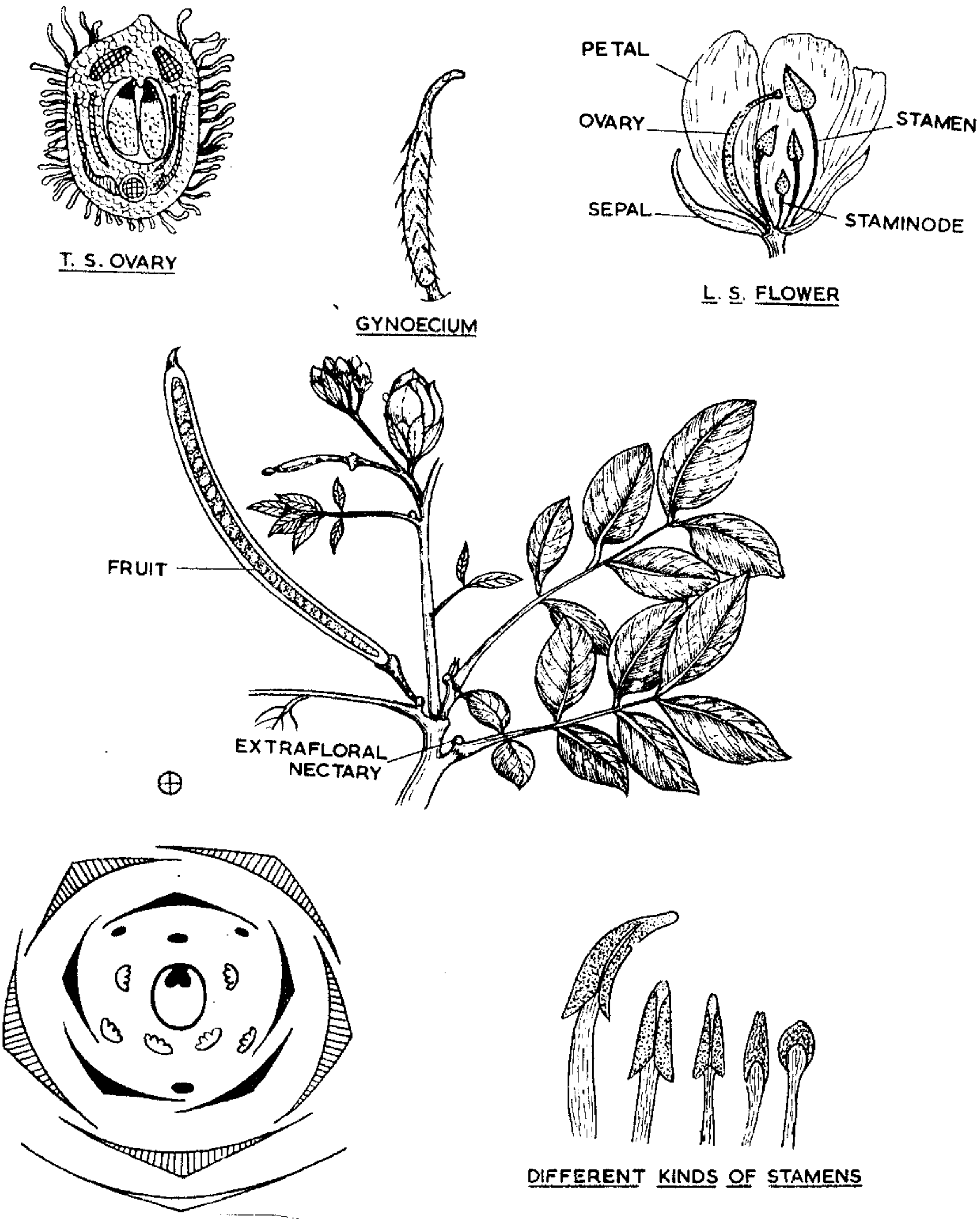

Fig. 6.7 *Cassia occidentalis*

10) Calyx:

The calyx is composed of five sepals which are basally connate or form a short or long tube. The aestivation is imbricate or valvate. The odd sepal is usually anterior. The calyx becomes petaloid in *Saraca* and the two upper sepals are united in *Tamarindus.*

11) Corolla:

The corolla is usually of five free petals which alternate with the sepals. The aestivation is ascending imbricate, the adaxial petal is always inside. In *Tamarindus* and *Amherstia,* only the upper three petals are developed and the two lower are reduced to scales. Petals are altogether absent in *Saraca.*

12) Androecium:

The androecium is diplostemonous with two alternate whorls of five stamens each. All the ten stamens are perfect as in *Caesalpinia* and *Parkinsonia,* but often some of the stamens are reduced to staminodes or altogether absent. For example, in *Cassia,* five to seven and in *Bauhinia* three to five stamens are perfect and the remaining are either reduce to staminodes or absent. In *Tamarindus* only three stamens are perfect, while the others are reduced to small bristles. The filaments are free or united into a tube as in *Tamarindus.* In *Amherstia,* the filaments of the nine lower stamens are united into a tube and the tenth upper stamens is free from the base (diadelphous condition). The anthers are dithecous, introrse and dehiscing longitudinally or sometimes by terminal pores as in several species of *Cassia.*

13) Gynoecium:

The gynoecium is monocarpellary with a superior unilocular ovary. There are usually two rows of ovules on the marginal placentation. The style is simple with a capitate stigma.

14 & 15) Fruit and Seed:

The fruit is usually a pod. It often becomes transversely septate in *Cassia.* The seeds are endospermic or non-endospermic with a large embryo.

16) Pollination:

The flowers are often large and showy and the stamens and stigma are freely exposed. They are pollinated by insects. Some species of *Cassia* are visited by sun birds.

17) Dispersal:

The dispersal of seeds takes place by wind or by animals.

18) Floral Formula: Br % ⚥ K_5 C_5 A_{5+5} $\underline{G}_1$

19) Economic Importance:

The plants have a wide range of usefulness.

I. Dyes and tannins:

(i) The bark of some species of *Bauhinia* such as *B. malabarica, B. racemosa, B. purpurea* and *Phanera vahlii, Caesalpinie sepiaria* and C. *digyna* yields tannins of commercial importance, which are widely used in tanning.

(ii) The heart of *Hematoxylon campechianum* (Log wood) yields a dye known as hematoxylin.

II. Edibles:

(i) The flower buds of *Bauhinia variegata* (Mandari chettu) and *B. purpurea* (Devakanchanamu) are eaten as vegetable and are also pickled.

(ii) The fruits of *Tamarindus indica* (Tamarind) contain an acidic pulp which is extensively used for souring curries, sauces, chutneys and some beverages.

III. Medicines:

(a) The fruits of *Cassia fistula* and *C. senna* are used as laxative.
(b) The leaves and bark of *Cassia glauca* are beneficial in diabetes and gonorrhoea.

IV. Ornamentals:

The following plants are grown as ornamentals:

(i) *Delonix regia*
(ii) *Saraca indica*
(iii) Bauhinia - B. racemosa, B. variegata, B. acuminata, B. purpureo.
(iv) Cassia - C. fistula, C. nodosa, C. marginata, C. glauca.
(v) *Parkinsonia aculeata*
(vi) *Caesalpinia pulcherrima*

20) Distinguishing characters:

1) Mostly shrubs and trees.
2) Pulvinous leaf base.
3) Leaves are paripinnate, stipulate.
4) Flowers arranged in simple raceme or corymbose raceme.
5) Flowers usually bracteate and irregular, bisexually.
6) Sepals and petals Perigynous usually five and free.
7) Slightly zygomorphic corolla, with ascending imbricate aestivation.
8) Stamens usually ten, free; in some plants staminodes are present.
9) Unicarpellary, unilocular ovary.
10) Marginal Placentation.
11) Fruit is a legume.

21) Questions:

1. Describe the characters of the family Caesalpiniaceae. Explain its economic importance.
2. Distinguish between Papilionaceae and Caesalpiniaceae.

22) Reference Books:

i) Taxonomy of Angiosperks – B.P. Pandey, S.Chand & Co. Ltd., New Delhi.
ii) Introductory Taxonomy (Angiosperms) – Dr. B.S.Trivedi & Dr. B.B.Sharma, Kithab Mahal, New Delhi.

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Ch. E. USHA RANI

6.5 Sub-family : MIMOSEAE
(The Acacia family)

STRUCTURE

1. Systematic position
2. Distribution
3. Familiar Plants
4. Vegetative characters
5. Root
6. Stem
7. Leaves
8. Inflorescence
9. Flower
10. Calyx
11. Corolla
12. Androecium
13. Gynoecium
14. Fruit
15. Seed
16. Pollination
17. Dispersal
18. Floral Formula
19. Economic importance
20. Distinguishing Features
21. Questions
22. Reference Books

1) Systematic position:

Division	Spermatophyta
Subdivision	Angiospermae
Class	Dicotyledonae
Sub-class	Polypetalae
Series	Calyciflorae
Order	Rosales
Family	Leguminosae
Sub-family	Mimoseae

2) Distribution:

There are about 75 genera and 2,800 species widely distributed in the tropical and subtropical regions. In India, this subfamily is represented by 15 genera and 72 species mostly in the tropical and subtropical Himalayas and Western Peninsular India.

3) Familiar Plants:

1) *Acacia Arabica* (Nalla tumma)
2) *Acacia concinna* (Shikakai)
3) *Acacia leucopholea* (Tella tumma)
4) *Acacia melanoxlon* ((Australian Tumma)
5) *Albizzia lebbek* (Dirisena)
6) *Enterobium saman* (Nidra ganneru)
7) *Leucalna Glauca* (Subabul)
8) *Mimosa pudica* (Touch me not)
9) *Pithacollobium dulce* (Seema Chinta)
10) *Prosopis spicigera* (Jammi)

4) Vegetative characters:

They are mostly trees *(Acacia, Albizzia)* and shrubs *(Dicrostachys)* and rarely herbs *(Neptunia)* or woody climbers climbing with the help of leaf tendrib *(Entada)*, many Xerophytes *(Acacia, Prospis).*

5) Root:

Tap root, deep and branched, having bacterial nodules.

Vegetative Characters

6) Stem:

Erect or climbing, woody, branched, angular or cylindrical, solid, spiny, Tanin sacs and gum passages are common in the pith and medullary rays.

7) Leaves:

Usually alternate, stipulate and bipinnate (unipinnate in Inga). In some species of *Acacia,* the stipules are modified into thorns. In many species of *Australian acacia,* the leaves are represented by simple green phyllodes. The leaves of *Mimosa and Nepternia* are sensitive to touch and assume a sleep position. The leaf base is pulvinate.

Inflorescence and Flower:

8) Inflorescence:

The flowers are minute and are condensed usually into dense and globes heads but sometimes they are spicate or racemose *(Prosopis* and several species of *Acacia).* In *Dicrostachys,* the spikes are dimorphic, the flowers in the upper half of the spike are perfect and those in the lower half are neutral having long staminodes.

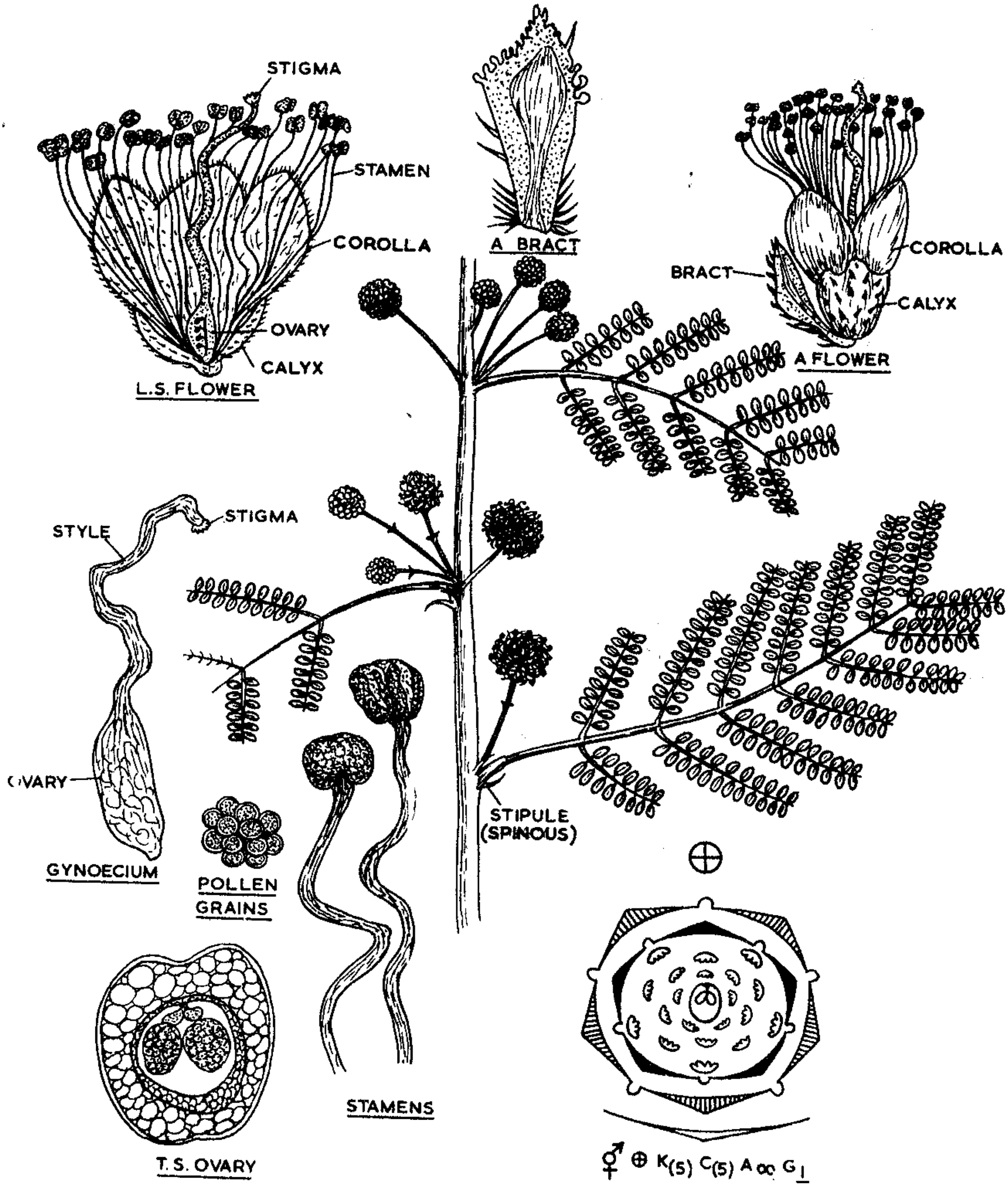

Fig. 6.8 *Acacia nilotica*

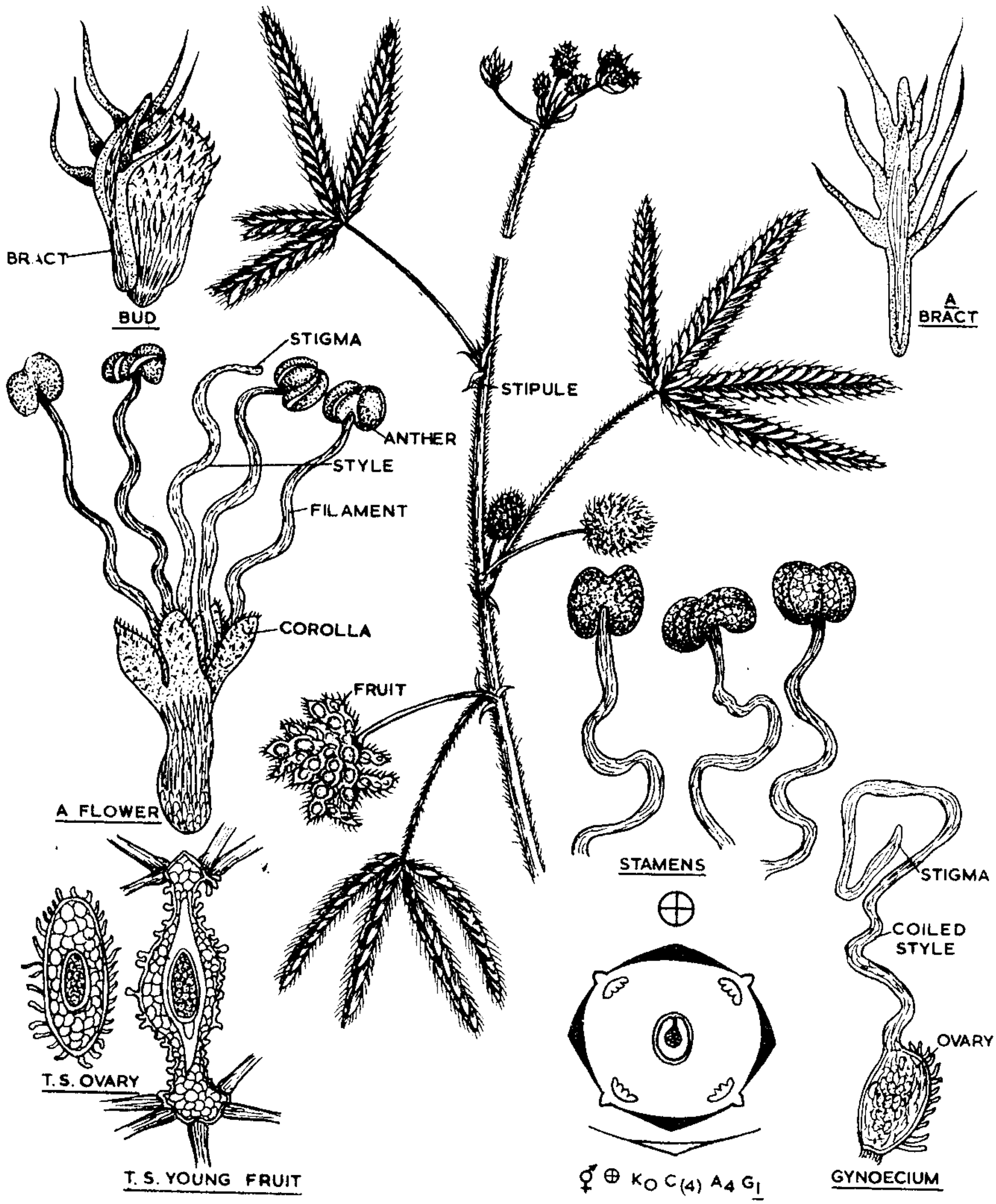

Fig. 6.9 *Mimosa pudica*

9) Flowers:

Bracteate, sessile, complete, actinomorphic, bisexual (unisexual or polygamous in *Dicrostachys)*, mostly pentamerous (sometimes three, four or six merous, e.g. *Mimosa)* and hypogynous.

10) Calyx:

It is composed of usually four or five sepals which are united into a short tube. The aestivation is valvate or rarely imbricate as in *Parria*. Odd sepal anterior.

11) Corolla:

It is composed of usually four or five petals which are subconnate at the base or form, a short tube. The aestivation is valvate. In prosopis petals are free.

The pressure of head inflorescence, the minute flowers, incomspicuous corolla and coromred stamens of this subfamily make it distinct from the other two subfamilies.

12) Androecium:

The number and cohesion of stamens show much variation. In *Acacia* there are numerous stamens which are free, where as in *Albizzia*, *Pithecolobium*, the indefinite stamens are monadelphous at the base. In *Prosopis* & *Lencaena*, the stamens are twice the number of the petals and are free and diplostemonous. Sometimes as in acrocarpus and some species of mimosa, the stamens are as many as petals. The filaments are long, filiform and often exerted. The anthers are dithecous, introrse, versatile and show longitudinal dehiscence.

13) Gynoecium:

Monocarpellary. The ovary is superior and unilocular with usually several ovules along the ventral suture. The placentation is marginal. The style and stigma are one.

Fruits and Seeds

14) Fruit:

It is legume or indehiscent. In several species of *Acacia*, the fruit is a lomentum. It is constricted between the seeds and breaks up into one-seeded discoid joints.

15) Seeds:

They are with a scanty endosperm or without any endosperm. Sometimes, as in *Pithecolobium dulce*, the seeds are half enveloped in a pulpy aril. In inga naked embryo falls from the fruit and it directly germinates.

Pollination and Dispersal

16) Pollination:

The flowers are pollinated by insects which are attracted by long exerted and beautifully coloured stamens or in some cases they visit the flowers for nectar.

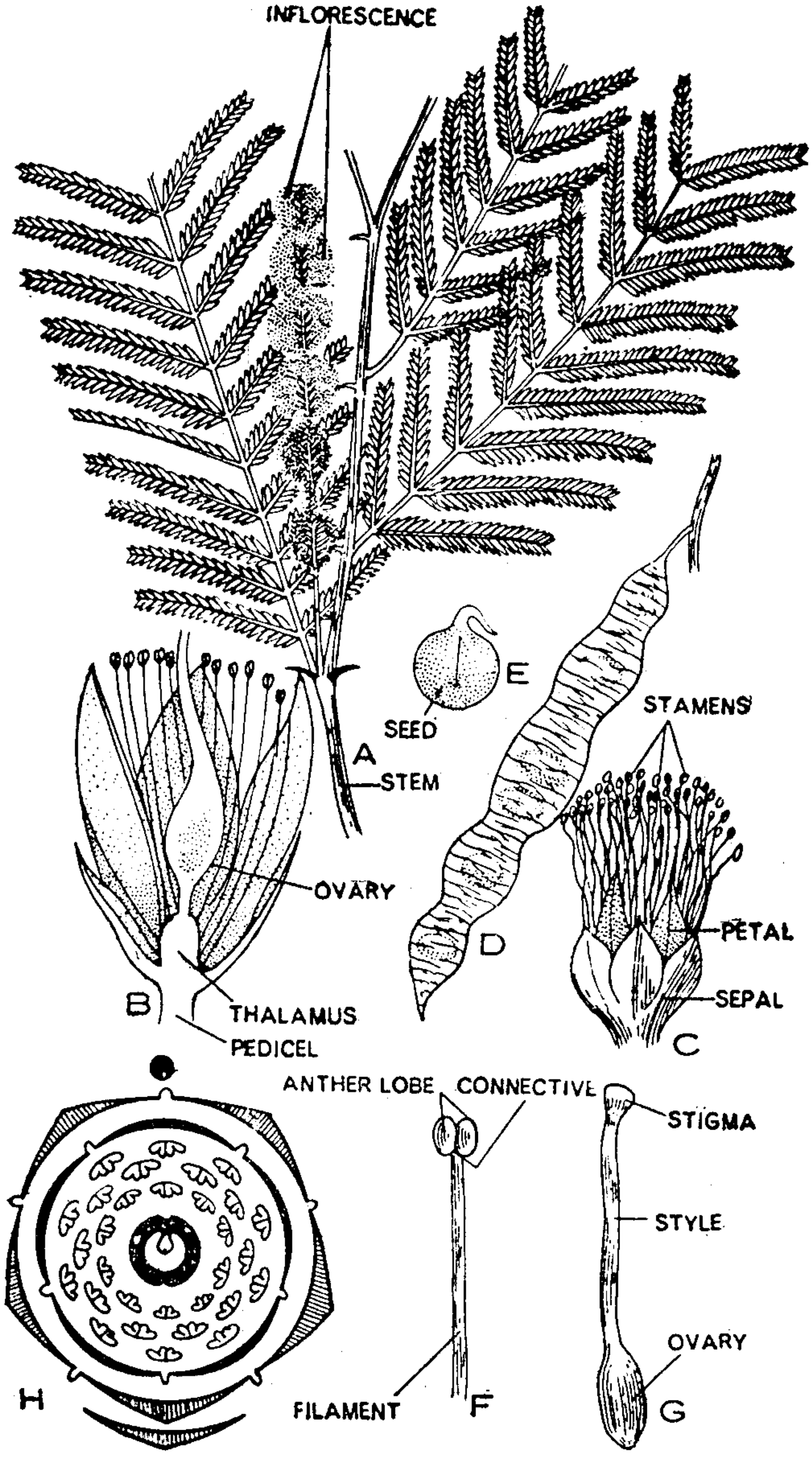

Fig. 6.10 Mimosaceae (Leguminosae) – *Acacia nilotica* (Linn.) Del; **A**, twig; **B**, L.S. of flower; **C**, flower; **D**, fruit (lomentum); **E**, seed; **F**, stamen; **G**, gynoecium; **H**, floral diagram.

17) Dispersal: Seeds are dispersed by wind, birds or animals.

18) Floral Formula: Br ⊕ ⚥ $K_{(4)or(5)}$ C_{4or5} $A_{\alpha}G_1$

19) Economic Importance:

I. Ornamentals:

a) *Mimosa pudica* (sensitive plant)
b) Leucaena leucophloea
c) *Acacia indica, A. farnesianna, A. melanoxylon, A. auriculaeformis*
d) *Albizzia - A. lebbek, A. procera*

II. Tannins:

Obtained from the barks of *Acacia nilotica, A. catechu, A. pinnata*

III. Gums:

True gum Arabic is obtained from *Acacia senegal* which is used in medicine and sizing and finishing material in textile industry. *A. nilotica* and *A. catechu* also give valuable gum.

IV. Timbers:

a) Many species of *Acacia (A. nilotica, A. catechu, A. ferruginea, A. leucophloea)* yield important timber used for tool handles, cart wheels and are also valuable source of fuel.

b) Several species of *Albizzia* such as *A. amara, A. lebbek, A. lucida, A. procera* yield valuable timber used for furniture, cabinet work and agricultural implements.

c) *Xylia xylocarpa* provides a very valuable timber used for railway sleepers and boat building.

V. Edibles:

a) The stem tips of *Neptunia prostrata* are earlier as pot herb and the pods are used as vegetables.
b) The sweet and juicy avil of *Pithecolobium dulce* is edible.

20) Distinguishing characters:

1. Mostly trees with Xerophytic habit.
2. Pulvinous leaf base.
3. Stipulate, Pinnately compound leaves.
4. Inflorescence a cymose head or a spike.
5. Actinomorphic, penta or tetramerous flowers.

6. Perigynous condition.
7. Fused petals with valvate aestivation.
8. Stamens numerous, monadelphous with shory filaments.
9. Superior, monocarpellary, unilocular ovary.
10. Marginal placentation.
11. Fruit a legume or lomentum.

21) Questions:

1. Describe the family Mimoseae and write the Botanical names of 3 plants and their economic importance.
2. Write short notes on:
   (i) Economic importance of the family Mimoseae.
   (ii) Floral characters of Mimoseae.

22) Reference Books:

i) Taxonomy of Angiosperms – B.P. Pandey, S. Chand & Co. Ltd., New Delhi.
ii) Introductory Taxonomy (Angiosperms) – Dr. B.S.Trivedi & Dr. B.B.Sharma, Kithab Mahal, Allahabad.
iii) Taxonomy of Vascular Plants – George H.M. Larence, Oxford & IBM Publishing Co., New Delhi.

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CH.E. USHA RANI

Unit-II

Class : **Dicotyledons**
Subclass **: Polypetalae**
Series **: Calyciflorae**
Order **: Passiflorales & Umbellales**

Lesson 7

TAXONOMY AND ECONOMIC IMPORTANCE OF FAMILIES BELONGING TO THE ORDERS PASSIFLORALES AND UMBELLALES IN THE SERIES CALYCIFLORAE

OBJECTIVES

⇒ To study the vegetative and floral characters of the families belonging to orders Passiflorales and Umbellales.
⇒ To know the similarities and differences between the families in Passiflorales and Umbellales.
⇒ To know the economic importance of the families in Passiflorales and Umbellales.

CONTENTS

7.1 Orders Passiflorales and Umbellales

7.1.1 Characteristic features of order Passiflorales

1. Flowers bisexual or unisexual
2. Ovary usually inferior, unilocular with parietal placentation, sometimes 3-locular by fusion of placentae.
3. Styles free, or connate at the base.
4. Family included → **Cucurbitaceae**

7.1.2 Characteristic features of order Umbellales

1) Flowers regular
2) Ovary inferior
3) 1 - many locular with solitary pendulous ovule in each locule.

Family included → **Apiaceae** (Umbelleferae)

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7.2 CUCURBITACEAE
(The Gourd Family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Polypetalae
Series	Calyciflorae
Order	Passiflorales

2) Distribution:

The Cucurbitaceae are essentially a tropical family containing 110 genera and 640 species. In India, the family is represented by 37 genera and about 17 species, several of which are cultivated throughout India. The chief centre of distribution is however in Eastern Himalayas.

3) Familiar Plants:

Benincasa hispida (Budida gummadi) white ash gourd
Bryonopsis laciniosa (Linga potla)
C. pepo – Field pumpkin (Gummadi)
C. sativus - Cucumber (Dosa)
Citrullus lanatus – Water melon (Puccha kaya)
Coccinia indica (Donda)
Cucumis melo – Musk melon (Karbuja)
Cucurbita maxima (Teeya gummadi)
Luffa acutangula (Beera kaya)
Luffa cylindrica (Neti Beera)
M. dioica (Adavi kakara)
Momordica charantia – Bitter gourd (Kakara)
Schium edula (Bangalore vankaya)
Trichosanthes anguina – Snake gourd (Potla kaya)

4) Vegetative characters:

They are trailing or decumbent annual or perennial herbs, some shrubs (*Echinocystis*), usually climbing by means of tendrils. The morphological nature of the tendrils has been much disputed and they have been variously considered as roots, stem, leaves, stipules, shoots, flower stalks or organs sui-generis. May be they have a different origin in different genera. Tendrils are absent in *Ecballium*. *Dendrosciyos* is the only tree species of the family.

5) Root: Tap root

6) Stem:

The stem is usually herbaceous, branched, hairy and five-angular with two alternate rings of five vascular bundles each.

7) Leaves:

The leaves are alternate, exstipulate, long petioled, frequently cordate, simple but often palmately or pinnately lobed or divided and palminerved. The petioles are often hollow.

Inflorescence and Flower

8) Inflorescence:

The flowers are usually solitary axillary (*Cucurbita*) or are arranged in various types of cymose inflorescence (male flowers of Luffa). The plants are monoecious or sometimes dioecious as in *Coccinia cardifolia* and *Momordica dioica*.

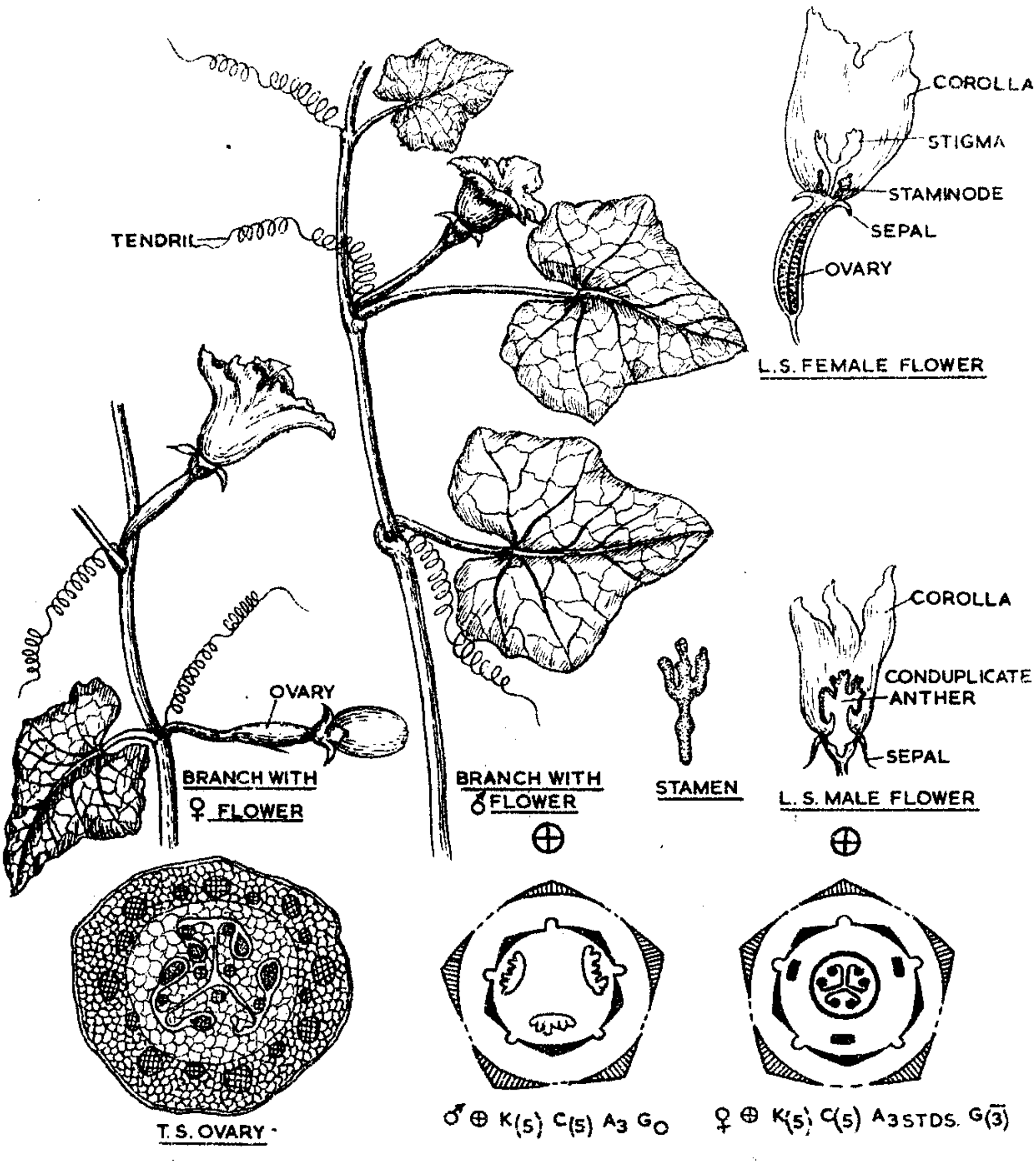

Fig. 7.1 *Coccinia cordifolia*

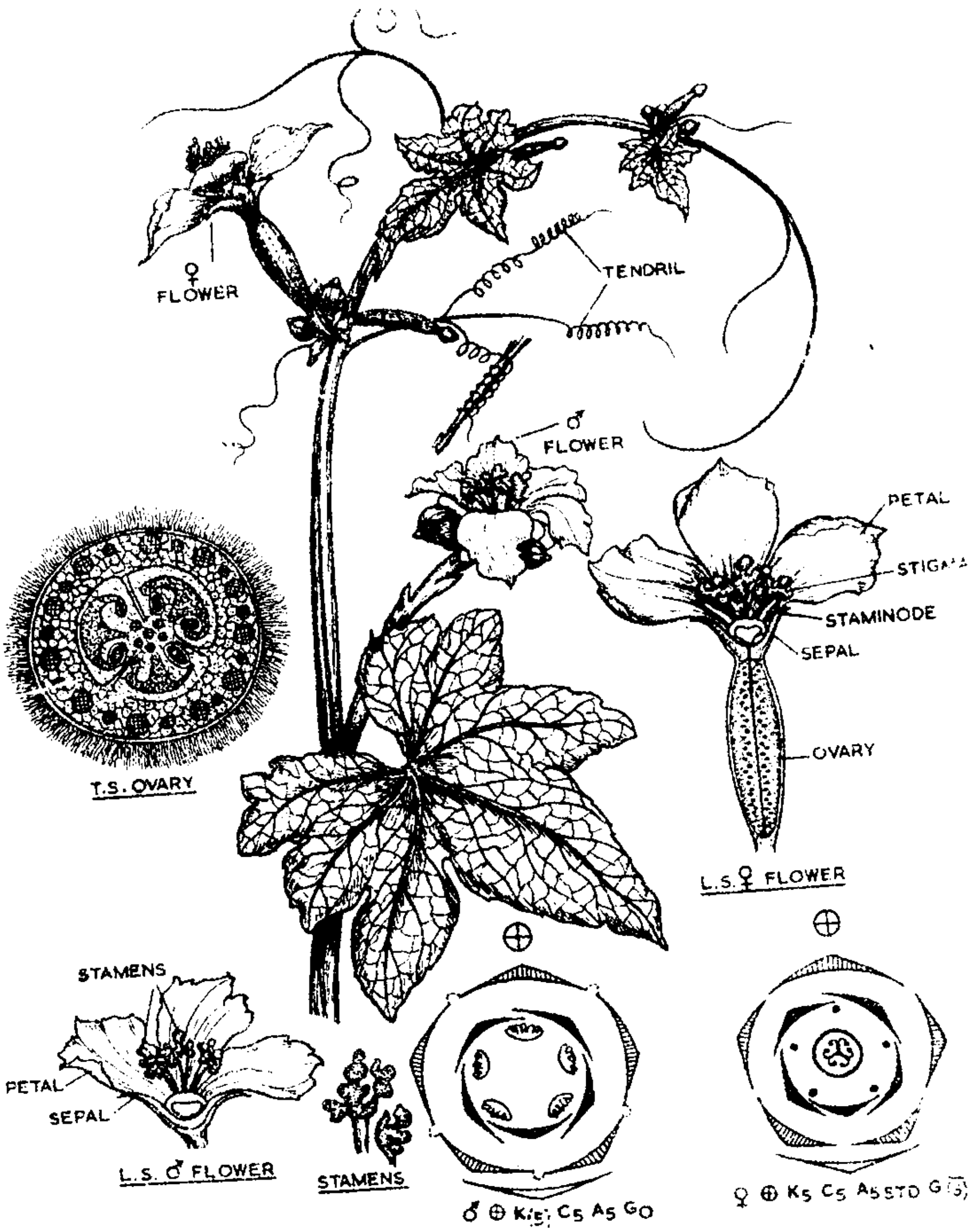

Fig. 7.2 *Luffa cylindrica*

9) Flower:

The flowers are yellow or white, unisexual (bisexual in *Schizopepon*), actinomorphic, pentamerous and epigynous (Perigynous in *Actinostemma*).

10) Calyx:

The calyx is of five sepals forming a tube which is wholly adnate to the ovary in female flowers. The aestivation is imbricate or valvate.

11) Corolla:

The corolla is of five petals which are united in a tube or nearly quite free (*Trichosanthes*). The corolla is campanulate, rotate or salverform, and the lobes are imbricate or induplicate valvate. Sometimes, the petals are fibriate as in *Trichosanthes*.

12) Androecium:

The androecium is present only in male flowers. In female flowers, it is either absent or represented by staminodes. The androecium shows much variation. Fevillea represents the simplest condition which has five free stamens (alternating with the petals) with dithecous anthers. *Luffa cylindrica* also have five free stamens but the anthers are monothecous. In *Thladiantha*, there are five stamens with monothecous anthers, the filaments of four stamens are coherent at the base into two pairs, the fifth stamen standing apart. In majority of genera (e.g. *Lagenaria*, *Cucumis* and *Citrullus*) there are apparently three stamens, one with a monothecous anther and the other two with dithecous anthers. This situation seems to have been brought about by complete union of the filaments and anthers of two pairs of stamens. In *Cucurbita* also there are apparently three stamens (one with monothecoas and two with dithecous anthers) but the anthers are twisted and the filaments have become connate. In *Sicyos*, the filaments of all the stamens are united into a column bearing the anthers which are remarkably curved. The most complex condition is found in *Cyclanthera* where stamens are all united into a column with two ring like pollen chambers running around the top. The anthers are extrorse and dehisce by a single longitudinal slit.

13) Gynoecium:

The gynoecium is present only in female flowers. In male flowers, sometimes it is represented by a pistillode. The gynoecium is usually of three syncarpous carpels with a completely inferior or rarely half-inferior (*Actinostemma*) ovary. The ovary is unilocular with three intruding and bifurcating parietal placentae which often meet in the centre and thus the ovary becomes spuriously three loculed. There are usually many anatropous ovules on each placenta. In *Sechium* only a solitary ovule is present in the ovary. The style is one with three stigmas.

Fruit and Seed:

14) Fruit:

The fruit is fleshy berry-like with soft or hard pericarp. This type of fruit is called Pepo. It is usually indehiscent but rarely dehiscent as in *Herpetospermum*.

15) Seed:

The seeds are often packed in a pulp or fibres. They are compressed and non-endospermic with a straight embryo and large and leafy cotyledons.

Pollination and dispersal:

16) Pollination:

The flowers are insect pollinated and are visited by insects for nectar which is secreted by a cup shaped disc present in both male and female flowers.

17) Dispersal:

Seeds are dispersed by explosive opening of fruit in *Ecballium* and *Cyclanthera* but usually they are dispersed by birds and animals.

18) Floral Formula:

Male flower: Br or Ebr $\oplus$ Γ $K_{(5)}$ $C_{(5)}$ $A_{(2)+(2)+1}$ G_0

Female flower: Br or Ebr $\oplus$ E$K_{(5)}$ $C_{(5)}$ A_0 $\overline{G}_{(3)}$

19) Economic Importance:

The family provides a large number of vegetables which are eaten raw or cooked. They have a delicious flavour and much food value. Some of the common species which provide edible vegetables are:

1) *Luffa cyclindrica*
2) *Luffa acutangula*
3) *Cucumis sativus*
4) *Cucumis melo*
5) *Citrullus lanatus*
6) *Cucurbita moschata*
7) *Cucurbita maxima*
8) *Benincasa hispida*
9) *Momordica charantia*
10) *Trichosanthes anguina*

Several plants of the family are used in medicines. Colocynthin obtained from *Citrullus colocynthis* is useful in rheumatism and urinary diseases and *elaterium* obtained from *Ecballium elaterium* used in malaria and hydrophobia.

The fruits of some species of *Benincasa* and *Lagenaria* with hard pericarp are used for making musical instruments and several decorative articles.

Some species of *Ecballium, Cyclanthera, Coccinia* and *Sechium* are grown as ornamentals.

20) Distinguishing features:

1) Herbaceous climbers, climbing by means of tendrils.
2) Leaves simple, cordate or palmately lobed with coarse hairs, alternate, palmate reticulate venation.
3) Flowers unisexual, actinomorphic, epigynous, plants monoecious, less commonly dioecious.
4) Calyx and corolla 5 each, united.
5) Stamens usually 5, most commonly 3 (2 larger and one smaller), anthers conduplicate, synandrous condition.
6) Ovary inferior, tricarpellary, syncarpous, parietal placentation.
7) Fruit fleshy berry with hard rind (pepo).

21) Questions:

1. Describe the vegetative and floral characters of Cucurbitaceae. Mention the botanical names of any five vegetable yielding plants.
2. Write short notes on:
   (i) Androecium in Cucurbitaceae.
   (ii) Flower of Cucurbitaceae.
   (iii) Economic importance of Cucurbitaceae.

22) Reference Books:

i) **Angiosperms (Systematics & Life Cycle)** – G.L. Chopra, Pradeep Publications, Jalandhar.
ii) **A text book of Botany – Angiosperms** – Dr. V.Singh, Dr. P.C. Pandey and Dr. G.K. Jain, Rasthogi Publications, Meerut.
iii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S.Trivedi &Dr. B.B.Sharma, Kithab Mahal, Allahabad.

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Ch. E. USHA RANI

7.3 UMBELLIFERAE (APIACEAE)

(The carrot family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Polypetalae
Series	Calyciflorae
Order	Umbellales
Family	Umbelliferae

2) Distribution:

A large family of 275 genera and about 3000 species, which are cosmopolitan in distribution. In the tropical countries, they are either found in hilly areas or cultivated in the plains during winter season. In India, the family is represented by 53 genera and nearly 200 species.

3) Familiar Plants:

Apium graveolens (Ajmud)
Apium carvi (Vamu)
Centella asiatica (Saraswathi aku)
Coriandrum salivum (Dhaniyalu, Kothimeera)
Cunimum cyminum (Jeela Karra)
Daucus carota (Carrot)
Foeniculum vulgare (Sompu)
F. dulce (Teepi sompu)
Pimpinella bracteata (Anise)
Ferula asafoetida (Inguva)

4) Vegetative characters:

The family consists of mostly annuals (Coriandrum, Caram carvi), biennial (*Daucus carota*) or perennial herbs (*Ferula*). Species of *Centella* are small, prostrate herbs rooting at the nodes.

5) Root: Tap root.

6) Stem:

Mostly they are with stout erect stems with hollow internodes. Species of *Angelica* attain a height of up to four meters. *Bupleurum falcatum* is a shrub with soft woody stem.

The plants usually have an aromatic smell due to the presence of essential oil or resin in all organs.

7) Leaves:

The leaves are alternate, rarely simple as in *Centella, Hydrocotyle* and *Bupleurum* but generally they are pinnately compound or decompound (*Coriandrum*). Sometimes as in *Sanicula*, the leaves are palmately compound. The petiole is often swollen and sheathing at the base. Stipules are usually absent but rarely as in *Hydrocotyle* small scarious stipules are present. In some taxa like *Eryngium*, the leaves look like monocotyledonous and exhibit parallel venation.

Inflorescence and Flower

8) Inflorescence:

As the name of the family suggests, an umbel inflorescence is the characteristic of the family. Rarely, the umbel is reduced to a single flower as in some species of *Hydrocotyle* or forms a compact head (*Eryngium*). The compound umbel is most common (*Coriandrum*), although simple umbel also occurs in some genera (*Hydrocotyle* and *Bupleurum*). The primary umbel is surrounded at the base by an involucre of bracts and each secondary umbel is subtended by an involucel of bractlets. In *Azorella* one flower is present.

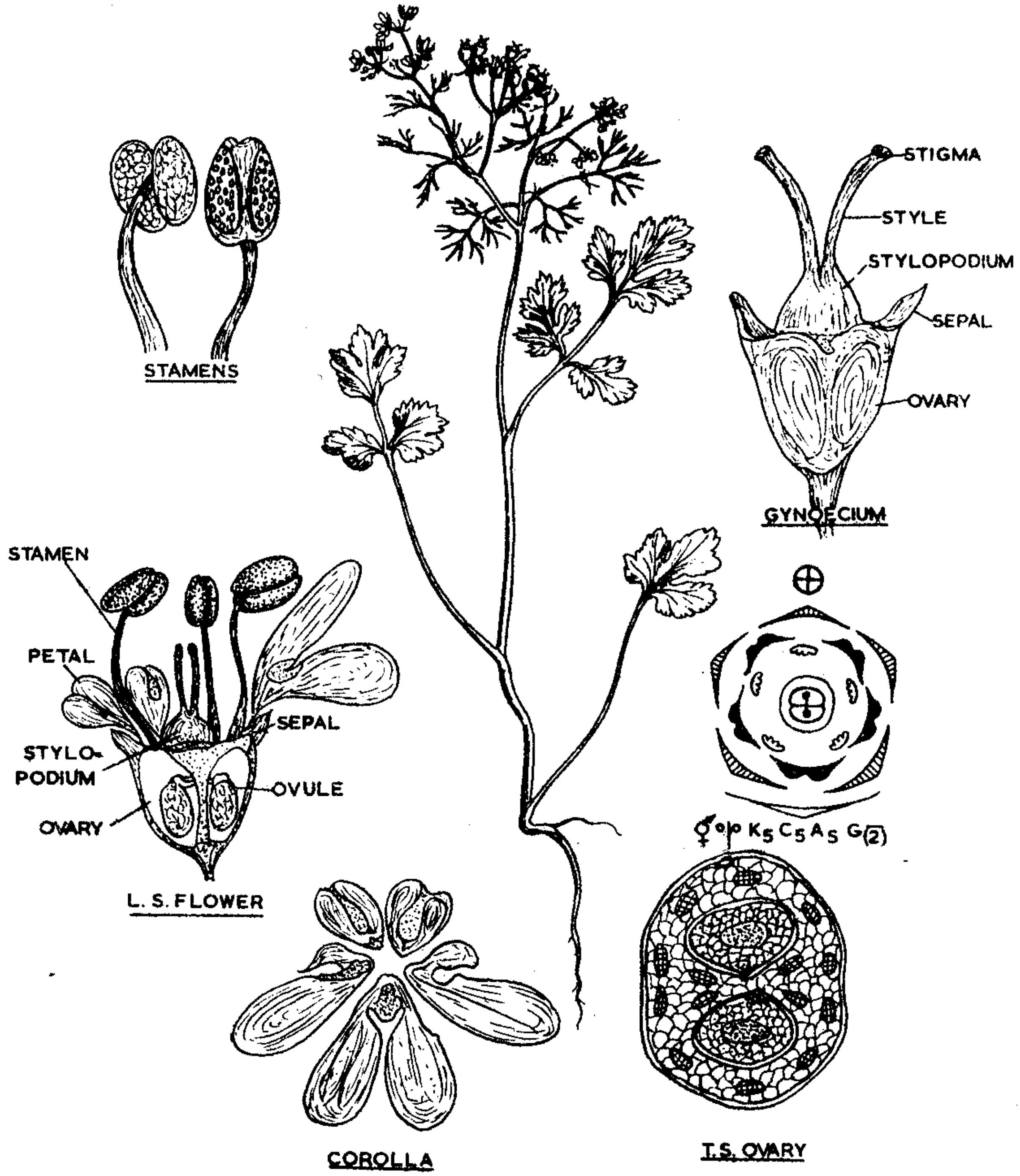

Fig. 7.3 *Coriandrum sativum* (Dhania)

9) Flower:

The flowers are small, actinomorphic (in *Coriandrum*, the peripheral flowers of an umbel are zygomorphic), hermophrodite (sometimes unisexual or polygamous), pentamerous and epigynous.

10) Calyx:

The Calyx is represented by five inconspicuous teeth or narrow circular ridge (Calyx tube) at the top of the ovary. Calyx is absent in *Apium* and *Foeniculum*. In *Eryngium conspicuous* calyx are present. The aestivation is imbricate (*Coriandrum*) or valvate.

11) Corolla:

The corolla is of five distinct petals alternating with the sepals. The petals are inflexed in bud and they fall of soon. The aestivation is imbricate or valvate. The petals are emarginate or two-lobed. The peripheral flowers of *Coriandum* have unequal petals.

12) Androecium:

The androecium is of five distinct stamens alternating with the petals. They arise from an epigynous disc. The filaments are inflexed in bud and the anthers are basi- or dorsifixed, dithecous, introrse and opening lengthwise.

13) Gynoecium:

The gynoecium is bicarpellary and syncarpous with an inferior bilocular ovary having a solitary pendulous unitegmic anatropous ovule in each locule. The placentation is axile. An epigynous disc (Stylopodium) is present on the base. The stigmas are differentiated from the styles.

Fruit and Seed:

14) Fruit:

The fruit is a schizocarp. It dehisces into two one-seeded mericarps which are attached to penduous, slender and often forked axis, the carpophore. The mericarps are variously marked with ribs, grooves and bristles which afford good taxonomic characters.

15) Seed:

The seed has a hard oily endosperm and a small embryo.

Pollination and Dispersal:

16) Pollination:

Aggregation of small flowers into dense inflorescence not only make them conspicuous but also permits them more quickly searched and pollinated by insects. The nectar is secreted by a massive conical disc (stylopodium) at the base of the styles. The flowers are mostly protandrous, thus making self-pollination almost impossible.

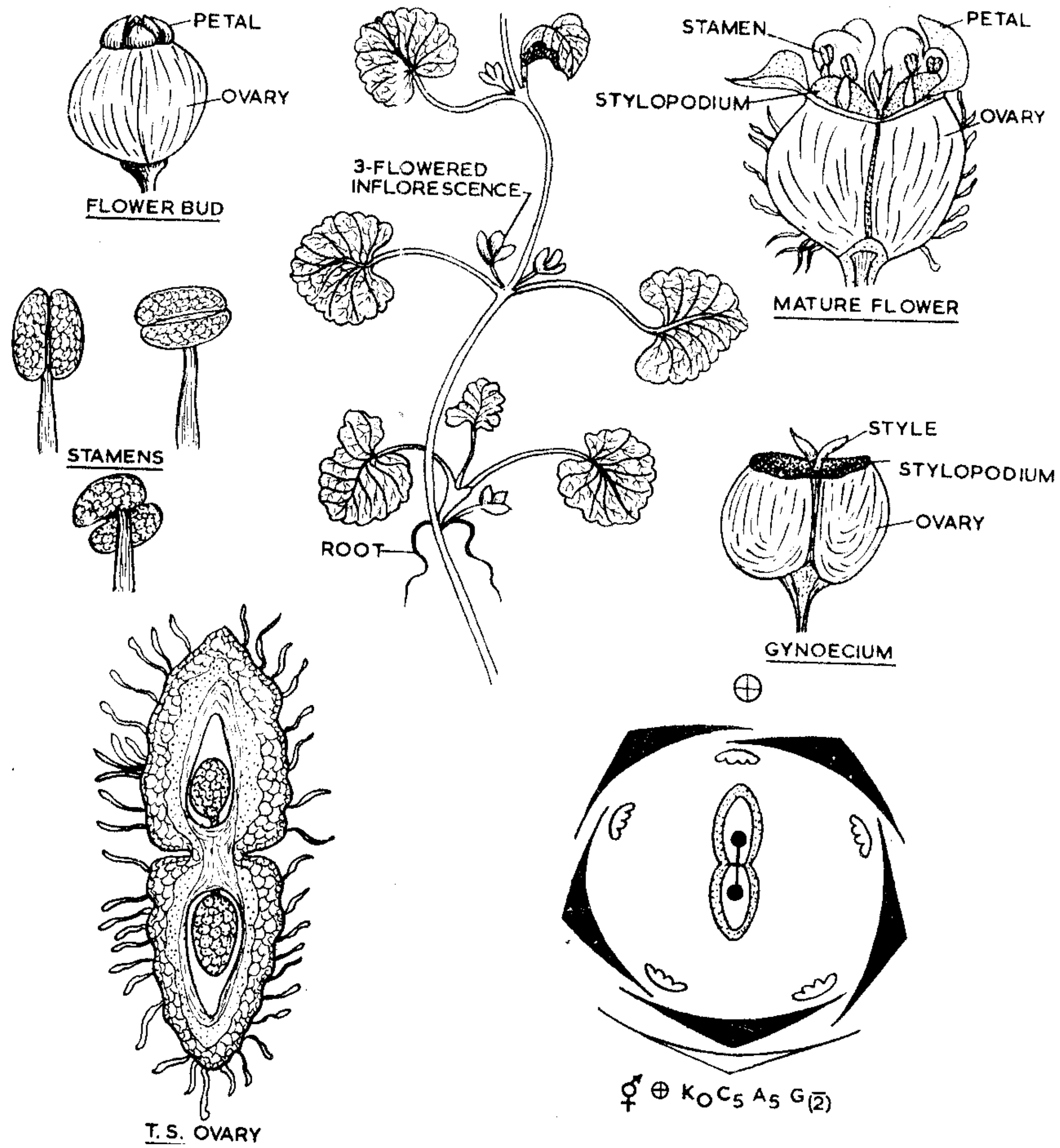

Fig. 7.4 *Centella asiatica* (Brahmi)

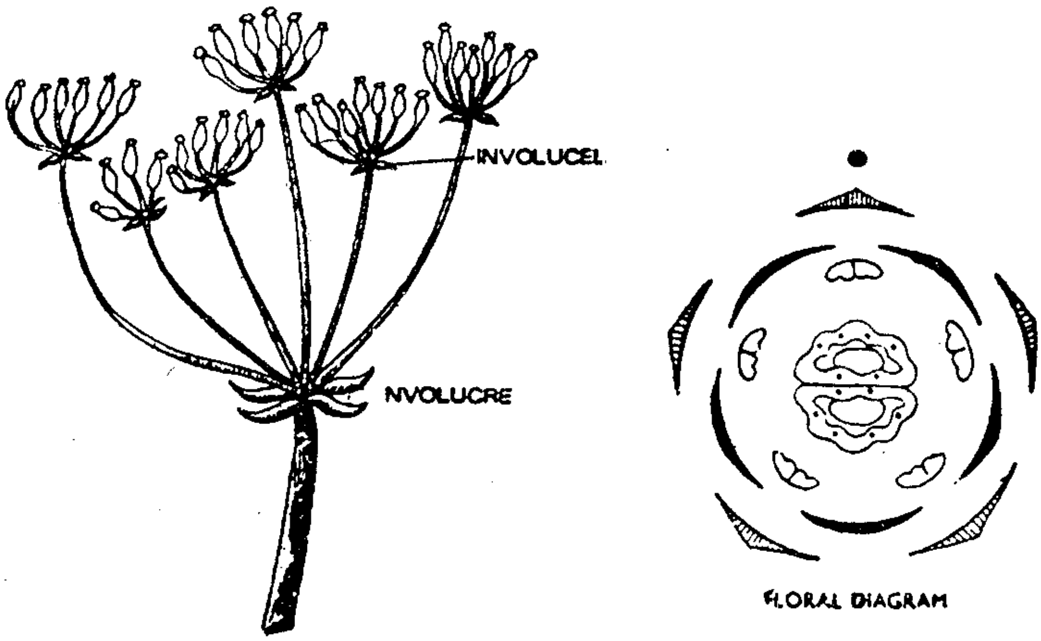

Fig. 7.5 A compound umbel of Coriander (Dhania)

17) Dispersal:

The mericarps are marked with ridges and bristles which help them to be carried by birds and animals.

18) Flower Formula

Central flower: Br $\oplus$ ⚥ $K_{(5)}$ C_5 A_5 $\overline{G}_{(2)}$

Peripheral flower: Br % ⚥ $K_{(15)}$ C_5 A_5 $\overline{G}_{(2)}$

19) Economic Importance:

The family is important chiefly for vegetables, condiments, volatile oils and ornamentals.

I. Vegetables: The thickened and fleshy roots of *Daucus carota* (carrot), *Apium graveolens* (Celery) and *Pastinaca sativa* are used as vegetables.

II. Spices: The seeds of several species are used as a spice and condiment for culinary purposes and for flavouring breads, biscuits, cakes, cheese, confectionery, liquors, etc. They are also stomachic, carminative and stimulative and are largely used in Indian system of medicine. The oil obtained from the seeds is used in perfumery and as a flavouring agent.

Coriandrum sativum (Dhania)
Foeniculum vulgare (Sompu)

Carum carvi (Vamu)
Cuminum cyminum (Jeela Karra)
Pimpinella anisum (Aniseed)

Some species of *Ferula*, such as *F. foetida*, *F. asafoetida*, *F. alliace* and *F. rubricaulis* are important source of oleo-gum resins. The dried latex obtained after making incisions in living root stocks and roots is the source of Asafoetida of commerce.

III. Medicines: *Centella asiatica* enjoys considerable reputation in Indian system of medicines as diuretic, alterative and tonic. It is also used in the treatment of leprosy and possesses insecticidal properties.

IV. Ornamentals: Some species of *Pimpinella*, *Heracleum* and *Angelica* are grown as ornamentals.

20) Distinguishing characters:

1) Annual or biennial herbs
2) Stem hollow, jointed at the nodes
3) Schizogenous oil cavities
4) Leaves alternate, exstipulate, mostly decompound
5) Sheathing leaf base
6) Simple or compound umbel inflorescence
7) Flowers bisexual, pentamerous, epigynous and regular.
8) Inflexed petals and stamens in bud
9) Bicarpellary, syncarpous, bilocular, inferior ovary
10) Axile placentation, pendulous ovule
11) Stylopodium
12) Schizocarpic mericap

21) Questions:

1. Describe the characters of the family Umbellifereae and explain its economic importance.
2. <u>Write short notes on</u>:
   (i) Fruit in Umbelliferae.
   (ii) Economic importance of Umbelliferae.

22) Reference Books:

i) **A text book of Botany – Angiosperms –** Dr. V. Singh, Dr. P.C. Pandey & Dr. G.K. Jain, Rasthogi Publications, Meerut.
ii) **Taxonomy of Angiosperms –** B.P. Pandey, S.Chand & Co. Ltd., New Delhi.
iii) **Introductory Taxonomy (Angiosperms) –** Dr. B.S.Trivedi & Dr. B.B.Sharma, Kithab Mahal, Allahabad.

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CH.E. USHA RANI

Unit-II

Class: Dicotyledons
Sub-class: Monochlamydae
Series: Curvenbryeae and Unisexuales

Lesson 8

TAXONOMY AND ECONOMIC IMPORTANCE OF THE FAMILIES BELONGING TO THE SUBCLASS MONOCHLAMYDAE

OBJECTIVES

⇒ To know the negative and floral characters of the families in Monochlamydae.
⇒ To know the difference in the plant characters in Monochlamydae.
⇒ To know the economic importance of the plants in Monochlamydae.

CONTENTS

8.1 Sub-Class: **Monochlamydae**

8.1.1 Characteristic features of Sub-class: **Monochlamydae**

1. Flowers usually with one whorl of perianth, usually sepaloid

8.1.2 Classification:

In Sub-class Monochlamydae two series are included:

(a) Curvembryeae
(b) Unisexuales

(a).Curvembryeae:

1. Terrestrial plants with bisexual flowers
2. Stamens as many as perianth lobes
3. Ovules solitary
4. Family included: Amaranthaceae

b) Unisexuales:

1. Flowers unisexual
2. Perianth sepaloid or much reduced or absent
3. Ovary syncarpous or of one carpel
4. Ovules one to two per carpel
5. Family included: **Euphorbiaceae**

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8.2 AMARANTHACEAE
(The Amaranthus Family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Perianth
11) Androecium
12) Gynoecium
13) Fruit
14) Seed
15) Pollination
16) Dispersal
17) Floral Formula
18) Economic importance
19) Distinguishing Features
20) Questions
21) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Monochlamydae
Series	Curvembryeae

2) Distribution:

This family includes 65 genera and 850 species widely distributed in the tropical and temperate regions of the world. Tropical America and India are the chief centres of distribution. In India, the family is represented by 17 genera and over 50 species occurring mostly in the warmer parts.

3) Familiar Examples:

1. *Achyranthes aspera* (Uttareni)
2. *Alternenthera sessilis* (Ponna gantikura)
3. *Amaranthus spinosus* (Mulluthotakura)
4. *Amaranthus tricolor* (Peruguthotakura)
5. *Digera muricata* (Chenchalikura)
6. *Gomphrena globosa* (Erra bagada banti)
7. *Gomphrena serrata* (Tella pagadabanti)
8. *Pupalia lappaceae* (Tella Uttareni)

4) Vegetative characters:

The plants are mostly annual or perennial herbs or undershrubs are rarely erect (*Bosia*) or climbing (*Deeringia*) shrubs.

5) Root: Tap root.

6) Stem:

The stem often show abnormal secondary growth and the vascular bundles are arranged in several concentric rings or are somewhat irregular.

7) Leaves:

The leaves are alternate (opposite in *Gomphrena*), exstipulate, simple and usually entire.

8) Inflorescence:

The small flowers are aggregated into simple or branched panicles, spikes, heads or cymes. The influence is very dense, showy and fascinated in *Celosia cristata*.

9) Flowers:

The flowers are bracteate, bracteolate, actinomorphic, bisexual or unisexual (then the plants are polygamo-dioecious or dioecious), pentamerous and hypogynous.

10) Perianth:

The perianth is composed of five, free or basally connate tepals which are rigid or scarious, more or less membranous and persistant. They are imbricate in bud.

11) Androecium:

The stamens are five and they lie opposite the sepals. Rarely as in *Nothosaerva*, there are only one or two stamens. The filaments are free (*Digera* and *Amaranthus*) or united at the base into a membranous tube (*Cyathula* and *Celosia*). The anthers are usually dithecous (monothecous in *Gomphrena*), introrse and opening by longitudinal slits.

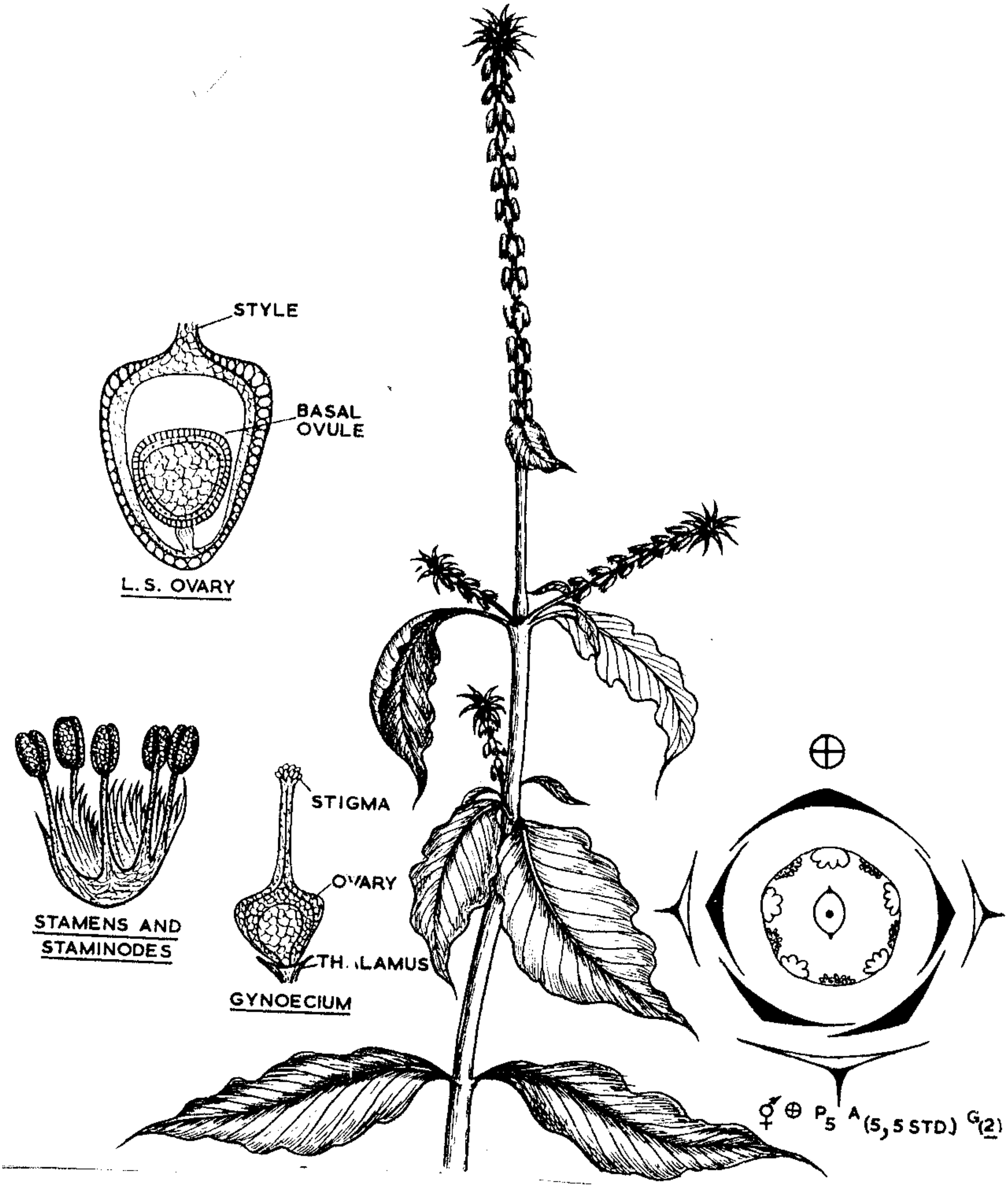

Fig. 8.1 *Achyranthes aspera*

12) Gynoecium:

The gynoecium is bi- or tri-carpellary and syncarpous. The ovary is superior, unilocular with a solitary (sometimes more as in *Celosia*) pendulous or erect campylotropous ovule arising from the base of the locule. The styles are one to three with as many stigmas.

Sometimes, as in *Bosia*, a hypogynous nectar secreting disc is present in which stamens are inserted.

13) Fruit:

The fruit is usually an utricle which is dehiscent or indehiscent but sometimes it is a berry (*Deeringia*), circumscissile capsule (*Celosia*) or nut (*Digera*). It is enclosed in or seated on the persistent calyx.

14) Seed:

The seeds are compressed or ellipsoid with a horse-shoe shaped or annular embryo surrounding a mealy endosperm.

15) Pollination:

The aggregation of small flowers into dense and showy inflorescence and presence of nectar in some favour insect pollination.

16) Dispersal:

Some genera, such as Gomphrena, with winged fruits are dispersed by wind. Many genera, such as *Achyranthes, Cyathula* and *Pupalia* develop hooks on the sepals with which they adhere to passing animals or human beings.

17) Floral Formula:

(Male flower) : Br Brl $\oplus$ Γ P_5 A_5 G_0

(Female flower) : Br Brl $\oplus$ E P_5 A_0 $\underline{G}_{(2)}$

Achyranthes aspera : Br Brl $\oplus$ ⚥ P_5 A_5 $\underline{G}_{(3)}$

18) Economic Importance:

The family is of little economic importance. A few are used as food and some are cultivated as garden ornamentals.

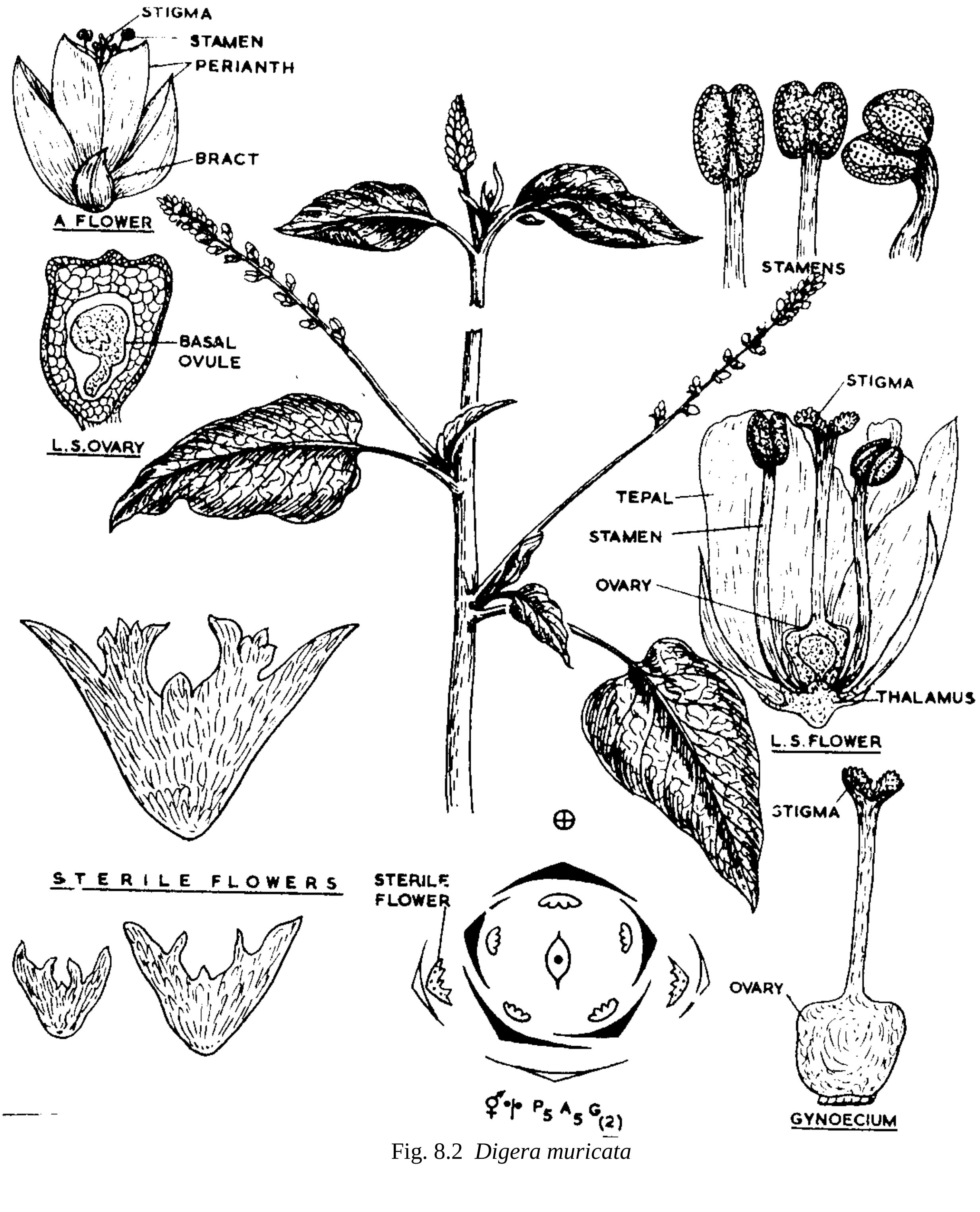

Fig. 8.2 *Digera muricata*

I. Edibles:

Some species of *Amaranthus* (*Amaranth, Chaulai*) such as *A. blitum*, *A. candatus* and *A. hybridus* are grown as pot herbs for their leaves and branch tops which are used as vegetable.

II. Ornamentals:

1) Several species of Amaranthus are grown in gardens for their brightly coloured spikes and variegated foliage, e.g. *A. salicifolius, A. caudatus* var. alapecurus and *A. tricolor*.
2) *Celosia argentea* (Cockscomb)
3) *Gomphrena globosa* (Globe amaranth)
4) *Deeringia amaranthoides*.

III. Medicines:

1) *Achyranthes aspera* **–** It is a much valued plant in indigenous medicine. The flowering spikes ground into paste are used as an external application in poisonous insect bites.
2) *The leaves of Deeringia amaranthoides are applied to sores*.

19) Distinguishing features:

1) Plants mostly herbs or shrubs.
2) Leaves hairy, simple, exstipulate.
3) Inflorescene usually spike, head or cymose panicle.
4) Flowers bisexual, with dry and membranous bracts, bracteoles and perianth.
5) Stamens 5, opposite to perianth lobes.
6) Ovary superior, bicarpellary, syncarpous unilocular.
7) Single ovule on basal placentation.
8) Fruit one seeded nut or utricle.
9) Seeds have a mealy endosperm.

20) Questions:

1. Describe the characters of the family Amaranthaceae. Add a note on its economic importance.
2. Write short notes on:
   (i) Economic importance of Amaranthaceae.
   (ii) Floral characters of Amaranthaceae.

21) Reference Books:

i) **Angiosperms (Systematics & Life Cycle) –** G.L. Chopra, Pradeep Publications, Jalandhar.
ii) **Introductory Taxonomy (Angiosperms) –** Dr. B.S. Trivedi & Dr. B.B.Sharma, Kithab Mahal, Allahabad.
iii) **Taxonomy of Vascular Plants –** G.H.M.Lawrence – Oxford & IBM Publishing Co., New Delhi.

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Ch. E. USHA RANI

8.3 EUPHORBIACEAE

The Spurge Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Monochlamgdeae
Series	Unisexuales
Family	Euphorbiaceae

2) Distribution:

A large and extremely variable family which includes 300 genera and 5,000 species, cosmopolitan in distribution except in the Arctic region but they are most abundant in tropical regions. In India, the family is represented by about 61 genera and 336 species mostly in the tropical and subtropical Himalayas and the mountains of South India.

3) Familiar Plants:

1) *Acalypha indica* (Kuppinta)
2) *Cicca acida* (Racha vsiri)
3) *Emblica officinalis* (Pedda Usiri)
4) *Euphorbia pulcherrima* (Poinsettia)
5) *Hevea brasiliensis* (Para Rubber tree)
6) *Jatropa curcas* (Pedda nepalam)
7) *Manihot esculenta* (Karra pendalam)
8) *Mannihot graziovii*
9) *M. pamata*
10) *Racinus communis* (Amudamu)

4) Vegetative characters:

The family shows a great range in vegetative as well as floral structure. The plants are mostly shrubs (*Euphorbia pulchenima, Jatropha*) or trees (*Ricimus communis, Emblica officinalis, Hevea brasiliensis*) and are rarely herbs as some species of Euphorbia (*E. hirta, E. cristate, E. elegans, E. heterophylla*), *Acalypha, Croton* and *Phyllanthus*. The species of Tragia are climbers. Several species of *Euphorbia* (*E. royleana, E. neriifolia* and *E. trigona*) are cactus-like in habit with thick and fleshy stems and leaves reduced to spines. The plants often contain a milky latex in special laticiferous vessels.

5) Root: Tap root system. In *Manihot*, the root becomes tuberous.

6) Stem: Usually aerial, herbaceous or woody, smooth or ridged. In Xerophytic sp. of *Euphorbia*, stem is green in colour, cylindrical or float.

7) Leaves:

The leaves are usually alternate (opposite in *Choriophyllum* or whorled in *Mischodon*), simple, entire or sometimes deeply palmately lobed (*Racinus* and *Jatropha*) or compound (*Bischofia*). The stipules are usually present and they are represented by ciliate glands (*Jatropha*) or spines (*Euphorbia*). The venation is pinnate or palmate as in Ricinus. In species of *Euphorbia* with cactus-like habit the leaves fall off early and photosynthesis is carried by green stem.

8) Inflorescence:

It is complex. The first branching is usually racemose and the subsequent branchings are cymose. In Euphorbieae (*Euphorbia* and related genera) the inflorescence is a Cyathium which appears as a single flower. Each cyathium is surrounded by an involvucre of four or five connate bracts and between these large and often coloured glands are present which bear petaloid appendage in some (*E. splendens*). In the middle of the cyathium, there is a single female flower (represented by a tricarpellary gynoecium). In the axile of each bract, a number of male flowers (each represented by a single stamen with a joint half way up the stalk) and arranged in scorpiorid cymes. The oldest flower is nearest to the centre and thus the maturation is centrifugal.

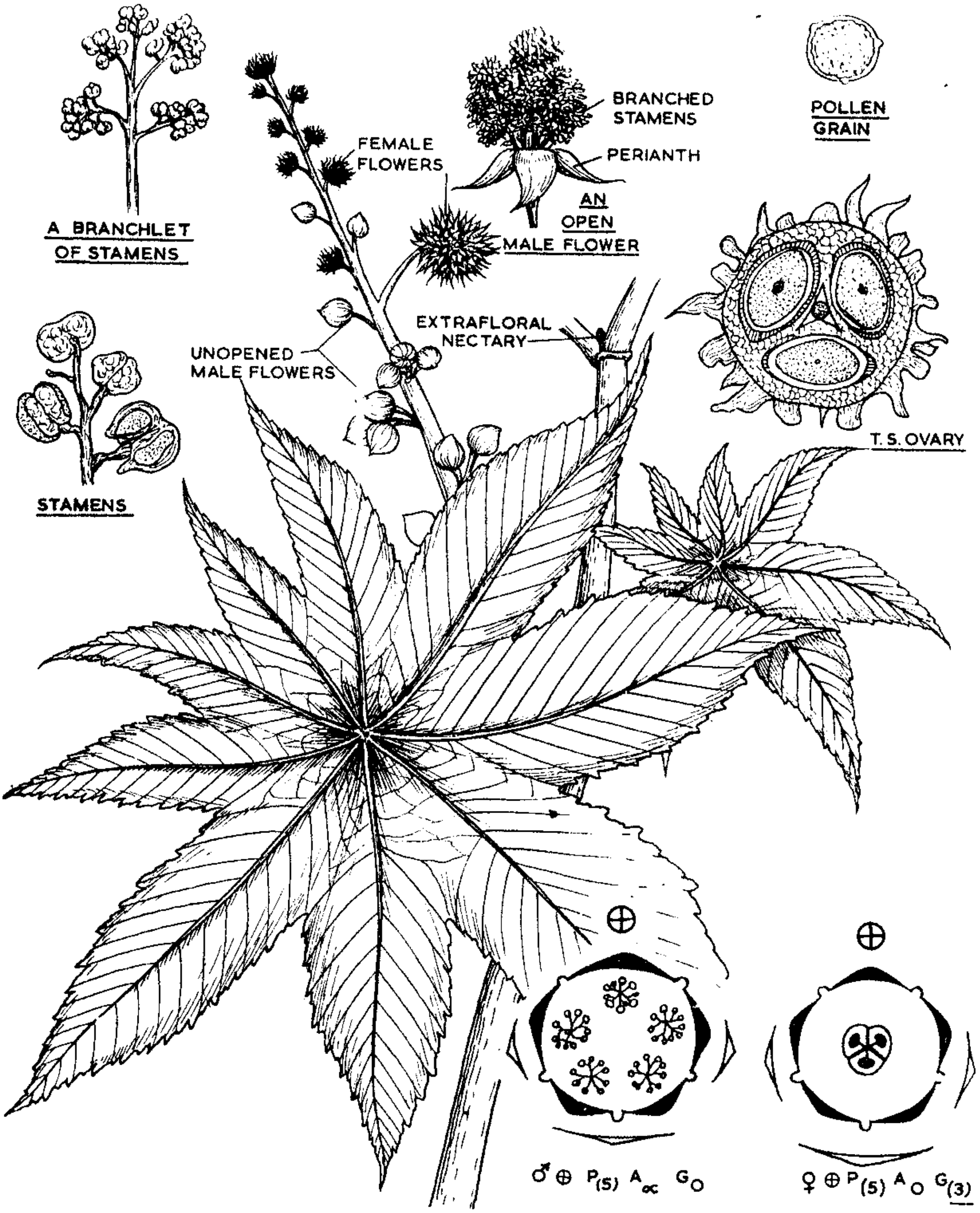

Fig. 8.3 *Ricinus communis* (the castor)

In *Acalypha*, the inflorescene is a catkin, whereas in *Croton* and *Ricinus*, it is a terminal raceme, and in *Jatropha* it is a terminal cyme.

9) Flowers:

The flowers are unisexual, actinomorphic and hypogynous (perigynous in *Bridelia*). They show considerable variation. In *Euphorbia*, both male and female flowers are naked, whereas in *Anthostema* both have a tubular perianth. In the remaining genera of the tribe, the male flowers are naked and the female have a rudimentary perianth.

10) Calyx & 11) Corolla:

Sometimes, as in *Jatropha* both calyx and carolla are present and each has five members. In croton the corolla is distinct in the male flower, whereas it is inconspicuous or absent in the female flowers. The flowers are, however, often apetalous. In *Manihot* the calyx becomes petaloid. In *Ricinus* male flowers have five sepals and the female only three. There are only three or four sepals in *Trewia* and only three in *Mercurialis*. The petals, when present are free or rarely united as in *Jatropha*. The aestivation of the sepals and petals is valvate or imbricate.

12) Androecium:

The number of stamens in the male flowers ranges from one to numerous; one (*Euphorbia*), three (*Breynia*), three to five (*Phyllanthus*), eight (*Acalypha*), 10 in two alternate whorls with the members of the outer whorl opposite, the petals (*Jatropha*), 15 (*Crozophora*) 8 to 20 (*Mercurialis*), 15 to 30 (*Codiaeum*) and 80 to 100 (crotons). The filaments are free or united into a column as in *Breynia* and *Jatropha*. In *Phyllanthus cyclanthera* besides filaments, the anthers are also united into a ring like common anther as in *Cyclanthera*. There are basically five stamens in Ricinus opposite to the sepals which are much branched and the anthers are borne on the ultimate branches. The anthers are monothecous (*Phyllanthus, Ricinus*) or dithecous (*Euphorbia*), erect or inflexed in bud and opening by longitudinal or transverse slits (as in *Euphorbia*). A rudimentary ovary is often present in the male flowers.

An intrastaminal disc is present in flowers with many stamens.

13) Gynoecium:

The gynoecium is tricarpellary (bicarpellary in *Mercurialis*) and syncarpous with a superior (semi-inferior in *Bridelia*) and trilocular ovary. There are one or two collateral, pendulous, anatropous ovules in each locule and the placentation is axile. The styles are three, often bipartite, free or more or less united.

At the base of the ovary, a nectariferous disc is present which is annular or of separate glands.

14) Fruit:

It is usually a three chambered schizocarpic capsule splitting into three one-seeded cocci. Rarely, it is a drupe (*Drypetes*) or a berry (*Bischofia*).

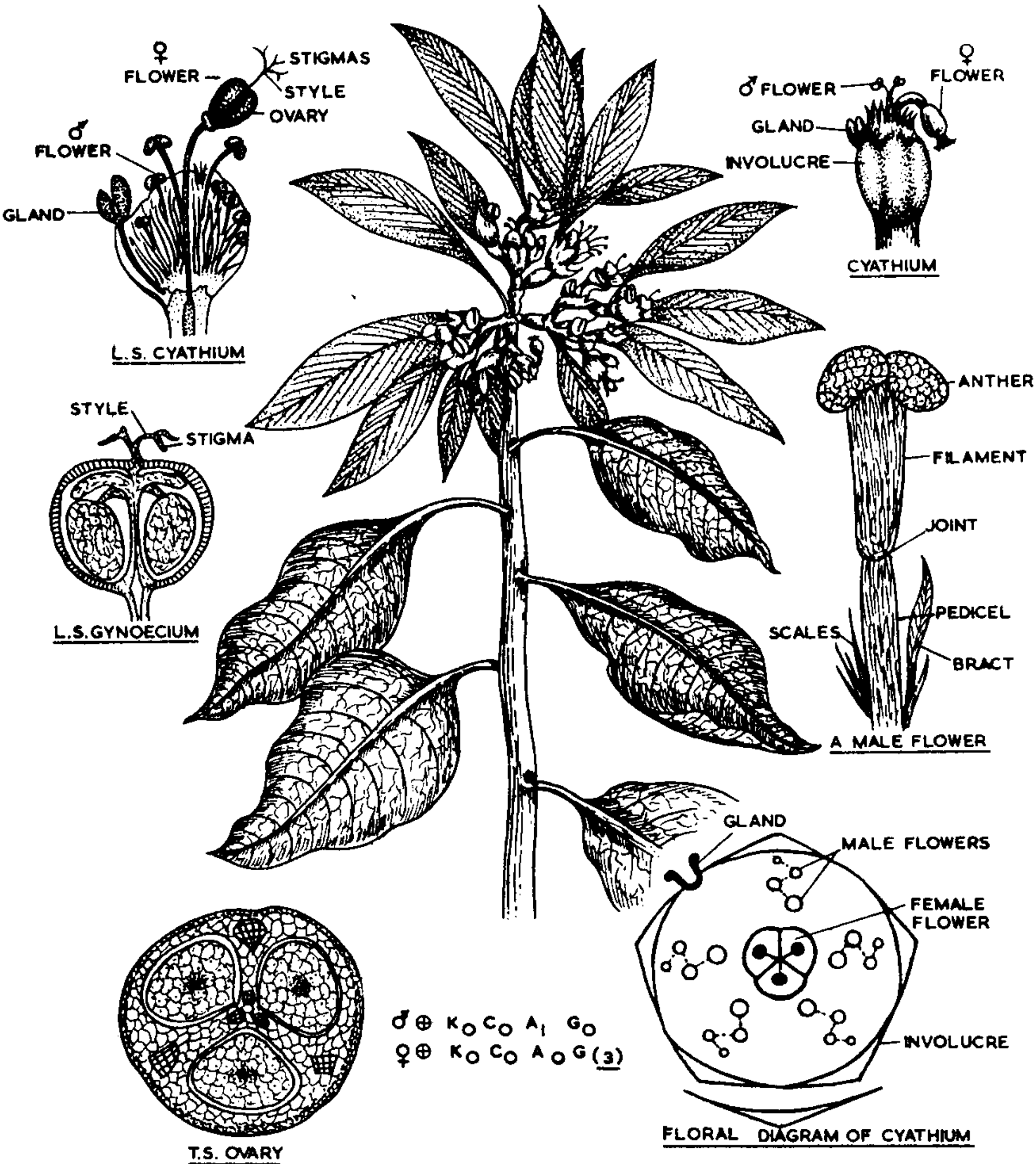

Fig. 8.4 *Euphorbia pulcherrima* (the poinsettia)

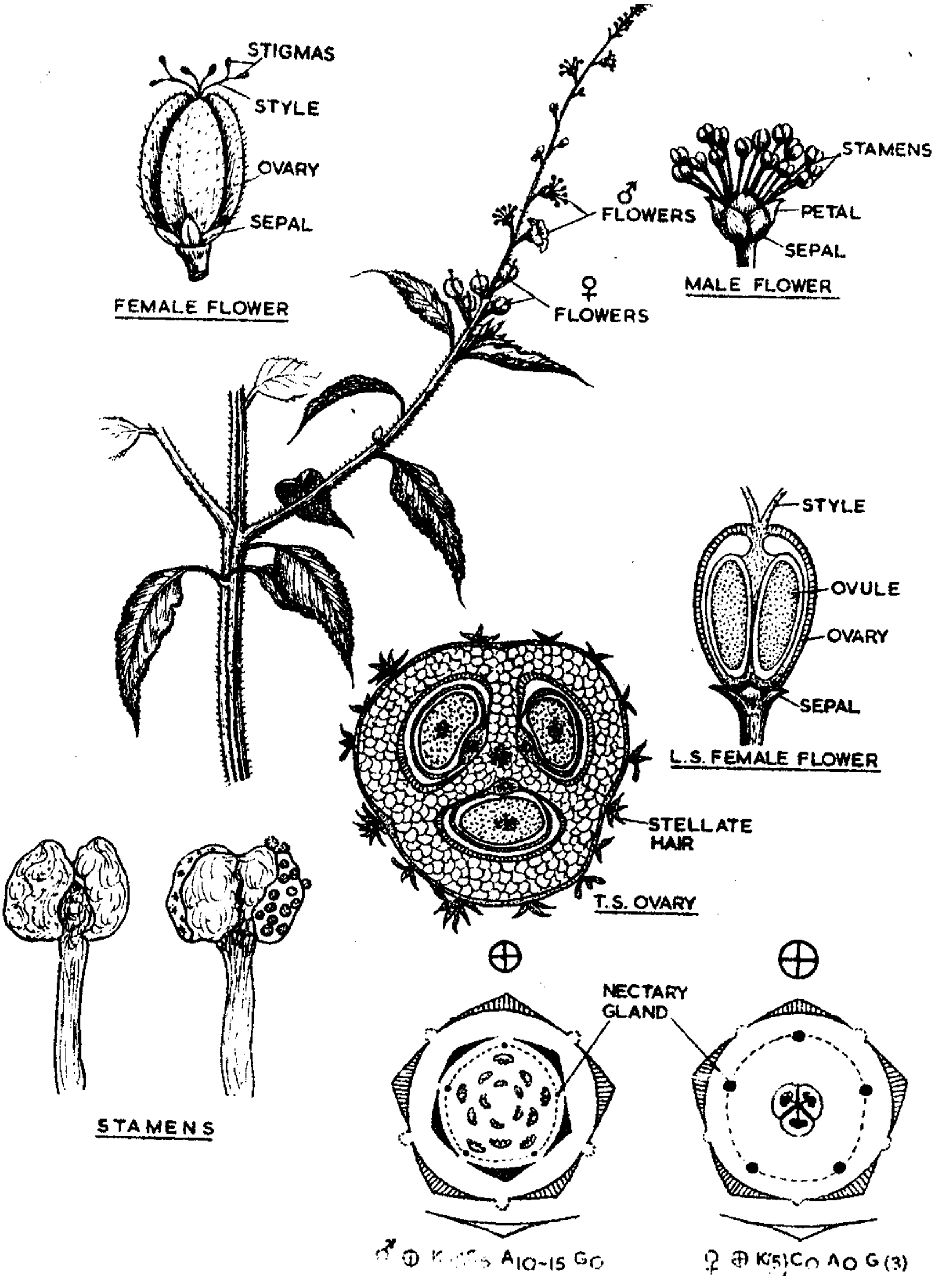

Fig. 8.5 *Croton bonplandutnum*

15) Seed:

They are fleshy endosperm and straight embryo. They are often with a conspicuous caruncle.

16) Pollination:

The presence of unisexual flowers necessiate cross pollination. The presence of brightly coloured glands or bracts, petaloid calyx or nectar favour insect pollination. Certain taxa, such as *Mercurialis,* with long thread-like styles are anemophilous.

17) Dispersal:

Seeds in some, such as *Ricinus* and *Hevea*, are dispersed by the explosive mechanism of the capsules. *Trewia* and some others with buoyant fruits are dispersed by water. Many are dispersed by birds and animals.

18) Floral Formula:

Euphorbia : Male flower : Br $\oplus$ Γ K_0 C_0 A_1 G_0
Female flower: Br $\oplus$ E K_0 C_0 A_0 $\underline{G}_{(3)}$

Ricinus : Male flower : Br $\oplus$ Γ P_5 A_5 G_0
Female flower: Br $\oplus$ E P_3 A_0 $\underline{G}_{(3)}$

Phyllanthus : Male flower : Ebr $\oplus$ Γ P_{3+3} A_3 G_0
Female flower: Ebr $\oplus$ E P_{3+3} A_0 $\underline{G}_3$

Jatropha gossypifolia : Male flower : Br Brl $\oplus$ Γ K_5 C_5 A_{5+5} G_0
Female flower : Br Brl $\oplus$ E K_5 C_5 A_0 $\underline{G}_{(3)}$

19) Economic Importance:

The Euphorbiaceae furnish several valuable commodities, such as food, drugs, rubber and oil.

I. Edibles:

(1) The large fleshy tuberous roots of *Manihot esculenta* (Cassava) is rich in starch and form a valuable food stuff.
(2) The fruit of *Emblica officinalis* (*Emblica myrobalan; Amla*) are a rich source of vitamin ‘C’. They are used as pickles and in the treatment of scurvy.

II. Rubber:

(1) The tree of *Manihot glaziovii* (Manicoba rubber) is tapped for latex made into rubber.

III. Medicines:

(1) The castor oil obtained from the seeds of *Ricinus communis* (castor bean, Arand) is used medicinally as a cathartic and mild laxative.
(2) The seeds of *Jatropha curcas* (Purging nut) are purgative and anthelmintic. The seed oil is used externally for skin disease and rheumatism.

IV. Timbers:

(1) *Bischofia javanica* (Bishop wood, Malkot) is a valuable timber tree used for bridges, boats and rafters.

(2) The wood of *Trewia nudiflora* (False white teak) is largely used for packing cases, tea boxes and in match industry.

V. Ornamentals:

Some notable ornamentals include:

1. *Codiaeum variegatum* (croton)
2. *Pedilanthus tithymaloides* (Red bird - Cactus)
3. *Jatropha – J. Podagrica, J. panduraefolia* and *J. gossypifolia.*
4. *Euphorbia* – Several *Euphorbias* are commonly planted as hedges, shrubberies and on rockeries in gardens, e.g. *E. pulchenima* syn. *Poinsettia pulcheornina* (Poinsettia), *E. milis* syn. *E. splenders* (crown of thorns), *E. tirucalli* (Milk bush), *E. neriifolia* (Sehund), *E. antiquorum* (Tidhara sehnd).

20) Distinguishing features:

1) Mostly shrubs, trees and a few are herbs.
2) Xerophytic habit in many genera.
3) Milky latex in vegetative parts.
4) Leaves simple, stipulate and alternate.
5) Inflorescence variable, cyathium is characteristic feature.
6) Flowers unisexual, hypogynous and regular.
7) Parianth in one or two whorls or absent.
8) Stamens one to many, free or united.
9) Ovary tricarpellary, trilocular, pendulous ovules on axile placentation.
10) Styles 3, stigmas bifid.
11) Fruit a schizocarpic regma consisting of three cocci.

21) Questions:

1. Enumerate the floral characters of Euphorbiaceae. Mention the botanical names of any five plants of economic importance and their use.
2. Write short notes on:
   (a) Economic importance of Euphorbiaceae.
   (b) Cyathium in Euphorbiaceae.

22) Reference Books:

i) Taxonomy of Angiosperms – B.P.Pandey, S.Chand & Co. Ltd., New Delhi.
ii) A Text Book of Botany – Dr. V. Singh, Dr. P.C. Pande and Dr. G.K. Jain, Rasthogi Publications, Meerut.
iii) Introductory Taxonomy (Angiosperms) – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

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Ch. E. USHA RANI

Unit-III

Class : Dicotyledons
Subclass : Gamopetalae
Series : Inferae
Orders : Rubiales &Asterales

Lesson 9

TAXONOMY AND ECONOMIC IMPORTANCE OF THE FAMILIES BELONGING TO THE ORDERS RUBIALES AND ASTERALES OF THE SERIES INFERAE IN SUBCLASS GAMOPETALAE

OBJECTIVES

⇒ To study the vegetative and floral characters of the families in the orders Rubiales & Asterales.
⇒ To compare the characters of different families in Rubiales and Asterales.
⇒ To know the economic importance of plants in Rubiales and Asterales.

CONTENTS

9.1 Sub-class: Gamopetalae
9.1.1 Characteristic features of sub-class: Gamopetalae
1) Corolla of united petals
2) Epipetalous stamens
9.1.2 Classification: Sub-class Gamopetalae has three series:
a) Inferae b) Heteromerae c) Bicarpellatae

a) Series : Inferae

1. Ovary inferior
2. Orders include: 1) Rubiales) Asterales

1) Order: Rubiales

1. Flowers regular to zygomorphic
2. Stamens epipetalous
3. Ovary o-many locular with 1-many ovules in each locule
4. Family included → **Rubiaceae**

2) Order: Asterales

1. Flowers regular or zygomorphic
2. Stamens epipetalous
3. Ovary unilocular with a single ovule
4. Family included → **Asteraceae**

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9.2 R U B I A C E A E

(The Madder Family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Gamopetalae
Series	Inferae
Order	Rubiales
Family	Rubiaceae

2) Distribution:

The Rubiaceae are a very large family of 500 genera and 6,000 species mostly tropical but some grow in the temperate zone and a few species of Galium even occur in the arctic region. In India, the family is represented by about 76 genera and 274 species.

3) Familiar Plants:

1. *Adina cordifolia* (Haldu)
2. Anthocephalus cadamba (Kadam)
3. *Cinchona spp.* (Quinine)
4. *Coffee arabica* (Coffee)
5. *Hamelia patens*
6. *Ixora* spp. (Ixora)
7. *Mussaendra frondosa*
8. *Oldenlandia umbellata* (Indian madder)
9. *R. uliginosa* (Balusaku)
10. *Randia dumatorum* (Madana)

4) Vegetative characters:

The members are mostly trees and shrubs. Infrequently they are herbs as species of *Borreria, Ruhia* and *Galium* and sometimes they are woody climbers (*Paederia*).

5) Root: Tap root.

6) Stem:

Aerial, erect, woody or herbaceous. In *Canthimum* axillary buds are modified into thorns.

7) Leaves:

The leaves are opposite decussate or sometimes whorled (*Galium*), simple, entire and stipulate. The stipules show much variation in form. They are frequently interpetiolar (the stipules stand between the petioles) or intrapetiolar (the stipules stand between the petiole and the axis). The two stipules, one from each leaf of a pair are often united. Sometimes, as in *Gardenia* and related genera, the four stipules are united into a conical cap which is thrown off as the bud opens. In *Galium* and related genera the stipules become foliar and are indistinguishable from the leaves. The stipules are reduced to plandular setae in *Pentas*.

Inflorescence and Flower

8) Inflorescence:

The inflorescence is basically a dichasial cyme and sometimes, the small flowered cymes are aggregated into dense head as in *Anthocephalus* and *Adina*. Rarely, the flowers are solitary as in *Gardenia*, and in *Coflea* one to three flowers stand in the axil of a leaf.

9) Flower:

The flowers are actinomorphic (or slightly zygomorphic), bisexual, tetra - or pentamerous and epigynous.

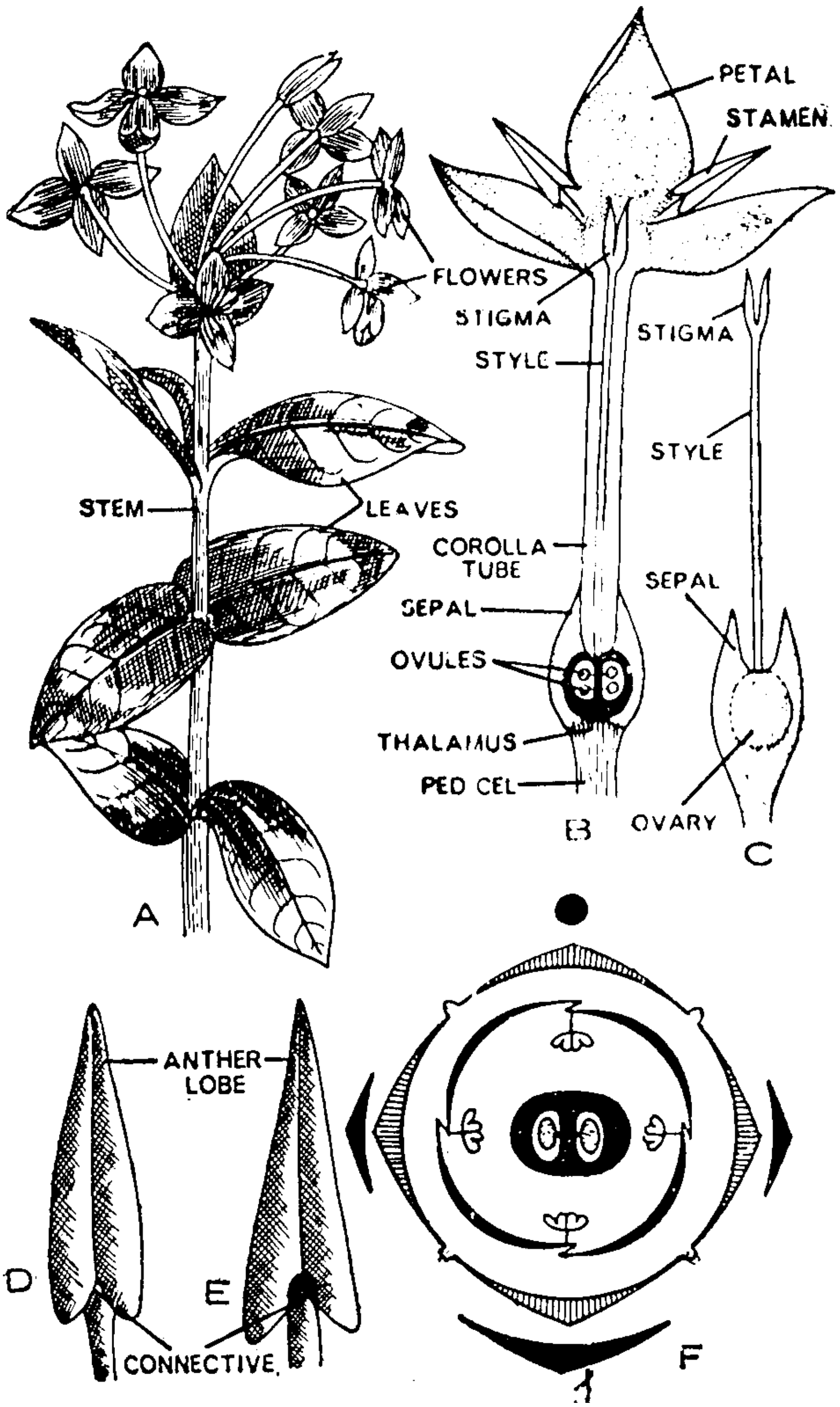

Fig. 9.1 Rubiaceae – *Ixora coccinea*

10) Calyx:

The calyx consists of four or five free sepals and the aestivation is valvate. Sometimes, as in Mussaenda, one of the sepals in one or more flowers of an inflorescence becomes brightly coloured.

11) Corolla:

The corolla is of four or five fused petals and is salverform, rotate or funnel form. The petal lobes are valvate, twisted or imbricate in bud.

12) Androecium:

The stamens are as many as the number of corolla lobes and they alternate with them. They are epipetalous and inserted in or at the mouth of the corolla tube. The anthers are dithecous, introrse and opening lengthwise.

13) Gynoecium:

The gynoecium is usually bicarpellary and syncarpous. The ovary is inferior (rarely semi inferior in *Gaertnera*) and bilocular with axile placentation. There is one (*Coffea)* or numerous (*Cinchona*) ovules in each locule. Sometimes the placenta is T-shaped (*Mussaenda*) or stalked spherical (*Oldenlandia*). In *Gardenia*, the ovary is unilocular with parietal placentation. The style is simple and the stigma is capitate or bilobed.

14) Fruit:

The fruit is usually a septicidal or loculicidal capsule. Sometimes it is a berry (*Coffea*) or schzocarpic, separating in one seeded segments (*Gulium*).

15) Seeds:

The seeds are mostly endospermic with straight or curved embryo.

16) Pollination:

The pollination is brought about by the agency of insects. The flowers of *Mussaenda* are rendered conspicuous by the development of brightly coloured petaloid lobes. The necter is secreted by an epigynous disc. The wide occurrence of heterostyly in several genera, such as *Borreria, Knoxia* and *Cinchona,* and protandry (*Galium*) favour cross pollination.

17) Dispersal:

Sticky fruits and persistent calyx limbs often favour their distribution by birds and animals. Sometimes the seeds are winged and are dispersed by wind.

18) Formula:

Br Brl % or $\oplus$ ⚥ K_5 $C_{(5)} \leftarrow A_{(5)}$ $\overline{G}_2$

19) Economic Importance:

The family is of considerable importance as the source of coffee beans, cinchona bark, dyes timber and several ornamentals.

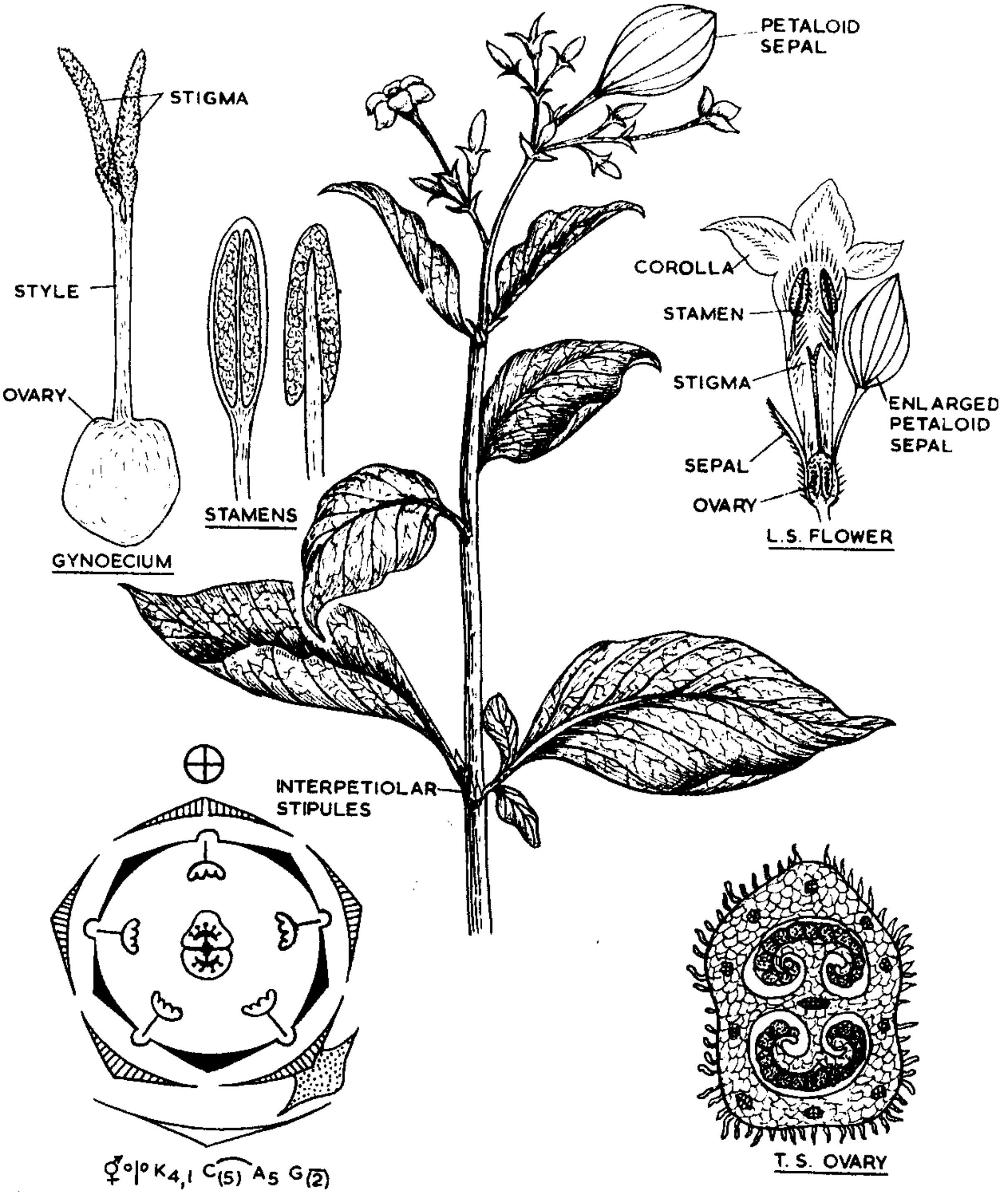

Fig. 9.2 *Mussaenda frondosa*

Beverages: The seeds of *Coffee arabica* (Arabian coffee) provide highest quality of coffee. *C. liberica* (Liberian coffee) and *C. canephora* (Robusta coffee) are other species which provide inferior grades of coffee.

Medicines:

1. The bark of several species of *Cinchona,* such as *C. calisaya, C. ledgeriana,* C *officinalis* and *C. succirubra* is the commercial source of the valuable drug Quinine, used in the treatment of malarial fever.

2. The roots of *Cephaelis ipecachuanha* are the source of a well known drug Ipecachuanha, an excellent remedy of the treatment of amoebic dysentery.

3. The fruit pulp of *Randia tinctoria* (Common emetic nut) is emetic and anthelmintic. The fruit extract possesses insecticidal and insect repellent properties.

Dyes: The roots of *Rubia tinctoria* (Madder) contain a dye, Alizarin. It was widely cultivated before the introduction of aniline dyes.

Timbers: Some species, such as *Adina cordifolia* (Haldu), *Anthocephalus cadamba* (Kadam), *Mitragyna parviflora* (Phaldu), and *Randia spinosa* provide useful timber.

Ornamentals: The family provides a number of ornamentals:

1. *Anthocephalus cadamba* (Kadam), *Mitragyna parviflora* (Phaldu), *Morinda coreia syn. Morinda tinctoria* are cultivated along roadsides and in public gardens.
2. *Ixora – I. coccinea, I. arborea syn. parviflora* (The torch tree).
3. *Gardenia* (Cape jasmine) - *G. jasminoides, G. gummifera.*
4. *Mussaenda - M. frondosa, M. luteola.*
5. *Spermadictyon suaveolens syn. Hamiltonia suaveolens* (Padera).
6. *Hamelia patens.*
7. *Pentas lanceolata.*
8. *Galium* spp.

20) Distinguishing characters:

1. Leaves simple, opposite decussate phyllotaxy.
2. Stipulate, stipules inter – or intrapetiolar.
3. Inflorescence a cyme or cymose panicle or Umbel.
4. Flowers bisexual, regular, epigynous, 4-5 merous.
5. Sepals 4-5, gamosepalous, valvate, persistant.
6. Petals 4-5, gamopetalous, tubular.
7. Stamens 4-5, epipetalous.
8. Carpels 2, syncarpous, bilocular, inferior, style long and stigma bifid.

9. Ovules 1 – many in each locule on axile placentation.
10. Fruit capsule, berry or drupe.
11. Seeds often winged.

21) Questions:

1. Describe the vegetative and floral characters of the family Rubiaceae.
2. Write short notes on:
   (i) Economic importance of Rubiaceae.
   (ii) Distinguishing characters of Rubiaceae

22) Reference Books:

i) **Taxonomy of Angiosperms –** B.P.Pandey, S.Chand & Co. Ltd., New Delhi.
ii) **Introductory Taxonomy (Angiosperms) –** Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.
iii) **Taxonomy of Vascular Plants –** G.H.M. Lawrence, Oxford & IBH Publishing Co., New Delhi.

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CH.E. USHA RANI

9.3 ASTERACEAE

ORDER : ASTERALES

Order Asterales commonly known as compositae includes four families, comprising mostly herbs and rarely woody shrubs or trees, Flowers bisexual or unisexual by suppression of one of the essential whorls, epigynous, actionmorphic or zygomorphic mostly in heads (capitula) ovary inferior, 1 or more - celled; ovule 1 - many.

Family I. COMPOSITAE (ASTERACEAE)

(The Sunflower family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic Position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dictotyledonae
Sub-class	Gamopetalae
Series	Inferae
Order	Asterales
Family	Compositae (Asteraceae)

2) Distribution:

The Asteraceae are one of the largest family of the flowering plants comprising about 900 genera and over 13,000 species. They form more than ten percent of the total number of species of flowering plants. They are distributed throughout the world inhabiting every conceivable situation. In India, the family is represented by about 138 genera and 708 species.

3) Familiar Plants:

1. *Ageratum conyzoides* (Goat weed)
2. *Aritemisia nilagirica* (Machipatri)
3. *Chrysanthemum indicum* (Chamanthi)
4. *Cichorium intybus* (Chickory)
5. *Cosmos sulphureus* (yellow cosmos)
6. *Eclipta prostrata* (Guntagalagara Aku)
7. *Helianthus annuus* (Poddutirugudu)
8. *Parthenium hysterophorus* (Pichi machipatri)
9. *Solidago canadensis* (Golden rod)
10. *Tagetus patula* (Banti)
11. *Tridax procumbens* (Gaddichamanti)
12. *Taraxacum officinale* (Dandelion)

4) Vegetative Characters:

The plants are mostly annual or perennial herbs *Tgridax, Tagetus, Chrysanthemum* but a few are shrubs or trees *(Vernonia arborea)* or woody climbers *(Mikamia)*, Marsh plants (*Caesulia*) occasionally occur in the family.

A few species like *Helianthus tuberosus* (Jerusalem artichoke) produce stem tubers or rhizomes, whereas tuberous roots are present in Dahlia. Many species have milky sap. The roots and stems contain oil passages.

5) Root:

Tap root, In *Dahlia* the adventitious roots become Tuberous roots.

6) Stem:

Ariel, in *Helianthus tuberosus*. It is underground in and tuberous.

7) Leaves:

The leaves are alternate (*Vernonia*) rarely opposite (*Helianthus*) or whorled *(Eupatorium),* simple or pinnately or palmately lobed, divided or compound and exstipulate. Sometimes leaves are present in basal rosette as in *Taraxacum*.

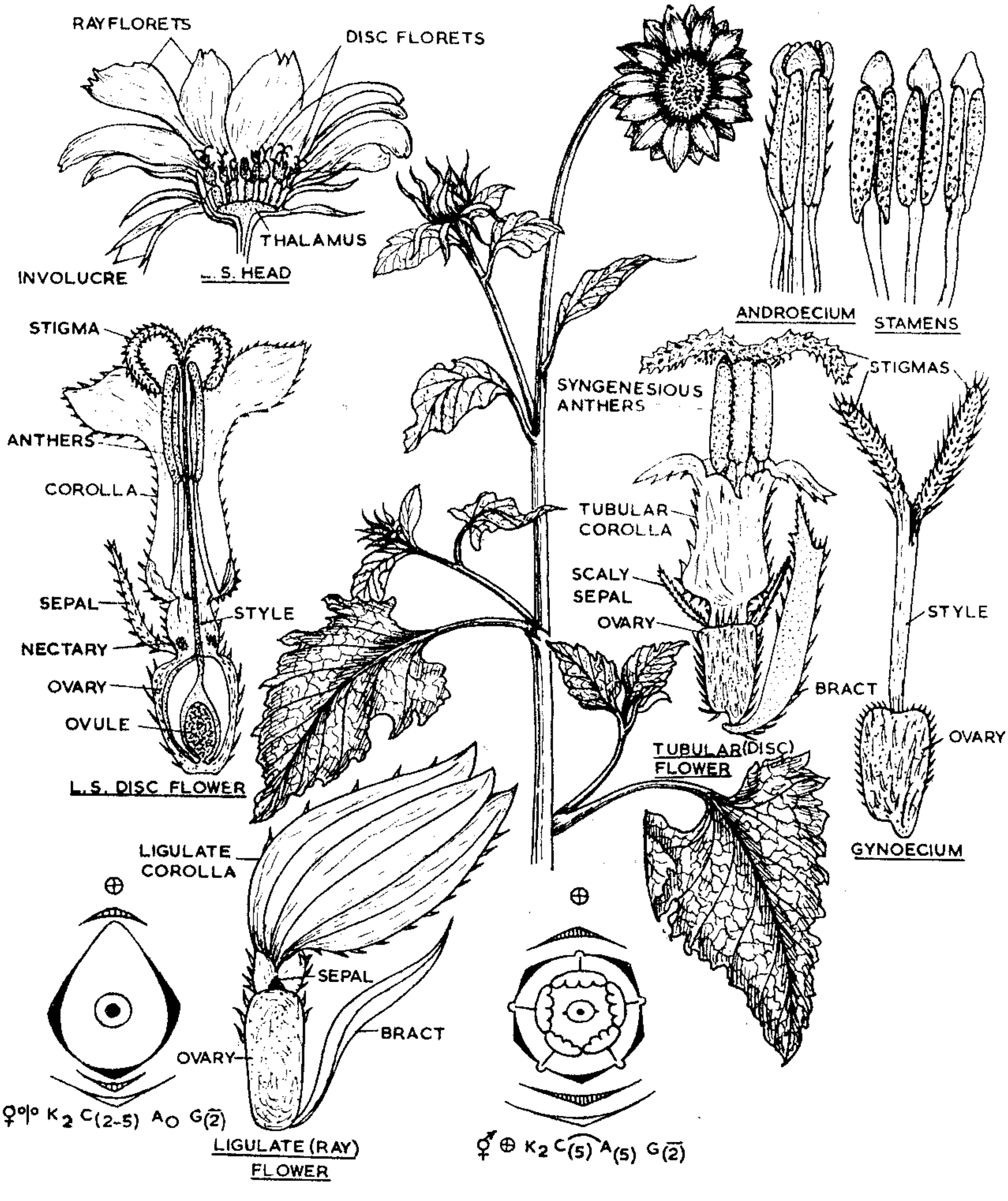

Fig. 9.3 *Helianthus annuus*

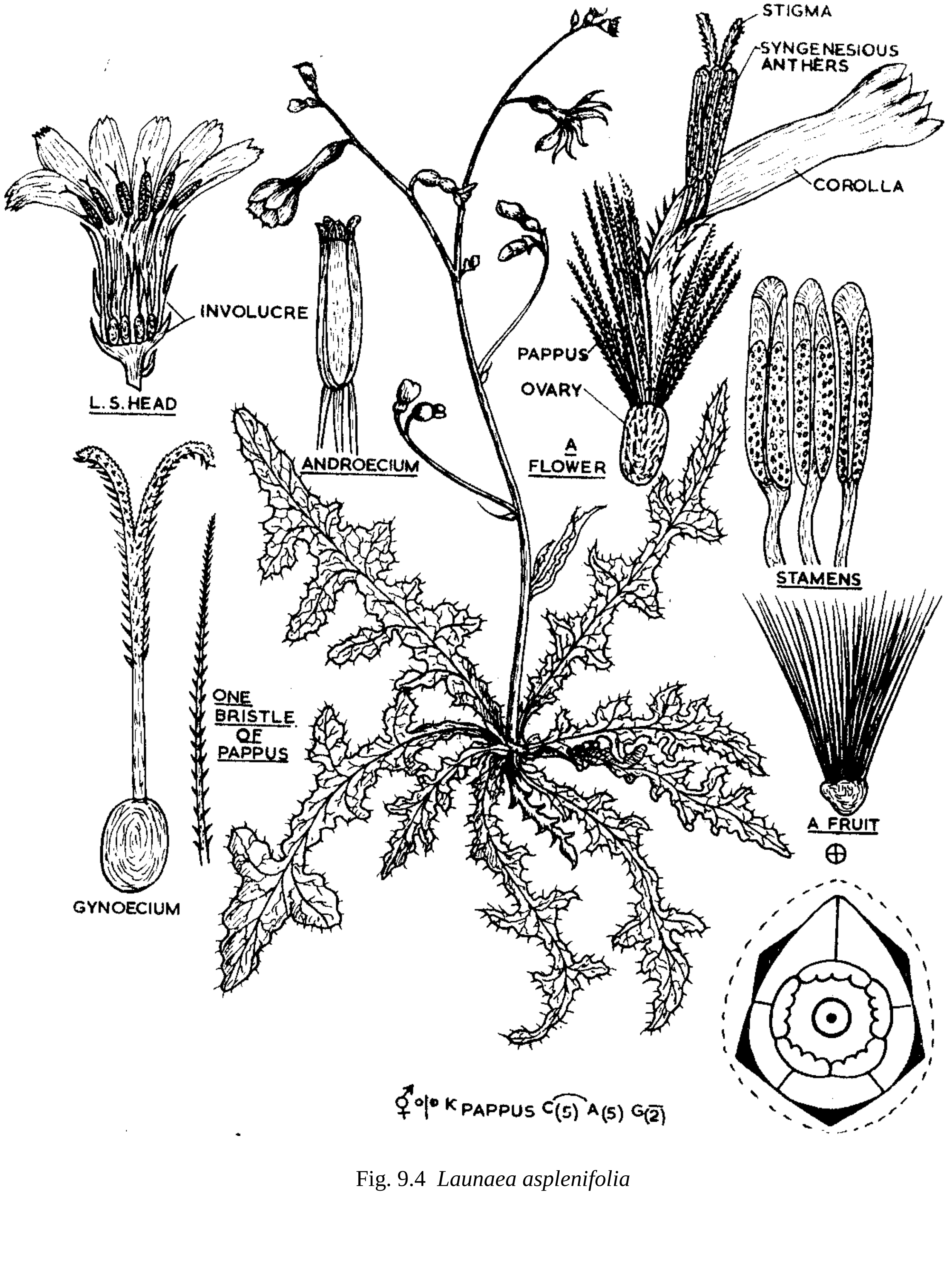

Fig. 9.4 *Launaea asplenifolia*

8) Inflorescence:

The primary inflorescence is a racemose head or capitulum. The primary heads are often usually arranged into larger inflorescences, such as racemes, corymbs or compound heads. Each head is subtended by an involucre of green or membranous bracts which are protective in function. The number of flowers (florets) in a head varies from few to many (*Helianthus*) but sometimes as in *Echinops*, the heads are reduced to a single flower. The receptacle may be flat (*Helianthus*), concave, convex or very much elongated and cone-like.

9) Flower:

The flowers are mostly bisexual, sometimes unisexual or neutral, pentamerous and eigynous. The form of flowers varies in a head and the heads may be homogamous or heterogamous. In homogamous heads all florets are alike in structure and function, and they are bisexual and either regular (tubular) *(Vernonia, Eupatorium and Ageratum)* or ligulate (*Cichorium, Taraxacum and Lactuca).* In heterogamous heads e.g. *Helianthus*, there is a distinction into central disc florets which are actionomorphic and bisexual and peripheral ray forests which are ligulate and generally pistillate or neutral.

10) Calyx:

The Calyx is sometimes altogether absent (*Siegesbeckia)* or represented by a scarious five lobed rim at the top of the ovary (*Ageratum).* Usually, it is represented by pappus or hairs or bristles.

11) Corolla:

The Corolla is of five fused petals. It may be tubular with distinct tube and five small equal lobes or ligulate (strap shaped) with three to five teeth at the end or it is bilabiate, in which the upper lip is three lobed and the lower lip is two lobed, the aestivation is valvate.

12) Androecium:

The androecium consists of five, epipetalous and syngenesious stamens. The anthers are dithecous, introse and opening by the longitudinal slits.

13) Gynoecium:

The Gynoceium is bicarpellary and syncarpous. The ovary is inferior and unilocular with a single basal anatropous ovule. The style is mostly bifid or bilobed with the stigmas of various forms. A nectariferous disc is present at the top of the ovary.

14) Fruit:

Cypsela is the characteristic fruit of the family. It is often compressed and crowned by a pappus comprised of hairs, plumes, barbs or scales.

15) Seed:

The Seeds are non-endospermic and with a straight embryo.

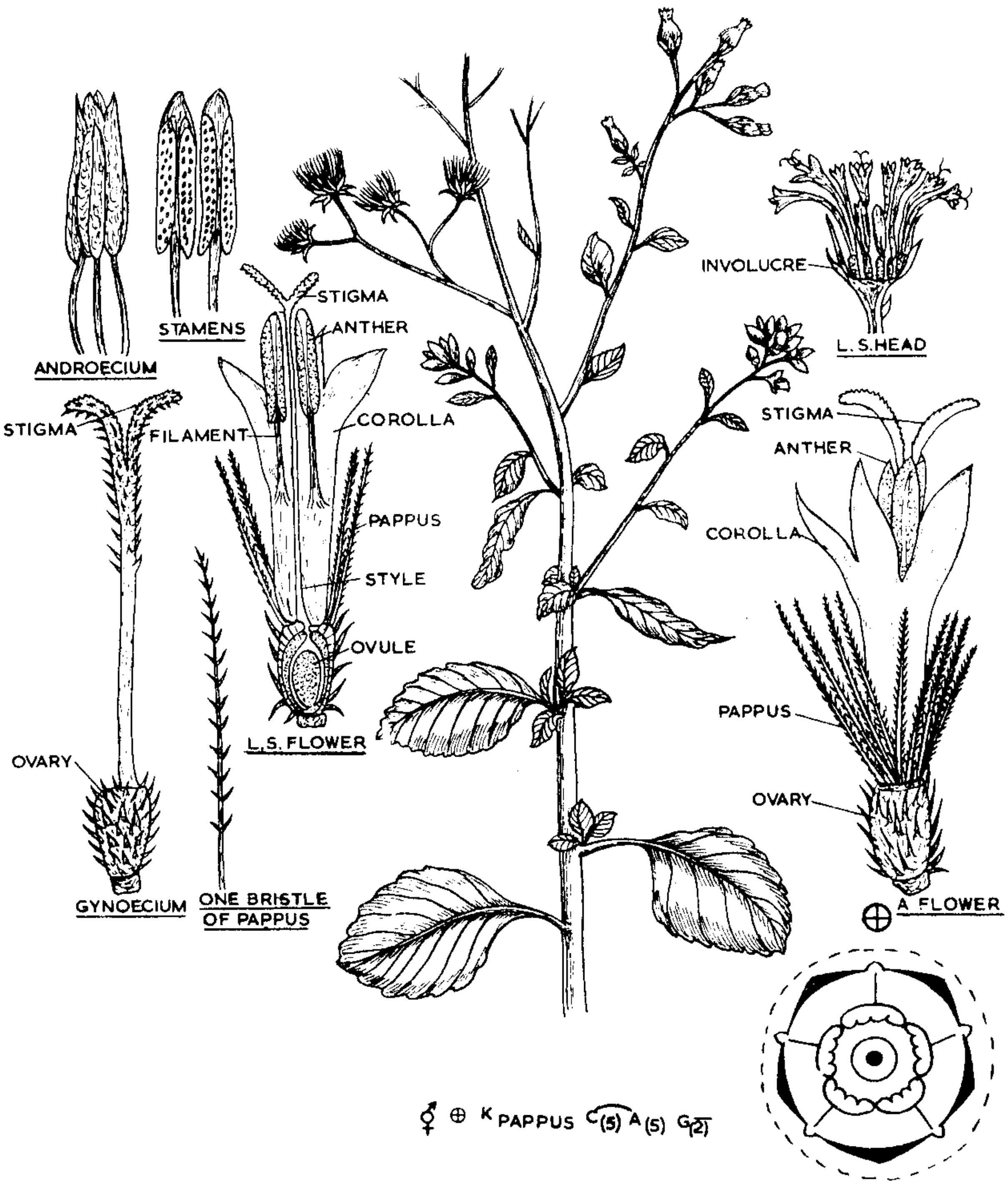

Fig. 9.5 *Vernonia* sp.

16) Pollination:

The Asteraceae are cross pollinated by a large variety of insects. Small flowers are rendered conspicuous by aggregation into heads. Single visit of insect may pollinate large number of flowers. The nectar is secreted by a ring shaped disc around the base of the style and collects in corolla tube which is accessible to a wide variety of insects. In the absence of cross-pollination, self-pollination may occur in several taxa.

17) Dispersal:

Those fruits which have a pappus of plumes or hairs are adapted for wind dispersal. The pappus of *Taraxacum* enlarges into a parchute. Hooked bristles on the pappus of *Bidens* and the development of hooked spines on the fruiting receptacle in *Xanthiuk* favour their distribution by birds and animals to the feather or fur of which they cling.

18) Floral Formulae:

Ray floret: $\mathrm{Br}\ \%\ \mathrm{E}_{\text{or neuter}}\ \mathrm{K}_{\text{pappus}}\ \mathrm{C}_{(2/3)\text{ or }0/5} \leftarrow \mathrm{A}_0\ \mathrm{G}_2$

Dis floret: $\mathrm{Br} \oplus ♀^{\nearrow}_{\text{or neuter}}\ \mathrm{K}_{\text{pappus}}\ \mathrm{C}_{(5)} \leftarrow \mathrm{A}_{(5)}\ \mathrm{G}_2$

19) Economic Importance:

The family yields some food, oil yielding and medicinal plant besides a number of ornamental plants.

(i) **Edibles:** The leaves of *Lactuca sativa* is used in salads.

(ii) The roots of *Chichorium intybus* (Chicory) are used for blending coffee.

(iii) Oils:

(1) The seeds of *Helianthus annuus* (Sunflower) are the source of an edible fatty oil.
(2) The Oil obtained from the seeds of *Carthamus tinctorius* is useful for heart patients. Besides, it is used for the manufacture of soaps, paints, varnishes, linoleum etc.
(3) *Tagetes minuta* and *T. patula* yield a strong aromatic essential oil which is used as an antiseptic, a fly repellent and a modifier in hair lotions. It is also used in high grade perfumes.

IV. Medicines:

(1) The flower heads of *Splianthes paniculata* are chewed to relieve toothache and affections of throat and gum. It is also a popular remedy for stammering in Children.
(2) The dried ligulate florets of *Calendula officinalis* from the drug Calendula, used in the treatment of sprains and bruises.
(3) Flowering tops and leaves of *Tanacetum vulgare* yields an essential of employed as a linament for gout, rheumatism and chronic ulcers.

(4) The leaves of *Blumea balsamifera* yield an essential oil known as Blumea camphor, and the leaf extract is used in the treatment of excitement and insomnia.

V. Ornamentals:

Species of a large number of genera are cultivated as ornamentals. The important ones are:

1) Helianthus annuus (Sunflower).
2) *T. erecta* and *T. patula*.
3) Dahila *pinnata*.
4) Chrysanthemum *carinatum*, *C. coronarium*, *C. cinerariaefoliumk* and *C. morifolum*.
5) Cosmos *bipinnatus*.
6) Zinnia *elegans* and *Z. linearis*.
7) Aster *amellus* and *A. grandeiflorus*.
8) Galillardia *pulchella.*
9) Calendula *officinalis*

20) Distinguishing Characters:

1. Plants mostly herbs, some are climbers.
2. Leaves simple, exstipulate, alternate or opposite.
3. Homogamous or heterogamous heads.
4. Flowers epigynous, actinomorphic or zygomorphic, unisexual and bisexual.
5. Florets are of two types - ray florets and disc florets.
6. Calyx reduced to pappus hairs.
7. Stamens 5, epipetalous with syngenesious anthers.
8. Ovary inferior, bacarpellary, syncarpous, unilocular
9. Single basal anatropous ovule.
10. Style simple, stima bifid.
11. Cypsela fruit.

21) Questions:

1. Bring out the floral characters of Asteraceae with the help of neat labelled diagrams.
2. <u>Write short notes on</u>:
   (i) Economic importance of Asterallceae.
   (ii) Pollination in Asteraceae.

22) Reference Books:

i) Taxonomy of Vascular Plants – G.H.M. Lawrence, Oxford & IBH Publishing Co., New Delhi.
ii) Introductory Taxonomy (Angiosperms) – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.
iii) Taxonomy of Angiosperms – B.P. Pandey, S. Chand & Co. Ltd., New Delhi.

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Ch. E. USHA RANI

Unit-III

Class : Dicotyledons
Subclass : Gamopetalae
Series : Heteromerae & Bicarpellatae
Orders : Ebenales & Gentianales

Lesson 10

TAXONOMY AND THE ECONOMIC IMPORTANCE OF THE FAMILIES BELONGING TO THE ORDERS EBENALES AND GENTIANALES OF THE SERIES HETEROMERAE AND BICARPELLATAE

OBJECTIVES

⇒ To study the vegetative and floral characters of the families in the orders Ebenales and Gentianales.
⇒ To compare the characters of the different families in Ebenales and Gentianales.
⇒ To know the economic importance of the plants in Ebenales and Gentianales.

CONTENTS

10.1 Series Heteromerae & Bicarpellatae

10.1.1 Characteristic features of Heteromerae

1) Ovary usually superior
2) Stamens as many or twice as many as the corolla lobes
3) Carpels more than 2.
4) Order included → a) Ebenales

a)Ebenales:

1) Flowers regular
2) Stamens usually more than corolla lobes
3) Ovary 2-many locular with few ovules in each locule
4) Family included → **Sapotaceae**

10.1.2 Characteristic features of Bicarpellatae

1) Ovary superior
2) Stamens as many or fewer than corolla lobes
3) Carpels usually 2
4) Order included → a) Gentianales

a) Gentianales:

1) Flowers regular
2) Stamens as many as corolla lobes
3) Leaves usually opposite
4) Family included → **Asclepiadaceae**

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10.2 SAPOTACEAE
(The Sapodilla Family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Gamopetalae
Series	Heteromerae
Order	Ebenales
Family	Sapotaceae

2) Distribution:

This is a small family comprising about 40 genera and 800 species. The plants are distributed mainly in tropical and subtropical regions. In India, over 12 genera and 32 species are found in the plains.

3) Familiar Plants:

1. *Achras sapota* (Sapota)
2. *Butyrospermum parkii*
3. *Madhuca longifolia* (Ippa)
4. *Manilkara hexandra* (Palapandu chettu)
5. *Mimosops elengii* (Pogada)
6. *Palaquium gutta* (Gutta percha)
7. *Payana lerri*
8. *Reptonia buxifolia*
9. *Sideroxylon tomentosum*
10. *Sodaroxylon assamicum*

4) Vegetative characters:

They are trees or shrubs. *Reptonia buxifolia* with young parts often rusty tomentose. The plants contain a milky juice present in secretory pages in the pith and cortex of the stem and in the leaves.

5) Root: Tap root.

6) Stem: Woody, erect, branched.

7) Leaves:

The leaves are alternate (rarely subopposite as in *Sarcosperma*), simple, entire, petioled and coriaceous or leathery. Stipules are usually absent but sometimes very caducous stipules are present as in *Sarcosperma*.

8) Inflorescence:

The flowers are solitary or in cymose clusters in the axils. In *Sarcosperma*, the flowers are arranged in simple or compound panicles. Sometimes, as in *Dischopsis* and *Madhuca*, the flowers are borne on old branches (*Cauliflorous*).

9) Flower:

The flowers are bisexual, actinomorphic and hypogynous.

10) Calyx:

The calyx has four to eight sepals which are usually united at the base. They are arranged in two or one series (e.g. 2+2, 3+3, 4+4) or 5. The calyx lobes are imbricate but when the calyx is biseriate, the outer series is valvate and persistent.

11) Corolla:

The corolla is gamopetalous but the corolla tube is shorter than calyx tube. The corolla lobes are usually as many as the calyx lobes and alternate with them and sometimes twice as many as the calyx lobes. In *Mimusops* each petal has two dorsal outgrowths from the base which resemble the other petal lobes. The petal lobes are imbricate in bud.

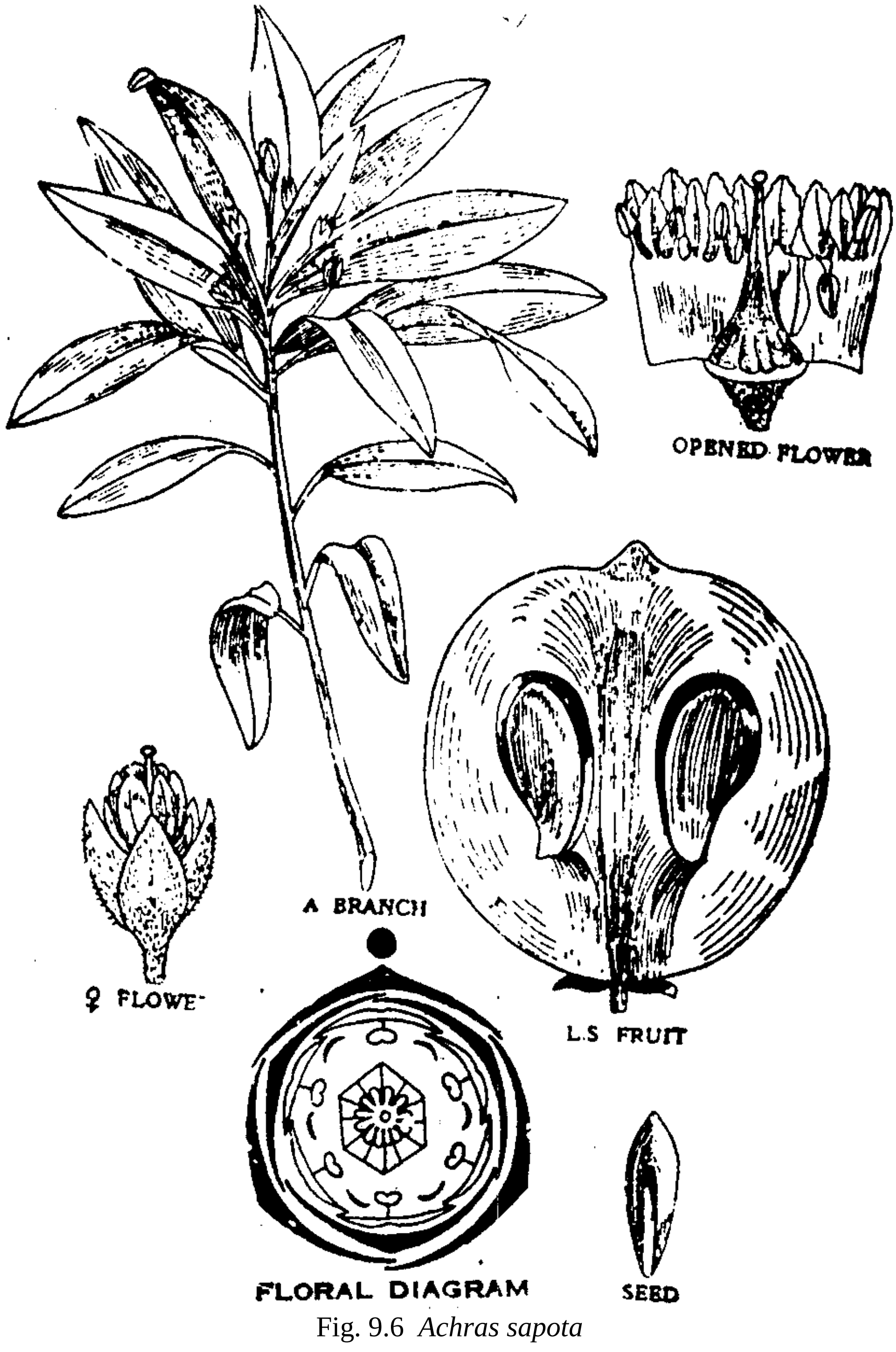

Fig. 9.6 *Achras sapota*

12) Androecium:

The stamens are inserted upon the corolla tube. They are usually as many as the corolla lobes and lie opposite to the corolla lobes. Sometimes (*Madhuca*) the stamens are two to three times as many as the corolloa lobes and then they are two- or three- seriate. The outer statemens are sometimes reduced to staminodes as in *Minusops*. The filaments are usually short. The anthers are oblong-lanceolate, dithecous and commonly extrorse. The connective is often produced beyond the anthers.

13) Gynoecium:

The gynoecium has two to eight synacarpous carpels. The ovary is superior with as many locules as the number of carpels. There is a single anatropous ovule in each locule, ascending from the inner angle, and the placentation is axile. The style is one, often apically lobed.

14) Fruit:

The fruit is one to eight seeded berry, often with a sclerenchymatous outer layer. Latex sacs are also present in the inner pulp of the berry.

15) Seeds:

The seeds are often compressed with a crustaceous testa. They are either nonendosperimic and with fleshy cogyledons or endospermic and with flat cotyledons. The embryo is straight.

16) Pollination:

The Sapotaceae are pollinated by insects.

17) Dispersal:

The Species with small sticky berries are distributed by birds and the others by animals or water currents.

18) Floral Formula:

Br $\oplus$ ⚥ $K_{(4\text{-}8)}$ $C_{(4\text{-}8)}$ $A_{(8\text{-}16)}$ $\underline{G}(2\text{-}8)$

19) Economic Importance:

The family provides several edible fruits and other useful products such as Gutta Percha and Chicle gum. A few species are grown for ornamental use.

(1) Achras sapota is cultivated extensively in the tropics for its edible fruits. A coagulated resinous latex (Chicle gum), derived from the bark is used for chewing gum. The Chicle gum is also used in dental surgery.

(2) The fruit of *Manilkara hexandra* is edible and the tree also provides a strong dense wood. The bark is used for tanning.

(3) The fruits of *Manilkara kauki* are edible. The seeds are used as tonic and febrifuge.

(4) *Mimusops elengi* (Pogada) is an evergreen tree with dense foliage and very fragrant flowers. It is cultivated in gardens. The flowers are used for garlands and for perfumery. It also provides a very strong wood known as Bullet wood. The fruits are edible.

(5) *Chrysophyllum cainito* is cultivated for its ornamental beauty and for its delicious fruits.

(6) The berries of *Xantolis tomentosa* are bitter and used in pickles and curries. The tree also provides a useful timber.

(7) *Madhuca indica* is common throughout Central India. The dried corolla is eaten by man and animals and also yields coarse spirit by distillation. The seeds yield an inferior quality of oil which is edible and also used in the manufacture of soap. It is also effective in skin diseases.

(8) The seeds of *Diploknema butygracea* yield a white substance resembling lard, which is used in the manufacturing of soap and candles, and in the preparation of an ointment for relieving rheumatic pain. The pulp of fruit and oil cake are eaten.

(9) The milky latex of *Palaquim gutta* is the chief source of *Gutta percha* of commerce which is much used for insulation.

(10) The latex of some species of *Mimusops* and *Payena* is also the source of *Gutta Percha*.

(11) Some species of Sideroxylon provide very useful timber known as iron wood.

20) Distinguishing features:

1. Trees or shrubs.
2. Presence of Milky latex.
3. Unicellular hairs with two arms.
4. Many whorled floral parts.
5. Anther lobes-extrose.
6. Single ovule in each locule in axile placentation.
7. Fruits: Berries.

21) Questions:

1. Describe the vegetative and floral characters of the family Sapotaceae.
2. Write short notes on:
   (i) Economic importance of Sapotaceae
   (ii) Flower in Sapotaceae

23) Reference Books:

i) Taxonomy of Angiosperks – B.P. Pandey, S. Chand & Co. Ltd., New Delhi.
ii) A Text Book of Botany – Dr.V.Singh, Dr. P.C. Pande & dr. G.K. Jain, Rastogi Publications, Meerit.
iii) Introductory Taxonomy (Angiosperms) – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

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CH.E. USHA RANI

Unit-III

PALYNOLOGY

Morphology of different pollen:

I. Pollen grains of Hibiscus (Malvaceae)

1. Pollen grains are spherical, p thick walled, large, radially symmetrical.
2. Pollen grains are pantoporate, isopolar.
3. Pollen grains are echinate, base of spines not bulbous, tip blunt.
4. Exine tectate sexine thicker than nexine, collumellae prominent.
5. Interspinal surface is granular.

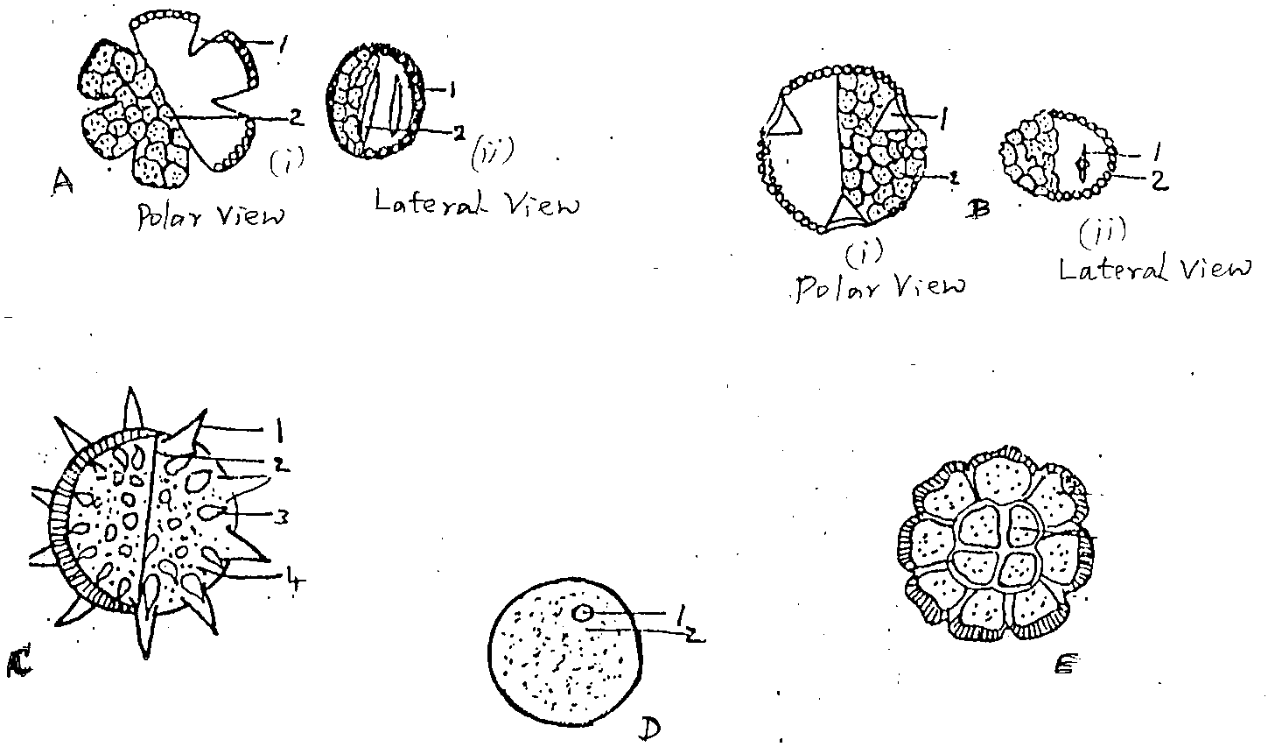

Fig. 45. **(A).** Ocimum, **(B)** Delonix sp. **(C)** Hibiscus **(D)** Grass **(E)** Acacia.

II. Pollen grains of Acacia (Mimosaceae)

1. Pollen grains an anged in polyads, 16 grains are present in a polyad.
2. Pollen grains radially symmetrical. Sphaeroidal to subsphaeroidal.
3. Polar view of individual grain squarish, 12-15 μ in diameter.
4. Exine tectate, sexine as thick as hexine, columellae fine.
5. Surface grainular to fainted reticulate.

III. Pollen grains of Grass (Poaceae)

1. Pollen grains are sphaeroidal, radially symmetrical, heteropolar.
2. Pollen grains are monoporateo, pore more or less circular.
3. Exine tectate, sexine as or thicker than hexine.
4. Surface psilate to faintly granular.

IV. Ocimum (Lamiaceae)

1. Pollen grains are radially symmetrical, isopolar.
2. Polar view more or less rounded and gives a lobed look because of broad colpi.
3. Equational view subprolate.
4. Hexacolpate, colpi broad with blunt ends.
5. Exine subtectate, sexine thicker than hexine.
6. Surface reticule, lumina polygonal.

V. Delonix sp (Caesalpinaceae)

1. Pollen grains radially symmetrical, isopolar.
2. Polar view more or less rounded to subtriangular.
3. Equatorial view oblate.
4. Tricolporate, colpal ends almost blunt, more or less rounded.
5. Exine subtectate, sexine thicker than nexine.
6. Surface reticulate.

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Unit-III

EMBRYOLOGY

I. STRUCTURE OF ANTHER

(a) Structure of young anther.

1. T.S. of young anther appears as four lobed structure in outline.
2. The outermost layer is the epidermis.
3. In each lobe below the epidermis microsporangium is present. Thus the section shows four microsporangia, one situated at each corner.
4. The microsporangium develops from a few hypodermal archesporial cells. These archesporial cells divide periclinally to form outer primary parietal layer and inner sporogenous layer.
5. Below the epidermis 3-5 middle layers and tapetum layer are present. These are derived from primary parietal layer.
6. The primary sporogenous cells divide and function as microspore mother cells.

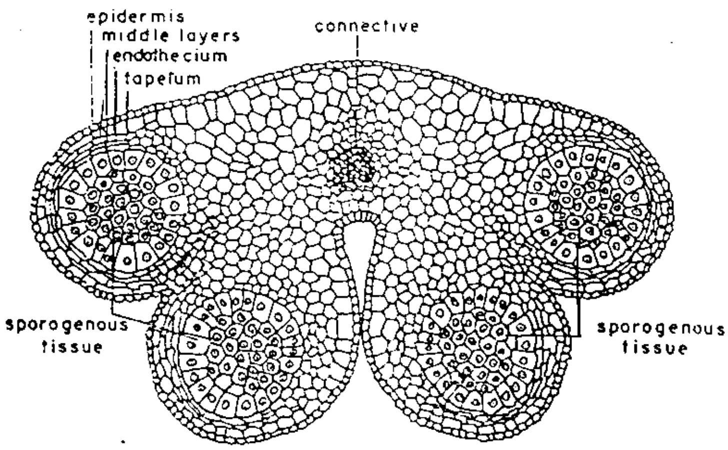


Fig. 46. T.S. of young anther

(b) Structure of mature anther

1. The transverse section of mature dethecous anther shows four pollen chambers at four corners.
2. The anther wall shows an outer epidermis, an endothecium, one to three middle layers and an innermost tapetum layer.
3. At maturity, the partition between two pollen sacs is dissolved, so that it appears as a single sac in each theca.
4. In each pollen sac are present many pollen tetrads which on separation for microspores.
5. A connective is present between two banther lobes.

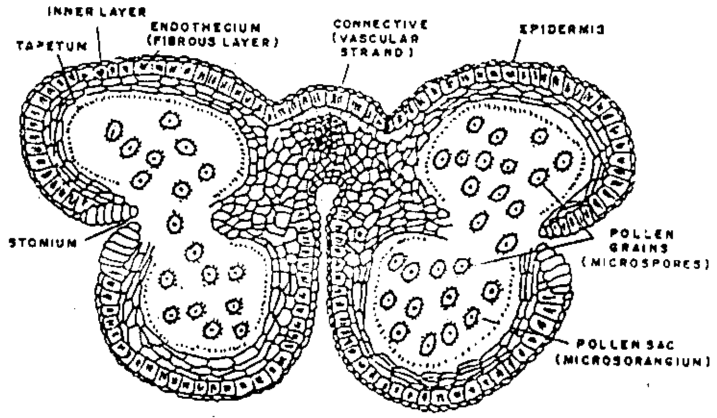


Fig. 47. Structure of mature anther

2. STRUCTURE OF OVULES

(a) L.S. of ovule

L.S. of ovule shows the following parts:

1. The ovule is attached to the placenta by means of a small stalk funicle.
2. The place of attachment of funicle to the body of the ovuleis called hilum.
3. The ovule consists of a central homogenous mass of tissue called nucellus.
4. The body of the ovule has two integuments which surround the nucellus. The concept at the micropylar and
5. The base of the ovule opposite to micropyle is called chalaza.
6. The nucellus encloses an embryosac.
7. The embryosac consists of egg apparatus towards the micropyle, a central cell with two polar nuclei and three antipodals at the chalazal end.

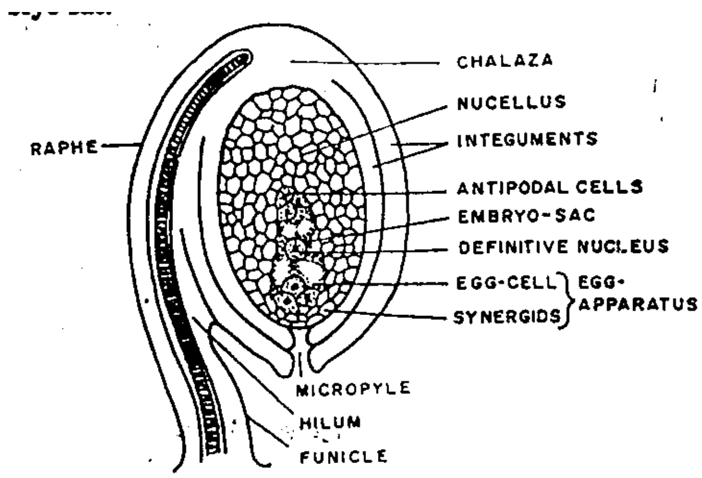


Fig. 48. L.S. of ovule

(b) Types of ovules:

(i) Atropus or Orthotropous ovules

1. It is the most primitive type of ovule.
2. The ovule is attached to the placenta by means of a funicle.
3. In this type, the micropyle, chalaza and funiculus lie on the same line.
   e.g. Polygoniaceae, Purticaceae, Piperaceae.

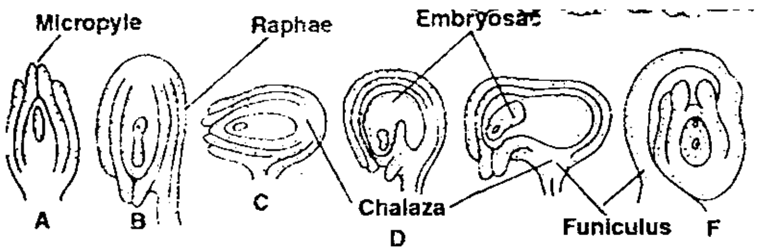


Fig. 49. Types of Ovules

(A) Orthotropous, (B) Anatropous (C) ia (D) Amphitropous
(E) Campylotropous (F) Circinotropous

(ii) Antropous ovule

1. This is the most common tye of ovule among angiosperms.
2. The body of the ovule is completely inverted so that themicropyle becomes close to the hilum.
3. The micropyle and chalaza lie along one line and the faniculus lies parallel to it.

(iii) Hemianatropous or hemitropous ovule

1. In this type, the body of the ovule bent transversely or somewhat at right angle to funicle.
2. Micropyle and chalaza lie in one straight line.
   e.g. Ranunculus.

(iv) Campylotropous ovule

1. In this type, the body of the ovule is curved so that the chalaza and the micropyle do not lie in the same straight line.
   e.g. L.S. guminosac.

(v) Amphitropous ovule

1. In this type, the body of the ovule has more curvature.
2. The embryosac becomes horse-shoe shaped.
   e.g. Alismaceae, Butomaceae

(vi) Cirinotropous ovule

1. In this type, the funicle is very long and the ovule rotates by an angle of 360^o in such a way that it is completely encircled around by the funicle.
2. Micropyle faces upward. e.g. Cactaceae.

II. STRUCTURE OF EMBRYOSACS

(a) Structure of 2-nucleate embryosac

1. The developing two nucleate embryosac lies within the nucellus of an ovule.
2. These two nuclei are formed by the division of the nucleus of the functional megaspore.
3. Of the two nuclei, one is present towards the micropylar end and the other one is towards the chalazal end.

(b) Structure of 4-nucleate embryosac

1. The developing 4-nucleate embryosac lies within the nucellus an ovule.
2. Out of the two nuclei are present towards the micropylar end, and the other two towards the chalazal end.
3. A large central vamole is present at the centre.

(c) Structure of 8-nucleate embryosac or mature embryosac (Polygonum type)

1. The 8-nucleate or mature embryosac lies within the nucellus of an ovule.

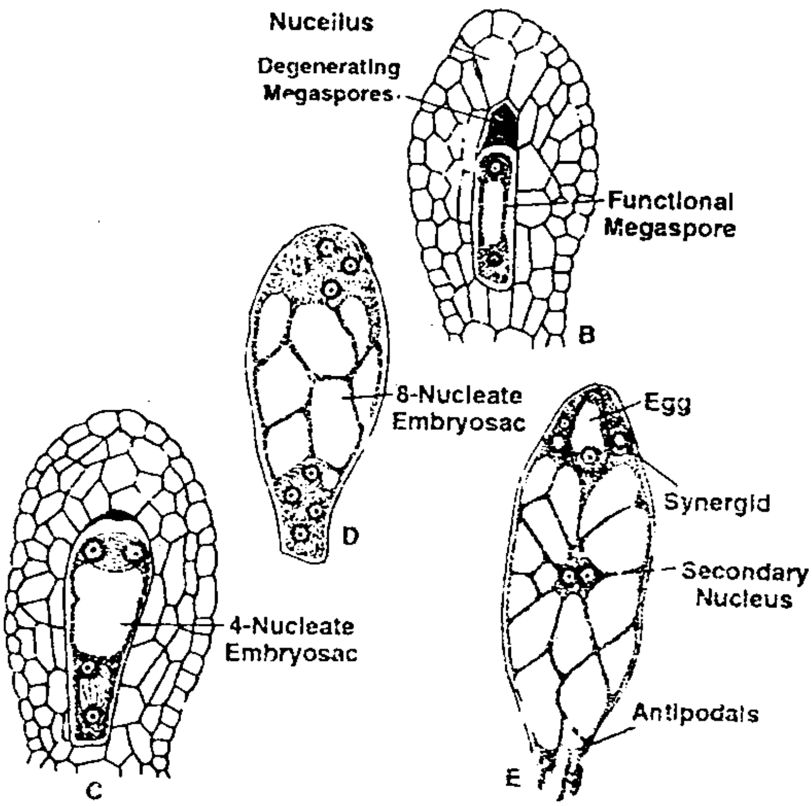


Fig. 50. (B) 2-Nucleate Embryo sac (C) 4-Nucleate Embryosac
(D) 8-Nucleate Embryosac (E) Mature Embryosac

2. It has 3-nuclei at micropylar end, 2 two nuclei at the centre, 3-nuclei at chalazal end.
3. Three nuclei present at micropylar end get organised into egg apparatus (one egg cell and two synergids).
4. The two nuclei in the centre are polar nuclei which ultimately fuse and form a secondary nucleus.
5. The three nuclei at the chalazal end get organised into antipodal cells.

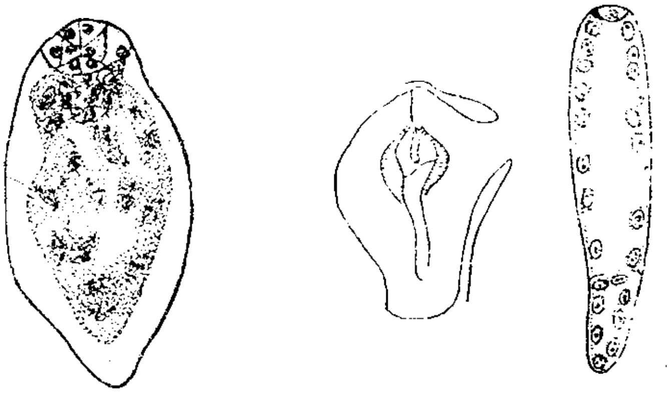
(d) Endosperm

(i) Nuclear endosperm

1. Nuclear endosperm is developed from primary endosperm nucleus which is formed by the fusion of two polar nuclei and male gamete.
2. The primary endosperm nucleus divides many times thus forming many free nuclei.
3. These free nuclei are pushed towards the periphery of the embryo sac with a central big vacuole.

(2) Cellular, Endosperm

1. Nuclear endosperm is developed from primary endosperm nucleus which is formed by the fusion of two polar nuclei and male gamete.
2. Every division of the primary endosperm nucleus is immediately followed by wall formation.
3. The cells are formed in regular rows.



(1) (2) (3)

Fig. 51. (1) Nuclear type (2) Cellular type (3) Helobial type

(3) Helobial type

1. Helobial endosperm is developed from primary endosperm nucleus.
2. In this type, the primary endosperm nucleus divides transversely forming two unequal chambers – large micropylar chamber and small chalazal chamber.
3. In micropylar chamber free nuclear divisions occur, so that a large number of nuclei are formed. Later wall formation occur.
4. In chalazal chamber, the nucleus does not divide further or may undergo few divisions.
5. This type of endosperm is intermediate between nuclear type and cellular type.

(d) Embryo

(1) Dicot embryo

1. The embryo consists of an embryonal axis with two large lateral cotyledons.
2. The cotyledons cover a small plumule which is in terminal position.
3. A suspensor is swollen and is present at the other end.
4. The portion of embryonal axis above the level of cotyledons is called epicotyl and below the level of cotyledons is called the hypocotyl.
5. Radicle is present at the end of hypocotyl.
6. Procambial strand is present in the central region of hypocotyl.

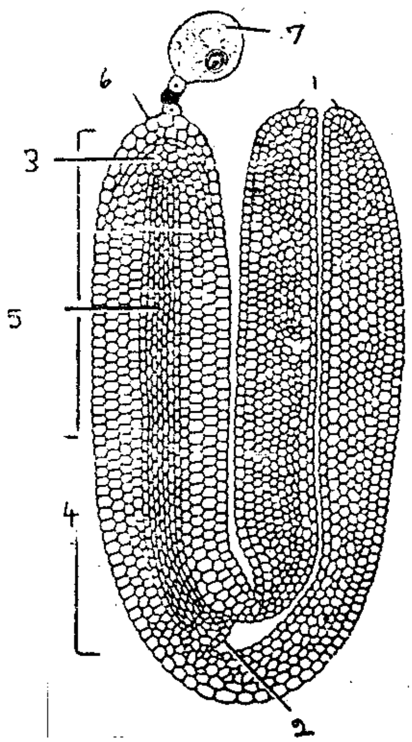


Fig.52. Median longitudinal section of Mature dicot embryo
(1) Cotyledons, (2) Plumma (3) Radicle (4) Hypocotyl (5) Procambial layers (6) root cap (7) suspensor

(2) Monocot embryo

1. The embryo consists of an embryonal axis and a single cotyledon.
2. The embryonal axis consists of radicle and plunule.
3. Plunule is lateral in position.
4. Radicle is present at the base of hypocotyl.
5. A small suspensor is present.

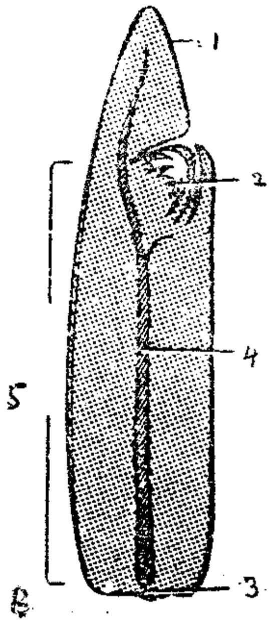


Fig. 53. Mature Monocot Embryo
1. Cotyledon, 2. Plumule, 3. Radicle, 4. Procambium, 5. Hypocotyl

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Smt. S.V. Padmaja

10.3 ASCLEPIADACEAE
The Milk-Weed Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Gamopetalae
Series	Bicarpellate
Order	Gentianales

2) Distribution:

The family includes about 175 genera and over 2,200 species widely distributed in the tropical and subtropical regions of the world. In India, the family is represented by 53 genera and about 250 species occurring mostly in the tropical Himalayas and Southern and Western India.

3) Familiar Plants:

1. *Asclepias curassavica* (Silk weed)
2. *C. procera* (Rakta Jilledu)
3. *Catohopis gigantea* (Tella Jilledu)
4. *Ceropegia bulbosa* (Adavipala teega)
5. *Cryptostegia grandiflora* (Rabbaru teega)
6. *Dischidia rafflesiana* (Pitcher plant)
7. *Gymnema sylvestris* (Podapatri)
8. *Hemidesmus indicus* (Sugandhipala)
9. *Sarcostemma acidum* (Aku jemudu)
10. *Tylophora india* (Goripala)

4) Vegetative characters:

The plants are perennial herbs (*Asclepias*), shrubs (*Calotropis*) or woody climbers (*Tylophora, Daemia* and *Leptodenia*). Sometimes, the plants are succulent (*Hoya*) or Xerophytic with cactus – like habit (*Stapelia*).

5) Root:

A perennial root stock is commonly present and sometimes the roots are fleshy or tuberous.

6) Stem:

The vascular bundles in the stems are bicollateral and the plants contain a milky juice present in long branching laticiferous tubes.

7) Leaves:

The leaves are opposite decussate (rarely alternate), simple, entire and exstipulate. In xerophytic species, such as *Stapelia*, leaves are reduced to spines. A thick waxy covering is found on the leaves of *Calotropis procera*. The leaves of *Asclepias curassavica* are petiolate, whereas they are semi-amplexicaul in *Calotropis procera*. The petiole is pulvinous in *Cryptostegia grandiflora*.

Inflorescence and Flower

8) Inflorescence:

It is usually dichasial cyme, arising in the leaf axil or sometimes, it is racemose or umbellate as in *Asclepias* and *Calotropis*.

9) Flower:

The flowers are bractate, usually bracteolate, complete, hermaphrodite, actinomorphic, pentamerous and hypogynous.

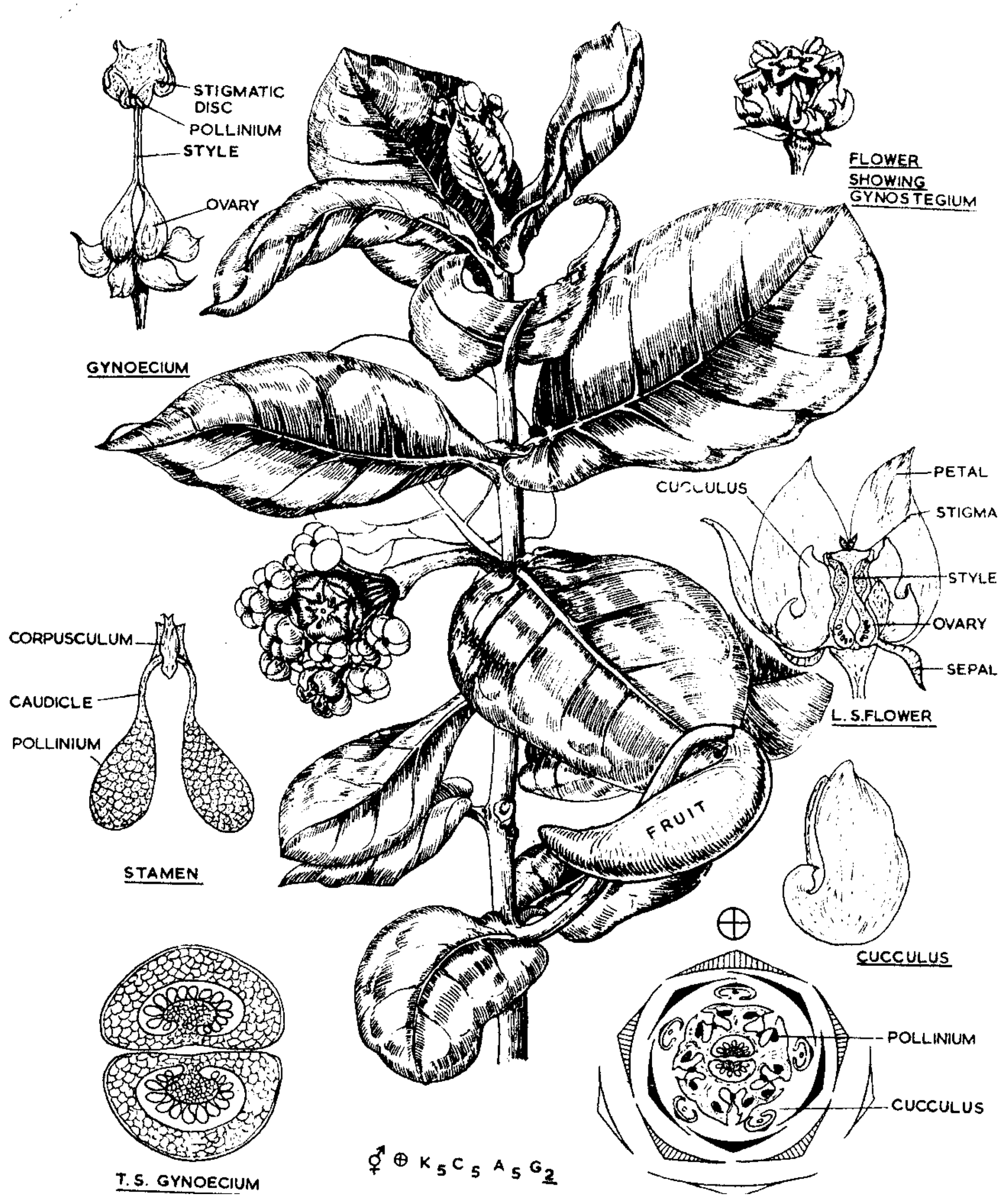

Fig. 10.1 *Calotropis procera*

10) Calyx:

The calyx is composed of five sepals which are united below to form a short calyx tube. The lobes are quincuncial, imbricate or valvate in buds.

11) Corolla:

The corolla is gamopetalous and usually rotate and five clefted or lobed but sometimes it is campanulate (*Gymnema*) or funnel form (*Crytostegia*). In *Ceropegia*, the straight or curved corolla tube is swollen at the base. The aestivation is valvate or twisted. The corolla tube is often with a corona which is in the form of a ring of hairs, scales or processes (*Coralline corona*).

12) Androecium:

The stameus are five, epipetalous and inserted at or near the base of the corolla tube.

The anthers are coherent and appressed to the expanded stylar head. The pollen is granular and united into tetrads. The pollen from one half of two adjacent anthers discharge on to spathulate translator arising from the style-head and alternating with the anthers. Each translator ends below in an adhesive disc. Usually, a staminal corona of five free lobes arise from the base of the filaments.

The filaments are connate in a short fleshy column. The anthers crowning the column are adnate by the connective to the pentagonal stigma forming the gynostegium. The pollen grains are united in two waxy masses (pollinia) in each cell. The pollinia are united in pairs by caudicles (retinaculae) of various shapes to a gland (Corpusculum) which lies on the stigma. The short filaments are ornamented with nectariferous corona which varies in form in different genera.

13) Gynoecium:

The gynoecium is bicarpellary, the ovaries of the two carpels are free as so also their styles which are united by their apices and dilate to form a peltate stigma with five lateral stigmatic surfaces. The ovary of each carpel is unilocular with a single (ventral) placenta bearing numerous anatropous pendulous ovules.

Fruit and Seed:

14) Fruit:

The fruit is of two follicles which are close together or divergent. They vary in shape and are membranous to woody.

15) Seed:

The seeds are flattened and commonly bear a terminal tuft of white silky hairs. The endosperm is dense and copious and the embryo is large.

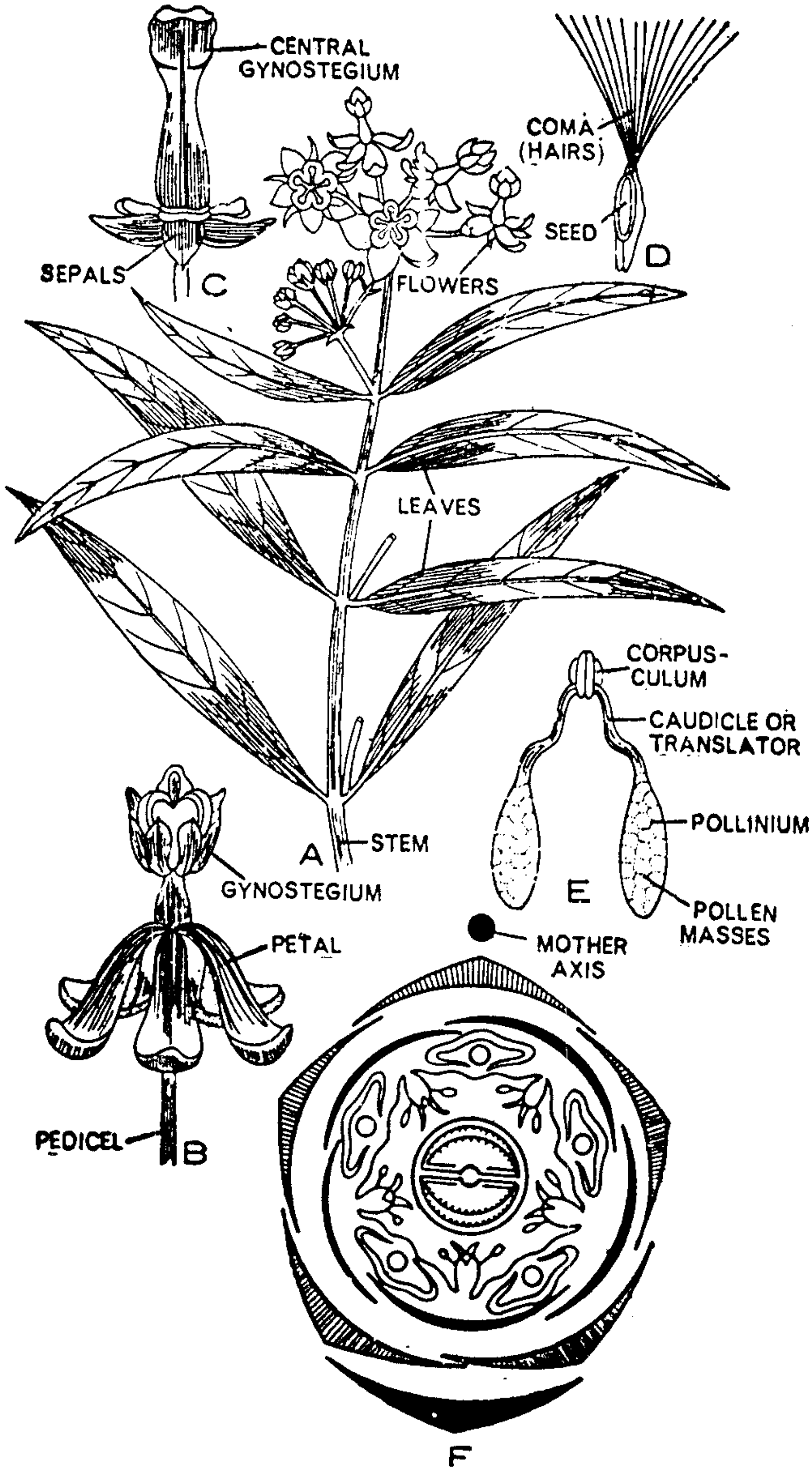

Fig. 10.2 Asclepiadaceae – *Asclepias curassavica*

Pollination and dispersal:

16) Pollination:

The flowers are perfectly adapted for insect pollination. In the subfamily Periploceae, the pollen is transferred on to the spoon-shaped translators each of which has a sticky basal disc. The insect visitor on retiring, carries the whole translator as the basal disc adheres to its head. The pollen contents of the translator may be deposited on the stigmatic surface when the same insect visits another flower.

In the subfamily Euasclepiadeae an insect visiting the flower for nectar traps its legs or proboscis between the osmotically elastic anther wings and on withdrawl it carries with it the sutured corpusculum with the pollinia. When this insect visits another flower, in the process of catching leg or proboscis, the pollinia are transferred to the receptive surface of the stigma which is beneath the anther wings.

17) Dispersal:

The seeds with a terminal tuft of hairs are distributed by wind. In others, they are dispersed by water or by the human agency.

18) Floral Formula:

Br brl ⊕ ⚥ $K_5\ C_{(5)}\ A_{(5)}\ \underline{G}_2$

19) Economic Importance:

The members of the family are important for ornamental and drug plants and for floss of seeds.

I. Ornamentals:

Species of Asclepias (*A. curassavica*), Ceropegia (*C. woodii*), Stapelia (*S. gigantea*) and *Cryptostegia grandiflora* are grown for ornament.

II. Medicines:

1) The roots of *Tylophora indica* are used for the treatment of asthma, bronchitis and whooping cough.
2) *Cynanchum arnotianum* is used as an insecticide.
3) The dried stem of *Sarcostemma acidum* is emetic and an infusion of the roots is used as antidote of snake bite.
4) *Gymnema sylvestre* is stomachic, stimulant, laxative and diuretic and is useful in cough, biliousness and sore eyes.

III. Others uses:

1) Latex of *Calotropis gigantea* and *C. procera* is used in tanning industry for deodorizing, for removing hair and imparting yellow colour to hides.
2) The latex of *Cryptostegia grandiflora* is a commercial source of rubber.
3) A bast fibre obtained from the stems of *Asclepias curassavica, Tylophora tenuis*, *Leptandenia pyrotechnica*, *Calotropis gigantea* and *Cosmostigma rocemosa* is used for fishing nets and twines.

20) Distinguishing features:

1) Perennial erect herbs or shrubs with milky latex.
2) Leaves with opposite-decussate phyllotaxy.
3) Presence of bicollateral vascular bundles.
4) Exstipulate leaves.
5) Axillary or terminal cymose umbels.
6) Flowers regular, bisexual and hypogynous.
7) Presence of gynostegium, translators.
8) Bicarpellary, sub-apocarpous ovary.
9) Ovary unilocular, placentation marginal.
10) Fruit a pair of follicles.

21) Questions:

1. Describe the salient features of Asclepiadaceae and mention the economic importance of any three plants with their botanical uses.
2. Write short notes on:
   (i) Flower in Asclepiadaceae.
   (ii) Pollination mechanism of Asclepiadaceae.
   (iii) Gynoecium in Asclepiadaceae.

22) Reference Books:

i) **Angiosperms (Systematics & Life Cycle) –** G.L. Chopra, Pradeep Publications, Jalandhar.

ii) **Introductory Taxonomy (Angiosperms) –** Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

iii) **Taxonomy of Angiosperks –** B.P. Pandey, S. Chand & Co. Ltd., New Delhi.

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CH.E. USHA RANI

Unit-III

Class : Dicotyledons
Subclass : Gamopetalae
Series : Bicarpellatae
Orders : Polemoniales, Personales & Lamiales

Lesson 11

TAXONOMY AND THE ECONOMIC IMPORTANCE OF THE FAMILIES BELONGING TO THE ORDERS POLEMONIALES, PERSONALES AND LAMIALES OF THE SERIES BICARPELLATAE IN THE SUBCLASS GAMOPETALAE

OBJECTIVES

⇒ To know the vegetative and floral characters of the families in the orders Polemonials, Personales and Lamiales.
⇒ To compare the characters of the different families in Polemoniales, Personales and Lamiales.
⇒ To know the economic importance of the plants in Polemoniales, Personales and Lamiales.

CONTENTS

11.1 Orders: Polemoniales, Personales and Lamiales

11.1.1 Characteristic features of order Polemoniales

1) Leaves generally alternate and exstipulate
2) Flowers regular
3) Stamens as many as corolla lobes
4) Family included → **Convolvulaceae**

11.1.2 Order: Personales

1) Flowers usually zygomorphic
2) Corolla often bilipped
3) Stamens generally fewer than corolla lobes
4) Ovules many in each locule
5) Family included → **Acanthaceae**

11.1.3 Order : Lamiales

1) Corolla usually bilipped
2) Stamens usually didynamous or sometimes two
3) Ovary 2-4 locular with usually 1 ovule in each locule
4) Fruit a drupe or nutlets
5) Family included → **Lamiaceae**

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11.2 CONVOLVULACEAE
(Sweet Potato Family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Gamopetalae
Series	Bicarpellatae
Order	Polemoniales

2) Distribution:

The family includes about 56 genera and 1,820 species distributed chiefly in the tropics and subtropics. In India, the family is represented by 20 genera and about 158 species occurring chiefly in the Southern to Western India.

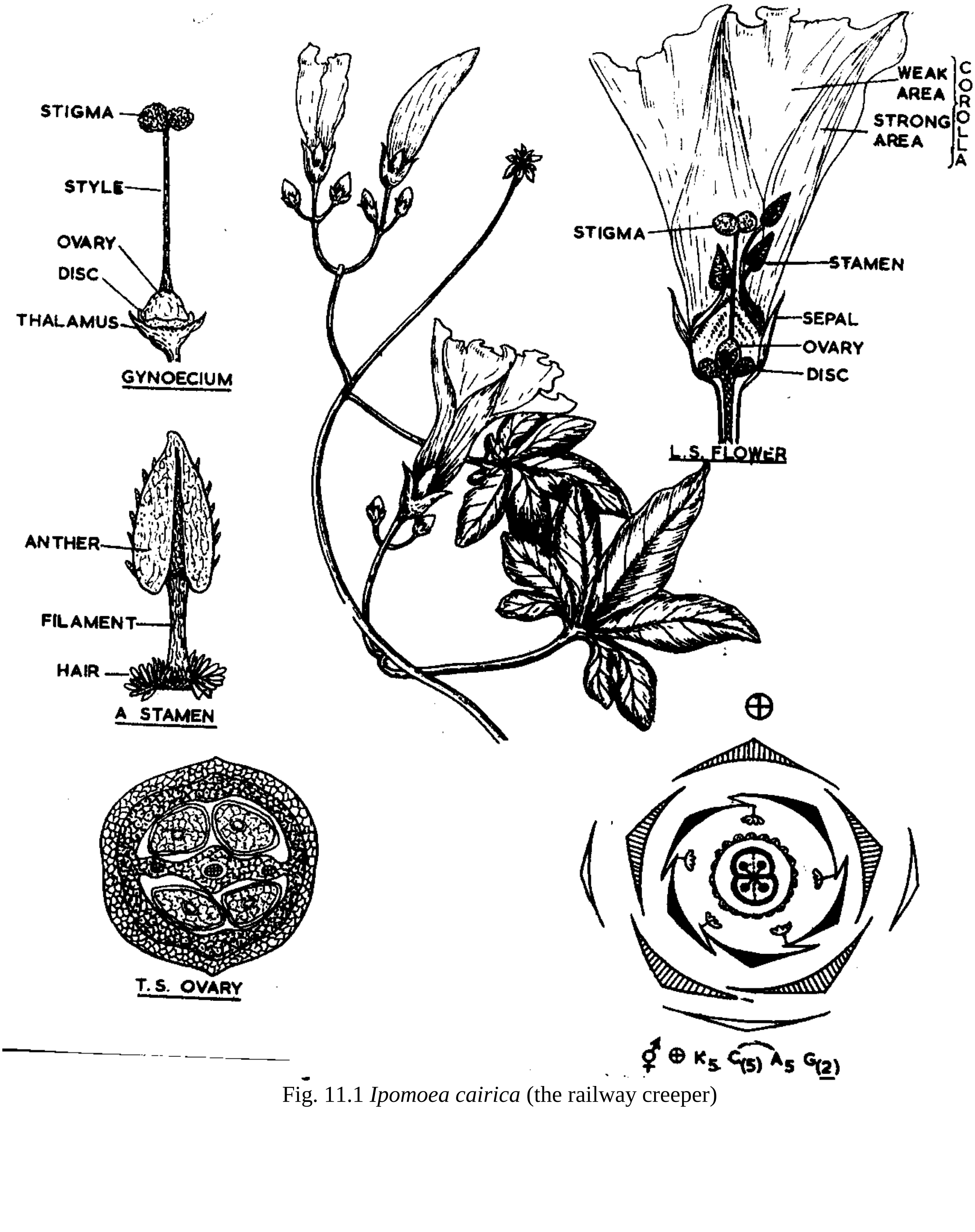

Fig. 11.1 *Ipomoea cairica* (the railway creeper)

3) Familiar Plants:

1. *Argyreia nervosa* (Verriboddi teega)
2. *Convolvulus arvensis*
3. *Cuscuta reflexa* (Bangaru teega)
4. *I. aquatica* (Thutikura)
5. *I. fistulasa* (Rubber chettu)
6. *I. palmata*
7. *I. quamoelit*
8. *Ipomoea batatas* (Chilagada dumpa)
9. *Ipomoea cairica* (Kakara thooti)
10. *Ipomoea tuberosa* (Wood rose)

4) Vegetative characters:

The plants are mostly herbs or shrubs, often twinning (*Ipomoea nil*) and very rarely trees (*Eryciba*).

5) Root: Tap root.

The species of *Cuscuta* are leafless and rootless total parasites with thread like twinning stem. Sometimes, as in *Ipomoea batatas*, the roots store great quantities of food and they become thick and fleshy.

6) Stem:

The stem is usually herbaceous aerial, erect, cylindrical, branched and hairy. In climbing species, it is weak and twinning.

7) Leaves:

They are alternate, exstipulate, simple, sometimes pinnate (*Ipomoea quamoclit*) or palmately (*Ipomoe pes-tigridis*) divided.

8) Inflorescence:

It is an axillary cyme or sometimes the flowers are solitary as in *Calystegia*. In *Porania*, the *cymes* form large panicle.

9) Flower:

They are bractiate, often showy, perfect, bisexual, actinomorphic, pentamerous and hypogynous.

10) Calyx:

The Calyx is deeply five-lobed, persistent and sometimes enlarged in fruit. The sepal lobes are sometimes unequal and they are imbricate or valvate in bud.

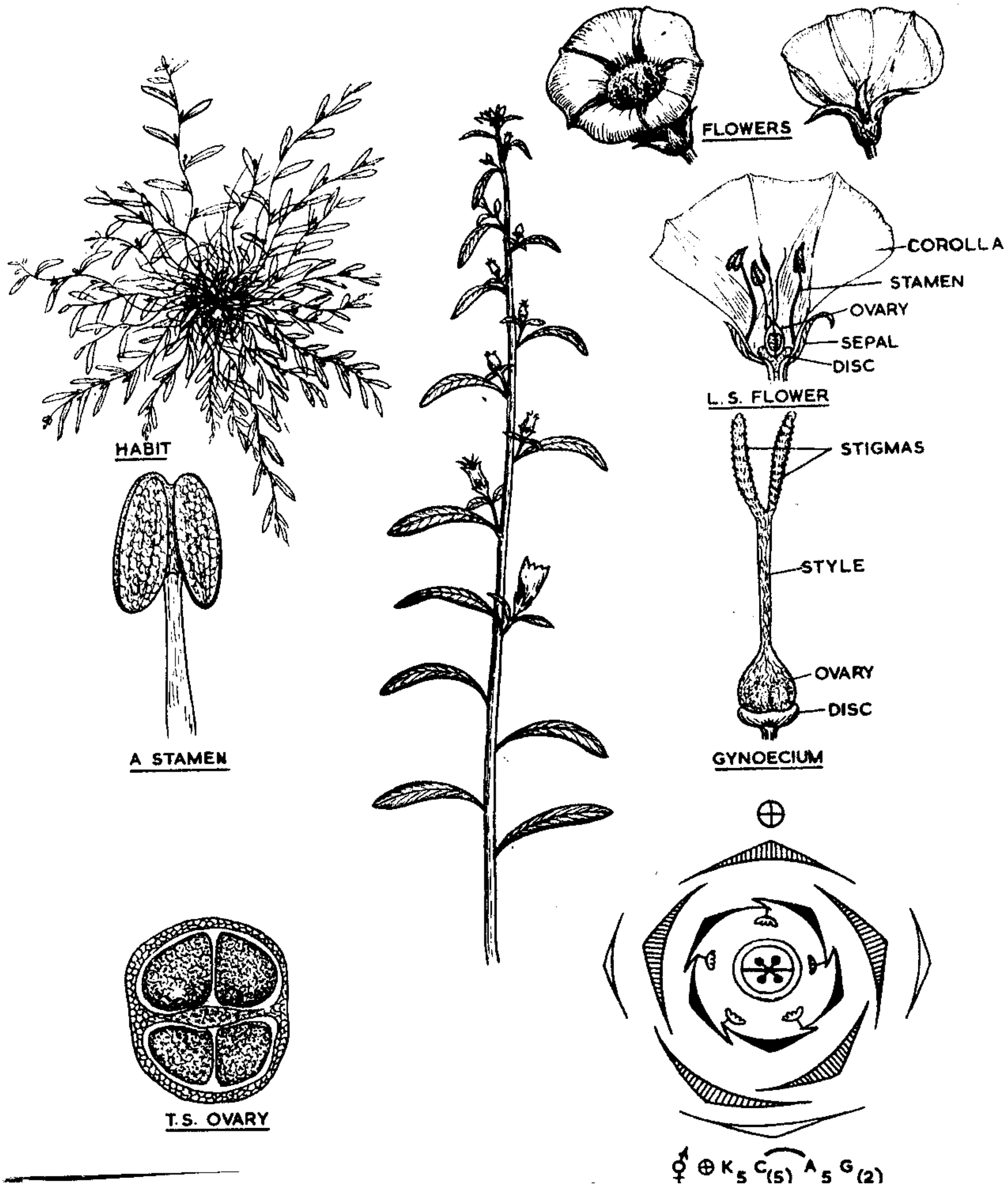

Fig. 11.2 *Convolvulus pluricaulis*

11) Corolla:

The Corolla is gamopetalous, five lobed, Campanulate (*Convolvullus*), funnel shaped (*Argyreia* and *Ipomoea*) or subglobose (*Cuscuta*). The aestivation is induplicate valvate (*Ipomoe*) or imbricate. In *Cuscuta fibriate* scales are often present inside the base of the corolla tube.

12) Androecium:

The Stamens are five, epipetalous at the base of the corolla tube and alternate with the corolla lobes. The anthers are oblong, dithecous, introrse and dehiscing longitudinally.

13) Gynoecium:

The Gynoecium is bicarpellary (rarely three to five carpellary as in some species of Ipomoea and Erycibe) and syncarpous with a superior ovary. The ovary is typically bilocular with two anatropous ovules in each locule on axile placentation. Frequently, the ovary becomes tetralocular by the formation of false septum. In *Erycibe*, the ovary is unilocular with parietal placentation. The style is usually filiform and one but in *Cuscuta* there are two styles and style is absent in *Erycibe*. The stigma is capitate, bilobed or two-branched.

A ring-like or cup-shaped nectariferous disc is present at the base of the ovary which is often lobed.

Fruit and Seed:

14) Fruit:

The fruit is usually a two or four valved capsule. In *Cuscuta*, the fruit is a dry or fleshy capsule, dehiscing transversely or irregularly. Sometimes, it is fleshy and indehiscent (*Argyreia*).

15) Seed:

The seeds are smooth or hairy, non-endospermic or with a scant endosperm. The embryo is usually large and the cotyledons are often plaited.

16) Pollination:

Brightly colomned and showy flowers of the Convolvulaceae are visited by insects for nector secreted by a hypogynous disc. The species of *Ipomoea* with narrow tubes (*I. quamoclit*) are visited by small nector seeking birds. The flowers of *Calonyction* (Moon flower) which open during night are adapted for visits of insects which are active during night. The flowers of *Cuscuta*, in the absence of insects, pollinate themselves. The flower of *Calonyction* are sterile to their own pollen.

17) Dispersal:

Seeds are dispersed usually by birds and animals.

18) Floral Formula:

Br Brl ⊕ ⚥ $K_{(5)}$ $C_{(5)} \leftarrow A_5$ $\underline{G}_{(2)}$

19) Economic Importance:

The family provides sweet potato and many ornamental plants.

1) Edibles:

(i) The fleshy roots of *Ipomoea batatas* are rich in starch and sugar and are eaten after boiling or roasting.

(ii) The young shoots and leaves of *Ipomoea aquatica* is used as vegetables.

II. Ornamentals

(i) Several twinning species of Ipomoea are very commonly grown for their beautiful companulate or funnel form flowers.

Ipomoea purpurea (Common morning glory)
Ipomoea violacea (Heavenly blue)
Ipomoea carica (Railway creeper)
Ipomoea tuberosa (Wood rose)

(ii) Argyreia (Woolly morning glory)

(iii) Porana (Christmas vine) – *P. paniculata* and *P. racemosa*.

20) Distinguishing features:

1) Mostly twinning creepers.
2) Bicollateral vascular bundles and milky latex.
3) Exstipulate, alternate, simple leaves.
4) Mostly dichasial cymes.
5) Complete, actinomorphic, bisexual, hypogynous big flowers.
6) Persistent calyx.
7) Funnel shaped or bell shaped corolla.
8) Stamens five, epipetalous, filaments unequal in height.
9) Superior ovary which is present on a disc.
10) Bicarpellary, syncarpous, bilocular ovary. Two ovules in each locule on axile placentation.
11) Fruit loculicidal capsule.

21) Questions:

1. Describe the family Convolvulaceae.
2. Write short notes on:
   (i) Economic importance of Convolvulaceae.
   (ii) Distinguishing characters of Convolvulaceae.

22) Reference Books:

i) **Taxonomy of Vascular Plants –** G.H.M. Lawrence & Oxford & IBM Publishing Co., New Delhi.
ii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.
iii) **Angiosperms (Systematics & Life Cycle)** – G.L. Chopra – Pradeep Publications, Jalandhar.

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Ch. E. USHA RANI

11.3 ACANTHACEAE
The Acanthus Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Gamopetalae
Series	Bicarpellatae
Order	Personales

2) Distribution:

This family includes 256 genera and 2,765 species mostly in the tropical parts of the world. The four centres of distribution are Indo-Malaysia, Africa, Brazil and Central America. In India, the family is represented by about 68 genera and 337 species occurring mostly in the maintains of South and West India and some also in the tropical and subtropical Himalayas.

3) Familiar Plants:

1) *Acanthus ilicifolius*
2) *Adhatoda vasica* (Vasaka)
3) *Asystasia gangetica*
4) *Berleria strigosa* (Nilambaram)
5) *Blepharis repens*
6) *Crossandra infundibuliformis* (Kanakambaram)
7) *Eranthemum nervosum*
8) *Justicia procumbens*
9) *Ruellia tuberosa*
10) *Thunbergia grandiflora* (clock wine)

4) Vegetative characters:

They are mostly annual or perennial herbs, under shrubs or shrubs and sometimes climbing as species of *Thunbergia* and *Mendonica*. They generally inhabit damp and marshy places but some are Xerophytic (*Barleria*).

5) Root:

6) Stems:

The stems of climbing species show anomalous secondary growth. The cystoliths are commonly present in the epidermal cells of the leaf and stem. They are very characteristic and are useful in distinguishing various genera and tribes.

7) Leaves:

The leaves are opposite and decussate, exstipulate (*Adhatoda*) or stipulate (*Justicia*), simple and entire or very rarely divided.

Inflorescence and Flowers

8) Inflorescence:

The inflorescence is most commonly a dichasial cyme becoming monochasial in its ultimate branching. The cymes are often condensed into axillary whorls (*Hygrophila*) or dense spikes (*Adhatoda, Daedalacanthus*). The flowers are axillary solitary in *Thunbergia*.

9) Flowers:

The flowers are bracteate, bracteolate, pedicellate (sessile in *Adhaloda*), perfect, hermophrodite, zygomorphic and hypogynous. They are often well developed and coloured. In *Thunbergia* and related genera, the bracteoles are large and form an involucre which encloses the flowers.

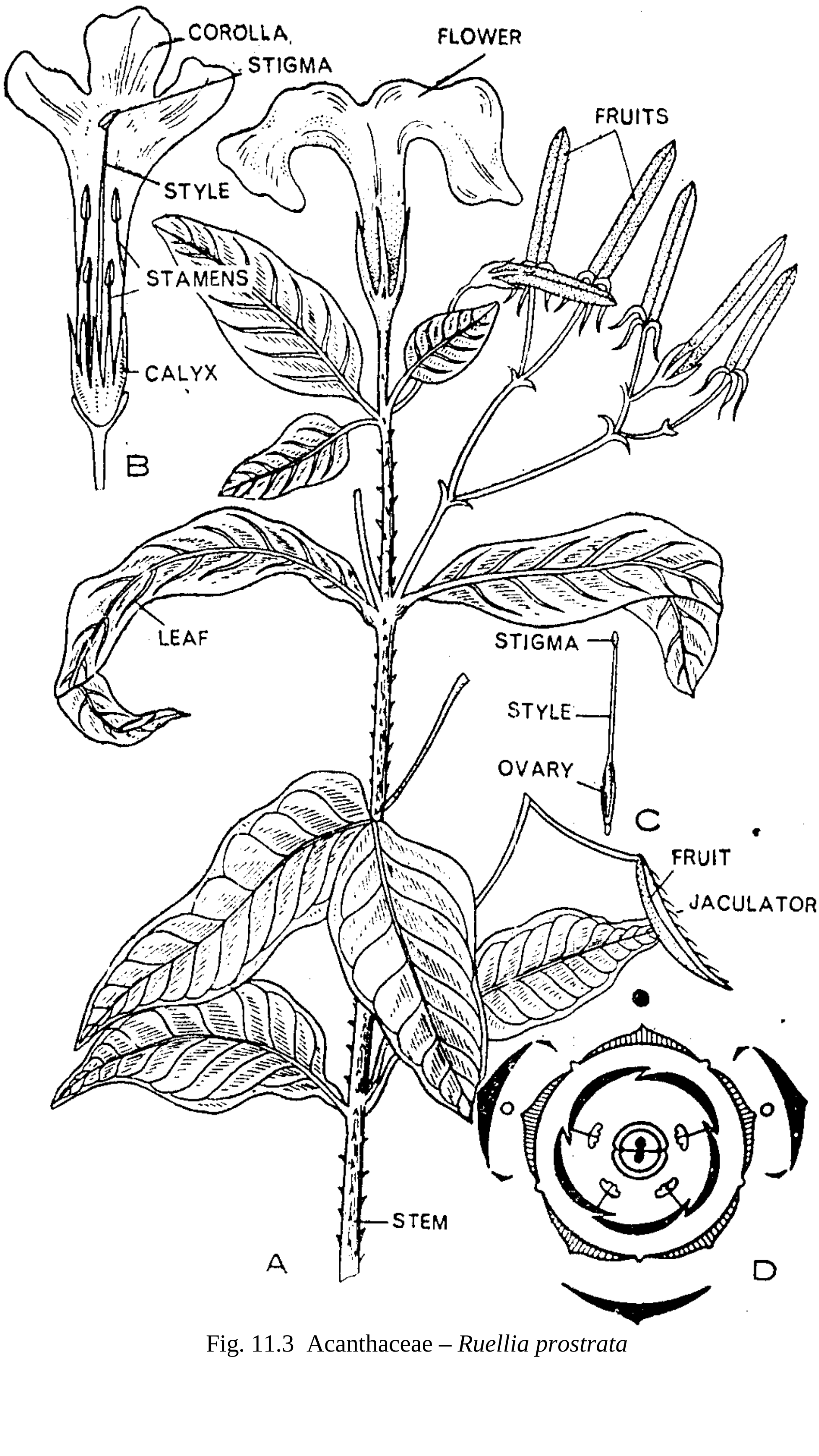

Fig. 11.3 Acanthaceae – *Ruellia prostrata*

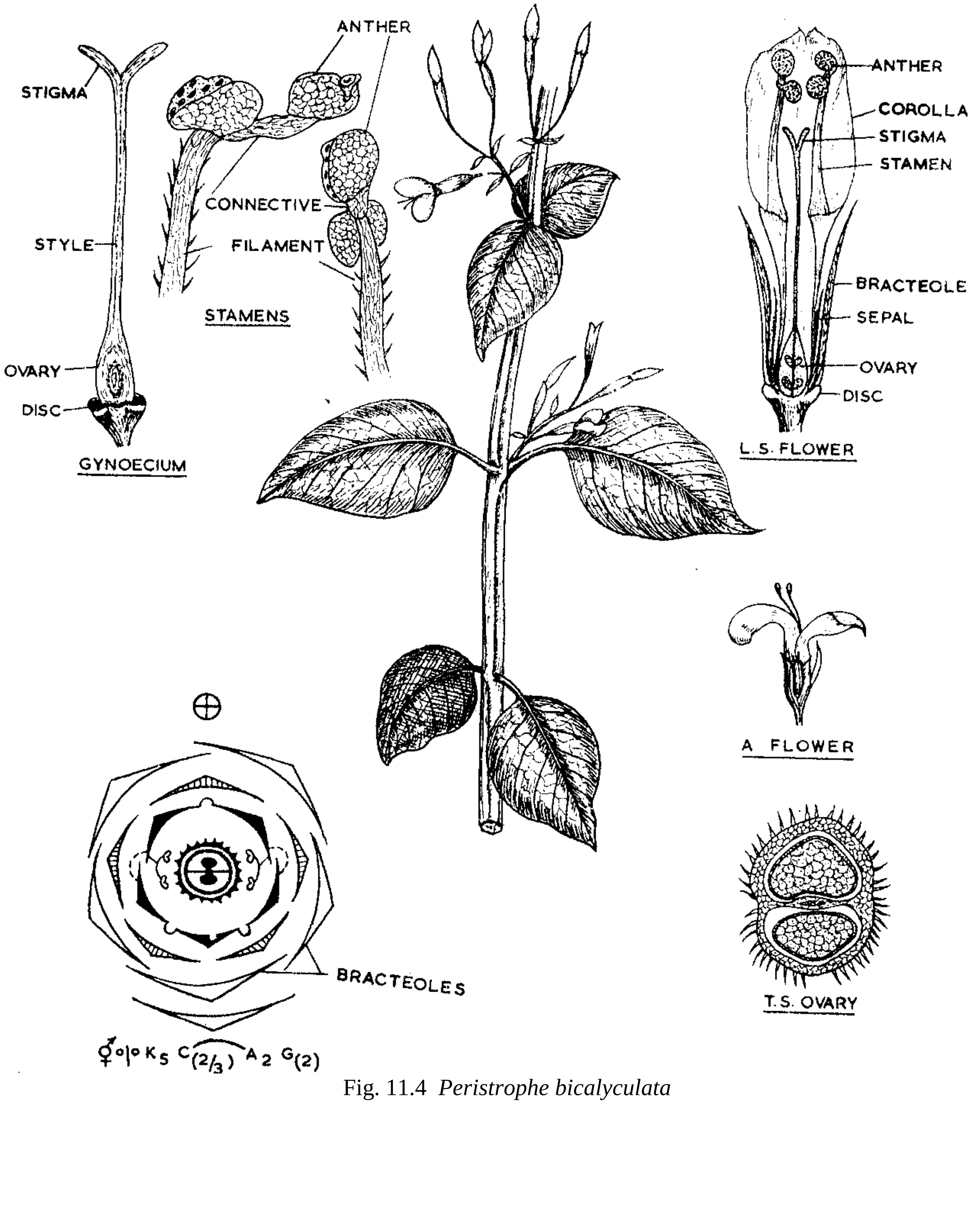

Fig. 11.4 *Peristrophe bicalyculata*

10) Calyx:

The calyx is usually five-partite and the calyx - segments are imbricate or valvate in bud. In *Peristrophe*, the sepals are free. In *Thunbergia*, the calyx is reduced to a narrow ring.

11) Corolla:

The corolla is gamopetalous with a long or short tube. The limb is sometimes almost equally five-lobed as in *Thunbergia* and *Ruellia* but usually it is two-lipped or rarely one-lipped as in *Acanthus* where upper lip is completely absent. When corolla is bi-lipped, the upper lip is usually erect and bifid and the lower lip is horizontal and trifid. The aestivation of the corolla is imbricate or contorted.

12) Stamens:

The stamens are more often four and didynamous and frequently two as in *Blapharis, Acanthus* and *Justicia*. The one to three missing stamens are frequently represented by the staminodes. Rarely, as in *Pentostemonacanthus* all the fine stamens are present and they are fertile. The stamens are inserted on the corolla tube and alternate with its lobes. The filaments are quite free and usually exerted. The anthers are dithecous or monothecous by reduction and the rudiment of the second anther cell is frequently present (*Blepharis*). In dithecous anthers the two anther cells are equal and die at the same level (*Strobilanthes*) or the anther lobes are separated by the development of connective and they are unequal in size and the lower one is often spurred (*Justicia*). The anthers open by longitudinal slits.

A hypogynous nectar secreting disc is present at the base of the ovary.

13) Gynoecium:

The gynoecium is bicarpellary and syncarpous with a superior, bilocular ovary having one or more anatropous ovules in each locule. The placentation is axile. There is one long and narrow style and two variously sharped stigmas of which the posterior one is often smaller.

Fruit and Seed:

14) Fruit:

The fruit is usually a loculicidal capsule.

15) Seed:

The seeds are ovoid or compressed, non-endospermic and with a large embryo.

16) Pollination:

The flowers of Acanthaceae are pollinated by insects which visit them for nectar secreted by a hypogynous disc. They are generally markedly protrandrous. The lower lip of the corolla forms a platform for alighting insect visitor. The insect entering the corolla tube to reach the nector at the base first touches the stigma (which projects from the mouth of the corolla tube) with its back and then the anthers.

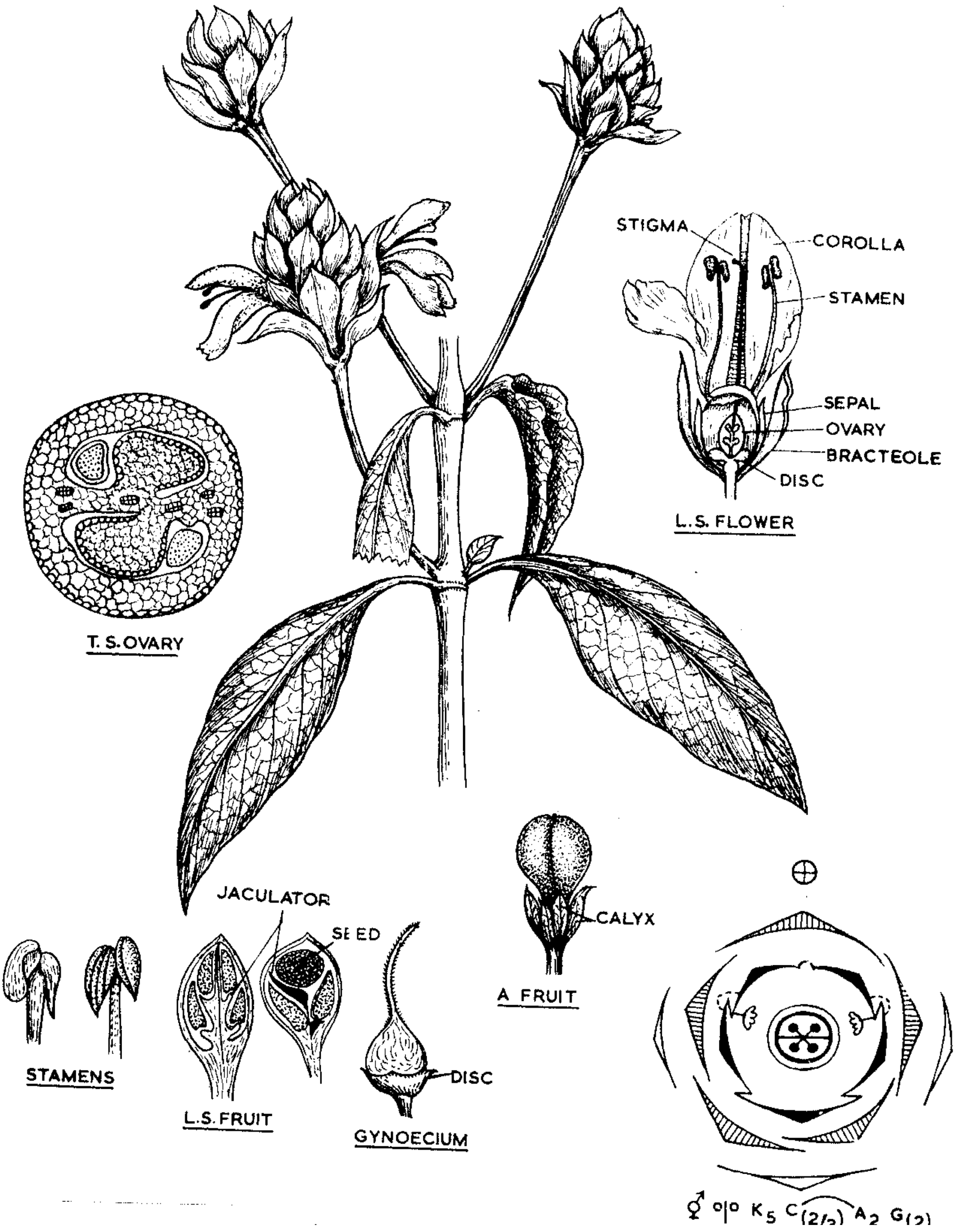

Fig. 11.5 *Adhatoda vasica*

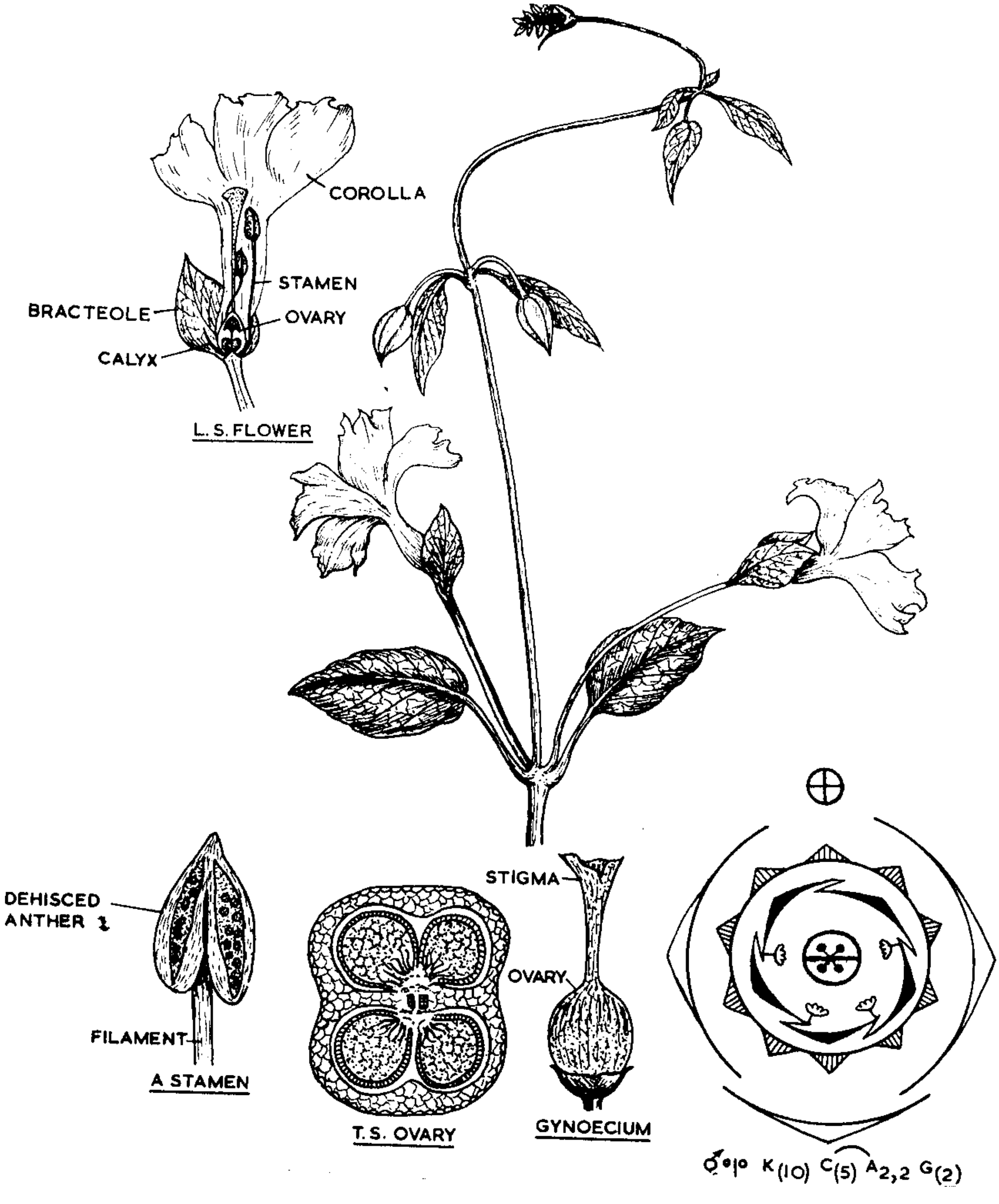

Fig. 11.6 *Thunbergia alata*

17) Dispersal:

Seeds are dispersed by explosive mechanism of the capsules (*Ruellia* and *Thunbergia*) or by adhesion of recurved spines present on the surface of the seeds to the feathers or furs of birds and animals (*Blepharis* and *Dicliptera*) or sometimes by water (*Acanthus*).

18) Floral Formula:

Br brl % ⚥ K_5 $C_{(2/3)} \leftarrow A_2$ $\underline{G}_{(2)}$

19) Economic Importance:

Species of several genera are cultivated as garden ornamentals.

I. Ornamentals:

1) *Thunbergia* (clock vine) – *T. grandifolia, T. alata, T. laurifolia*.
2) *Eranthemum (Eranthenum) – E. nervosum, E. bicolor* and *E. reticulatum.*
3) *Beloperone guttata* (Shrimp plant)
4) *Ruellia – R. tuberosa* and *R. brittoniana*

II. Medicines:

1) The leaves and roots of *Adhatoda vasica* (Vasaka) provides a well known drug used for bronchitis, asthama and cough.
2) The roots and leaves of *Hygrophila spinosa* are used for jaundice and rheumatism.

20) Distinguishing features:

1) Mostly herbs or shrubs.
2) Leaves simple, exstipulate, opposite-decussate, petiolate or sub-sessile.
3) Terminal or axillary dichasial cyme, with prominent bracts and bracteoles.
4) Flowers bisexual, zygomarphic, hypogynous.
5) Sepals and petals 5.
6) Bilabiate corolla.
7) Stamens 4, epipetalous, didynamous.
8) Ovary superior, bicarpellary, syncarpous, bilocular.
9) Axile placentation.
10) Fruit a loculicidal capsule.

21) Questions:

1. Give an account of the family Acanthaceae. Mention the plants of some economic importance.
2. Write short notes on flower of Acanthaceae.

22) Reference Books:

i) **A Text Book of Botany** – Dr. V. Singh, Dr. P.C. Pande & Dr. G.K. Jain – Rastogi Publications, Meerut.

ii) **Taxonomy of Vascular Plants –** G.H.M. Lawrence & Oxford & IBM Publishing Co., New Delhi.

iii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

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Ch. E. USHA RANI

11.4 LABIATAE (LAMIACEAE)
(The Mint family)

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Calyx
11) Corolla
12) Androecium
13) Gynoecium
14) Fruit
15) Seed
16) Pollination
17) Dispersal
18) Floral Formula
19) Economic importance
20) Distinguishing Features
21) Questions
22) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Dicotyledonae
Sub-class	Gamopetalae
Series	Bicarpellatae
Order	Lamiales

2) Distribution:

The mint family is rather large, containing 180 genera and 3,500 species of world-wide distribution. The Mediterranean region is the chief centre of distribution. In India, the family is represented by about 64 genera and 380 species occurring chiefly in comparatively dry areas and moderate altitudes. The two chief centres of distribution are South India and North Western India.

3) Familiar Examples:

1. *Coleus blunei* (Nemalipincham)
2. *Lavendula vera* (Lavender plant)
3. *Leonitis axillaris* (Ranabheri)
4. *Majorana hortensis* (Maruvam)
5. *Mentha arvensis* (Mint-Menthol)
6. *Mentha piperita* (Peppermint)
7. *Mentha viridis* (Podina)
8. *O. gratissimum* (Rama tulasi)
9. *Ocimum sanctum* (Krishna Tulasi)
10. *Rosmarinus officinalis* (Rosemany)
11. *Salvia officinalis* (Sage)

4) Vegetative characters:

They are mostly annual or perennial herbs, sometimes shrubs (as some species of *Ocimum* and *Orthosiphon*) or rarely trees as *Leucosceptrum*. Species of *Mentha* and *Lycopus* are marsh plants which persist by perennial rhizomes. *Rosmarinus* and some other taxa are Xerophytic.

5) Root: Tap root.

6) Stem:

The stems of the herbaceous species are often quadrangular.

7) Leaves:

The leaves are opposite (whorled in *Dysophyla*), exstipulate, simple and the blade is from entire to finely multisect as in some species of *Salvia*. They are abundantly loaded with epidermal glands secreting volatile aromatic oils which import characteristic odour.

8) Inflorescence:

It is usually a dichasial cyme which often becomes cincinal in its later branching. These cymes occur in the leaf axils and often form a whorl of flowers at each node. This type of inflorescence is often called a verticillaster. Rarely the flowers are solitary in the axils of the leaves or bracts and form a recemose inflorescence as in *Sentellaria*. Each flower is usually subtended by ebract and a pair of bracteoles.

9) Flower:

The flowers are bracteate, perfect, hermaphrodite, zygomorphic (nearly actinomorphic in *Mentha*), pentamerous and hypogynous.

10) Calyx:

The calyx is persistant and composed of usually five sepals which show various degrees of union. Sometimes, as in *Salvia*, *Ocimum* and several other taxa, it is two-lipped. The aestivation is valvate or rarely imbricate.

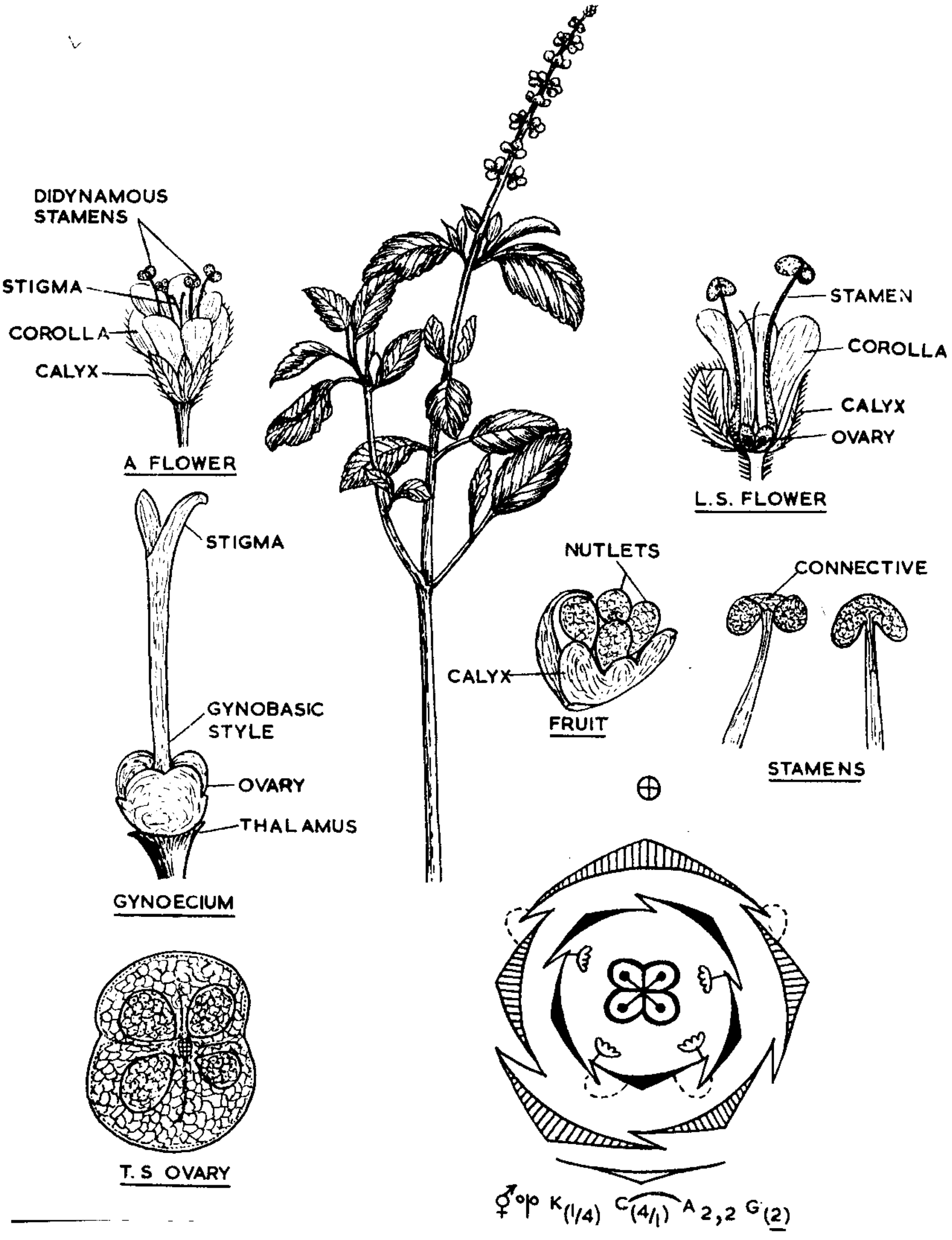

Fig. 11.7 *Ocimum sanctum* (the sacred Tulsi)

11) Corolla:

The corolla is gamopetalous and is differentiated into a tube and limb. The tube is straight or bent and often widens upward. The limb is usually two-lipped. In *Lamium* and *Salvia* the upper lip is composed of a posterior petal, while the remaining three petals form the lower lip in which the median lobe is most developed. In *Ocimum* and related genera the upper lip, which is four-fid, is formed by the four petals, while the remaining fifth anterior petal forms the lower lip which is hardly longer than the upper lip. In *Teucrium* the limb is one-lipped and all the five lobes are pushed on the lower side. The corolla lobes are contorted or imbricate in the bud.

12) Androecium:

The stamens are usually four, didynamous and inserted on the corolla tube. The anterior pair of stamens is usually longer. The fifth (posterior) stamen is sometimes represented by a staminode but usually it is completely suppressed. In *Lycopus, Salvia, Mosla* and some other genera only two stamens (anterior pair) are fertile whereas the other two (posterior pair) are reduced to staminodes. The filaments are usually free but they are connate in colens. The anthers are dithecous, introrse and dehisce lengthwise. In *Salvia*, the two anther cells are separated apart by the development of the connective. The posterior cell alone is fertile and the anterior cell is reduced to a sterile knob.

13) Gynoecium:

It is bicarpellary and syncarpous. The ovary is superior, deeply four-lobed, bilocular or apparently becoming four-locular by the formation of false septa. There are two anatropous ovules in each locule (only one when the ovary is tetralocular) and the placentation is axile. The style is gynobasic arising between the lobes of the ovary. The stigma is usually bifid.

A hypogynous disc is present at the base of the ovary. It is usually four-lobed and the anterior pair of lobes which are more developed secrete nectar.

14) Fruit:

The fruit is of four one-seeded nutlets enclosed by the persistent calyx.

15) Seed:

The seeds are either non-endospermic or with a scanty endosperm and the embryo is usually straight.

16) Pollination:

The brightly coloured flowers with nectar secreted by the posterior lobes of a hypogynous disc are adapted for insect pollination. They are mostly visited by moths and butterflies. Dichogamy is of universal occurrence.

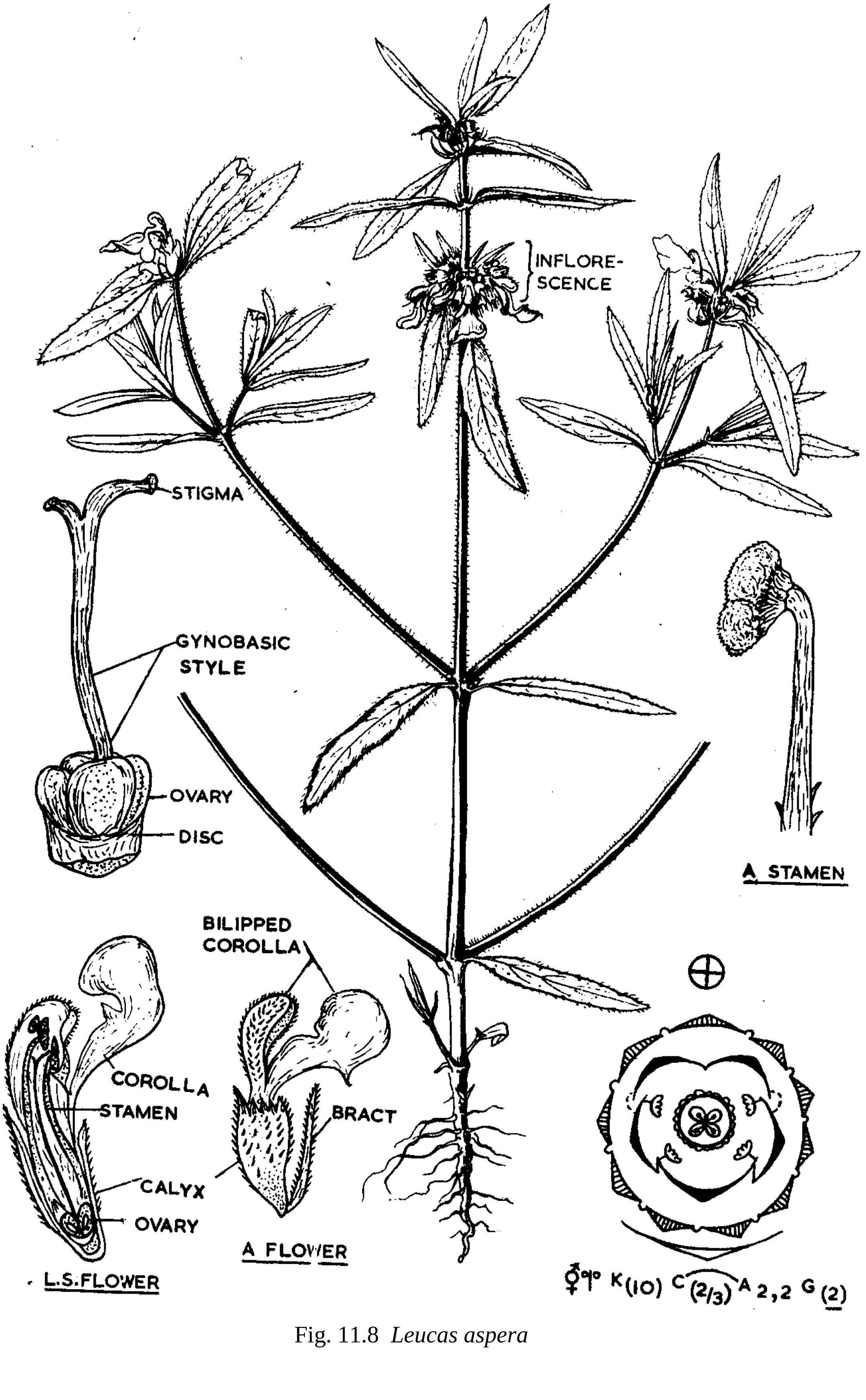

Fig. 11.8 *Leucas aspera*

17) Dispersal:

The persistent calyx sometimes forms a swollen bladder or develops barbed or thorny outgrowth which help in the distribution of the nutlets.

18) Floral Formula:

Ocimum : Br % ♀⚥ $K_{(1/4)}$ $C_{(4/1)} \leftarrow A_{2+2}$ $\underline{G}_{(2)}$

Salvia : Br % ♀⚥ $K_{(3/2)}$ $C_{(2/3)} \leftarrow A_{2}$ $\underline{G}_{(2)}$

19) Economic Importance:

The Lamiaceae are chiefly valuable as a source of volatile essential oils which are used for flavouring, for perfumery and for medicine and some garden ornamentals.

I. Perfumery and medicines:

1. Several species of *Ocimum* (Basil) such as *O. americamum* syn. *O. canum* (Kukka tulasi), *O. basilicum* (Sweet basil) and *O. sanctum* (Krishna tulasi) yield essential oils which are used in medicine and perfumery.

2. *O. kilimandscharicum* is a rich source of camphor.

3. *O. sanctum* (Krishna tulasi) is held in religious veneration. The leaf juice is used for cough, cold and fever and it also relieves earache. The plant is mosquito-repellent.

4. Several species of *Mentha* are useful, particularly for their essential oil. *M. piperita* (Peppermint) is the source of peppermint oil used in pharmacy, confectionery and for flavouring. The plant is used for allaying nausea and vomiting. *M. pulegium* is the source of pennyroyal oil used in the production of synthetic menthol and in cosmetics.

5. The leaves of *Rosmarinus officinalis* (Rosemary) are the source of an important essential oil used in perfumery and medicine. It also exhibits antibacterial property.

6. Several species of *Lavandula* (Lavender) such as *L. angustifolia, L. latifolia* and *L. hybrida* are the source of Lavender oil used in perfumery, cosmetics and soaps. The oil is also carminative, stimulant and insect repellent.

7. The leaves and flowering tops of *Plectranthus mollis* yields an essential oil which is cardiac depressant and respiratory stimulant. The crushed leaves when applied stop bleeding.

II. Ornamentals:

1) *Salvia* (Sage) – *S. splendens* (Scarlet sage), *S. leucantha, S. coccinea* and *S. officinalis* (Garden sage).
2) *Coleus blumei*.

20) Distinguishing features:

1) Herbaceous habit, armoured by hairs.
2) Quadrangular stem.
3) Aromatic leaves
4) Exstipulate, simple, opposite-decussate leaves.
5) Thyrsus or verticillaster inflorescence.
6) Irregular and persistant calyx.
7) *Bilabiate corolla* (2/3, 4/1 or 0/5)
8) Stamens 4, epipetalous, didynamous.
9) Bicarpellary, syncarpous, superior, tetralocular ovary.
10) Gynobasic style, stigma bifid.
11) Placentation axile (basal)
12) Nectariferous disc
13) Schizocarpic fruit, Carcerulus.

21) Questions:

1. Describe the characters of the family Lamiaceae. Explain the economic importance of the family.
2. Write short notes on:
   (i) Economic importance of Lamiaceae.
   (ii) Pollination mechanism in Lamiaceae.
   (iii) Compare between Lamiaceae and Euphorbiaceae.

22) Reference Books:

i) **Taxonomy of Angiosperms –** B.P. Pandey – S.Chand & Co. Ltd., New Delhi.
ii) **Taxonomy of Vascular Plants –** G.H.M. Lawrence & Oxford & IBM Publishing Co., New Delhi.
iii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

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Ch. E. USHA RANI

Unit-III

Class: Monocotyledons

Lesson 12

TAXONOMY AND ECONOMIC IMPORTANCE OF THE FAMILIES BELONGING TO THE CLASS: MONOCOTYLEDONS

OBJECTIVES

⇒ To know the vegetative and floral characters of the plants belonging to the families in Monocotyledons.
⇒ To know the similarities and differences between the families of Monocotyledons.
⇒ To know the economic importance of the families in Monocotyledons.

CONTENTS

12.1 Class: **Monocotyledons**:

12.1.1 Characteristic features of Class: Monocotyledons

1) Venation parallel
2) Flowers trimerous

12.1.2 Classification: Series included in class Monocotyledons

a) Microspermae b) Coronarieae c) Calycinae d) Glumaceae

a. <u>Microspermae</u>:

1. Inner perianth petaloid
2. Ovary inferior with three parietal or rarely axile placentae
3. Seeds minute, exalbuminous
4. Family included: **Orchidaceae**

b. <u>Coronarieae:</u>

1. Inner perianth petaloid
2. Ovary superior
3. Endosperm abundant
4. Family included: **Liliaceae**

c. Calycinae

1. Perianth sepaloid, herbaceous or membranous
2. Ovary superior
3. Endosperm abundent
4. Family included: **Arecaceae (Palmae)**

d. Glumaceae:

1. Perianth of scales or non
2. Ovary unilocular, one ovuled
3. Seeds endospermic
4. Family included: **Poaceae (Gramineae)**

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12.2 ORCHIDACEAE
The Orchis Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Perianth
11) Androecium
12) Gynoecium
13) Fruit
14) Seed
15) Pollination
16) Dispersal
17) Floral Formula
18) Economic importance
19) Distinguishing Features
20) Questions
21) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Monocotyledonae
Series	Microspermae

2) Distribution

A very large family of 735 genera and over 17,000 species, cosmopolitan in distribution but abundant in the tropics and rare in arctic regions. This is the second largest family of Indian flora, represented by 128 genera and about 881 species occurring mostly in the Himalayas, Western ghats and Khasia Hills but they are most abondant in the Eastern Himalayas.

3) Familiar Plants:

1. *Arundina bambusifolia*
2. *Bulbophyllum roxburghii*
3. *Dendrobium superbum*
4. *Epipactis giganteum*
5. *Eulophia virens*
6. *Neottia listeroides* (Birds nest orchid)
7. *Orchis latifolia*
8. *Vanda parviflora*
9. *Vanilla planifolia*
10. *Zenxina sulcata*

4) Vegetative characters:

They are all perennial herbs of various habits, terrestrial, epiphytic and saprophytic. The tropical species are mostly epiphytes, while those occurring in the temperate zones are largely terrestrial.

5) Root & 6) Stem:

Most species produce fleshy roots, root stocks, corms or bulbs.

Terrestrial forms: The terrestrial forms (*Epipactis* and *Orchis*) are sympodial. In most of them, the internodes are often swollen which serve as storage reservoir of food. Others develop a thick or fleshy adventitious roots forming a large tuber which help the plant overwinter.

Epiphytic forms: The epiphytic forms (*Cypripedium, Cattleya* and *Cymbidium*) are mostly sympodial or sometimes monopodial. They develop aerial roots which have an outer layer of water absorbing tissue, the velamen. Their internal tissue is green which helps in photosynthesis. Most of the epiphytic forms drop their leaves during dry season. They usually develop one fleshy pseudo-bulb (consisting of one or more thickened internodes of stem) each year. Those epiphytic species which do not form pseudo-bulbs have fleshy leaves which store water and other reserves.

Saprophytic forms: The saprophytic forms (*Neottia*) do not develop green leaves. They produce a much branched fleshy rhizome, with or without roots, which absorbs food materials from humus.

7) Leaves:

The leaves are alternate, often distichous or rarely opposite. In most terrestrial and epiphytic species, the leaves are often fleshy and varying in shape from linear to ovate. They are characteristically sheathing at the base and encircling the stem. Sometimes, as in saprophytic species leaves are reduced to scales. *Epipogon* is leafless terrestrial herb. Occasionally there is only one (*Bulbophyllum*) or two (as in some *Dendrobium*) leaves.

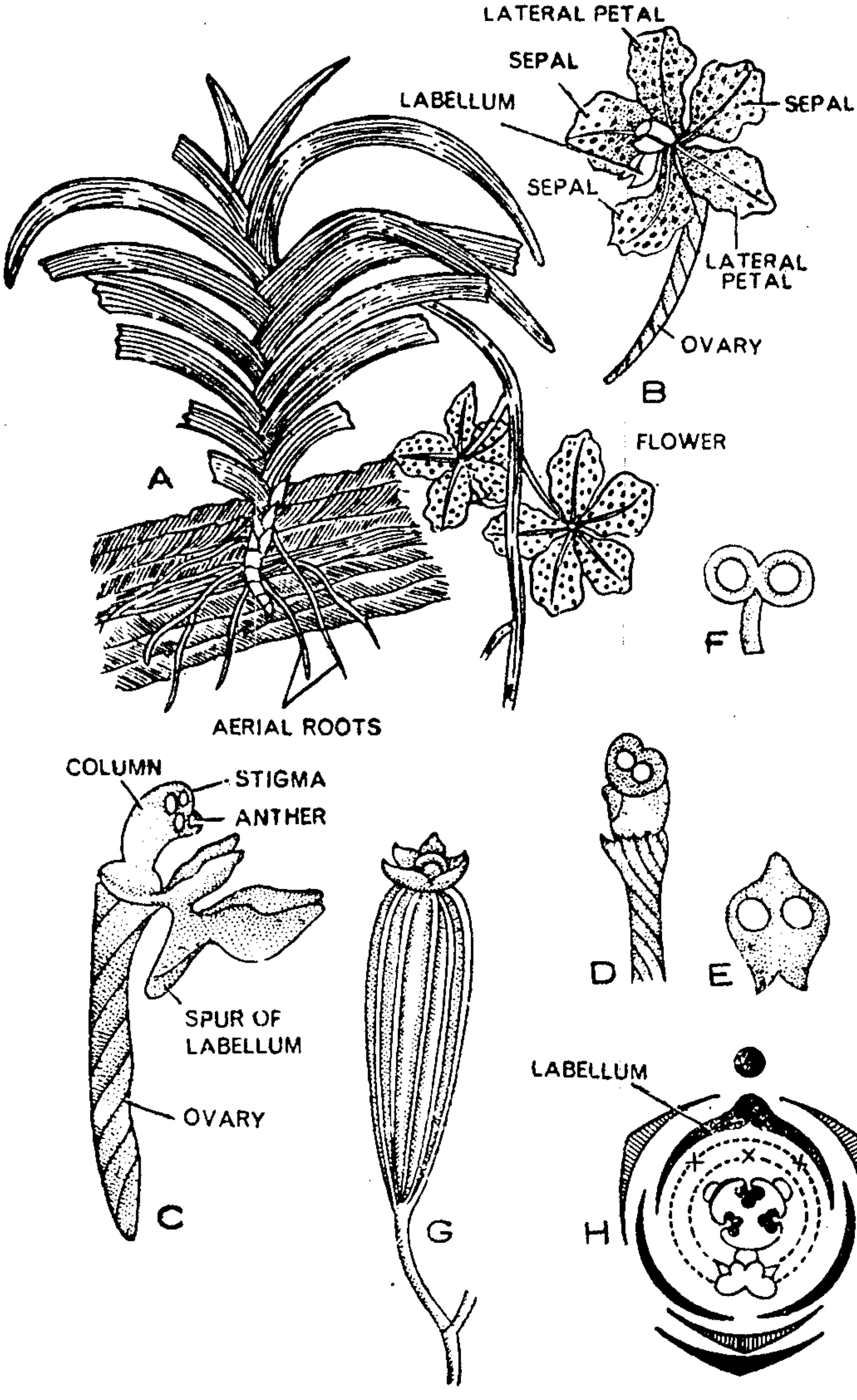


Fig. 12.1 Orchidaceae – *Vanda roxburghii*

8) Inflorescence:

The flowers are either solitary (*Cypripedium*) or are borne in racemes spikes or panicle.

9) Flower:

The flowers are often very showy and beautifully coloured. They are bracteate, bisexual or rarely unisexual (the plants monoecious or dioecious), zygomorphic (bilaterally symmetrical) and epigynous. The flowers are usually resupinate at anthesis as the pedicel or ovary twists at an angle of 180^o during development.

10) Perianth:

The perinath is in two trimerous whorls, the outer often calyx-like (sometimes petaloid) and the inner corolla-like. The tepals are free or variously connate in each whorl. The three outer tepals are alike in appearance. They are imbricate or subvalvate in bud.

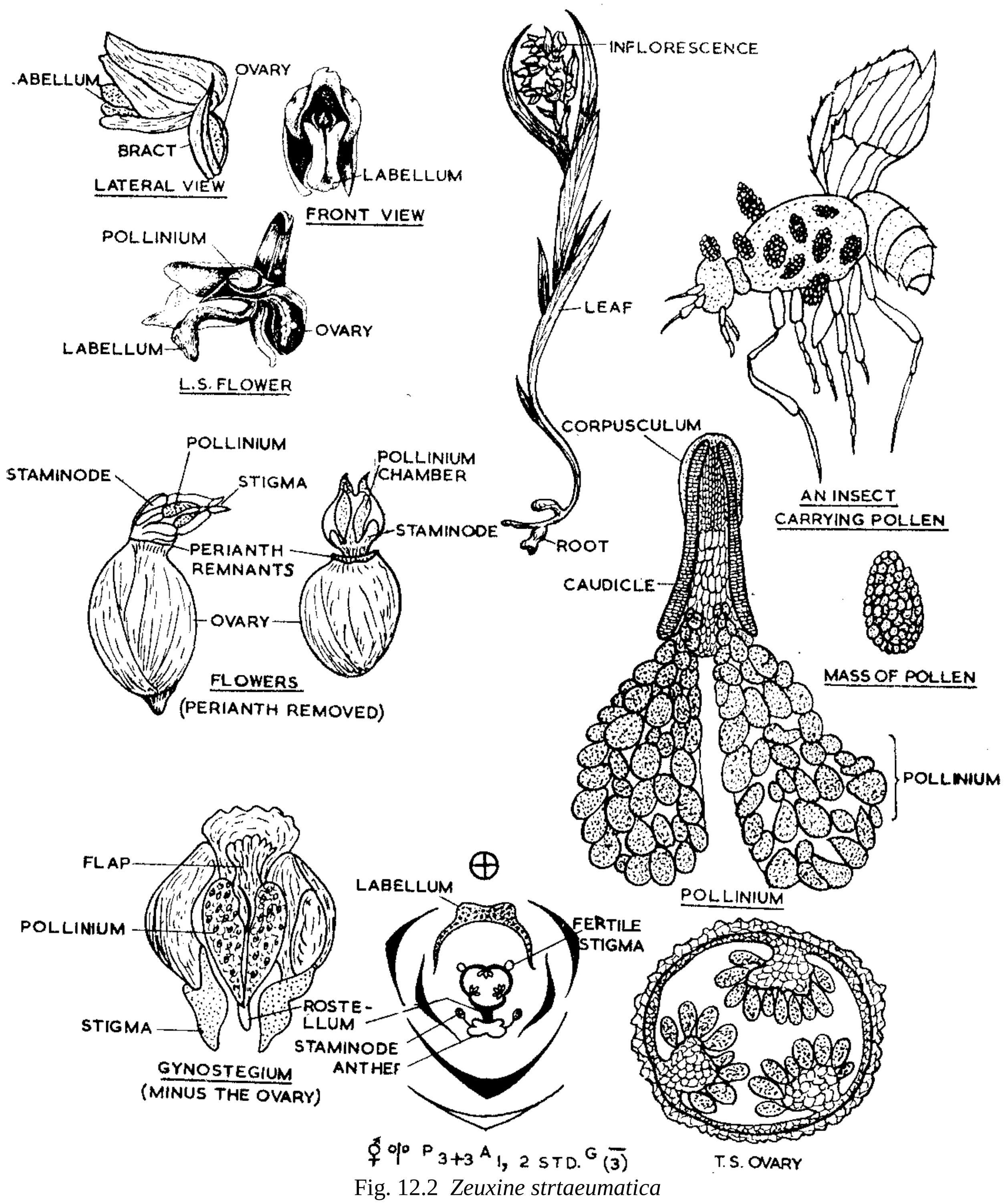
The two lateral tepals of the inner whorl are alike but the median tepal is very different in size, shape and colour from the lateral tepals. It is bulbous, spurred, tubular, strap shaped or variously divided, and contribute to the beauty of the flower. This highly modified tepal is called lip or labelliu. When resupinate, the labellium stands at an adaxial position. The labellum was considered by some earlier workers as a compound structure formed by the fusion of two stamens (of the absent outer whorl) and a petal. However, Swamy (1948), on the basis of his study of floral anatomy, concluded that the labellum represents only one of the three members of inner whorl as no vascular tissue of staminal origin is involved in it.

The most characteristic part of the orchid flower is gynandrium or column which is a highly complex structure formed by the adnation of stamens, style and stigma.

11) Androecium:

The androecium is represented by usually one or sometimes two sessile anthers. In monandrous forms there is only single fertile stamen, terminal on the column. This stamen is considered to represent the anterior member of the outer whorl, the two other (latral) stamens of this whorl and also all the three of the inner whorl are entirely absent. The two lateral members of the outer whorl are sometimes represented by staminodes as in *Epipactis*. In diandrous forms (*Cypripedium* and allied genera) there are two fertile stamens belong to the inner whorl and they are lateral on the column. The median member of the outer whorl (which is fertile in monandrous forms) is represented by a large staminode. The other staminal members are completely absent.

The anthers are dithecous, instrorse and opening by longitudinal slits. The pollen grains are either granular or agglutinated into mealy, waxy or bony masses, the pollinia. One end of the pollinium is extended into a sterile structure, the caudicle. There are two to eight pollinia per anther and they are free or more or less loosely united.



$⚥ \; \% \; P_{3+3} \; A_{1,\ 2\ STD.} \; G_{\overline{(3)}}$

Fig. 12.2 *Zeuxine strtaeumatica*

12) Gynoecium:

It is tricarpellary and syncarpous with an inferior ovary, which is unilocular with three parietal placentae. Sometimes, as in Apostasia, the ovary is trilocular with axile placentation. There are numerous ovules on each placenta. In monandrous forms the column has two fertile stigmas and a specialised organ, the rostellum, which represents the third stigma. Sometimes (*Habenaria*), a portion of rostellum is modified into a viscid disk (*Vicidia*) to which pollinia are attached. In diandrous forms there is no rostellum and all the three stigmas are simple and fertile.

13) Fruit:

The fruit is usually a capsule opening laterally by three to six hygroscopically sensitive valves.

14) Seeds:

The seeds are minute, often fusiform and rarely winged. They are non-endospermic and the embryo is undifferentiated.

15) Pollination:

The flower of the Orchidaceae are admirably adapted to insect pollination. The insects are attracted by beautiful form and colour and fragrance of flowers, and the nectar secreted in the sac or spur or labellum in several taxa. In others, where spur has no free nectar, the insect has to bore the tissues of spur to reach the sweet sap contained in the labellum. The resupination of flowers brings the labellum into a position where it makes an effective landing place for the insects.

16) Dispersal:

The innumerable light seeds which are sometimes winged are suited to distribution by wind.

17) Floral Formula:

Br %E P_{3+3} A_{1-2} $\overline{G}_{(3)}$

18) Economic Importance:

The orchids have one of the most beautiful flowers in the plant kingdom. Their remarkable colours, form and profusion make them favourite to florists and horticulturalist. Many genera and their hybrids are cultivated as ornamentals. The notable among these are Cypripedium, Cattleya, Habenaria, Bletilla, Vanda, Cymbidium, Dendrobium, Epidendrum, Orchis, Epipactis, Coelogyne and Aerides.

The capsules of *Vanilla fragrance* (Vanilla) and several other species of this tropical genus are the sources of Vanilla extract of commerce which is extensively used for flavouring various food products.

The tubers of *Platenthera sussannae* are edible.

The dried tuberous roots of *Orchis latifolia* constitute Salep of commerce which is used as a farinaceous food and nervine tonic. It is also used as sizing material in silk industry.

19) Distinguishing features:

1) Epiphytes or land plants with rhizomes or tubers.
2) Inflorescence recemose.
3) Flowers strongly zygomorphic, bisexual and epigynous.
4) Perianth in two trimerous whorls.
5) Posterior perianth member of inner whorl modified into labellum or lip.
6) Stamens one or two.
7) Adhesion of stamens with style and stigma to form a structure called column or gynostemium.
8) Pollen grains united into pollinia.
9) Gynoecium inferior, 3-carpellary, syncarpous, unilocular with numerous ovules on parietal placentation.
10) Fruit capsule, seeds minute.

20) Questions:

1. Mention the floral structure and pollination mechanism in Orchidaceae.
2. Describe the Orchid flower and explain the mechanism of pollination.
3. Write short notes on:
   (i) Androecium in Orchidaceae.
   (ii) Pollination mechanism in Orchidaceae.
   (iii) Floral characters in Orchidaceae.

21) Reference Books:

i) **Taxonomy & Angiosperms –** B.P. Pandey – S. Chand & Co. Ltd., New Delhi.
ii) **Angiosperms (Systematics & Life Cycle)** – G.L. Chopra – Pradeep Publications, Jalandhar.
iii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

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Ch. E. USHA RANI

12.3 L I L I A C E A E
The Lily Family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Perianth
11) Androecium
12) Gynoecium
13) Fruit
14) Seed
15) Pollination
16) Dispersal
17) Floral Formula
18) Economic importance
19) Distinguishing Features
20) Questions
21) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Monocotyledonae
Series	Coronarieae

2) Distribution

A large family of about 254 genera and 4,075 species widely distributed over most part of the world. In India, the family is represented by 35 genera and about 189 species occurring chiefly in the Himalayas.

3) Familiar Plants:

1. *Allium cepa* (onion) – (Neerulli)
2. *sativum* (garlic) – (Vellulli)
3. *Agave americana* (Century plant)
4. *Aloe barbadensis* (Kalabanda)
5. *Asparagus racemosus* (Satamuli)
6. *Dracaena angustifolia*
7. *Foritillaria cirrhosa*
8. *Gloriosa supera* (Nabhi)
9. *Lilium candidum* (Madonna lily)
10. *Ruscus aculeatus* (Butcher's broom)
11. *Smilax zeylanica* (Adavi tella gadda)
12. *Yucca gloriosa* (Spanish dagger)

4) Vegetative characters:

They are mostly perennial herbs persisting by means of a sympodial rhizome (*Polygonatum*) or by a bulb (*Lilium*). Sometimes, as in *Asparagus* they are annual herbs.

5) Roots: Adventitious roots.

6) Stem:

Yucca, Dracaera and *Aloe* are shrubby or tree like with a perennial aerial stem growing in thickness by successive rings of meristems which form concentric secondary vascular bundles and ground tissue.

The species of *Smilax* and *Heterosmilax* are woody climbers with often prickly stem. They climb with the help of stipular tendrils which arise from the leaf sheath.

The species of *Asparagus* are rhizomatous plants with herbaceous or woody, erect, straggling or climbing stems. The leaves are reduced to minute scales and the ultimate branches become needle-like or flattened. These cladodes take up the function of leaves. In *Ruscus*, which is an erect shrub, the ultimate branches are also modified into flattened leaf-like phylloclades.

Gloriosa is a perennial tuberous herb with a climbing stem. The climbing is affected by the leaf tip which elongates to form a spiral.

7) Leaves:

The leaves are basal (*Allium* and *Lilium*) or *Cauline*. They are usually alternate, rarely opposite (*Gloriosa*) or whorled (*Trillium* and *Paris*). They vary in shape from linear to broadly ovate. They are fleshy in *Aloe* with a large water-storing tissue. The venation is usually parallel but in smilax the leaves are net-veined. In *Smilax*, two tendrils spring from the base of the leaf which are usually regarded as modified stipules. In *Ruscus* and *Asparagus* leaves are reduced to minute scales.

8) Inflorescence: The flowers are usually borne in simple or branched recemes. They form apparent umbel in *Allium* subtended by spathe-like bracts but these umbels consist of a number of monochasial cymes with shortened internodes. In Yucca, the inflorescence is a huge terminal panicle. Sometimes, the flowers are solitary terminal (*Lilium* and *Tulipa*) or solitary axillary (*Gloriosa*).

9) Flowers:

The flowers are often showy, bracteate, bisexual (unisexual in *Smilax*) actinomorphic (slightly zygomorphic in *Gellesia*), usually trimerous and hypogynous.

10) Perianth:

The perianth is of six tepals arranged in two whorls of three each. They are free or united (*Polygonatum*). The perianth segments are usually petaloid and the two whorls are generally undifferentiated. They are imbricate or valvate.

11) Androecium:

The androecium is usually of six stamens arranged in two alternate whorls of three members each. They are always opposite to the tepals and sometimes adnate to the perianth. The filaments are free a variously connate. The anthers are basifixed, dithecous, introrse or extrorse and opening by longitudinal slits or terminal pores.

12) Gynoecium:

The gynoecium is tricarpellary and syncarpous with a superior and trilocular ovary. There are numerous anatropous ovules in each locule in two rows and the placentation is axile. The style is usually one with three distinct stigmas or a three-lobed stigma.

Usually, the ovary has three septal nectaries, one on each septum.

13) Fruit:

The fruit is usually a loculicidal or septicidal capsule or sometimes berry as in *Smilax* and *Polygonatum*.

14) Seeds:

The seeds are endospermic with a straight or curved embryo.

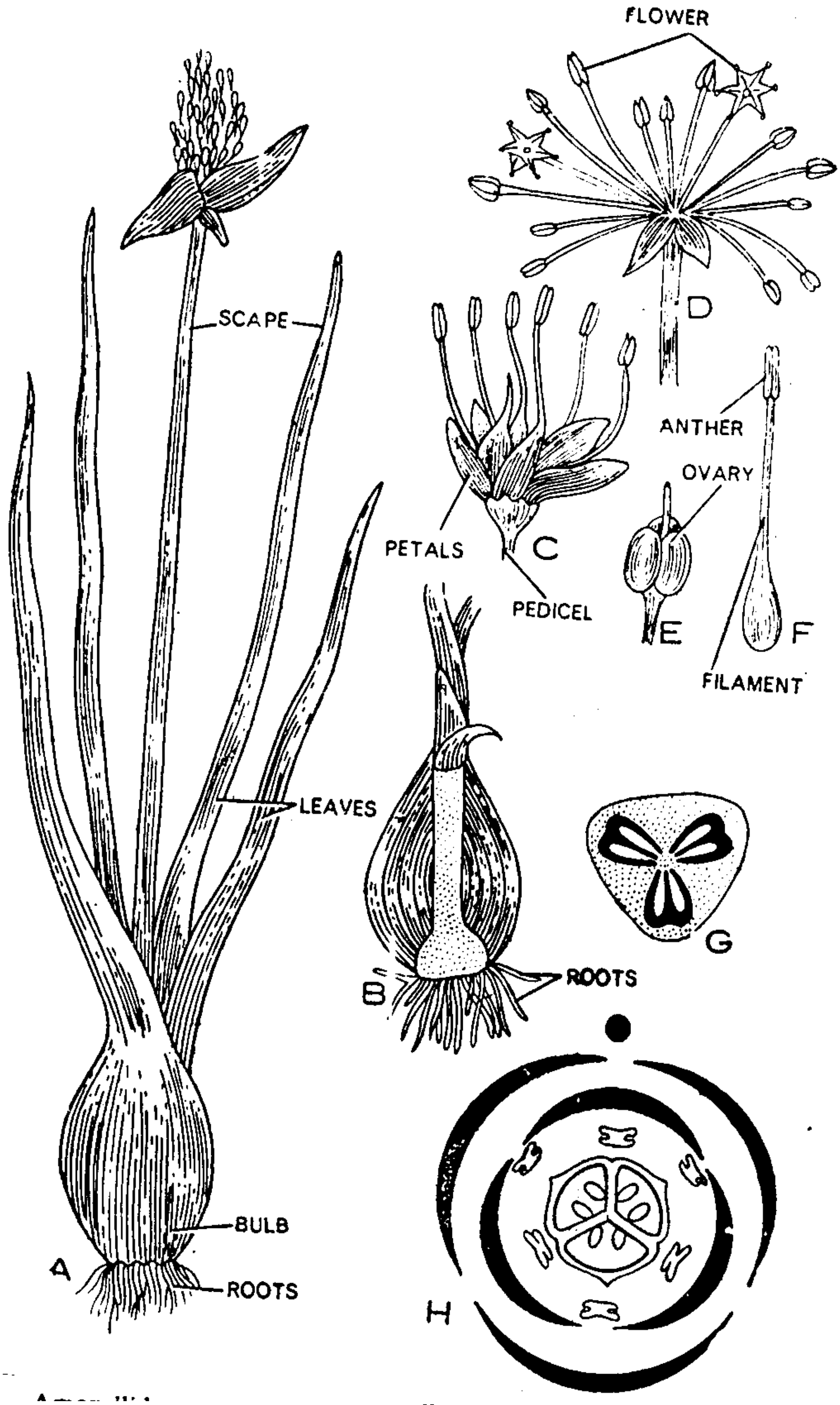

Fig. 12.3 *Allium cepa*

15) Pollination:

The flowers are usually insect pollinated. Insects are attracted by the showy and often fragrant flowers and the nectar secreted by the septal nectaries. *Yucca* has an unique pollination mechanism which is intimately associated with the life history of a moth, *Pronuba yuccasella*.

16) Dispersal:

The dispersal of fruits takes place by air, human beings and animals.

17) Floral Formula:

Br ⊕ ⚥ P_{3+3} or $_{(3+3)}$ A_{3+3} $\underline{G}_{(3)}$

18) Economic Importance:

The family provides several food, drug and fibre plants and some are important as ornamentals.

I. Edibles:

1) The bulbs of *Allium cepa* (onion) are popular as vegetables and are also used for flavouring and pickling. They possess stimulant, diuretic and expectorant properties. The fresh juice possesses bactericidal properties.

2) *Allium sativum* (Garlic) is largely cultivated as an important spice or condiment crop. The bulb yields an essential oil which is used as a spice, as a tonic and stimulant to the stomach and as a vermifuge. Garlic is good for heart.

3) The fleshy shoots of *Asparagus officinalis* are used as vegetables.

II. Medicines

1) The roots of *Asparagus racemosus* are used in the preparation of medicated oils used for nervous and rheumatic complaints. *A. gonocladus* is useful in skin disease.

2) *Aloe vera* (Aloe) is one of the constituents of several laxative preparation. It is also valuable in treatment of piles and fissures.

3) *The* corn and seeds of *Colchicum luteum* are useful in the rheumatism and liver diseases.

4) The bulbs of *Urginea indica* are cardiostimulant. They are also useful in dropsy, rheumatism and skin disease.

5) The dried bulbs of *Fritillaria cirrhosa* are given in asthama, bronchitis and tuberculosis.

6) The roots of several species of Smilax such as *S. ovalifolia* and *S. china* constitute the drug *Sarsapra rilla*, used in the treatment of venereal diseases and skin affections.

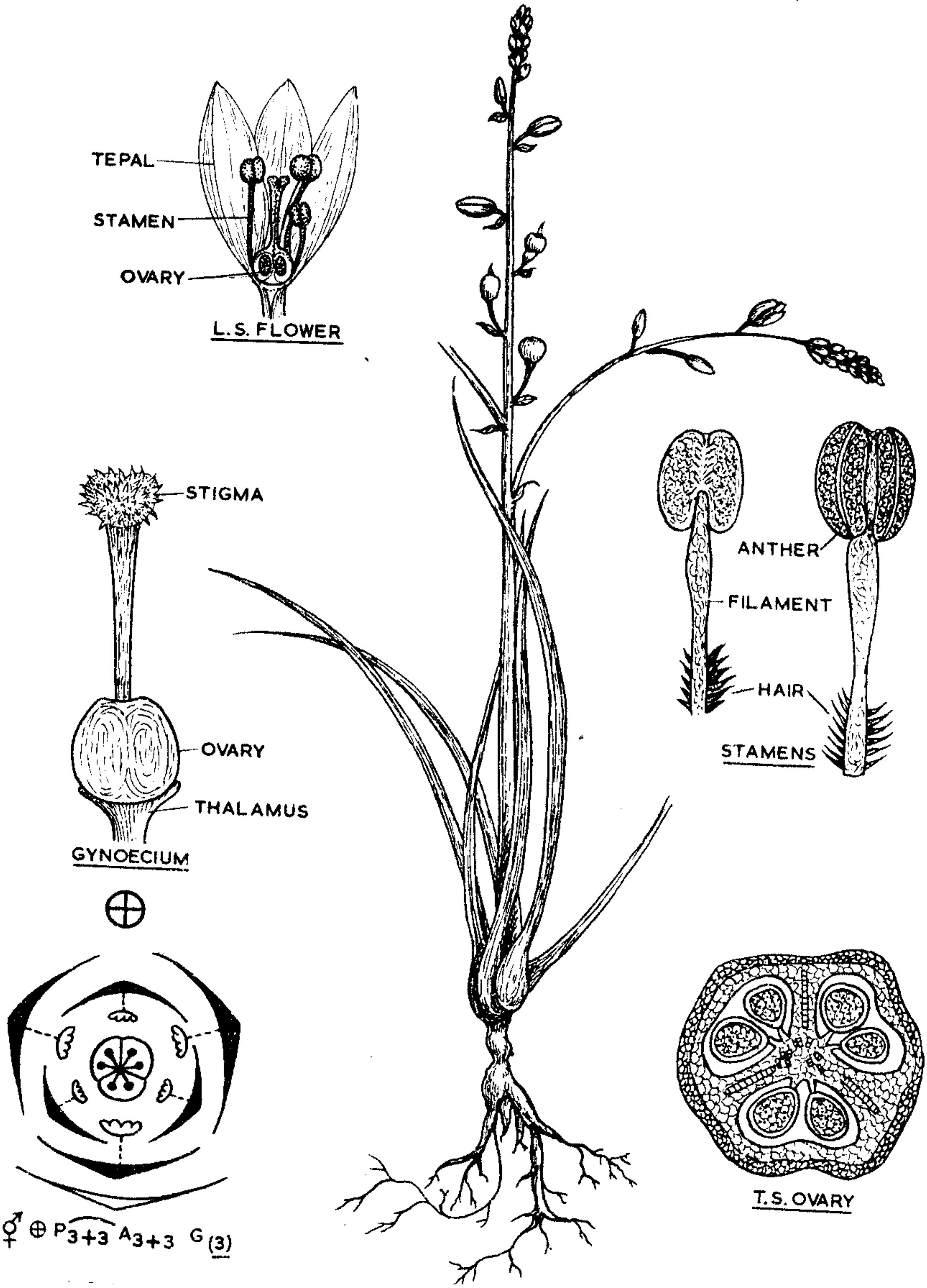

Fig. 12.4 *Asphodelus tenuifolius*

7) The tubers of *Gloriosa superba* are used for promoting labour pains and also as abortifacient. The leaf juice is used for killing lice.

III. Fibres:

1) The leaves of some species of *Sansevieria* such as *S. roxburghiana* and *S. trifaciata* provide a strong fibre used for making bowstrings, fishing lines, nets and for cordage and matting.
2) The leaves of *Phormium tenax* yield a strong fibre used for towline, twine and other cordage.
3) The leaves of *Yucca filamentosa* and some other species furnish an excellent fibre used for cordage.

IV. Ornamentals:

1) *Yucca* **–** *Y. gloriosa, Y. aloifolia*
2) *Lilium* (Lily) **–** *L. giganteium, L. candidum*
3) *Agapanthus africans*
4) *Tulipa* (Tuli) **–** *T. gesneriana* and *T. suaveolens*
5) *Ruscus aculeatus*
6) *Gloriosa superba*

V. Others uses:

1) The flowers of *Iphigenia indica* yield a red dye.
2) *Colchicum luteum* contains an alkaloid, colchicine, widely used inplant breeding to induce polyploidy.

19) Distinguishing features:

1) Plants generally rhizomatous or bulbous perennial herbs.
2) Leaves radical or cauline, alternate or whorled.
3) Inflorescence geneally racemose.
4) Flowers actinomorphic, bisexual and trimerous.
5) Perianth 6, biseriate, homochlamydeous.
6) Stamens 6, in two whorls of 3 each, epiphyllous.
7) Gynoecium tricarpellary, syncarpous.
8) Ovary superior, trilocular, several ovules on axile placentation.
9) Fruit is a capsule or berry.
10) Seeds albuminous, with small embryo.

20) Questions:

1. Give an account of the family Liliaceae and mention its economic importance.
2. Write short notes on:
   (i) Pollination mechanism in Liliaceae.
   (ii) Economic importance of Liliaceae.
   (iii) Characters of Liliaceae.

21) Reference Books:

i) **Taxonomy of Vascular Plants –** G.H.M. Lawrence, Oxford & IBM Publishing Co., New Delhi.

ii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

iii) **Taxonomy of Angiosperms –** B.P. Pandey – S.Chand & Co.Ltd., New Delhi.

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Ch. E. USHA RANI

12.4 ARECACEAE (PALMAE)

The Palm family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Perianth
11) Androecium
12) Gynoecium
13) Fruit
14) Seed
15) Pollination
16) Dispersal
17) Floral Formula
18) Economic importance
19) Distinguishing Features
20) Questions
21) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Monocotyledonae
Sub-class	Calycinae

2) Distribution:

The family contains 217 genera and 2,500 species widely distributed in the tropical and subtropical regions of the world. In India, the family is represented by about 28 genera and 93 species occurring chiefly in the eastern Himalayas and Assam.

3) Familiar Plants:

1. *Areca catechu* (Betelnut palm) – Vakka
2. *Borassus flabellifer* – Thatichettu
3. *Cocos nucifera* (coconut) – Kobbari
4. Elaeis guinensis (oil palm)

5. *Livistonia australis* (cabbage palm)
6. *Lodoicea maldivica*
7. *Oreodoxa regio* (Royal palm, bottle palm)
8. *Phoenix humilis* – Chitti eetha
9. *P. sylvestris* (wild date) – Eetha
10. *P. dactylifera (Date palm) – Kharjuram*
11. *Washingtonia filifera* (Canon palm)

4) Vegetative characters:

The palms are a characteristic feature of the tropical vegetation. They are mostly trees of diverse dimensions and a considerable number are woody shrubs and few are vines (*Calamus*) with slender stems which may attain immense length. They scramble over the surrounding vegetation.

5) Roots:

The primary roots are soon replaced by adventitious roots arising from the base of the stem.

6) Stem:

The stem exhibits various forms. Some palms (*Nypa*) have a very short stem branching below the ground and the leaves appear to arise from the ground, others (*Calamus*) have long and slender stems with distinct internodes and still others (*Cocos*, *Phoenix* and *Borassus*) have a tall and unbranched stem, often covered with persistent leaf bases and bearing a crown of leaves at the top.

Branching in palms is rare. The stem of *Phoenix sylvestris* may exceptionally branch as a result of injury to the terminal bud.

7) Leaves:

The leaves are usually in terminal clusters but in the climbing species (*Calamus*) they are scattered alternately. They are often large with a stout petiole expanding at the base into a broad fibrous and sheathing base. In *Calamus*, the sheath is produced into a ochrea. The petiole is often prickly at the margins. The blade is digitately divided (*Borassus*) or pinnately compound with many leaflets (*Phoenix*). The leaflets or segments are induplicately or reduplicately folded in the bud.

8) Inflorescence:

The inflorescences are axillary and often large. They are either amongst (inter foliar, *Borassus*) or below the leaves (intrafoliar, *Areca*). The Inflorescence is a spadix, either simple (*Borassus*) or richly branched cluster (*Phoenix*). The branching is racemose and the flowers are often embedded in the axis. The young inflorescence is enclosed in a sheath of several leaves.

Some palms (*Plectoconnia*) are monocarpic. They produce inflorescence only once during their life time and the flowering marks the end of their life.

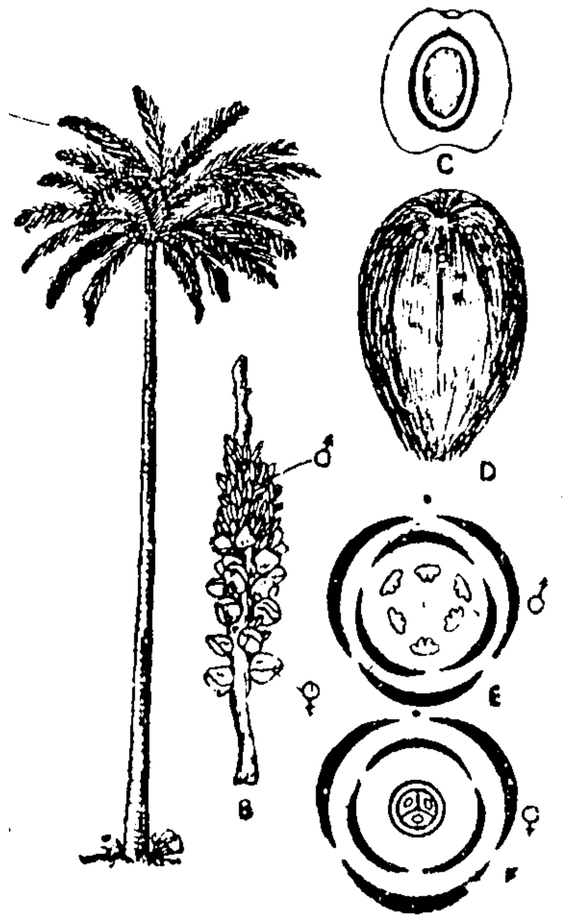

Fig. 12.5 Palmaceae – *Cocos nucifera*

The plants are monoecious (*Areca*) or dioecious (*Phoenix*).

9) Flowers:

The flowers are small, actinomorphic, generally unisexual (sometimes bisexual), trimerous and hypogynous. The bracteoles are present and often connate below the flowers.

10) Perianth:

The perianth is of six segments in two alternate and similar series of three each. They are free or connate, often thick and persistant and greenish or whitish in colour. The outer perianth segments are imbricate or valvate in bud, whereas the inner segments are valvate in the male floewrs and imbricate in the female flowers.

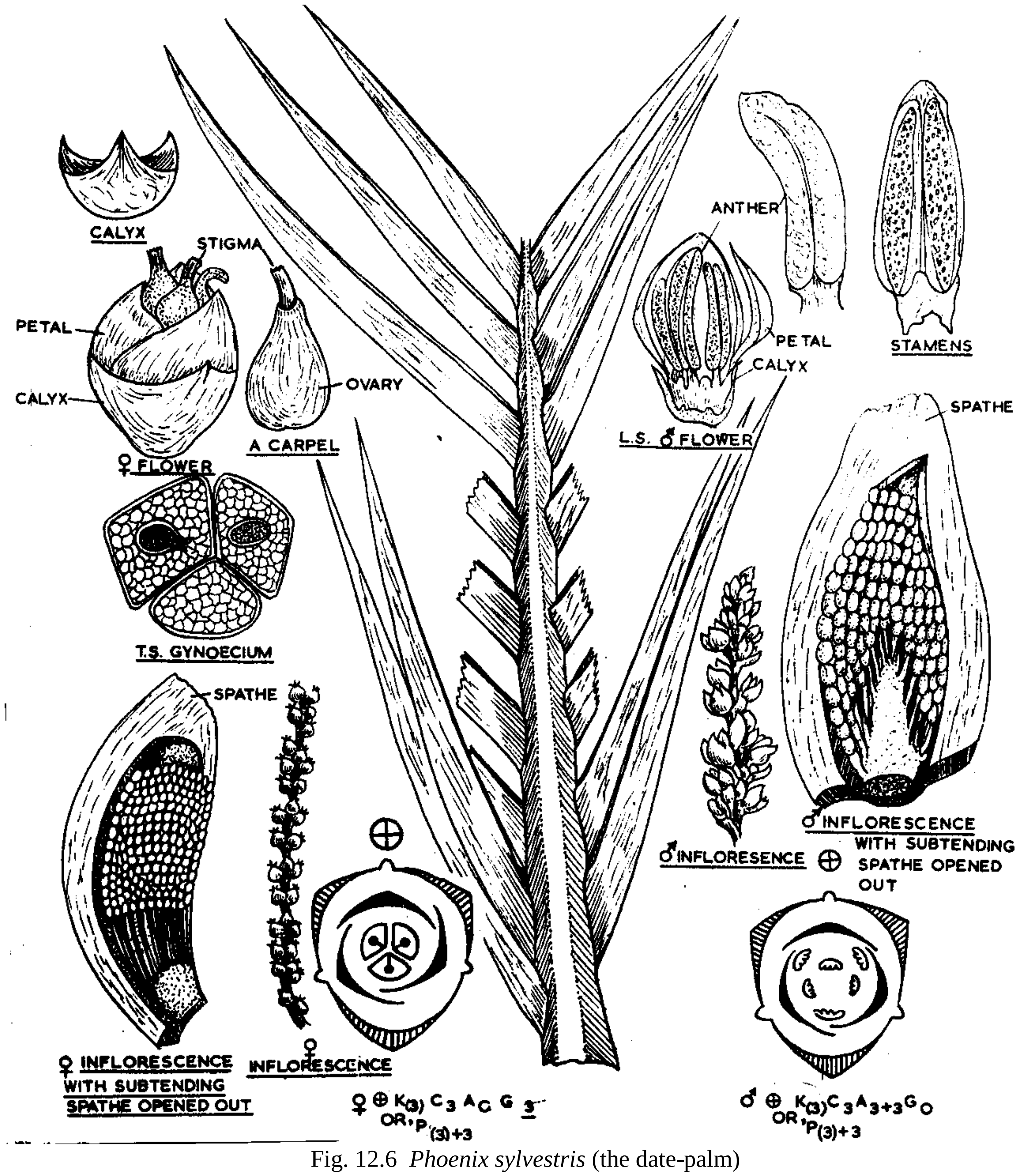

Fig. 12.6 *Phoenix sylvestris* (the date-palm)

11) Androecium:

The androecium is of usually six stamens arranged in two series of three each opposite the perianth segments. Sometimes, there is a single whorl of three stamens as in *Nypa* or there are numerous stamens as in *Caryota*. Filaments are free and often short, and the anthers are dithecous, introrse and dehising by longitudinal slits.

A conical pistillode is often present in the male flowers.

12) Gynoecium:

The gynoecium is tricarpellary and syncarpous but sometimes the three carpels are partly (*Nypa*) or completely (*Phoenix*) free. The ovary is superior and usually trilocular with a single ovule in each locule. The placentation is axile. Sometimes the ovary is unilocular with parietal (*Oncosperma*) or basal (*Areca*) ovules. When he gynoecium is of three free carpels, the ovary of each carpel is unilocular with a single ovule. Sometimes, as in *Cocos* and *Phoenix*, two of the three carpels abort during maturation. There are usually three sessile stigmas. Staminodes are usually present in the female flowers in several genera.

13) Fruit:

The fruit is a berry or drupe, the latter often develops from one of the three carpels, the other two degenerate. The exocarp is often fibrous and the endocarp is usually united to the seed.

14) Seeds:

The seeds are endospermic; the endosperm is large, sometimes hard (*Phoenix*) or ruminate (*Areca*). The embryo is small.

15) Pollination:

Most of the palms are wind pollinated. They produce large quantities of smooth pollen. Some palms are pollinated by insects.

16) Dispersal:

The fruits are distributed by water or by animals.

17) Floral Formulae:

Female flower : $Br \oplus E\ P_{3+3}\ A_0\ \underline{G}_{(3)}$

Male flower : $Br \oplus \Gamma\ P_{3+3}\ A_{3+3}\ G_0$

18) Economic Importance:

The family is of considerable economic importance and only second to the Poaceae in utility. It furnishes several necessities of life in the tropics.

1) Almost every part of *Cocos nucifera* (coconut palm) is useful and yields a large variety of products. The endosperm of young fruits is eaten and the milky fluid makes a refreshing drink.

The ripe dried endosperm is a valuable source of a vegetable fat which is used for cooking margarine, soaps, hair oil and shampoos. The oil cake left is used for fattening cattles. The fibrous mesocarp is the source of coir, used for making door mats, floor coverings, rops, brushes and for stuffing sofa, chairs etc. The woody endocarp is made into several decoration articles. The inflorescence, when young, is tapped for toddy which on fermentation gives an intoxicating alcoholic drink. The leaves are used for making fans, baskets, mats etc., and also for thatching. The stalks of midrib of leaves are made into brooms. The stem is used for posts, pillars and as a fuel.

2) The fruits of *Phoenix dactylifera* (Khajur) which have a high food value are edible. They are widely used in bakery and confectionery. The stem is tapped for toddy. The leaves are used for thatching and are also made into hats, mats, baskets etc.

3) The seeds of *Areca catechu* (Betelnut palm, Supari) are cut into slices and chewed with betel leaves (pier betel). The seeds are also made into beads and other fancy articles.

4) *Nypa fruticans* is much valued for the sweet sap tapped from the inflorescence. The sap is used for making sugar and jaggery, alcohol and vinegar.

5) Several palms are planted in gardens for their majestic and handsome appearance. The following are more common ones:

   Caryota urens (Fish-tail palm)
   Livistona chinensis (Chinese fan-palm)
   Phoenix saccharifolia
   Heterospathe elata

19) Distinguishing features:

1) Xerophytic tropical plants with palm habit.
2) Leaves fan or feather type with sheathing leafbase.
3) Infloresecene a spadix.
4) Flowers mostly uniexual, dioecious or monoecious, inconspicuous, bracteate, trimerous.
5) Perianth 3+3
6) Stamens 3+3 with verbatile anthers for wind pollination.
7) Ovary superior, 3-carpels, syncarpous, with one ovule in each carpel.
8) Usually two carpels are suppressed.
9) Fruit drupe or berry
10) Seed monocotyledonous and endospermic.

20) Questions:

1. Give an account of the vegetative and floral characters of Palmae. Explain its economic importance.
2. Write short notes on:
   (i) Economic importance of Palmae.
   (ii) Floral characters of Palmae.

21) Reference Books:

i) **Taxonomy & Angiosperms –** B.P. Pandey – S. Chand & Co. Ltd., New Delhi.
ii) **Introductory Taxonomy (Angiosperms)** – Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.
iii) **Taxonomy of Vascular Plants** - G.H.M. Lawrence – Oxford & IBM Publishing Co., New Delhi.

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Ch. E. USHA RANI

12.5 GRAMINEAE (POACEAE)

The grass family

STRUCTURE

1) Systematic position
2) Distribution
3) Familiar Plants
4) Vegetative characters
5) Root
6) Stem
7) Leaves
8) Inflorescence
9) Flower
10) Perianth
11) Androecium
12) Gynoecium
13) Fruit
14) Seed
15) Pollination
16) Dispersal
17) Floral Formula
18) Economic importance
19) Distinguishing Features
20) Questions
21) Reference Books

1) Systematic position:

Division	Spermatophyta
Sub-division	Angiospermae
Class	Monocotyledonae
Series	Glumaceae

2) Distribution

The Poaceae are one of the largest and most important family of the plant kingdom. They contain about 600 genera and over 10,000 species, widely distributed all over the world. They show great adaptability and thrive under the most varied conditions, occurring from artic to antarctic, from sea level to high mountains, from fresh water of lakes and rivers to brakish situations on the coast, and under extreme desert conditions. This is the largest family of Indian flora and is represented by about 239 genera and 1,180 species, occurring through out the country from sea level to an elevation of about 6,000 meters in the Himalayas.

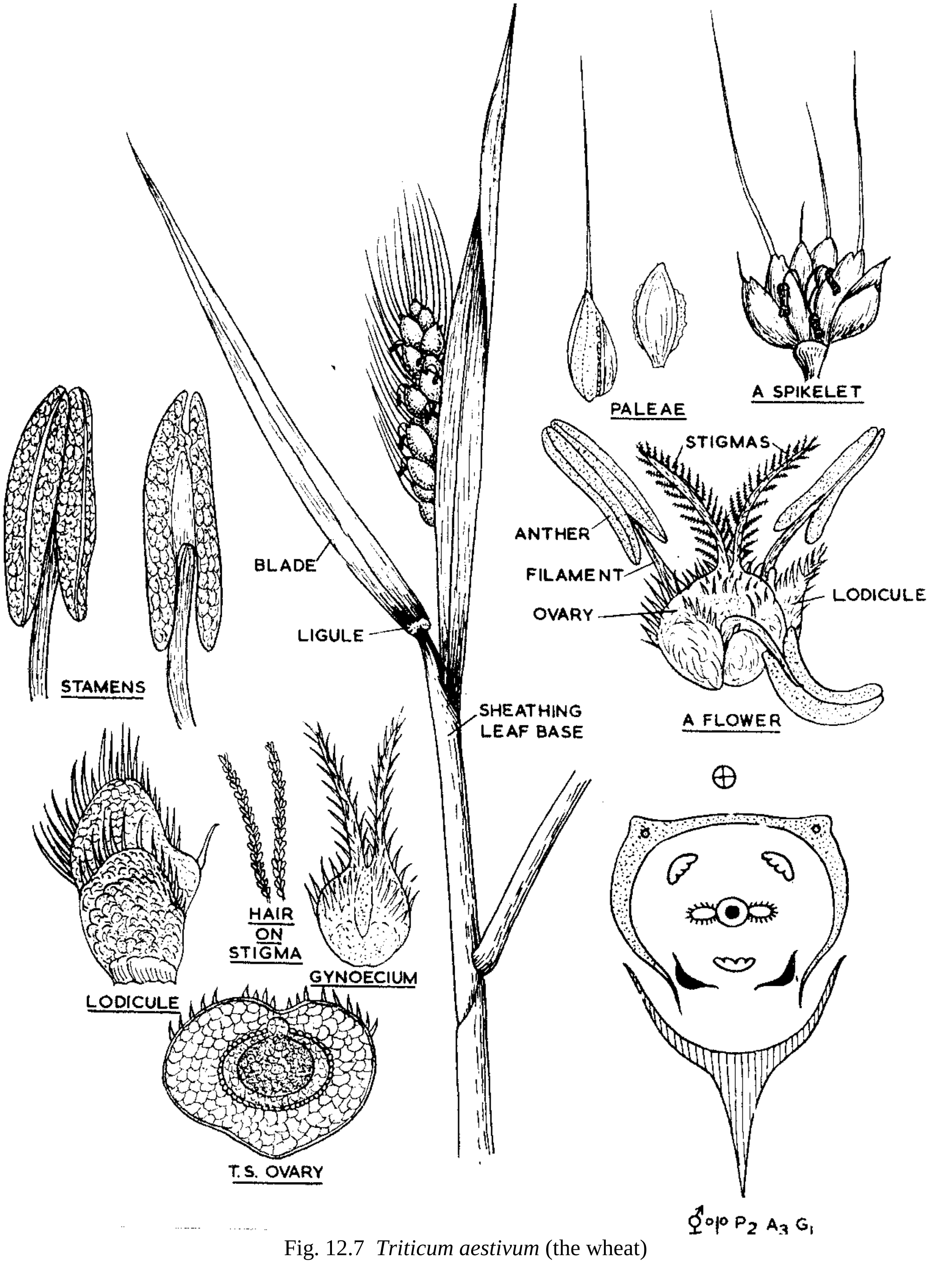

Fig. 12.7 *Triticum aestivum* (the wheat)

3) Familiar Plants:

1. *Andropogon odoratus* (Ginger grass)
2. *Arena sativa* (Oat)
3. *Aristida depressa* (Chipuru gaddi)
4. *Cymbopogon citratus* (Nimma gaddi)
5. *C. nardus* (Citronella oil grass)
6. *Dendrocalamus giganteus* (Giant bamboo)
7. *Eleusine coracana* (Ragulu)
8. *Hordeum vulgare* (Barley)
9. *Oryza sativa* – Rice (Vadlu)
10. *Penniseum typhoideum* – Pearl millet (Sajjalu)
11. *Saccharum officinarum* - Sugarcane (Cheruku)
12. *Sorghum vulgare* – Jowar (Jonnalu)
13. *Spinifex littoreus* (Ravanasuruni meesalu)
14. *Triticum aestivum* (Godhuma)
15. *Zea mays* - Maize (Mokka jonna)

4) Vegetative characters:

Most of the grasses are annual, biennial or most frequently perennial herbs. They range in height from less than two cm to six meters (savanna grasses of the tropics). They are rarely shrubs or trees with woody stems which attain a height of 30 meters or more in Asiatic bamboos. Some bamboos have a life cycle upto more than 100 years.

5) Roots:

The plant is attached by a tuft of fibrous adventitious roots.

The perennial grasses persist by means of a sympodial rhizome formed by the lower internodes of the stem. The rhizome is widely creeping in sand loving grasses.

6) Stem:

The aerial stems terminated by inflorescence are known as culms. The culms are simple or branched, the branching at upper nodes is rare in temperate grasses, but is characteristic of many tropical grasses. They are erect, geniculate, prostrate or creeping, usually cylindrical, jointed with long internodes which are usually hollow or sometimes solid as in *Zea*, *Sorghum* and related genera. A mechanical tissue present in the form of a ring of sclerenchyma below the epidermis provides rigidity to the culm.

7) Leaves:

The basal leaves are crowded in a tuft but the leaves on the culm are alternate and distickous. Each leaf is usually composed of two parts, the sheath and the blade (*Lamina*). The sheath, which forms the basal part of the leaf, encircles the culm. The margins of the sheath are sometimes united to form a tube as in *Bromus*. The blade, which is the upper portion of the leaf, is usually flat or sometimes convulate or involute, long and narrow and generally linear to lanceolate and often tapering to a fine point. Blade usually passes directly into the sheath but rarely, as in bamboos, it is separated from the sheath by a petiole.

At the junction of the sheath and blade, on the inner surface, a ligule is developed which is a delicate membranous outgrowth varying much in form in different genera. It is sometimes reduced to a fringe of hairs and rarely it is completely suppressed as in some species of *Echinochloa*.

The venation is usually parallel but occasionally, as in some bamboos the veins are provided with transverse veinlets.

In xerophytic grasses the blades are often folded or rolled up due to the loss of turgor in the special parenchymatous cells (motor cells) present between the veins.

8) Inflorescence:

The inflorescence terminate the culm and its branches. The basic unit of the inflorescence is spikelet. The spikelets are sessile or pedicelled and several to many are combined in various ways into spikes (*Triticum*), racemes (*Paspalum*) or panicles (*Arena*). The spikes or racemes are solitary, digitate or scattered along the main axis (rachis).

Spikelet: Each spikelet consists of a very short or minute axis (rachilla) bearing two opposite rows of bracts, following closely one above the another. Generally, the two lowest bracts (sometimes one to six) are sterile and they are termed as sterile (or empty) glumes. They vary considerably in shape, size and texture and provide good taxonomic characters. Occasionally lower and rarely both empty glumes are lost by reduction. Sometimes, as in *Panicum*, there are more than two empty glumes. The sterile glumes are followed by a variable number (1-50) of fertile or flowering glumes or lemma. The fertile glumes are closely similar to the sterile glumes (*Eragrostis*) or differ from them in shape, size and texture (*Arena*). They are often greenish, keeled or rounded and awned or awnless.

A membranous binerved or bikeeled structure is present between the fertile glume and the rachilla. This structure, known as Palea, is partially or wholly enclosed by the fertile glume. The palea morphologically represents bracteole below the flower.

The lemma and palea bear a flower in their axil.

9) Flowers:

The flowers are small, inconspicuous, bisexual (unisexual in *Zea* and related genera), Zygomorphic and hypogynous.

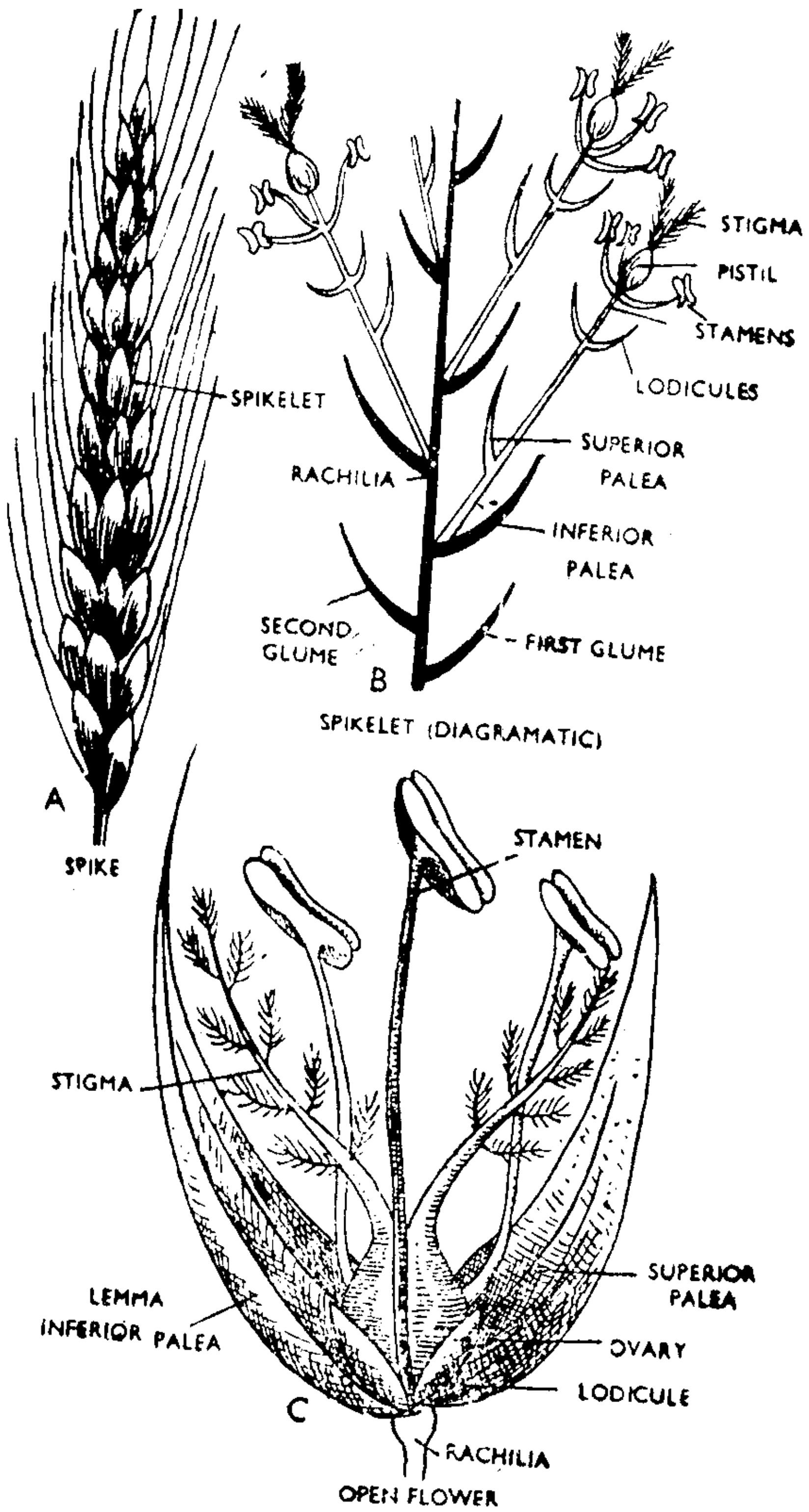

Fig. 12.8 Open flower of Poaceae

10) Perianth:

The perianth is highly modified and much reduced and is represented usually by two minute or fleshy and hyaline structures, known as lodicules. The two lodicules are present antero-laterally. Sometimes, as in *Bambusa* the third posterior lodicule is also present.

11) Androecium: The androecium consists of usually three stamens in a whorl, the odd stamen being anterior. In *Bambusa* and *Oryza* there are two alternate trimerous whorls of stamens. Sometimes, as in *Uniola*, only a single stamen is present which is usually anterior. Rarely there are numerous stamens as in *Pariana*. The filaments are free and delicate, and the anthers are basifixed (apparently and functionally versatile), dithecous, introrse and opening usually by a longitudinal slit.

12) Gynoecium:

The gynoecium is monocarpellary with a superior unilocular ovary having a single anatropous ovule adnate to the adaxial side of the ovary. The placentation is basal. There are usually two styles but a third style is also present in Bambusa. The stigmas are generally plumose.

13) Fruit:

The fruit is mostly a one-seeded caryopsis in which the thin ovary wall closely adheres to the seed. Sometimes the fruit is a nut or berry (as in some *Bambusa*) or a utricle (*Eleusine*).

14) Seed:

The endosperm is starchy and the embryo is straight.

15) Pollination:

The grasses are self or wind pollinated. The inconspicuous flowers, long flexible filaments, abundant powdery pollen, and large feathery stigmas are characteristic of wind pollinated plants.

16) Dispersal:

The ‘seeds’ which are very small and light are usually distributed by wind. In others where the glumes enclosing the seeds are barbed, bristly or owned, dispersal takes place by animals to which the seeds adhere.

17) Floral Formula: Br % ⚥ P_2 A_3 $\underline{G}_1$

18) Economic Importance:

The Poaceae are the most valuable family in the whole plant kingdom. They are second to none in the importance of their products. They provide food in the form of cereals for man and forage for domestic and wild animals. Besides these, they provide a wide variety of other useful products, such as sugar, aromatic and edible oils, fibres, paper, starch, alcohol, beverages and liquors, adhesives, plastics and packing, thalching and building materials.

I. Cereals:

The following are the major cereals:

1) *Triticum vulgare* (Wheat)
2) *Oryza sativa* (Rice)
3) *Zea mays* (Maize)
4) *Hordeum vulgare* (Barley)
5) *Avena sativa* (Oats)
6) *Secale cereale* (Rye)
7) *Sorghum vulgare* (Jowar)
8) *Pennisetum typhoides* (pearl millet)
9) *Panicum miliaceum* (common millet)
10) *Eleusine coracana* (Ragi)

II. Fodder:

The fodder grasses for domestic animals are:

Cynodon dactylon, Paspalum scrobiculatum, Lolium multifloram, L. perenne, Phalari aquatica, Heteropogon contortus, Poa annua, Dactylis glomerata.

III. Sugars:

Saccharum officinarum (Sugarcane) is a very important source of sugar. Molasses, a byproduct of sugar industry, is used in the manufacture of industrial alcohol and alcoholic beverage. The baggase is used for strawboards.

IV. Bamboos:

They are tall arbouscent grasses inhabiting the humid tropical and extra-tropical regions. *Arundinasia, Bambusa, Cephalostachum, Melocanna* and *Ochlandra* are used for making ladders, bridges, fences, beds, tool handles, walking sticks, tent poles, furniture, kites, umbrella handles etc.

V. Fibres:

A fibre obtained from the leaves of *Erianthus munja* and *Saccharum spontaneum* is largely used for making ropes.

VI. Oils

(1) *Cymbopogon citratus* (Lemon grass oil from leaves)
(2) *C. nardus* (Citronella oil from leaves)

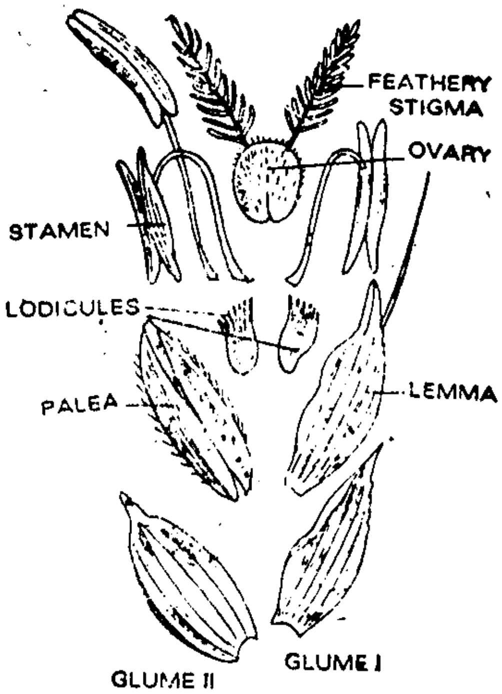

Fig. 12.9 An opened spikelet

19) Distinguishing features:

1) Herbaceous plants with jointed stems.
2) Fibrous roots.
3) Stem hollow, cylindrical, rarely solid.
4) Leaves simple, sheathing, ligulate, sheath cleft on one side, distichous.
5) Inflorescence one-to-many flowered spikes or spike of spikelets.
6) Flowers zygomorphic, hypogynous, triinenous, protected by palea and lemma.
7) Perianth represented by lodicules.
8) Stamens usually 3, versatile.
9) Ovary superior, with two feathery stigmas and a single basal ovule.
10) Caryopsis fruit.

20) Questions:

1. Describe the characteristic features of family Poaceae. Add a note on its economic importance.
2. Write short notes on:
   (i) Spikelet
   (ii) Distinguishing characters of Gramineae
   (iii) Flower in Gramineae
   (iv) Economic importance of Gramineae

21) Reference Books:

i) **Taxonomy of Vascular Plants –** G.H.M. Lawrence – Oxford & IBM Publishing Co., New Delhi.

ii) **Introductory Taxonomy (Angiosperms) –** Dr. B.S. Trivedi & Dr.B.B.Sarma, Kithab Mahal, Allahabad.

iii) **Taxonomy of Angiosperms –** B.P. Pandey – S. Chand & Co. Ltd., New Delhi.

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Ch. E. USHA RANI

Unit-III

Lesson 13
ECONOMIC BOTANY

OBJECTIVES

To know about economically useful plants and study about different food yielding plants and their use.

13.1 FOOD PLANTS

13.1.1 INTRODUCTION

All nature is divine. Nature has given plenty of resources to human beings and he started using these available resources according to their needs. With the help of this knowledge many new economic plants have been added to already existing ones.

Economic botany basically deals with the all pervading plants in relation to human welfare as food, clothing, shelter, medicine etc. Plant bring about economy to the country. This branch of science embraces crop plants timber plants, medicinal plants, etc.

A glance of the world statistics of food production of the important crops gives us the impression that the figures are quite satisfactory to meet the needs of the people in different ways as food, sugars, beverages and fibre crops etc. The world production of total cereals amount to 1.5 billion metric tones of which rice and wheat comprise more than half the total production. Thus these two crops form the staple food of almost the whole human race except some minor races. Maize is also equally important in many ways other than food from its production point of view. Other crops are used as adjuncts to cereal food in the form of pulses, root crops, fruits, nuts, oils and sugars or beverages fibres, narcotics, rubber and woods.

So it is clear that to solve the food problem, the protein deficiency in food stuffs; and new introduction of plants to cultivation for increased production. So to solve this problem it is better to bring about more land into cultivation, the unused pasture land, meadows, forests and even deserts. This will be a costly affair in terms of money and water requirements, even of land fertility.

Another important factor is to modernize the agricultural methods. By this we can solve the problem of food to the human beings.

In the forth coming chapters we can study about food plants, fibres, vegetable oils, wood yielding plants, spices, medicinal plants, Beverages, Rubber etc. In this unit we know about the botanical name family, vernacular names, morphology of useful part, uses of the following plants, they are:

1) Food plants - Rice, Wheat, Maize, Potato, Sugarcane
2) Fibres - Cotton, Jute
3) Vegetable Oils - Groundnut, Mustard, Coconut
4) Wood yielding plants - Teak, Rose wood, Sandal wood, Red sanders, Terminalia catapa
5) Spices - Coriandrum, Cardamom, Cloves, Cinnamon, Carum, Cuminum, Pepper
6) Medicinal Plants - Ocimum, Vinca, Datura, Rau wolfia, Phyllanthus
7) Beverages - Tea, Coffee
8) Rubber

13.1.2 RICE

General characters

Rice is staple food of half of the world's population. Rice cultivation dominates the economic and agricultural life in the South East Asian countries. Rice can be grown two (or) even three times a year. Rice can be raised on any kind of soil. The plants can tolerate high degree of acidity. It is know that there are about 1,20,000 morphological varieties of rice in the world. Among this number India has a great collection of 30,000 varieties. In the volume of world production rice ranks far above all the other cereals. India has the largest acreage under rice of all countries. The annual production of Paddy in India is more than 83 million mt. In India 83 per cent of cultivated area is under food crops. Of which rice covers about 32 per cent. In India Central Rice Research Institute (CRRI) is situated at Cuttack. Here in this centre they educate the people and help them in many ways. International Rice Research Institute (IRRI) is located at Philippines. It is rich in carbohydrates, a small quantities of proteins, and rich in vitamins. It is an annual herb, grows upto height of 2-6 feet. The inflorescence is called Panicle.

Origin

George Watt, author of six volume monograph on economic products of India, wrote at great length on rice. He concluded that rice is originated in Peninsular India and that is spread out from there. The rice plant was spread to China in about 3000 B.C. Vavilov suggest that rice was originated in India and then spread to China. Roscheveez proposed a polyphyletic origin for rice, and the rice might have arisen in the region of India, China and Indo-China. Ting and de Candolle strongly believed that rice originated in China. Ramiah and Ghose supported Watt's theory that rice evolved in peninsular India.

Botanical Name: *Oryza sativa*

Family: Rice belongs to family POACEAE.

Vernacular Names

English	-	Rice
Sanskrit	-	Dhanya
Hindi	-	Chaval
Kannada	-	Akki
Tamil	-	Arisi
Telugu	-	Vari
Malayalam	-	Ari
Marathi	-	Bhatt

Morphology of useful part

The morphological part of Rice is called *Caryopsis*. The rice grain is one seeded. The rice grain is of various textures, colours, sizes and shapes. The rice fruit is a caryopsis in which the single seed is fused with the wall of the ripened ovary (pericarp) forming a seed like grain. The remaining part of the caryopsis is the endosperm, which provides nourishment to the growing embryo.

Economic Uses

1) Rice products are sold in Indian markets as parched Rice, parched Paddy, flaked Rice, Sake, Bran, Bran Oil, Bran Wax, Husk, Straw.
2) Parched Rice prepared for making Murmura.
3) Parched Paddy is prepared by drying the Paddy in sun and then moistened by adding hot water and decanted immediately.
4) Flaked rice is a type of parboiled rice made flat and thin.
5) This flaked rice is used in many ways for preparation Upma, Sweets, etc.
6) Sake an important alcoholic beverage of Japanese for thousand of years.
7) Bran is by-product of rice milling industry and it is used as a cattle feed.
8) Bran Oil is extracted immediately after milling the rice.
9) It is used as edible oil.
10) It is also used in preparing vanaspathi, making soaps, textile industry, leather industry, flexible film industry and enamels.
11) Bran Wax is obtained as a by-product in bran oil extraction.
12) It is used in chocolate industry, coating for candy and lozenges, preparation of wax emulsions, applied to fruits, vegetables and cosmetics like lipsticks.
13) Paddy husk is used as a fuel in making bricks.
14) Straw is used as a cattle feed.
15) Straw is used in manufacturing straw boards, pulps for making paper. It is also used in thatching, making baskets, hats, ropes, mats etc.

13.1.3 WHEAT

General Characters

Among the world's crops, wheat is pre eminent both in regard to its antiquity as well as its importance as a food of mankind. Wheat forms the principal staple food of majority of human race in the world. The important wheat growing countries are Russia, USA, India, France, Canada, Italy and Argentina. India today ranks fourth among the wheat-growing countries of world. Three species of wheat are under cultivation in the country. They are bread wheat (*Triticum aestivum*), macaroni wheat (*Triticum durum*), Emmer wheat (*Triticum dicocum*). Wheat is one of the earliest cereals to have been brought under cultivation. Nearly about 17,000 varieties of wheat are grown in all the continents. According to calculations and production of wheat crop is above 350 Mt/year. Bread wheat is grown through out the country. Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Bihar, Orissa, Assam exclusively grow only bread wheat. Both bread and Macorini wheat are grown in Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat, Karnataka, Maharastra, Andhra Pradesh etc. It is rich in carbohydrates, its annual plant grows upto height of $2^{1}/_{2}$ to 5 feet. The inflorescence is called panicle.

Origin

The origin of wheat is still a subject of speculation. The ancient civilizations of Babylonia Crete, Egypt, Greece, and Rome used wheat and the Chinese also grew this crop as long back as 2700 B.C. It seems that in South-Western Asia man had began to domesticate the two wild varieties of wheat by 6000 B.C. Until 300 B.C. Emmer wheat dominated the world, but later Macaroni wheat began to appear. Durum (or) Macaroni wheats soon displaced the Emmer wheats in Europe. From Europe, the wheat cultivation reached Asia. The Indian Dwarf Wheat, a form closely related to *T. aestivum* have been found at Mohanjodaro in Indus valley.

Botanical name: *Triticum aestivum*

Family: It belongs to family Poaceae.

Vernacular names

English	-	Common Wheat
Hindi	-	Gehum
Marathi	-	Gahum
Telugu	-	Goodhumalu
Tamil	-	Kothumai
Kannada	-	Godhi
Malayalam	-	Gendum

Morphology of useful part

The useful part of wheat plant is the fruit which is called Caryopsis. The seed consists of four parts namely the seed coat, embryo, nucellar layer, endosperm. Seed coat is reddish brown which covers Embryo and Endosperm. It is folded in the centre to form a furrow, which joins the funicle of the seed. Next one is nucellar layer. Next to nucellar layer the remaining part inside is Endosperm and in the Endosperm there is highly differentiated part called Embryo.

Economic uses

1) Wheat is consumed mostly in the form of flour.
2) A small quantity of flour is converted to break fast foods.
3) In India wheat is ground generally into Atta (whole meal), Suji (semonia) and Maida (flour).
4) It is used to prepare Upma, Chapathis, Sweets etc.
5) Among other countries wheat is used to prepare Bulgar, Farina, Gluten.
6) Bulgar is parboiled wheat.
7) It is traditional food of North Africa, West Asian countries.
8) Farina is obtained from hard wheat.
9) It is used in preparation of break fast foods.
10) Gluten is obtained by processing wheat.
11) It is used in preparation of puffed wheat, breads.
12) The by-products obtained from wheat are bran, germ and feeds for live stock.
13) The starch obtained from wheat is used in textile industry from sizing the cloth.
14) Bran is also used for preparing some types of oils.
15) Dried plant parts are used as cattle feed.

13.1.4 MAIZE (CORN)

General Characters

Maize is the important cereal crop of the world. Maize occupies next place in its total area production after Wheat and Rice. In case of yield it supresses all the other cereals. The maize growing countries are USA, Mexico, Brazil, Argentina, Yugoslavia, Romania, Germany, Italy, New Zealand, Belgium and China. In India maize is grown in Uttar Pradesh, Bihar, Punjab and Madhya Pradesh. In our country hybrid maize has become an important food crop. Maize occupies more than 10 million acres of land. America exports only 5 per cent of its crop. Where is Argentina exports more than half the total need of world. It is tall herbaceous annual. The average height of maize plant is 5-10 feet. The inflorescence is of two kinds: (i) Pistillate inflorescence (ii) Single staminate inflorescence. It is rich is carbohydrate. It is a good substitute for tapioca.

Origin

The historical findings says that Corn plants were taken to Spain by Columbus in his second voyage. The origin of maize is a much discussed topic. The old ears of corn found in caves indicate that the plants had originated at least 5000 years age. The place of origin probably was Mexico, Central America. The Spanish writer applied the name Maize to Corn from which the modern word maize was derived. Other European names applied to corn include Triticum, Frumentum, Turkish Corn, Indian Corn etc. It was soon introduced to France, Italy, Europe and North Africa. From genetical evidences it is believed that the ancient maize probably hybridized several times with maize relatives such as Tripsacum and Euchlanta. In mid 1950's archaelogical findings of pollen grains of maize in Mexico city have been dated 60,000 to 80,000 years old. The Portuguese explorers introduced maize to India.

Botanical name: *Zea mays*

Family: Poaceae

Vernacular names

English	-	Corn
Hindi	-	Makka
Marathi	-	Makke
Kannada	-	Musukina
Malayalam	-	Cholam
Telugu	-	Mokkajonna
Tamil	-	Makka

Morphology of useful part

The grain of maize is one seeded and called as caryopsis. It has starchy Endosperm and an Embryo separated from one another by means of an aleurone layer. The colour of endosperm ranges from white, yellow, orange. The outer layer of aleuron may be colourless, red, purple, brown.

Economic uses

1) Maize plants are extensively used as cattle feed.
2) Both fresh and dried stalks are used as feed.
3) The digestability of maize is much better than sorghum, bajra etc.
4) In most of countries maize is used as animal feed.
5) As maize does not posses hydrocyanic acid and prussic acid it can be fed to cattle of any age of its growth.
6) Cattle, Chicken, Ducks, and other domestic animals usually fed on maize.
7) In India over 85 per cent of maize production is used as food in the form of Chapatis, Corn-flakes, Pop corn, Porridges, roasted green ears.
8) In Europe bread is prepared from maize flour.
9) Maize is also used in large number of industrial products.
10) Starch industry using the wet milling process produce starch, maize oil and gluten for feed.
11) The starch is used to produce a series of products like dextrose, corn syrup etc.
12) Corn is also used in the distilling and fermentation industries in manufacturing of ethyl and butyl alcohol.

13) Maize Oil is a poly unsaturated oil.
14) When maize oil is refined it is used as edible oil.
15) Maize Oil is also used in soap making.

13.1.5 POTATO

General Characters

Potato is a leading starchy root crop. It is extensively grown in north temperate countries. Major Potato growing countries are Russia, USA, France, Poland, China, Germany. Major Potato exporting countries are France, Netherlands, Poland and Russia. In India Potato has been under cultivation since 17^{th} century. In India about 0.4m hectares with an annual production of 8.4 million metric tons. Potato is generally used as vegetable. Wild Potato tubers have toxic alkaloids and are bitter in taste. The Christians called Potatoes as evil tubers, because they were not mentioned in Bible. Potatoes are usually cultivated in cool and moist climate. The plants are annual, weak stemmed, profusely branched. It grow upto a height of 2 to 3 feet. The plants bear small yellow, white or purple flower. The important structure is the swollen tips of the under ground branches and these are called tubers. Potatoes are rich in carbohydrates, less proteins, fats.

Origin

The plant is originated in South America around like Titicaca, on the borders of Peru and Bolivia. From South America cultivation has spread throughout world. The first step in the evolution of the crop is the emergence of alkaloid – free diploid in the period of 2000 – 5000B.C. There have been two views regarding the origin of cultivated Potato (i) It might have arisen from the ancestral forms of *Solanum stenotomum* by a process of simple chromosomal doubling. (ii) It might have arisen as a spontaneous amphidiploid hybrid from an ancestor of *Solanum stenotomum* and *Solanum sparsipilum*. A number of varieties are recommended in India by Central Potato Research Institute, Simla.

Botanical name: *Solanum tuberosum*

Family: This belongs to family solanaceae.

Vernacular names

English	- Potato
Hindi	- Alu
Telugu	- Bangaladumpa, Urlagadda
Tamil	- Urla Kilangu
Malayalam	- Urulan Kizhangu
Marathi	- Batata
Kannada	- Batate

Morphology of useful part

Under ground tuber is the useful part. The tubers bear number of "eyes" which are groups of buds borne in the axils of aborted leaves. Each eye has central bud which is surrounded by smaller lateral buds. These are helpful in vegetative propagation.

Economic uses

1) Potato is one of the important food of certain countries.
2) In India they are used throughout the year as the main vegetable.
3) A number of delicious food items like cutlets, chips, papar are prepared.
4) A portion of crop is fed to the stock in European countries.
5) Potatoes have number of industrial uses.
6) Potato starch is used in sizing the paper.
7) It is also used frequently in fine finishing of cotton goods.
8) Pre gelatinized starch is used to prepare moulded articles and poster paints.
9) Oxidised starch is used in printing Ink.
10) Dextrins and adhesives are produced from acidified starch.
11) Dextrose and commercial glucose and prepared by acidic hydrolysis of starch.
12) Alcohol may be obtained by fermenting the starch.
13) Fresh Potato tubers are rich in vitamin B and C.
14) These are used to cure beri-beri and scurvy diseases, due to presence of vitamins.
15) Potato contain folic acid, panto thenic acid, pyridoxine.
16) It is a good source of potassium, traces of sulphur, iodine, magnesium.
17) An average medium sized potato boiled with its skin supplies about 25% vitamin C, 8-10% iron, thiamine, niacine, 4% protein, riboflavin and food energy.
18) Potato spirits are used in certain European countries.
19) Potato flour, the oldest commercially processed potato products are used in baking industry.
20) It is used in preparing bread, pastries, cakes, biscuits etc.

13.1.6 SUGARCANE

General Characters

The name sugar comes from a Sanskrit word "Sarkara". It is a complex of two or more hybrid species. Sugar Cane is cultivated in many countries of World. In India 2.65 million hectares of land is cultivated under Sugar Cane production. This is the main sugar producing plant. The best production of sugar cane is in tropics. The chief sugar cane producing countries are India, Cuba, Brazil, Philippines, Hawaii, Java, Australia etc. In India Uttar Pradesh and Bihar are leading states which grow Sugar Cane. More than 4 million acres of land is cultivated in India. The plant is a coarse grass. It is quite tall at a height of 10-20ft. The stem is solid and jointed. The stems are supported by stilt roots. The nodes bear axillary buds. The stems bear terminal inflorescence. The plants are propagated by vegetative means. Sugar Cane needs hot and moist climate to grow.

Origin

The Sugar Cane is known from the earliest times and is referred as ancient civilizations before Christian era. The original home of Sugar Cane is New Guinea. Barber started that the earliest mention of Sugar Cane is found in Indian writing dating 1400-1000B.C. It was introduced from India to China in about 4^{th} century A.D. From the botanical evidence two separate classes of cane with different origins have been distinguished namely the North India indigenous cane of North India, and the tropical forms from oceanic islands with New Guinea as the centre. Chaturvedi states that India is the home of sugar cane. According to Grassl and Daniels Saccharum is evolved in Indo Burma. At present Sugar Cane Breeding Institute at Coimbatore in Tamilnadu help the farmer to improve the crop varieties. Indian Institute of Sugar Technology established at Kanpur helps to impart know-how of sugar cane and sugar industry. The composition of Cane Juice consists of Iron, Manganese, Zinc, Copper, etc.

Botanical name: *Saccharum officinarum* is the botanical name of sugar cane.

Family: It belongs to family Poaceae.

Vernacular names

English	-	Sugar Cane
Telugu	-	Cheruku
Hindi	-	Pundis
Tamil	-	Poovan Karumbu
Malayalam	-	Karimbu
Kannada	-	Patta pottee kabbu

Morphology of useful part

It is perennial gaint grass. The stem is useful part of the plant. The stem consists of nodes and inter nodes. Near the nodes there arise stilt roots, which are useful for supporting. The inflorescence is called panicle and the fruit is called caryopsis. The so called Sugar Cane Juice is obtained from solid stems. 80% of Sugar Juice contains varying sugar contents. From Sugar Cane Juice we can prepare Jaggery, Sugar and other things.

Economic uses of Sugarcane

1) In India 80-90 per cent of production of Sugar Cane is used for the manufacturing of three products namely Jaggery, Vacuum pan sugar, Open pan sugar.
2) People eat sugar cane as it is.
3) They drink fresh juice of sugar cane in summer season to cool their bodies.
4) The major by products obtained during the manufacturing of jaggery, sugar from sugar cane are molasses, bagasses, filter cake etc.
5) Bagasses is used as fuel.
6) Bagasse is also used in manufacturing of paper, in place of bamboo.
7) The filter cake is used as a manure.

8) Sugar Cane is used in the manufacture of Carbon Paper, Shoe and other polishes, wax paper etc.
9) Cane trash and cane tops are used as feed to cattle and elephants.
10) Molasses is used as animal feed.
11) The great value of molasses is it is used in distillaries for the manufacturing of rum, alcohol, and vinegar.
12) There are many other sources of sugars, they are Maple sugar, Palm sugar, Sorghum sugar.
13) The preparation of sugar consists of a special procedure that is

    1. Extraction of Juice
    2. Purification of Juice
    3. Concentration
    4. Refining

14) By extracting sugar cane juice in mills two products are obtained they are sugary sap and fibrous residue called bagase.
15) The sugary sap consists of glucose, small quantities of proteins, sucrose, gums, pectin, ash minerals etc.
16) The sugary sap is filtered to purify the juice.
17) The pure sugar juice is boiled in vacuum pans and a thick syrup is prepared and cooling it becomes solid mass of brown crystals.
18) The liquid material obtained is called molasses, this is used in alcohol industry.
19) The brown crystals consists of 96% of sucrose.
20) The brown crystals are further refined to give white crystals of sugar.

13.1.7 SHORT ANSWER QUESTIONS

1. Write the family, botanical name of Rice and wheat with their economic uses.
2. Give a general account of maize.
3. Write short notes on:
    a) Potato
    b) Sugarcane
    c) Maize
4. Write the botanical name, family and economic uses of sugarcane.

13.1.8 REFERENCE BOOKS

1. **A text book of Economic Botany –** A.V.S.S. Sambamurthi (Wiley Eastern Limited)
2. **A Text Book of Economic Botany –** V. Verma, Emkay Publications.
3. **Economic Botany –** Bendre & Kumar, Rastogi Publications, Meerut.

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P. SHIVANI

Unit-III

13.2 FIBRES

OBJECTIVES

To study about different fibre yielding plants and their use.

13.2.1 INTRODUCTION

The fibre plants of the world are second only to the food plants in importance. Man has been dependent on these plants for his clothing and for a variety of other needs from times immemorial. In commerce fibres include practically all small, thin, slender fragments of many substance. According to the use to which fibres are put into, they are classified commercially as textile fibres, cordage fibres, brush fibres, plaiting fibres, filling fibres and paper fibres. The fibres may be grouped into two broad categories, namely natural fibres and synthetic fibres (or) artificial fibres. The natural fibres include fribres obtained from plants and animals. Nearly 90 per cent of the world production of fibres is from the natural vegetable fibres. The source of these fibres was known to man since he was said have used variety of plant sources for preparation of ropes and cords. With the advance of time, man made use of large number of fibres, including many fibres of animal origin Eg: Wool and Silk. Fibres are obtained from fibre cells which are different from vessels, tracheids, parenchyma etc of wood. During the growth of plant body in size, sclerenchyma cells develop which give more support. These are mostly fibres. Fibres are 1-250mm long, thick walled and with a very small cavity. They are present in groups and bundles. The cell wall of fibre is chiefly made up of pure cellulose. Sometimes percentages of hemicellulose, lignins and other substances may also be present. The chief elements C, H and O (Carbon, Hydrogen and Oxygen) are arranged in unknown but unique fashion to form cellulose. Fibres which obtained from wood are known as wood fibres. These wood fibres are classified into three types depending upon their origin and structure. They are as follows soft stem (or) bast fibres, Hard leaf (or) structural fibres and surface fibres. In this lesson we will study about two fibre yielding plants Cotton and Jute.

13.2.2 COTTON

General Characters

Cotton find its mention in Rig-veda, the oldest scripture of Hindus. In India it has the pride place among the cash crops. India was having a flourishing export trade in cotton and cotton goods as early as 569-525B.C. Two Arabian travellers, describing Indian fabrics have recorded that the Garments were of such extra ordinary perfection that now where else being woven to that degree of fineness that they might be drawn through a moderate size ring. The cotton goods in the trade with the west, were carried either on camels or in boats which piled between India and the middle east. India now occupies the foremost position among the cotton growing countries of world. In respect of production, however it has the fourth place the first, second and third positions being taken by USA, Russia, China respectively. The yield of rain fed cotton is highest in the Punjab 343/Kg/ha and followed by Haryana and Rajasthan (298/kg/ha, 208 kg/ha) respectively. Cotton needs a soil with good moisture holding capacity, black cotton, red sandy soils. The plant is a shrub with thick rigid stem, twigs and young leaves hairy, rarely glabrous, leaves 3.7 lobed, flat, fruits are capsules with 3-4 locules.

Origin

The cotton made its appearance in England in 1298 and soon established there as a major industry. The earliest civilization known to have spun and woven cotton was the Harappan in the Indus valley in Pakistan (2300–1750 B.C.) and for many centuries the cotton plant was known outside India only in traveller's tables. The original cultivated Asiatic cottons belong to the species *Gossypium arboreum* and *G. herbaceum* both of which have short staple length. *G. arboreum* is grown in 40 per cent of the total acreage in India and about 30 per cent of the acreage by *G. herbaceum*. The origin of new world cottons has been attributed to allopolyploidy resulting from the cross between the 13 chromosome American wild species and the old world cultivated type bearing 'A' genome. The plant is distributed throughout the savannah areas from Africa, through Arabia and India to China, Japan and East Indies. According to Herodotus 445 B.C., use of cotton as a textile fibre in India. He wrote there are trees which grow in India, the fruit of which is a wool exceeding in beauty and goodness that of sheep.

Botanical name

The botanical name of Cotton is *Gossypium herbaceum.*

Family

Gossypiom herbaceum belongs to family **Malvaceae.**

Vernacular names

Hindi	-	Kapas
English	-	Cotton
Telugu	-	Patti
Tamilnadu	-	Paruthi
Malayalam	-	Paruthi
Kannada	-	Hathi
Marathi	-	Kapas

Morphology of useful part

The epidermal hairs of the seeds are useful. Seeds usually bear two coats of hairs, long lint hairs and short fozz hairs in rare types bearing lint only. The cells pass through three stages of development (i) differentiation (ii) growth (iii) desiccation. Differentiation of some epidermal cells into fibre cells starts even before pollination. The growth of hair cell begins as a bulge on the outer wall of the epidermal cell and they elongate for about 3 weeks. Desiccation period lasts for 15 to 25 days during tubular fibre collapse and a residue of proteinaceous solids is left in the lumen.

Economic uses

1) Cotton is major commercial crop.
2) It produces important products like fibre, food and feed.
3) Lint fibre is used for clothing, house hold and industrial articles.
4) Articles of clothing include shirtings, outer wear, under wear, gloves, hosiery etc.
5) House hold articles includes bed sheets and covers, pillow cases, towels, table clothes, mosquito nettings, blankets etc.
6) Industrial articles includes bags, belting, industrial thread, awnings, tents, tarpaulins, insulation, cellulose plastics etc.
7) The linter is used for stuffing custions, pillows mattress etc.
8) It also find wider application in manufacturing of high quality paper cellophane, rayon, varnishes, and absorbent cotton.
9) The cotton seed is used for extracting oil.
10) Cotton seed oil is used in the manufacture of Vanaspati.
11) Cotton flour is obtained from the seed and used for bread and biscuit making in USA.
12) Cotton seed cake after extraction at oil is a good organic manure.

13.2.3 JUTE

General Characters

It is a bast fibre of great commercial importance. It is extensively used in the manufacture of gunny bags. The jute is the secondary phloem fibres of the stem. The jute crop requires a warm and humid climate. It is cultivated during the rainy season when the temperature and humidity are quite high. They are distributed through out the tropical regions of Africa, America, Australia, China, Bangladesh, Srilanka, Nepal, India, Java, Japan etc. The plant is a slender annual, it is quite tall and attains a height of 10 feet. Stem may be branched near the tip, but when planted close together they remain unbranched. It bears alternate simple leaves, the plant bears small groups of two or three yellowish coloured flowers. *Corchorus capsularis* bears small globular capsular fruit, white *Corchorus olitorius* bears long cylindrical capsules. The jute crop requires alluvial soils for cultivation in delta regions of India. The fibre of jute is frequently finer, softer, stronger and more lustrous. It is whitish and commonly called white jute. For extracting fibre from jute a process called retting is used.

Origin

Corchorus capsularis is considered to have its origin in the Indo Burma region. *Corchorus olitorius* is found wild both in Africa and India. There are about 40 species of jute distributed throughout the tropics of the world. Out of these eight species occur in India. The cultivated type under this species are found only in India. The data when the fibre-yielding properties of the jute plant were utilised by the Indians is not definitely known, there is however evidence of trade in jute cloth in the sixteenth century in Bengal. Towards the end of eighteenth century jute was exported to England. *C. capsularis* is believed to be native of South China where it is found in the wild state. The plant might have entered India from there. Jute had occupied the fore most place among the Indian industries.

Botanical name

The botanical name of Jute is *Corchorus capsularis.*

Family

Corchorus capsularis belongs to the family *Tiliaceae*

Vernacular names

English	-	Jute
Telugu	-	Janapanara
Hindi	-	Tita-pat, Miltha-pat
Sanskrit	-	Patta
Tamil	-	Sanuku

Morphology of useful part

Useful part of Jute is secondary phloem fibres of the stem. The Jute fibre is developed in the outer portion of the bast. The fibre strand consists of a loose net work of many smaller strands, each of which contains many elongated cells. The cells have pointed to tapering ends and are polygonal in cross-section. Jute fibres vary from 2 to 5 millimeters in length and have wide lumen.

Economic uses

1) Jute is a cheap and readily spun.
2) Jute fibre is the world's principal material for manufacturing coarse textile for sacs, bags, and canvases.
3) The poorer fabrics are used in the making of gunny bags.
4) Better fabrics are used for the manufacture of curtains, rooting fabrics, covers for cotton bales etc.
5) The bags are used in the packing of sugar, potato, onions, pulses, coffee, cocoa etc.
6) Jute is used in the manufacture of twine, rugs, carpets etc.

7) The tender shoots are used as vegetable in Egypt, Sudan etc.
8) The jute butts (Here butts means lower ends of stalks and short fibres) are used in the manufacture of paper.
9) The jute stems after extraction of fibre are used for temporary fencing.
10) They are also used in the manufacturing of a kind of thick paper board.
11) Jute seeds are rich in oil.
12) 14.7% oil is extractable by petroleum ether.
13) This oil is used in manufacturing of soap.
14) It can be also converted into an edible oil.
15) The oil which is obtained from seeds of corchorus olitorius can be separated into non drying and drying portions, this latter can be used in paints and varnishes.

13.2.4 SHORT ANSWER QUESTIONS

1. Name importance fibre yielding plants with their botanical names, families, morphology of use part.
2. Write the economic uses of cotton.
3. Write the economic uses of jute.

13.2.5 REFERENCE BOOKS

1. A text book of Economic Botany – A.V.S.S. Sambamurthi (Wiley Eastern Limtied)
2. A Text Book of Economic Botany – V. Verma, Emkay Publications.
3. Economic Botany – Bendre & Kumar, Rastogi Publications, Meerut.

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P. SHIVANI

13.3 VEGETABLE OILS

OBJECTIVES

To study about different vegetable oil yielding plants, their use.

13.3.1 INTRODUCTION

Ancient Egyptians and Phoenicians used vegetable oils for food. Homer mentioned that oil is an aid to weaving and pliny talks about hard and soft soaps. Butter and Ghee were since known from vedic times. Oil, Fats and Wax have been used by man since very ancient times. Chinese and Hindus were known to extract vegetable oils from oil bearing materials since pre historic times. Vegetable Oils and Fats triglycerides of complex organic fatty acids and they have low percentage of oxygen.

The general formula of fatty acids are

CH_2 COO R_1
CH COO R_2
CH_2 COO R_3

Generally fatty acids are two types namely Saturated and Unsaturated. Oils are liquid at ordinary room temperatures, where as fats are soilid or nearly solids. Coconut Oil, Palm Oil, Cocoa butter, are examples for fats. Vegetable Oils are three types depending upon their ability to absorb oxygen from atmosphere. They are:

1) Non-drying oils - Eg: Groundnut, Palm, Olive, Castor, Rape and Almond.
2) Semi-drying oils - Eg: Cottonseed, Sesame, Sun-flower, Corn etc.
3) Drying Oils - Eg: Linseed, Soyabean, Safflower, hemp seed etc.

Vegetable oils differ from essential oils.

1) They do not volatolize of room temperature.
2) Cannot be distilled without being decomposed.
3) Have permanent greasy stain on paper.
4) Lack strong odour.
5) Become rancid after long exposure to air.

In this lesson we will study about Coconut, Mustard, Groundnut, Vegetable Oils.

13.3.2 GROUNDNUT

General Characters

It is a herbaceous, annual, tap rooted plant. The stem is cylindrical hairy and become more or less angular with age. The crop is best raised under irrigation during summer. Groundnut being a member of leguminous family is capable of fixing nitrogen through root nodules by a bacteria called Rhizobium. The plant attains a height of 1-2 feet. The leaves are quadrifoliate and bears large stipules. The small flowers are borne on the aerial parts of the plant. The flower bearing branches are thrust underground after the fertilization. The fruit formation does not take place until the ovary is pushed under the soil. Groundnut is cultivated in tropical and sub tropical countries. The plant would grow best on Sandy loam, loam and well drained black soils. The crop is used raised as a rainfed Kharif crop being sown from April-May to June-July. The crop is harvested when the leaves turn yellow. The varieties in cultivation fall into two categories namely i) Bunch or erect, ii) Runner or spreading. In the first type pods are produced in cluster while in the second type branches trail along the soil surface and produce pods all along them.

Origin

The groundnut is a native of Brazil where it grows wild. Portuguese explorers carried it to old world tropics. It was introduced into India in the sixteenth century. Since then groundnut is being grown extensively in India, East and West Africa, China and Indonesia. Brazil produces the highest amount of the groundnut in the world. China follows closely to occupy second place. Other groundnut producing countries France, Poland. In India groundnut is grown over 72.38 thousand hectares (1979-80) covering Bihar, Andhra Pradesh, Bengal, Madhya Pradesh, Tamilnadu, Maharashtra, Karnataka, Rajasthan, Punjab, and Uttar Pradesh. The seeds were introduced to East India and Philippines in 1500’s and early 1600’s. The crop was introduced to USA in middle of last century. Leiberherr states that the plant was introduced to India by Jesuit. Badami (1930) is of the opinion that the groundnut was introduced into India by Magellan expedition.

Botanical name

The Botanical name of Groundnut is *Arachis hypogaea*. It is derived from two Greek words Arachis meaning a legume and hypogaea meaning below the ground.

Family

Arachis hypogaea belong to the family *Fabaceae*.

Vernacular names

English	-	Groundnut, Peanut etc.
Tamil	-	Verkadalai
Telugu	-	Veru senaga
Malayalam	-	Nila-kadala
Kannada	-	Nelagadale
Hindi	-	Moong phullee
Marathi	-	Bhuimug

Morphology of useful part

Seeds are useful part of the plant. The fruit is one loculed pod. The shell of the pod consists of outer spongy layer, a middle fibrous and woody layer and an internal layer which lines the pod and becomes papery. Inside the shell there consists of two seeds or more. Each seed is composed of two cotyledons. A thin papery seed coat covers the seed. The cotyledons are creamy white in colour.

Economic uses

1) Groundnut kernals are rich and cheap source of vegetable protein.
2) The protein content of an ounce of roasted groundnut is nearly as much as that of 28 grams of dhal, 19.8 grams of mutton, 14-19 grams of eggs, 227ml of milk.
3) Groundnut kernals contains Vitamins A, B and some members of the B_2 group.
4) Peanut butter is prepared by grinding roasted kernals and blanched. To it little salt is added.
5) South Indians prepare chutney with these kernels.
6) Kernals are also eaten, fried and add small proportions to a number of dishes.
7) Groundnut milk is prepared and this boiled groundnut milk a little butter milk is added to prepare groundnut curd.
8) Groundnut oil is extracted iron seeds to use as cooking oil.
9) The oil is also used in manufacturing of Vanaspathi.
10) Ground oil is used to a limited extent in soap making.
11) It is also used in shaving creams, cold creams etc.
12) British pharmacopoeia recognises ground oil as a substitute for olive oil in the preparation of plasters, ointments and soaps.
13) The ground oil emulsion has been used successfully for the control of many insect pests of plants.
14) The oil cake can be applied as a manure for Paddy, Sugarcane, Vegetables, Bananas and other fruit trees.
15) The oil cake is used as cattle feed.
16) Groundnut shell is used in the manufacture of activated carbon, acetic acid, alcohol, acetone etc.
17) Finely ground peanut shells are used for polishing plates, cleaning air craft engines, fuel, bedding and plastics.

13.3.3 MUSTARD

General Characters

It is a annual herbaceous plant. Roots are slender and tapering. Stem is slender, branched, leaves are stalked and about 15-30cm long. The inflorescence is a corymbose raceme. Flowers are small, petals pale yellow, the fruit is siliqua. Seeds small, round, brown (or) dark brown. Mustard may be cultivated as a pure crop (or) as a mixed crop with wheat, barley and gram. Mustard is grown in India as a rabi crop. Medium or heavy soils are best for the cultivation of mustard. The crop is usually sown from the middle of October to beginning of November. Mustard crop comes to maturity in about 110-160 days. Harvest of crop goes on from February to March. Mustard seeds contain a glucoside called Sinigrin and Potassium myronate.
Sinigrin:

$$CH_2 = CH\,CH_2\,C \begin{matrix} /\!/\, NOSO_3 \\ \backslash\, S = \text{glucose} \end{matrix}$$

On hydrolysis sinigrin gives allyl – iso – thiocynate having the formula $CH_2 = CH\ CH_2\ NCS$. The pungency in Mustard oil is due to the chief component called euricic acid.

Origin

Rai (or) Indian Mustard is one of the important oil seed crops in India. According to Prain, Sinskai, Vavilov and Buknich rai was originally introduced from China into North Eastern India. According to Watt it was mentioned by theophrastus, Dioscorides and pliny and has been cultivated as an article of food in Europe since 13th century. Mustard has several references in the Bible and in Greek and Roman writings. Sanskrit records of 3000B.C. refer to mustard as an important spice. Mustard is believed to have originated in the Central Asia – Himalayas from where it spread to three secondary centres in India, China and Caucasus. Mustard is extensively cultivated in North America, Canada, U.K, Denmark, France, Germany, China, Japan and India. In India they are cultivated in Punjab, Haryana, U.P., Bihar, Bengal and Assam.

Botanical name

The botanical name of mustard is *Brassica juncea*. There are at least four more kinds in mustard they are:

White mustard - *Brassica hirta*
Black mustard - *Brassica nigra*
Brown mustard - *Brassica juncea*
Yellow mustard - *Brassica campestris*

Family

Mustard belongs to family *Brassicaceae*

Vernacular names

English	-	Mustard
Telugu	-	Aavaalu
Hindi	-	Rai
Malayalam	-	
Tamil	-	Kadugu
Kannada	-	

Morphology of useful part

The useful part of the plant is seed. The seeds are present in fruits called Siliqua. The fruits are long, erect with stout and short beaks. Seeds are small, round, brown and non mucilagenous.

Economic uses

1) Young leaves are used as green leafy vegetables.
2) The plants are used as green fodder for cattle.
3) The chief use of oil in India is for edible purpose.
4) The seeds and oil are used as a condiment in the preparation of pickles and for flavouring curries and vegetables.
5) Mustard Oil along with Rock Salt is used as a dental solution in the diseases of the gum.
6) It is also used in Ayurvedic medicated oils, for massage of paralytic diseases.
7) Sushrut Samhita has mentioned the mustard is used in the diseases of the head.
8) Mustard Oil is used for manufacturing of blown oil which is an oxidised and viscous oil.
9) Mustard Oil is used to make the leather soft in tanning industry.
10) The Oil cake is used as cattle feed.
11) The feedings of the seed to cattle is reported to be cooling, digestive and preventive for Skin diseases.
12) The seeds contain 35 to 45 per cent oil.
13) On small scale in villages oil is extracted by crushing seeds in wooden crushers (Kolhu) drawn by bullocks.
14) The oil is used as a fuel in lamps etc.
15) The oil is used as lubricant in machineries.
16) With the addition of camphor it is used for giving relief from muscular rheumatism and stiff neck.

13.3.4 COCONUT

General Characters

Coconut palm is one of the important sources of vegetable oil in the world and it is known as “wonder plant” yielding many products. Copra is the main product of the tree. The plant is tall and stately palm attaining a height of about 15 to 30 metres. Trunk is tall, stout some what flexible with swollen base surrounded by mass of roots. The trunk is unbranched with a crown of large pinnately compound leaves at the top. The inflorescence is present at the axils of leaves. The apical bud is located in this crown. Leaves, flowers and nuts develop from this bud. In adult coconut palm every leaf axil produces a inflorescence called spadix. The coconut palm is monoecious producing both male and female flowers ranges from 8,000 to 10,000 and female flowers from 10 to 50. After fertilization the nut takes about 11 to 12 months to reach maturity. Coconut is grown as a mixed crop. The palm continues to yield for about 80 years. Coconut is grown on a wide range of soil types. Sandy clay loan with a clay loam sub soil produce very good, crops. The coconut palm removes large quantities of nutrients from the soil continuously, for deriving the maximum benefit, it is necessary to apply fertilizers in small quantities.

Origin

There are three different theories in regarding the origin of coconut palm. The first theory suggested that northern end of Andes as the probable place of origin. This theory says that coconut came from American members of the genus. The second theory is in favour that its original habitat came from Central America from where the nuts have been carried by equatorial ocean currents to Pacific Islands. The third theory says its place of origin is some where in South East Asia from where coconuts might have accidentally reached the coasts of America. Fremound have summarized that coconut had considered a South East Asian origin is most probable. The coconut spread to East Africa from South East Asia via Seychelles Islands, from there coconut reached Central and South America. Coconut palm is confined almost entirely in South East Asia, India, Srilanka, Pacific territories and West Indies. It is grown in an area of about 6.8 metric hectors. In terms of acreage and production of coconuts India ranks third in the world. Coconut is mostly planted in Kerala, Tamilnadu, Andhra Pradesh, Karnataka, West Bengal, Assam and Orissa.

Botanical name

The botanical name of coconut is *Cocas nucifera*.

Family

Cocas nucifera belongs to the family *Arecaceae*.

Vernacular names

English	-	Coconut
Telugu	-	Tenkayi chettu, Kobbari chettu
Hindi	-	Narial

Tamil - Thennai
Malayalam - Thengu
Kannada - Thenginagida

Morphology of useful part

The most economically useful part of coconut is Endosperm. Even though each and every part of plant is useful. That is why Indian call coconut as Kalpavruksham. But any how endosperm is a fluid substance in the ripe fruit of coconut. The fruit is ovoid, three angled and contains single Embryo. The fruit consists of three layers outer exocarp, middle fibrous mesocarp, inner stony endocarp. Inside the endocarp there is brown testa with thick endosperm. (When the fruit is young the Endosperm is in liquid condition).

Economic uses

1) Coconut in ripe condition is an important food.
2) It is used in confectionery and other food industries.
3) Coconut fruit is always offered to God since ancient times till today.
4) Coconut water is a refreshing and agreeble drink particularly during summer.
5) The tender coconut water is useful as a substitute for saline glucose.
6) It is also prescribed in diarrhoea and vomitings.
7) It increases the blood circulation in Kidneys.
8) Coconut water has caloric value of 17.4 per cent for 100ml water.
9) It is used in culture medium for microbiological work.
10) A sugar containing juice known as toddy is obtained from spadix inflorescence.
11) Coconut oil is used as an vegetable oil for cooking purposes.
12) It is also used in soap manufacturing, toilet articles, hair oil, creams, cosmetics etc.
13) Coconut oil is now a days used for the manufacturing of synthetic detergents.
14) Coconut cake is used as animal and poultry feed.
15) Coconut cake is some times used as a manure for fields crops.
16) Coil or coconut fibre is obtained from mesocarp of coconut fruit.
17) There are three commercial fibres namely mat fibre mattress fibre and bristle fibre.
18) These are used for manufacturing mats, mattings, ropes, twines, cushions, brushes, brooms, coir, yarn, hard boards etc.

19) The stem of palm is popular timber for cheap construction.

20) Leaves are used for thatching houses, fencing, making baskets etc.

21) Roots are used in mouth wash, gargle in medicine as astringent.

13.3.5 SHORT ANSWER QUESTIONS

1. Write short notes on Groundnut.
2. Write the botanical name, family, morphology of useful part of mustard.
3. Write the economic uses of mustard.
4. Write a short notes on coconut.

13.3.6 REFERENCE BOOKS

1. A text book of Economic Botany – A.V.S.S. Sambamurthi (Wiley Eastern Limited)
2. A Text Book of Economic Botany – V. Verma, Emkay Publications.
3. Economic Botany – Bendre & Kumar, Rastogi Publications, Meerut.

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P. SHIVANI

13.4 WOOD YIELDING PLANTS

OBJECTIVES

To know about wood yielding plants.

13.4.1 INTRODUCTION

Woods are very important from day to day life in the form of furniture, papers, synthetic nylons, gums, resins etc. Every one realises that wood comes from trees (or) other wood yielding plants. So, we have to know about a detail structure of wood. Normally woods are classified into two types they are soft woods, hard woods. Wood is formed as a result of new tissues adding to increase the girth, this is due to the activity of cambium. If the base of the wood is cut across defined rings of varying width are seen these rings are called growth rings. Botanically the term wood is applied to secondary xylem produced by cambium in the stems of gymnosperms and dicotyledonous, angiosperms. The wood is used in two ways that is processed wood which consists pulp, paper, plastics, fermentation products. Where as unprocessed wood it consists timber, plywood fuel etc. Some of the wood yielding plants in India are Teak wood, Rose wood, Sandal wood, Red Sanders, *Terminalia catapa*. As we had already know that there are two types of wood that is softwoods and hard woods. Soft woods come from white silk cotton, red cedar, Red wood, etc. Hard woods comes from Sal, Cherry black, Teak, Chestnut etc. Hard wood consists of vessels instead of tracheids, where as soft wood consists of tracheids. Now in this lesson we will study a detail account of Teak Wood, Rose Wood, Sandal Wood, Red Sanders, *Terminalia catapa*.

13.4.2 TEAK WOOD

General Characters

Teak is the strongest among all woods. It grows on a great variety of soils but requires perfect drainage. Teak is a light demanding tree. It can grow to height 25-28 meters height and a girth of 8 meters. It is a large deciduous tree, leaves obovate, upper side rough and under side with dense hairs. Inflorescence very large, panicle type, flowers are small, white. Where as fruit – hard bong nut. The plant lives well with rainfall of 130-312cm per annum and at a temperature of 26°C to 30°C. Teak loses its leaves in dry and hot climate where as new foliage comes out around May. In teak sap wood is white in colour and heart wood is dark golden yellow turning dark brown to black with age.

Origin

The teak tree is native of Central and Southern India and South East Asian islands. It grows well South of 25° North latitude in India, Burma, Malaysia, Indonesia etc. In our country it is cultivated throughout Bengal, Assam, Sikkim, North West India. The Teak wood tree is indigenous in both peninsulas of India, in the North Eastern parts of Java.

Botanical name: The botanical name of Teak wood is *Tectona grandis*.

Family: *Tectona grandis* belongs to family *Verbenaceae*.

Vernacular names

English – Teak, Telugu – Teku, Tamil – Tekku, Kannada – Jadi, Sanskrit – Saka, Hindi – Sagun.

Morphology of useful part

The morphologically useful part of Teak tree is its wood (secondary xylem). Wood is moderately hard, strongly and characteristically scented containing oil which is the preservative annual rings are marked by one (or) more lines.

Economic uses

1) Teak wood is very durable and hence it is an important timber.
2) Teak wood do not shrink, crack or after its shape.
3) The wood takes fine polish.
4) It is used for ship building, boats, masts etc.
5) It is used in construction of houses, bridges.
6) It is used for interior construction of railway compartments, railway sleepers.
7) It is used for preparing agriculture implements.
8) It is used for house hold furnitures likes tables, sofas, doors, etc.

13.4.3 ROSE WOOD

General Characters

It is a deciduous tree attaining a height of 24 meters. Leaflets are broadly elliptic flowers whitish, pods oblong lanceolate. 1-4 seeds are present. Bark is grey colour with irregular short cracks, wood extremely hard, sapwood is yellow and small, heartwood is dark purple with longitudinal streaks. Annual rings are not distinct. This genus is very important genus in Indian forest economy. It consists of two important Indian timber trees.

i) Indian Rose Wood
ii) Sissoo, Shissam.

The wood is fragrant with distinctive characteristic smell. The average weight is in between 800 to 960 kg/m^3.

Origin

It is present through out the peninsular India extending north words. It is originated in South Peninsular India. It is extended to Bihar and Nagpur. It is found in sub-Himalayan tract i.e. from Utter Pradesh to Sikkim. Mysore rose wood commands the international market.

Botanical name: The botanical name of Rose Wood is *Dalbergia latifolia*.

Family: It belongs to family Fabaceae.

Vernacular names

English – Rose Wood; Telugu – Yerugudu, Jitigi, Jitangi; Marathi – Sisham; Tamil – Iti, Yeruvadi; Kannada – Biti; Sanskrit – Shishapa.

Morphology of useful part

The wood of the tree. It is diffuse porous with growth rings. Vessels are large and not very numerous.

Economic uses

1) The wood is used for furniture.
2) The wood is used for scientific instruments.
3) It is used to prepare sport, athletic goods etc.
4) It is also used in making musical instruments like Piano.
5) It is used to prepare railway sleepers.
6) It is used to prepare hammer handles, shoe heels, hookah tubes, tobacco pipes.
7) Leaves are used as fodder.

13.4.4 SANDAL WOOD

General Characters

It is a small evergreen glabrous tree. It consists of grouping branches. The leaves are opposite, ovate or lanceolate, leaf blade is 3.5 to 6.0cm long. Flowers are brownish-purple. They arise as axillary or terminal cymes. The flowers are bisexual, unscented and fruits are purplish black, globose drupes with sweet pulp. Generally plant grows well in cool climate, well drained loam soils. The tree take more than 30 years to develop an 8cm diameter central core of rich heat wood.

Origin

The plant is native of India. Indigenous in west peninsula from Nasik and Northern circans South wards. It is prominent in forests of Karnataka, Tamilnadu, Kerala, Andhra Pradesh.

Botanical name: The Botanical name of sandal wood is *Santalum album*.

Family: It belongs to family *Santalaceae*.

Vernacular names

Sanskrit – Chandana, English – Sandal Wood, Telugu – Chandanam, Tamil – Sri Gandham; Hindi – Chandan, Kannada – Gandha, Malayalam – Chandanam.

Morphology of useful part

The useful part is wood. The Bark is dark grey, sap wood is white and scentless, heart wood is yellowish brown, strongly scented. Annual rings are distinct.

Economic uses

1) The essential oil obtained from the stem is used in perfumery.
2) The wood is powdered and used in cosmetics.
3) Sandal Wood is used for manufacture of several decorative togs.
4) The essential oil extracted from wood acts as stimulant, cooling, antiseptic, anti-diuretic.
5) The oil is used for skin diseases and cardiac tonic.
6) Oil is used in

13.4.5 RED SANDERS

General Characters

It is a small tree. It favours a dry, rather rocky soil, and a hot fairly dry climate. Sapwood is white, Heart wood is purplish black dark orange red when cutted fresh. It is extremely hard. Bark darkish brown colour divided into rectangular plates by vertical horizontal cracks, excluding deep red juice. Leaves are 3, follicle. Leaflets thick, coracious, ellipticle, glabrous, shiny, margin entire. Flowers fellow axillary sythem seeds 1 or 2 long reddish.

Origin

It is the native of . It is restricted to dry hills, often rocky grounds. In India it is seen in Himalayan regions, Assam, West Bengal, Karnataka, Tamilnadu, Andhra Pradesh. In Andhra Pradesh it is restricted to Chittore, Nellore and Cuddapah.

Botanical name: The botanical name of Red Sanders is *pterocarpus santalinus*.

Family: It belongs to family *Fabaceae*.

Vernacular names

English – Red Sanders, Hindi – Lal chandana, Telugu – Agarugandhamu and Rakthagandham, Tamil – Sivappuchandanam; Kannada – Agaru, Malayalam – Patrangam, Marathi – *Tambada Chandana*.

Morphology of useful part

Wood which is obtained from stem. Sapwood which is white in colour and heartwood is dark orange red when it is cutted fresh.

Economic uses

1) It is highly prized for house posts.
2) It is also used for preparing agricultural implements.
3) It is used to prepare poles.
4) It is used to prepare picture frames, boxes, bent rims of carts.
5) In Japan it is used for preparing musical instruments called Shamisen.
6) Wood is ground and used for dying wool, cotton and leather.

13.4.6 *TERMINALIA CATAPPA*

General Characters

Myrobalan is the trade name given to the fruits of several species of Indian trees of the genus terminalia. These fruits are source of vegetable tannins. It is large, handsome, deciduous tree. The plant reaches a height of 18-24m having a trunk of 12 meters, with a smooth grey bark and whorled branched. Stems provided with buttress roots at the base. Leaves are simple, large, obovate, usually crowded at the ends of branchlets. Flowers are small, white, star-shaped, arranged in slender racemes. Fruits are drupes, yellowish (or) reddish, ellipsoidal and distinctly compressed. The epicarp is fibrous and fleshy and the endocarp is hard. The seed is edible.

Origin

It is native of Andaman islands. It is found in the beach forests on the raised sandy beaches and forests in these islands. The tree is plant commonly in India in the compounds and gardens for ornament and also for nut.

Botanical name: The botanical name of Myrobalan (Badam) is *Terminalia Catappa*.

Family: It belongs to the family *Combretaceae*.

Vernacular names

English – Myrubalan, Hindi – Badaam, Telugu – Badam Chettu, Tamil – Badam, Malayalam – Badam.

Morphology of useful part

The wood which is obtained from stem and where as the fruits are useful parts.

Economic importance

1) The seeds are edible.
2) The wood is lustrous, smooth and useful in many ways.
3) The timber is used in house-building, wheel-wrights.
4) The timber is used in general carpentry.
5) The timber is easy to saw and work as it polishes well.
6) The wood requires considerable filling as the vessels are very prominent on the longitudinal surface.
7) The kernel of the nuts are eaten at dessert.
8) The leaves act as sudorific and they are applied to rheumatic joints.
9) The juice of the young leaves is used to prepare an ointment for scabies, leprosy and other skin diseases.
10) The wood is often blotched with yellow due to a soluble dye.

13.4.7 SHORT ANSWER QUESTIONS

1) Write a short notes on Teak Wood.
2) Write a short notes on Rose Wood.
3) Write a short notes on Sandal Wood.
4) Write a short notes on Red Sanders.
5) Write a short notes on Terminalia catappa.

13.4.8 REFERENCE BOOKS

1) The text book of economic botany – A.V.S.S. Sambamurthy.
2) The text book of economic botany – V. Verma
3) Economic botany – Bendre Kumar.

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P. SHIVANI

Lesson 14

Unit-III

14.1 S P I C E S

OBJECTIVES

To study about the spice yielding plants and their economic uses.

14.1.1 INTRODUCTION

Spices are important group of agricultural products which are used for flavouring foods, extensively used in medicine, pharmaceuticals, perfumery and in several cosmetics. Spices are well known apetizers. Spices possess several properties like anti-oxidant properties. Spices are not foods since they do not have nutritional value. The flavour and aroma are due to essential oils, which are organic volatile compounds. Spices are generally derived from different parts of the plants like shoots, stems, leaves, flowers, seeds etc. It is very difficult to classify the spices. They are generally divided on the basis of the part or parts of the plant that give spices. They may be as follows.

a) Spices obtained from under ground parts. Eg:- Ginger, Turmeric.
b) Spices obtained from the bark. Eg:- Cinnamon.
c) Spices obtained from flower buds and flowers. Eg:- Cloves, Saffron.
d) Spices obtained from fruits. Eg:- Chillies, Pepper, Fennel, Coriander, etc.
e) Spices obtained from seeds. Eg:- Cardamom, Mustard.

Egypt is indicated as the place where spices seem to have been used for the first time. Their presence in the food gives pleasant flavour to the food items. The aroma of spices is due to volatile essential oils, pungency is due to alkaloids. In this lesson we will study about coriandrum, cardamom, cloves, cinnamon, carum, cuminum, pepper.

14.1.2 CORIANDRUM

General Characters

The plant is highly aromatic. It is a small perennial herb. The plant grows to a height of 30-70cm. It consists of broad, lobed leaves. Flowers are white in colour and they are small. The inflorescence is called umbel. Fruits and globular, yellow to brown in colour. They are two seeded and the fruits are called schizocarp. It is composed of two mericarps. Each mericarp is single seeded with fruit wall enclosed. The fruit consists of oil glands. The crop matures with in 4 months and yields 1120-2240 kg/per of dried fruits. It contains moisture of 6.3%, protein 1.3%, volatile oil 0.3%, fat 19.6%, carbohydrate 24.0%.

Origin

It is indigenous to eastern Mediteranean, coriander finds references in the old Egyptian countries. It also had its reference in Hebrew, Roman and Sanskrit literature. It grows in wild state in Sudan, Egypt. The plant is widely grown in Europe, South America, India.

Botanical name: The botanical name of coriander is *coriandrum satirum*.

Family: It belongs to the family *umbelliferaceae*.

Vernacular names

English – Coriander, Hindi – Dhaniya, Kannada – Kothambri, Malayalam – Kothumpkalari bija, Tamil – Kothamali, Telugu – Dhaniyalu.

Morphology of useful part

The useful part is fruit (schizocarp) leaves. Leaves are broad and lobed. The fruits are globular, small. It does not break easily into two mericarps. It has five small flaps near the apex, when the fruit is small and young its smell is unpleasant and when it becomes dried it gives very pleasant smell. The fruits contain essential oils.

Economic uses

1) The leaves are used in fish sauces and garnishing.
2) The fruits are used in flavouring soups, sauces.
3) The fruits are used in flavouring meat dishes.
4) The fruits yield a volatile oil which constitute anethole.
5) The oil is used as flavouring agents.
6) The fruits are aromatic, stimulant.
7) They are officially used in pharma copias.
8) They are used in medicines which cure chest, spleen and kidney diseases.
9) Oil is used in perfumes.
10) Seeds used for flavouring food item because it consists of oleoresin.

11) It is used as a medicine in curing bleeding piles.
12) It is used as refrigerant, carmanative.
13) It is used as eye wash in conjunctivities.
14) The oil is used in curing stomach pains, rheumatism.
15) The seeds are used for curing chronic ulcers, used as mouth and throat gargle.

14.1.3 CARDAMOM

General Characters

Cardamom is one of the profitable agricultural products. It is grown in ancient times in the mountain regions of Asia. It grows wild in evergreen rain forests. In cultivation the plant requires an annual rain fall of 150-500cm. The temperature ranges from 10-35^{o}C. Soil should be well supplied with humus, free from water logging. They are propogated by rhizomes. The plant is a tall herbaceous perennial. It consists of subterranean branched rhizomes. From these branded rhizomes there arise leafy shoots which are erect. Rhizome is stout, woody, leafy shoots are 10-20 in number, they look like a thick clump. Leaves are dark green, glabrous, petiolate. Inflorescence arise at the base of leafy shoot. Fruit is trilocular capsule. The seeds are 15-20 in number and fruits are pale yellow – yellow in colour, where as seeds are dark brown, aromatic and present with in mucilaginous aril, the endosperm is bulky and white with small embryo.

Origin

The plant is native of India. The crop is mostly cultivated in hilly forest regions. It is grown in Karnataka, Kerala, Madurai, Nilgiris. Cardamom is cultivated in Orissa to a small extent. It is grown in Archipelago, Java and Guatemala. Now attempts are being made to introduce cardamom cultivation in Assam and Maharashtra. These cardamoms are grouped into two categories, they are small cardamoms and large cardamoms.

Botanical name: The botanical name of cardamom is *Elettaria cardamom*.

Family: It belongs to the family *Zingeberaceae*.

Vernacular names

English – Cardamom, Telugu – Yalukkaya, Hindi – Elachi.

Morphology of useful parts

The useful part of the plant is fruit which bears seeds. The seeds consists of an essential oil. The composition of this oil is esters, terpinol, etc are present.

Economic uses

1) Cardamoms are used for flavouring curries, cakes, biscuits, pickles, sweet dishes etc.

2) They are used in medicines as carminative.
3) The oil is used in cooking and for flavouring.
4) Cardamoms are used as mouth freshners.
5) These are used in small quantities in preparing paans.
6) The oil is used in perfumery and also for flavouring liquors.
7) The cardamom oil is used in preparation of tincture.

14.1.4 CLOVES

General Characters

The term clove is derived from the French word clove and the english word clout both meaning "nail". It is a small ever green tree. The trunk often forks near base and give rise to 2-3 main erect branches. The bark of the tree is grey in colour. The leaves are opposite, glabrous, aromatic. The type of inflorescence is cyme. Flower are usually borne in groups of three fruits are called mother of cloves. These are dark red, fleshy drupes containing one, or two seeds. The buds initials appear for six months before the buds are ready to harvest. Clove tree thrives well in low attitudes. They need annual rainfall of 218-355cms and temperatures from 24-33^{o}C. The best soils for cloves are deep, sandy, red acid loans. Cloves are propagated by seeds. Trees begin to flower at about six years and continue to produce until seventy years. Clove clusters are picked by hand before the buds open. The average annual yield of dried cloves per tree is about 3.15 kg.

Origin

The native of cloves is Molucca – Islands. This were discovered by Portuguese. These are indigenous to the small volcanic islands of Ternate, Tidore, Mutir, Makkyan. In India clove tree was introduced in 1800 by the East India Company. The biggest clove producing regions in the world today are Zanzibar, Pemba, Madagascar and Indonesia. The major importers of cloves are the USA, India, Germany and France. In India cloves are cultivated on a small scale in Nilgiris, Tenkasi Hills, Kanyakumari, Kottayam etc.

Botanical name: The botanical name of clove is *Eugenia caryophyllus*.

Family: Clove belongs to the family *MYRTACEAE.*

Vernacular names

English – Clove, Hindi – Laung, Kannada – Lavanga, Malayalam – Grambu, Marathi – Luvang, Sanskrit – Lavanga, Tamil – Kirambu, Telugu – Lavangalu.

Morphology of useful part

The dried un-opened flower buds are economically used. The flowers buds appear in groups. The inflorescence is called cyme. The flower bud has cylindrical bases. The sepals of flower form a fleshy tube which encloses ovary.

Economic uses

1) It is very aromatic.
2) It has a fine flavour and imparts warming qualities.
3) It is used as a culinary spice as the flavour is suitable for both sweet and savoury dishes.
4) Cloves are used for gravies, pickles, baked foods, cakes, confectionary, chocolate, sweet syrups etc.
5) In Jara clove is used in preparation of a special brand cigarette for smoking.
6) Clove oil is used for flavouring meat, sausages, bake foods, candies, table sauces, pickles.
7) Clove oil is used in perfumes, toilet water soaps.
8) Clove oil is also used in tooth pastes.
9) Clove oil is used in biological laboratories in the preparation of permanent mount of plant materials.
10) Clove oil is used in the preparation of eugenol and vanillin.

14.1.5 CINNAMOM

General Characters

It is the popular tree spice of world. The plant is an evergreen small tree. It attains a height of 50 feet. The tree is very much branched. The cultivated plants are small in size. The plant consists of broad aromatic leaves which are 6-7 inches in length. The plant consists of an inflorescence which is terminal or axillary. The flowers are small, yellow. The type of inflorescence in panicle. The fruits are fleshy drupes. The plants are grown in semi wild conditions. The trees flower in May. The fruits become mature with in 2 to 3 months. The shoots when they attain a length of 6-7 feet are usually cut for getting the bark easily. This cutting for bark is done twice in a year. The collected bark is covered with canvas to ferment them. The outer portion of the bark is removed and remaining strips are slowly dried. During the drying process the strips get rolled into quills.

Origin

The name Dalchini is actually a derivation from the Arabian term Dar-al-chini which means the wood (or) bark of China. It was known to mankind since oldest days. As old as 2000 BC itself it was known to Egyptians. European and Arabian travellers confirm the trade in cinnamon from Srilanka, Seychelles, China, Indonesia and West Coast of India to other countries. Cinnamon tree occurs wild in Srilanka, India. Srilanka produces the best quality of the world's supply. In India cinnamon is cultivated in Kerala and Western ghats.

Botanical name: The botanical name of cinnamon is *Cinnamomum zeylanicum*.

Family: Cinnamon belongs to the family *Lauraceae*.

Vernacular names

English – Cinnamon, Hindi – Dalchini, Kannada – Lavanga patti, Malayalam – Lavanga patti, Tamil – Lavanga patti, Telugu – Dalchina Chekka, Sanskrit – Darushila.

Morphology of useful part

The inner bark of the tree is economically useful part. The best quality cinnamon is obtained from thin bark from shoots in the centre of the bush and from the middle portion of the shoots. The aromatic substance in its bark is cinnamic aldehyde.

Economic uses

1) Bark is used as a spice.
2) It is also used as condiment in the form of small pieces (or) powder.
3) Cinnamon oil is used as flavouring substances in confectionary.
4) It is also used in preparations of liquors, pharmaceuticals, soap industries.
5) Cinnamon oil is used in dental paster etc.
6) In Spain the chocolates are prepared by using this constitute.
7) It is also used in candy, gum, perfumes etc.
8) Bark is aromatic, stimulant and carmonative.
9) It is used in checking nausea and vomiting.
10) Bark oil is used as germicidal and fungicide.
11) It is also used for curing gastrodynia, flatulent colic, gastric debility.

14.1.6 CARUM

General Characters

This is a perennial plant. This is commonly called Caraway. This plant looks like coriandrum plant. The leaves are dissected. The type of inflorescence is compound umbel. The flowers are actinomophic and where as the fruits are small long and ridged. These fruits consists of oil glands. These oil glands are called vittae. Because of presence of vittae the caraway consists of aromatic smell. The fruits are brown in colour. The plant is biennial herb. Fruits are oblong, laterally compressed. The seeds have a characteristic aroma and sweet taste.

Origin

The plant is native of Europe and Western Asia. It is cultivated in northern Europe, U.S.A. and Canada. In India it is grown in Bihar, Orissa, Punjab, Bengal and Andhra Pradesh. It is essentially a crop of temperature regions. It is chiefly grown in Netherlands, Denmark, Poland and Russia. Holland is world’s most important commercial source of caraway.

Botanical name: The botanical name caraway or carum is *carum carvi*.

Family: Carum belong to the family *Umbelliferaceae*.

Vernacular names

English – Carum, Telugu – Seema Sopu, Tamil – Shimaishembu, Hindi – Shajira, Sanskrit – Sushavi.

Morphology of useful part

The useful pat of carum is fruit (seeds).

Economic uses

1) The seeds are usually used as condiment.
2) These are also used in perfumery, baking, medicine and beverages.
3) It is used for culinary purposes.
4) In India oil is used for flavouring soaps.
5) Caraway has anti bacterial properties.
6) Medicinally caraway seeds acts as a mild stomachic and carmonative.

14.1.7 CUMINUM

General Characters

Cumin is a small annual herb. It grows to a height of about 0.3 metres. The stem is much branched. The leaves have long narrow segments. The leaves are also much divided. The flowers are small, white in colour, they are born terminally on stems. The type of inflorescence is compound umbel. The fruits are elongated and oval. In India cumin is grown from seeds. The seed is sown at the rate of 31.5 to 38kg/hectare. The plants require mild, equable climate. The plant needs long growing period of about 90-120 days. A rich, well drained sandy soil and loam soils are recommended. The plant cannot with stand severe dry heat. It yields about 450-540kgs/hectare under favourable conditions.

Origin

It is native of upper Egypt, Turkistan and eastern mediterranean region. The plant is extensively grows in Iran, India, Morocco, China, Southern Russia, Japan, Indonesia, Turkey. Cumin is well known to ancient civilizations. It was included as medicinal plant in Egypt. Iran is the major world exporter of cumin seeds. It is known as green cumin. In Iran it is mainly cultivated in Khurasan province.

Botanical name: The botanical name of cumin is *Cuminum cyminum*.

Family: This belongs to the family *Umbellileraceae*.

Vernacular names

English – Cumin, Hindi – Jira, Kannada – Jirage, Malayalam – Jirakam, Tamil – Seerugam, Telugu – Jilakarra, Sanskrit – Ajaji.

Morphology of useful part

The useful part of the plant is fruit which is known as schizocarp. The schizocarp has hairy ridges, oil tubes, strong odour. The schizocarp means it is made up of small mericarps. Each mericarp contains single seed. Each fruit of cumin consists of two mericarps.

Economic uses

1) In India it is used traditionally.
2) It is used as stimulant, carminative.
3) When it is taken with water and sugar it avoids sunstroke.
4) It is also used in Stomach ache.
5) It is used for curing colic, diarrhoea.
6) Cumin is used as an important ingradient of curry powder and chilli powder.
7) It is also used in preparations of meats, pickles, cheese, chutneys, sausages etc.
8) It makes an excellent seasoning for soups.
9) It is also used biscuits, cakes, breads etc.
10) The fried fruits are used to flavour 'dal'.
11) The fruits are used in medicine and veternary medicine.

14.1.8 PEPPER

General Characters

Pepper is considered as king of Indian spices. It yields highest foreign exchange. Pepper is of two types black pepper and white pepper. Black pepper is nothing but the dried fruits where as white pepper is unripened young fruits. Pepper is an evergreen plant. It requires a high humid and warm tropical climate. It needs on annual rainfall of 250cm and an average temperature of 18-38^{o}C. The plant can be grown at an attitude of 1200m. The plant requires well drained loam soils. The plant is a trailing shrub. The stem has swollen nodes and from these nodes there arise adventitious roots, leaves and inflorescence. Leaves are simple, alternate, ovate, broad and have pungent taste. Inflorescence are born opposite to the leaves. Each inflorescence contains 50-100 small flowers in catkin spikes. Fruit is one seeded spherical drupe.

Origin

The plant is indigenous to rain forests of South West Coast of India. In Asia plant is cultivated in Indonesia, Malaysia, Srilanka, Thailand, Brazil. It is believed that pepper have originated in South India and South Eastern Asia. The Greeks and Romans used them. The Europeans developed a great liking for them during the middle ages. Pepper became very important trade crop in Western Europe. In India it is chiefly grown in Kerala, Karnataka, Assam, Bengal and some parts of Tamilnadu.

Botanical name: The botanical name of pepper is *Piper nigrum*.

Family: It belongs to the family *Piperaceae*.

Vernacular names

English – Black pepper, Hindi – Kali Mirch, Kannada – Kare menasu, Malayalam – Kurumaluku, Marathi – Mire, Sanskrit – Marichaushana, Telugu – Miriyalu, Tamil – Milagu.

Economic uses

1) Pepper is most important spice used in the whole world.
2) It is widely used as condiment.
3) It is a flavouring material for all types of food stuffs and dishes.
4) It is used for preserving food items.
5) It is used in manufacturing of food stuffs, like sauces and ketchups etc.
6) It has some medicinal uses.
7) It is also used as alkaloid.
8) It brings cooling effect to the human body.
9) It stimulates the flow of saliva.
10) It also stimulates gastric juices and thus this juice helps in the digestion of food.
11) Medicinally it is used for treatment of diarrhoea dyspepsia, piles and cough.
12) It is mixed with milk and taken by singers to gain good voice.

Morphology of useful part

The useful part of the plant are seeds. The seeds have a aromatic smell and sweet taste. The fruits are laterally compressed and light to dark brown in colour. The pericarp is differentiated into five distinct ridges. The seeds contain carvone and small amounts of carvene (d-limonene).

14.1.9 SHORT ANSWER QUESTIONS

1) Write a short notes on Coriandrum.
2) Write a short noes on Cloves.
3) Give an account of Cinnamon.
4) Write about Cardamom.
5) Write a short notes on Cuminum.
6) Write a short notes on Carum.
7) Write a short notes on Pepper.

14.1.10 REFERENCE BOOKS

1) **A text book of Economic Botany –** A.V.S.S. Sambamurthy.
2) **A text book of Economic Botany –** V. Verma.
3) **Economic Botany –** Bendre, Kumar.
4) **Pharmacognosy –** Nirali Prakashan Publication.

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P. SHIVANI

Unit-III

14.2 MEDICINAL PLANTS

OBJECTIVES

To study and know about the medicinal plants and their medicinal value.

STRUCTURE

14.2.1 INTRODUCTION

Plants are the important sources of medicine. During pre-historic period people use to apply plants as medicines. The writing indicate that Chinese were the first to use the natural vegetation as medicine. In India the earliest references of the curative properties of plants appear in Rigveda and Atharvanaveda which is said to be written between 3500-1600 B.C. Several plants have referred in the Suktas of Rigveda namely Simal, Pithvan, Palas, Pipal etc. However these references are brief. Later the Ayurvedic system of treatment of human diseases developed between 2500-500 B.C. Sometimes around 1500 B.C. herbal cure was described in detail in the works of Charaka and Susruta, namely Charak, Samhita and Susruta–Samhita. Since this time investigations have brought the number of drug plants of about 2000.

The Greeks and Romans were also familiar with many of the present day drugs. Hippocrates, the father of medicine was the first to attempt a scientific explanation for diseases. His influence remains even to day in the form of Hippocratic Oath taken by young doctors upon their graduation.

Disocorides has given valuable information about medicinal plants in his book. De Materia medica. This remained the supreme authority for over sixteen centuries most of the drug plants are wild. These occur in the wild state in nature, especially in tropics only a few of them are cultivated.

Medicinal plants have their value in the chemical substance present in their tissues. These chemicals produce specific physiological action in the human body and cure the ailment. The branch of science which deals with the drugs, their identification, collection etc is known as **Pharmacognosy**, while the study of action of drugs on organ comes under **Pharmacology**. The information of drug and drug plants, whose efficiency has been established is published in the form of book called **pharmacopoeia**. The drugs mentioned in these drugs are called **official drugs**.

In this lesson we will study about Ocimum, Vinca, Datura, Rauwolfia, Phyllanthus. These are medicinal plant included in the syllabus.

14.2.2 OCIMUM

General Characters

It is herbaceous, much branched, annual plant found through out India. It is considered to be sacred by Hindus. The plant is commonly cultivated in garden and also grown near temples. It is propagated by seeds. Tulsi now-a-days is cultivated commercially for its volatile oil. It grows about a height of 30 to 75cm. All parts are used as medicine. The leaves are oblong, acute with entire (or) serrate margin, pubescent on both sides and minutely gland-dotted. The leaves are green in colour with aromatic flavour and slightly pungent taste. The flowers are purplish in colour in the form of racemes. Nut lets are subglobose, slightly compressed, pale brown or red in colour. Seeds are reddish black and sub globose. It is commonly called basil.

Origin: It is native of tropical Asia, now it is cultivated in most of temperate North America.

Botanical Name: The botanical name of ocimum is *Ocimum Sanctum*.

Family: Basil belongs to the family *Labiatae.*

Vernacular names: English – Basil, Telugu – Tulasi, Tamil – Tulasi, Malayalam – Tulasi

Morphology of useful part

The whole plant parts are useful. Mostly leaves are useful in fresh as well as dried conditions.

Economic uses

1) Tulasi leaves are aromatic and contains a volatile oil.
2) The oil is collected by steam distillation method.
3) Chemically the oil contains 70% eugenol, 3% carvacrol, 20% Eugenol-methyl-ether.
4) Seeds contain fixed oil with good drying partts.
5) The plant also contains alkaloids.
6) It also consists of Saponin, Tannin, Vitamin C.
7) It also contains traces of maleic, citric and tartaric acid.

8) Fresh leaves are used as mouth freshners.
9) For curing several dental diseases leaves are used.
10) The oil is having anti bacterial activity.
11) The oil is having insecticidal activity.
12) The leaves are used as stimulant.
13) Th leaves are crushed and used for clearing nose when children suffer with cold.
14) It is used in many ointments, creams.
15) It leaves are dried and applied directly to face with the addition of milk, coconut water etc. It gives glowing to the skin.

14.2.3 VINCA

General Characters

This is a drought – resistant species and can be propagated by seeds and cutting. As the plant blooms throughout the year, the collections of seeds is not difficult. The plant requires very little irrigation and can hence be raised as off season crop. The cultivation is done in June-July in India and first crop of leaves is ready in November. Harvesting is done 2 to 3 times a year. The seeds are collected and plant is uprooted in February. Leaves are thoroughly dried and sent to market. Roots are washed, dried and marketed. The leaves are green, roots are pale grey, flowers are pink to violet, white, carmine red in colour. The odour is characteristic and taste is bitter. Vinca is an erect, pubescent herb, with branched tap root. Leaves are simple, petiolate, ovate or oblong, unicostrate reticulate, entire, brittle with acute tip. Flowers are bracteate, pedicellate, complete, normally 2 to 3 in cymose axillary clusters. Fruits are follicles with several black seeds.

Origin

It is probably indigenous to Madagascar. It is cultivated in South Africa, West Indies, India, U.S.A, Europe and Australia as an ornamental plant as well as for its medicinal properties.

Botanical name: The botanical name of vinca is *Vinca rosea*.

Family: It belongs to the family *Apocynaceae*.

Vernacular names: English – Vinca, Telugu – Billa Ganneru

Morphology of useful part: Leaves and roots are useful parts of the plant.

Economic Uses

1) Vinca contains a wide varieties of chemicals.
2) It consists of glycosides and alkaloids.
3) The important constituent of alkaloid is indole-indoline alkaloids.
4) About 60 alkaloids have been isolated so far from different parts of vinca.
5) The important alkaloids with anticancer property are vincristine and vinblastine.

6) Vincristine is used in treatment of eukaemia.
7) Vinblastine is used for the treatment of generalised Hodgkin's disease.
8) Vinblastin is also used in treatment.
9) Vinca also exhibits hypotensive activity.

14.2.4 DATURA

General Characters

It is a small shrub. The stem is branched, leaves are unequal at the base with acute apex and glabrous lamina. Each leaf has 3 to 4 coarse veins on each side and 4 to 6 secondary veins on either side of the midrib. Flowers are about 7 cm in length, white to reddish purple to purple on the outerside, while whitish internally. Curolla of the flowers is thin, acuminate and circular in shape. Flowers are funnel shaped with pedicel which is never erect. The stems as well as branches of the plant are purple coloured. Seeds are brown in colour. Fruits is a capsule. The germinating rate of seeds is poor. If the seeds are soaked in water and kept over night the rate of germination increases. About 7 to 8kg of the seeds per hectare are required for sowing. The seeds take about 15 to 20 day for germination. The drug is collected after 4 months of its cultivation.

Origin

Datura is a genus of poisonous shrubs of tropical and sub tropical parts. It is also found in India. It is cultivated in Europe.

Botanical name: The botanical name of Datura is *Datura metal*.

Family: The family which Datura belongs is *Solanaceae*.

Vernacular names: English – Datura, Telugu – Umettha, Tamil - Ummetthai

Morphology of useful part

Morphologically useful parts are leaves and branches.

Economic uses

1) The tropane alkaloid is prepared from this plant.
2) The drug is used as a parasympathetic depressant.
3) It is used in the treatment of asthama and cough.
4) It is also used as an antispasmodic and a depressant of the central nervous system.
5) Hyoscine butyl bromide and hyoscine hydro bromide are used in the treatment of gastric or duodenal ulcers.
6) The drug excites and then paralyses certain cerebral medullary centres.
7) Hyoscine is used to great extent in ophthalmic practice to dilate the pupil of the eye.

14.2.5 RAUWOLFIA

General Characters

Rauwolfia refers to the name of scientist Dr. Rauwolf and serpentina refers to long snake like structure of root. The plant is an erect perennial shrub. It is of a height of half feet to one and half feet. The plant is evergreen, leaves are in three whorls. Large number of small white (or) pink flowers are born in cymes. The fruit is drope. The plants lived well in hot and humid climates of tropicals. It prefers shady habitats of the forests. It grows well in areas of very high rainfall ranges from 250 cm to 500 cm. It can grow in different soils ranging from sandy alluvial loam to red lateritic loam. Well drained humus rich clayey soil is best for its growth. The plant is propogated by means of seeds.

Origin

It is native of India. The genus is found in the tropical regions of Asia, Africa and America. The Asian countries are India, Bangladesh, Srilanka, Burma, Malaysia, Thailand and Indonesia. Five species of Rauwolfia are grown in India. Rauwolfia is found in sub-himalayan tract from Punjab through Nepal, Sikkim, Bhutan to Assam, eastern and western ghats, Central India and the Andamanas. The plant is grown commercially in Utter Pradesh, Bihar, Orissa, West Bengal, Assam, Andhra Pradesh, Tamilnadu, Karnataka, Kerala and Maharashtra.

Botanical name: The botanical name of Rauwolfia is *Rauwolfia serpentina*.

Family: This belongs to the family *Apucyanaceae*.

Vernacular names: English – Rauwolfia, Telugu – Sarpagandhi

Morphology of useful part

The roots of the plant consists of the drug. The bark of the root gives several alkaloids. The most important alkaloid is *Reserpine*. It is extracted from another two species namely R. vomitoria and it is from Africa the second one is R. tetraphylla from America. Apart from the alkaloids it also contain oleo resin, phytosterol fatty acids, unsaturated alcohol and sugars.

Economic uses

1) The activity of Rauwolfia is mainly due to reserpine.
2) Reserpine consists of depressant action on central nervous system.
3) It produces tranquilizing effect and lowers the blood pressure.
4) It can be administered orally and has cumulative effect.
5) It is also given parenterally in the treatment of hypertension.
6) Reserpine should be used with caution in anxiety, depression and in the patients with cardiac arrhythmia.
7) It has tranquillizing effect than hyphotic one.

8) The drug is used in the treatment of high blood pressure.
9) These drugs which are known as antihypertensive drugs.
10) The high blood pressure leads to cardiac arrest Methyldopa, Clonidine, Reserpine are few drugs used for hypertension in modern age.

14.2.6 PHYLLANTHUS

General Characters

The Indian goose berry which is common name for Amla. The plant is perennial deciduous-tree reaching to a height of 10-15 m. The branch lets bears two regular rows of simple, stipulate leaves, pinnately compound with numerous leaf lets. The small leaves are oblong like leaflets of tamarind tree. Trees are monoecias. The fruit is green at first changing to light yellow or brick red in colour. There is great variation in size and taste of raw fruit. After chewing an amla fruit water tastes sweet. It is grown by seed germination. It can also be propagated by budding (or) cutting. It doesn’t tolerate the frost (or) drought. It is normally found upto an attitude of 1500 m. The tree flowers in hot season and the fruits ripen during the winter.

Origin

It is deciduous tree found both wild and cultivated over the greater part of India. It is also found in Srilanka and Myanmar.

Botanical name: The botanical name of phyllanthus is *Phyllanthus emblica* (or) *Emblica officinalis*.

Family: It belongs to family *Euphorbiacease*.

Vernacular name: English – Emblic myrobalan, Telugu – Usiri, Hindi – amla, Tamil – Usirikai

Morphology of useful part: Fruits are fleshy, 6 lobed with seeds. They are very hard and smooth.

Economic uses

1) Fresh fruits contains very high percentage of Vitamin C.
2) A small percentage of tannins, glucose, fats and minerals are present.
3) The tannins include – galic acid, Ellagic acid, Phyllemblin.
4) Fresh fruit is used as refrigerant.
5) It is also used as diuretic and laxative.
6) The green fruits stimulate appetite.
7) The dried fruits are useful in hemorrhage, diarrhea and dysentery.
8) It is used with iron it is valuable remedy in treating anaemia.
9) It is also used in treatment of Jaundice.
10) Amla is an ingredient of chyavanprash and Tripala churna.

14.2.7 SHORT ANSWER QUESTIONS

1) Write an account of the medicinal plant ocimum.
2) Write down the medicinal values of Rauwolfia.
3) Write a short notes on Vinca.
4) Write an account on Daturo.
5) Write about medicinal uses of phyllanthus.

14.2.8 REFERENCE BOOKS

1) Text book of economic botany – A.V.S.S. Sambamurthy.
2) Text book of economic botany – V. Verma.
3) Economic botany – Bendre, Kumar.
4) Pharmacognosy – Nirali Prakashan.

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P. SHIVANI

Unit-III

14.3 BEVERAGE PLANTS (OR) BEVERAGES

OBJECTIVES

To study about beverages and their economic use.

STRUCTURE

14.3.1 INTRODUCTION
14.3.2 COFFEE
14.3.3 TEA
14.3.4 MODEL QUESTIONS
14.3.5 REFERENCE BOOKS

14.3.1 INTRODUCTION

Beverages have always a proud place in all societies. The beverages are of two types generally they are alcoholic beverages and non-alcoholic beverages. Alcoholic beverages are extracted from cereals and fruits. Non-alcoholic beverages and prepared from number of plants. Alcoholic beverages examples are Wine, Beer, Rum, Whisky, Gin etc. Non alcoholic beverages are Coffee, Tea etc. These two are very popular. They are consumed all over the world Coffee and Tea are among the fore most items of international trade. Other than Coffee and Tea there are other non alcoholic beverages, they are Coca, Chat, Cola etc. These two which are consumed by man act as stimulants. Tea and Coffee are a substances of alkaloids. These alkaloids have medicinal values, acting as diuretic and nerve stimulant. However these are harmful if taken in large quantities.

14.3.2 COFFEE

General Characters

Coffee is obtained when the seeds are roasted and grounded. It is one of the most important beverage. The word Coffee is originated from Kaffa it is the name of a district in South West Abyssinia. There are 25 species of Coffee. The Coffee plant is a shrub or a small tree. It attains a height of 15 to 30 feet. The leaves are borne in opposite manner. They are dark green in colour. The white coloured fragrant small star shaped flowers are borne in the axils. The fruits are called cherries. They are two seeded drupes. The unripe fruits are green. When they become ripe they change into yellow or cherry red colour. The coffee seeds are covered with a thin membrane. The one seeded fruit is known as pea berry. It is more valuable than two seeded fruits. Coffee requires humid climate with 80 inches rainfall per annum. The temperature ranges from 55^o to 90^oF. Coffee grows well in loam soils. Coffee is produced in tropical or subtropical regions of the world especially in Brazil, Colombia, West Indies, Venezuela, Equador, Guatemala, Mexico, India, Srilanka, Kenya, Congo, Uganda etc. Brazil produces about one third of the total world out put.

Origin

Most of the species of Coffee are native of Africa and Madagascar. *Coffea arabica* is indigenous to South-Western Ethopia in North Eastern Africa. This has spread to Yemen in 14th century. From Yemen *Coffea arabica* spread to Malabar Coast of India and then to Srilanka. It was introduced to Arabia 500 years ago. Mainly there are three types of Coffee species they *C. arabica* (Arabian Coffee); *C. robusta* (Congo Coffee); *C. liberica* (Liberian Coffee). Coffee to India was brought by Baba Budan a muslim pilgrim on his return from Mecca. It was planted in Chandragiri Hills near Chickmanglur Karnataka later it was named as Baba Budan Giri. The Indian Coffee Board was set up in 1942 at Bangalore. Today Coffee is grown mainly in three states like Karnataka, Tamilnadu, and Kerala. The states which are growing Coffee under experimental basis are Andhra Pradesh, Assam, Orissa, Madhya Pradesh, Andamans, Maharashtra etc.

Botanical name

The botanical name of Coffee is *Coffea arabica*.

Family

Coffea arabica belongs to family *Rubiaceae*

Vernacular names

English - Coffee
All other Indian languages also - Coffee

Morphological of useful part

The coffee seeds are useful part. These seeds are present in the fruit. The seeds are covered with a thin membrane, which is called silver skin. These are enclosed in a dry husk like part. Coffee berries have fleshy mesocarp, thin endocarp. The leaves and fruits consists of an alkaloid called caffein. The green seed contains 34% cellulose, 8% chlorogenic acid, 10 to 13% oil, 7% sugar, 14% protein, 12% water etc.

Economic uses

1) It consists of a stimulative alkaloid called caffein.
2) It relieves fatigue and stimulates the physical and mental activities.
3) In Sumatra Coffee leaves are used like tea leaves to prepare beverage.
4) It is of medicinal value. It is used for curing digestive disorders, blood pressure.
5) The waste products like pulp is used as a fertilizer and fuel.
6) They are also used in making plastic material etc.
7) The wood of coffee tree is hard and it is used to make wooden boxes.
8) Branches of coffee tree are used as walking sticks and hammer handles.

14.3.3 TEA

General Characters

Tea a beverage prepared with dried leaves of Tea plant. It is most popular on alcoholic drink. It any stranger or any relative or a friend comes to our home we will first offer them a cup of Tea, this is the importance of tea in our daily life. Tea plant is a low growing evergreen shrubby bush. The leaves are simple, alternate, leathery and lanceolate. The plants bear white or pink flowers which produce sweet fragrance. The number sepals ranges from 5 to 7, petals ranges from 5-7, stamens are numerous, ovary superior. The plant is in nature self-sterile. Fruit is capsule. The plant is grown from seed. During July to October the tree blossom and tea flowers appear. The seeds ripens with in one year. The seed is about the size of marble. The periodic appearance of new leaves is called "flush". Like this the flushes are plucked 4 to 5 times in each season. These plucked leaves are used in processing of Tea. It grows well warm temperature with plenty of rainfall.

Origin

Tea is the native of China. But some people says that Tea is the native of India. Tea is found in a wild state in these areas. Tea is believed to have spread from lower Tibetan mountains. From there it spreaded to three directions namely China, Assam and Cambodia. Tea was carried to Japan in 1000A.D. The Dutch people introduced Tea to Europe in 1610A.D. It reached London in 1664. The chief Tea growing regions are China, Japan, Taiwan, Java, Sumatra, Bangladesh, India and Srilanka. In India tea is cultivated in Assam, Kerala and Nilgiri hills. Some other Tea growing area are Ranchi, Dehrudun, Kangra Districts. Tea consists of 82 species all over the world. But only 4 types of tea are in use they are (1) Small leaved Chinese shrub (2) Large leaved Assam Tea (3) Combodia type (4) Wilson's camellia. Generally Tea is grown in higher attitudes. It can be successfully grown on flat plains provided the soil is well drained. The soil type usually ranges from the light sandy to stiff clayey type soil. Tea Research Institute is locate at West Bengal (Docars).

Botanical name: The botanical name of Tea is *Camellia Sinensis*.

Botanical names of 4 important types of Tea are given below.

1) Chinese Tea - Camellia sinensis
2) Assam Tea - Camellia assamica
3) Combodia Tea - Camellia lasiocalyx
4) Wilson's Tea - Camellia irrawadiensis

Family: Camellia sinensis belongs to the family *Theaceae*.

Vernacular names

English – Tea; Hindi, Bengali, Marathi – Chai; Tamil – Thaeyilai; Telugu – Theyaku.

Morphology of useful part

Leaves are economically useful parts of the plants. The leaves are alternate, elliptical glabrous. The young leaves are mostly used in preparing tea powder. These leaves consists of mainly numerous oil glands. Old leaves are bright green in colour.

Economic uses of Tea

1) Tea consists of an alkaloid called *Theine*.
2) It also contains volatile oils, tannin etc.
3) It dissolves quickly in hot water and acts as a stimulating beverage.
4) It relieves the body fatigue.
5) Excess tea drinking is considered to be harmful for the digestive system.
6) Generally Tea is prepared in 4 varieties they are Black Tea, Green Tea, Oolong Tea, Brick Tea.

14.3.4 SHORT ANSWER QUESTIONS

1) Write the botanical name, family and economic uses of Coffee.
2) Write the botanical name, family, morphology of useful part and economic uses of Tea.
3) Write a short notes on Coffee.
4) Write a short notes on Tea.

14.3.5 REFERENCE BOOKS

1) Economic botany - A.V.S.S. Sambamurthy.
2) A text book of economic botany - V. Verma.
3) Economic botany - Bendre, Kumar.

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P. SHIVANI

Unit-III

14.4 RUBBER

OBJECTIVES

To study about Rubber and Rubber yielding plants.

STRUCTURE

14.4.1 INTRODUCTION

The name rubber as being used today owes its use to Joseph Priestly, the discoverer of Oxygen. He also noted that rubber erases pencil marks. In 1839 Charles Good year an American accidentally stumbled to discover vulcanised rubber that means sulphur treated raw rubber. Rubber is elastic, flexible, air tight, water proof, long lasting and a good insulator of heat and electricity. Chemically it is made up of macro molecules. Naturally rubber is soft and translucent at 20^oC. At a temperatures from 0^o-10^oC it is hard. Rubber is insoluble in water but dissolves in ether, chloroform, carbon disulphide benzene, naptha etc. Latex rubber contains 92-94 per cent rubber hydro carbon, 3 per cent resin, 2 per cent proteins and 0.2 per cent ash. Rubber hydrocarbon is colourless, odourless, transparent, elastic. Rubber is obtained from several plants like

Herea rubber	- *Hevea brasiliensis*
Castilla rubber	- *Castilla elastica*
Ceara rubber	- *Manihot glaziovii*
Indian rubber	- *Ficus elastica*
Landolphia rubber	- *Landolphia kirkii*
Palay rubber	- *Cryptostegia grandiflora*
Dandelion rubber	- *Taraxacum kok saghza*
Guayole rubber	- *Parthenium argentatum*

The plantations require a well distributed rainfall of 180 cms per annum, a temperature of 75^o to 95^oF, high atmospheric humidity and a well drained loamy soil. It grows from sea level to an altitude of 1,000 feet. Latex is produced in special cells called latex tubes and latex vessels. A latex tube is a single cell which grows and branches in a coenocytic manner like a fungal hypha. A latex vessel is formed by the break down of the transverse walls of special cells produced by the meristemalic cells of a plant. Latex exuding from the cut surface of a stem, leaf or root seal off a wound. Latex consists of various acids, mineral salts, sugar, proteins, enzymes, alkaloids, resins, gums and oil etc.

General Characters

The most important source of rubber is Hevea rubber or para rubber. The plant grows upto a height of 60 to 150 feet. The tree trunk grows to a thickness of six feet. The tree bears compound leaves of three leaflets. The flowers are small and are borne in inflorescences. The fruits are three lobed with each to be bearing one seed. The seeds contain about 50% of a dark red drying oil. The plant grows well within a temperature of 75 to 90^oF. It requires a rainfall of 80 to 120 inches. About 99% of the natural rubber produced in the world comes from *Hevea brasiliensis*. There are about 10 species of Hevea. In 1963 at Bareilly in Uttar Pradesh had produced 75,000 tones of synthetic rubber saving Rs. 22 Crores of foreign exchange. India put only about 1% of total world out put of rubber. It is produced on commercial scale in Kerala, Tamilnadu, Karnataka, Assam, Andaman and West Bengal.

Another important rubber producing plant is *Ficus elastica*, it is commonly called Indian rubber (or) Assam rubber. It is most important rubber tree of India. Since 1874 the plantations were grown in Assam and on much smaller scale in Karnataka and Tamilnadu. Some other types of Rubber are Panama rubber, Ceara rubber, Palay rubber etc. Latex is obtained by, when the tree is tapped at the level of three feet above the ground level by cutting several short and down ward incisions in the bark with a special knife. The tappings are generally made in the mornings because latex flows more easily before the temperature begins to rise. To collect this latex cups are placed below incisions. In this way latex is collected.

Origin

Rubber is indigenous to South America. Spanish settlers in 1600 used latex for smearing shoes, clothes and hats etc. La condamine reported here (or) jeve to be the native name for rubber in the Andean region. Hevea is native to South America (Amazon valley). It grows wild in the hot damp forests. It grows wild in eastern Peru, Bolivia, Colombia, Brazil etc. It has been introduced to Liberia, Srilanka, Malaysia, Indonesia. The rubber seeds came to India from England. Mr. H. Markham of India office forwarded para rubber seeds to Kew. Botanic Garden in England from Amazon river region of Brazil. These were germinated at Kew and the young plants taken out by Dr. George King then these are forwarded to Calcutta Botanic Garden. The first plantations appeared in 1902 from Periar valley. Rubber in India is cultivated in Kerala where 94% of the total India's out put is produced. It is followed by Tamilnadu, where it is cultivated in Coimbatore, Salem, Nilgiris and Kanya Kumari. Karnataka too has rubber plantations in Coorg. Other states cultivating rubber are Assam, Andaman and West Bengal.

Botanical name

The Botanical name of Hevea rubber is *Hevea brasiliensis*. Where as common Indian rubber botanical names is *Ficus elastica*.

Family: *Hevea brasiliensis* belongs to family **Euphorbiaceae**

Indian Rubber *Ficus elastica* belongs to family **Moraceae**

Morphology of useful part

The economically useful part of rubber is Latex. Latex is a white or yellow viscous fluid like substance. It is produced in special cells namely Latex tubes and Latex vessels. It is composed of various acids, mineral salts, sugar, starch, proteins, enzymes, alkaloids, resins, gums, and oil etc.

Economic uses

1) Three fourth of crude rubber is used for manufacturing tires and tubes of automobiles, aeroplanes, bicycles etc.
2) It is extensively used in manufacture of boots, shoes, tubes, mats, belting, rain coats etc.
3) It its also used in preparing water proof materials, toys, insulated wire etc.
4) It is vulcanized with 30% sulphur to produce hard rubber. Vulcanization = Charles Goodyear discovered that when rubber is heated with Sulphur this is know as vulcanization. Present day vulcanization includes selenium, organic peroxides, nitro peroxides. Due to vulcanization Rubber increases elasticity, strength, resistance etc.
5) Rubber is used in preparing gloves, rollers, gaskets etc.
6) It is also used in preparation of surgical appliances, telephone and radio parts.
7) At present it is used in extending road construction.
8) Rubber is used in making pillows.
9) It is also used in making surgical gloves, prosthetic devices.
10) It is used in making adhesives, paints, baby nipples, combs, enamels etc.
11) It is used in plumbing fixtures, cleaning equipment.
12) It is used in preparing heating pads, electric blankets.
13) It is also used in preparing flexible baskets tubes, cups, tea wagons, garbage, trash cans etc.
14) It is also used in making bathing caps, baby pants, hospital sheets, crib sheets, aprons, catheters etc.
15) It is used in preparing hard rubber fittings for douches and enemas.
16) Rubber is used in making foot balls, basket balls, golf balls, tennis balls etc.
17) Rubber is used n manufacturing swimming accessories like breathing tubes, masks etc.
18) Sponge (or) foam rubber is used in motor cars and furniture.
19) It is also used in making photographic adhesives rubber bands, erasers, gaskets etc.
20) It is used in farm transportation vehicles, power belting, sprayers equipment etc.

14.4.3 SHORT ANSWER QUESTIONS

1. Write the botanical name, Family of Rubber.
2. Write the structure morphologically useful part of Rubber.
3. Write the economic uses of Rubber.

14.4.4 REFERENCE BOOKS

1. A text book of Economic Botany – A.V.S.S. Sambamurthi (Wiley Eastern Limited)
2. A Text Book of Economic Botany – V. Verma, Emkay Publications.
3. Economic Botany – Bendre & Kumar, Rastogi Publications, Meerut.

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P. SHIVANI

Unit-IV

Lesson 15

PALYNOLOGY

CONTENTS

15.1 OBJECTIVE

The main aim of this lesson is know the structure, morphological features of pollen grains. Diagnostic features of pollen grains belongs some different taxa are also discussed in this lesson.

15.2 INTRODUCTION

The study of external morphological features of mature pollen grains is referred to as Palynology. The term palynology was coined by Hyde and Williams (1944) for the study of pollen and spores. It is derived from the Greek verb 'Palynein', 'meaning to scatter', since the pollen grains and spores often spread by wind, and 'logos' means to study.

15.3 HISTORY

The history of palynology is strongly associated with the development of microscope. By means of simple microscopes, Grew (1682) and Malpighi (1687) managed to depict pollen grains. In the 19^{th} century, Von Mohl, Fritschc and Fischer contributed greatly to pollen morphology. Von Mohl (1834) classified the pollen of more than 200 families with reference to the number of wall layers, type and geometrical arrangement of apertures. Fritsche (1837) introduced the terms exine and intine, still indispensable terms in pollen morphology. Fischer (1890) classified pollen of not less than 2000 species. In 20^{th} century, the works of Wodehouse (1965) and Erdtman (1963) are well known.

Indian scientists like Banerjee, Sayeeduddin, Nair, Ramnathan etc., studied pollen grains of several plants. The chief research centres of palynology in India are National Botanical Research Institute (Lucknow). Birbal Sahni Institute of Palaeobotany (Lucknow), Osmania University (Hyderabad) and Bose Institute (Calcutta). Several important contributions have been made in the field of palynology and it becomes an important discipline of fundamental and applied interests.

15.4 SCOPE OF PALYNOLOGY

Various palynological studies have been delimited under two main divisions. They are:

(1) **Basic Palynology:** It deals with the study of pollen and spore morphology, theoretical aspects of applied palynology output, dissemination and resistance of decay etc., of pollen grains and spores.

(2) **Applied Palynology:** Applied palynology can be classified further into -

- **(a) Geopalynology (Palaeopalynology):** It is the study of fossil pollen grains and spores.
- **(b) Palynotaxonomy:** It comprises pollen morphology as an aid to systematics.
- (c) **Meliltopalynology:** The study of pollen grains with regard to honey.
- (d) **Iatropalynology:** The study of pollen grains with regard to allergy.

(e) **Pharmacopalynology:** The study of rapentic properties of pollen grains that is given in drugs and tablets etc.

(f) **Aeropalynology:** The study with regard to atmospheric pollen grains and spores. It has basic importance in the study of allergies and related problems.

(g) **Forensic palynology:** The study of pollen with regard to criminology.

15.5 POLLEN MORPHOLOGY

On the basis of pollen morphology, angiosperms are distinguished into two groups.

(a) Stenopalynous: Pollen grains are similar or may show only slight variation in all the taxa of a family. E.g. Compositae, Gramineae, Meliaceae

(b) Eurypalynous: Pollen produced by different taxa differ greatly in their morphology within a family. E.g. Cruciferae, Leguminosae.

Pollen grains are formed as tetrads. They are the male reproductive cells. Each pollen grain has two layered wall surrounding the cytoplasm. The outer layer is called exine and the inner layer is called intine. The exine is usually broken though one or more openings called apertures.

The size, shape, symmetry and exine ornamentation are characteristic for the species, genus and family.

15.5.1 Size

The size of pollen grains varies from nearly 10 µm to 200 µm (Cucurbitaceae).

15.5.2 Shape

The shape of pollen grains may be spherical, peroblate, prolate or perprolate. The shape of pollen grain is described basing on the value of P/E x 100. Where P = Polar axis, E = Equatorial axis.

P/E x 100 value	Shape of pollen grain
Less than 50	Peroblate
50-75	Oblate
75-88	Suboblate
88-100	Oblate spheroidal
75-133	Subspheroidal
100-114	Prolate spheroidal
114-133	Subprolate
133-200	Prolate
More than 200	Perprolate

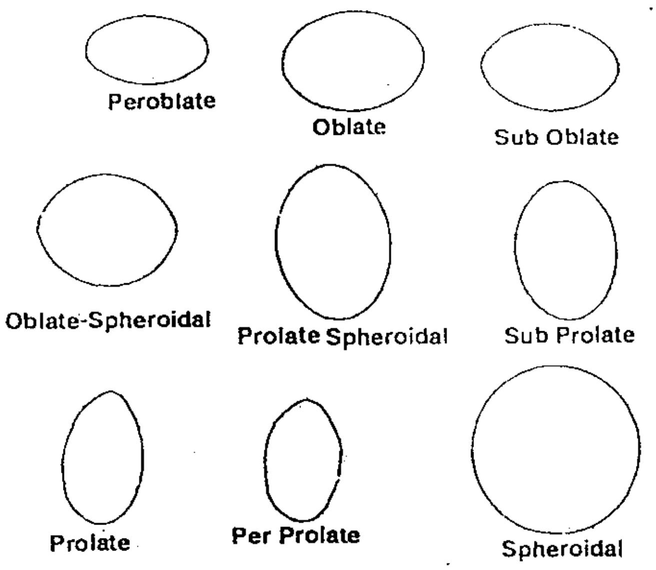

Fig. 15.1 Shape of pollen grains

15.5.3 Symmetry

Polar axis is the line drawn from the centre of the tetrad to the centre of the outer face of the individual pollen grain.

The pollen may possess radial symmetry or bilateral symmetry. In radial symmetry, both the vertical planes are equilong while in isobilateral one, the equatorial axes are not equilong. The pollen may symmetrical or asymmetrical.

15.5.4 Polarity

Pollen grains are generally formed in tetrads from their mother cells. The individual pollen grins are usually spheroidal. Each pollen grain has two poles along the polar axis – the proximal pole and the distal pole. The proximal pole is at the centre of the proximal face i.e., towards the centre of the tetrad whereas the distal pole is at the centre of the distal face i.e., away from the centre of the tetrad.

The pollen grains are said to be isopolar, if both the faces are similar and heteropolar, if the two faces are different. In heteropolar grains one face has an aperture while the other has none. Some spores do not show distinguished polar regions. They are called apolar.

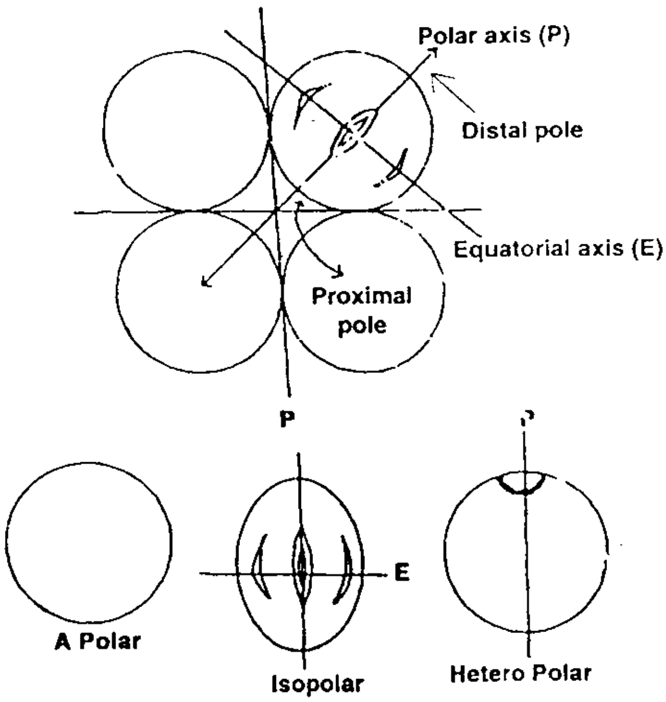

Fig. 15.2 Polarity of Pollen grains

15.5.5 Apertures

An aperture is a thin area in the pollen surface which is directly or indirectly associated with its germination. The apertures may be long or short. Long apertures are called colpus and short ones are called pores (pore). An elongated aperture which has the same shape as a colpus, but differs in orientation is called sulcus. Sulci are essentially latitudinal apertures whereas colpi are essentially longitudinal apertures.

The apertures may be simple or compound. Pollen grains with simple apertures are either colpate (with colpi) or porate (with pores). A compound aperture consists of a colpus and a pore. Such pollen are said to be colporate. In some pollen, the compound aperture has an outer pore and an inner pore and they are said to be pororate

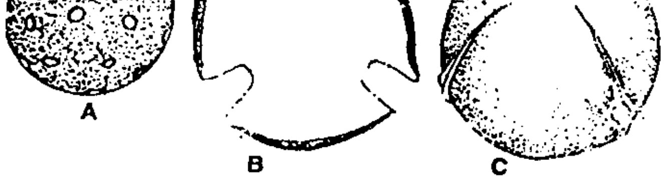

Fig. 15.3 Kinds of apertures

The number of apertures vary from one to many. In monocotyledons, one aperture is present at the distal end and dicotyledons, usually three apertures are present. The position of apertures also vary in different groups of plant kingdom as follows:

(a) Bryophytes - aperture is in proximal end
(b) Ferns - proximal
(c) Gymnosperms - Distal, Equatorial or scattered over the surface

15.5.6 NPC system

Erdtman (1961) and Turril (1964) have recognised a system of pollen classification based on the number (N), position (P), and character (C) of apertures. This is known as NPC system of spore classification. In this system, the term 'treme' is used instead of aperture for describing the pollen.

(a) Number: The pollen grains are described by various terms basing on the number of apertures. They are:

N_0 – Atreme spores - without apertures
N_1 – Monotreme spores - one aperture
N_2 – Ditreme spores – two apertures
N_3 – Tritreme spores – Three apertures
N_4 – Tetratreme spores – Four apertures
N_5 – Pentatreme spores – Five apertures
N_6 – Hexatreme spores – Six apertures
N_7 – Polytreme spores – Seven or more than seven apertures

(B) Position: The pollen grains are described by various terms according to the position of apertures.

P_0 – Spores with unknown position of apertures
P_1 – Catatrame spores – one aperture at proximal pole
P_2 – Anacatatreme spores – Spore two apertures, one at the distal pole and the other at the poximal pole.
P_3 – Anatreme spores – One aperture at distal pole
P_4 – Zonotreme spores – Apertures arranged at the equatorial plane
P_5 – Dizonotreme spores – Apertures in two rows, one on either side of the equator
P_6 – Pantotreme spores – Spores with many apertures which are uniformly distributed all over the surface.

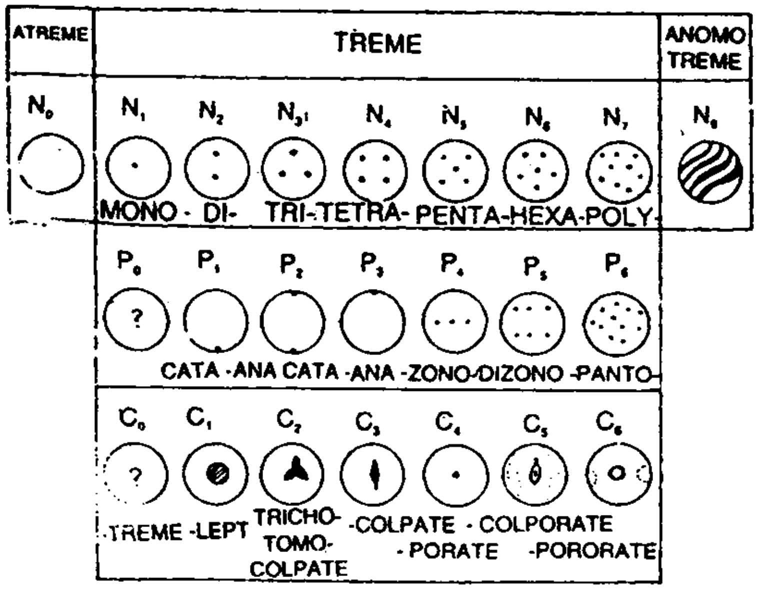

Fig. 15.4 The NPC – system Diagram showing Number (N), Position (P) and Character (C) of apertures (Erdtman, 1969)

(c) Character (C): Based on the characters of the apertures, the pollen grains are described by various terms:

C_0 – Nature of aperture not known
C_1 – Aperture is a thin area or leptoma
C_2 – Aperture has a 3-slit colpus and the pollen are described as trichotomocolpate
C_3 – Apertures are colpate
C_4 – Apertures are porate
C_5 – Apertures are colporate
C_6 – Apertures are pororate

An analysis based on number position character helps in classification of broadly spread dicotyledons and also in the preparation of diagnostic keys below family level.

15.5.7 Pollen Wall (or) Sporoderm

The stratified wall of mature pollen grain is called sporoderm. The term sporoderm is of Latin origin – meaning spore skin and was coined by Erdtman (1972) but was suggested by Leitbeg. Sporoderm is made up of two layers called exine and intine.

Exine: Exine is the outer wall and made up of sporopollenin. Sporopollenin is highly resistant to strong acids and strong adverse environmental conditions. Exine is distinguishable into two layers. An outer sculptured layer called sexine and an inner non-sculptured layer the nexine.

15.5.7.1 Nexine

The nexine is the inner layer of exine. This layer is trilaminar and each is designated as N_1, N_2 and N_3. N_1 is the foot layer and is chemically similar to sexine. Sometimes N_1 is known as ectonexine, N_2 as medinexine and N_3 as endonexine. The chemical nature of N_3 is almost similar to intine. However, they can be differentiated by the arrangement of sporopollenia fibres. The fibrils are arranged in parallel fashion in N_1 at tangential manner in N_2 and at random in N_3.

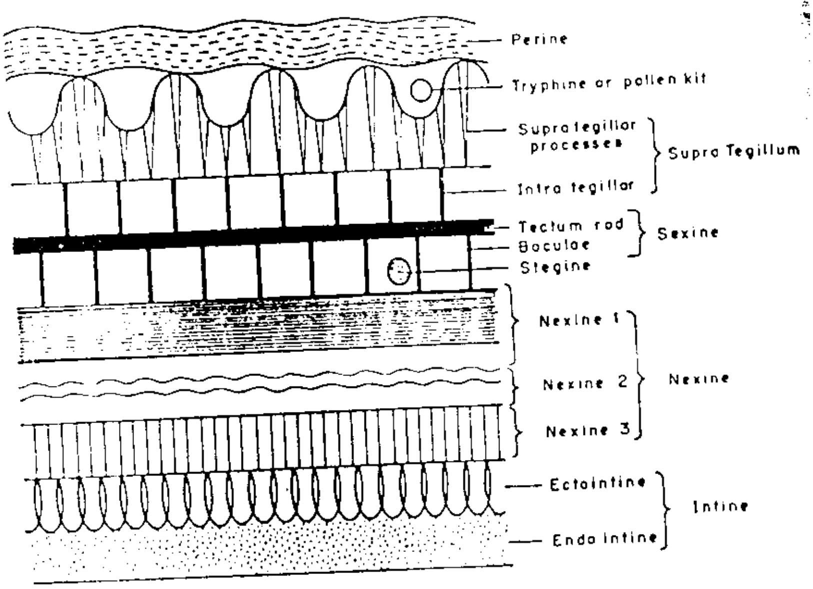

Fig. 15.5 Structure of sporoderm

15.5.7.2 Sexine

The sexine is the outer layer of exine. It is attached to the nexine with the help of rod like structures called baculae (singular-baculum). The baculae may be united above to form a roof like layer called tectum or may remain free. Structrurally the sexine is of four basic types, viz.

1. Tectate : In this type, the tectum is continuous roof like layer.
2. Semi-tectate: The tectum is discontinuous and perforated
3. Atectate : The tectum is absent and baculae are free and exposed.
4. Supratectate: Tectate condition is repeated twice. The new or second tectum is known as supretegillum and its basic structure is similar to sexine.

15.5.7.3 Intine

The intine is the inner most layer of pollen wall. It is usually thin and smooth, but is thick at the pores. It is made up of cellulose and pectin. It is bilaminar in nature, differentiated into ecto-intine and endointine. During pollen germination, the intine forms a pollen tube.

15.5.7.4 Special or Additional layers

The outer surface of mature pollen of insect pollinated (sen to mophilous) plants is coated by an oily layer rich in lipids, carotenoids and is known as pollen kitt. Carotinoids give colour whereas lipids give sticky nature to the pollen. The function of this pollen kitt is to attract insect and as an adherent to the body and protects against radiation. This pollen kitt is also known as Tryphine. In pteridophytes and gymnosperms, there is another layer called perine, present outside the pollen kit.

15.5.7.5 Ornamentations in Sporoderm

Sculpturing patterns of exine: Any structure over and above sexine is called sculpture or ornamentation. The exposed surface of the sporoderm shows ornamentation or sculpturing pattern. Some important types are – psilate (smooth), perforate (having small transparent dots like holes), foveolate (pitted), tuberculate (tubercle like), tossulate (grooved), scabrate (very fine projections), granulate (small particles), verrucate (warty), clavate (club shaped), baculate (rod like elements), pilate (rod-like elements with swollentips), gemmate (sessile pilar), echinate (spiny), rugulate (elongate elements irregularly distributed tangentially over the surface), punctate (minute perforations), reticulate (elements forming an open network), striate (elongate none or less parallel elements distributed tangentially over the surfaces).

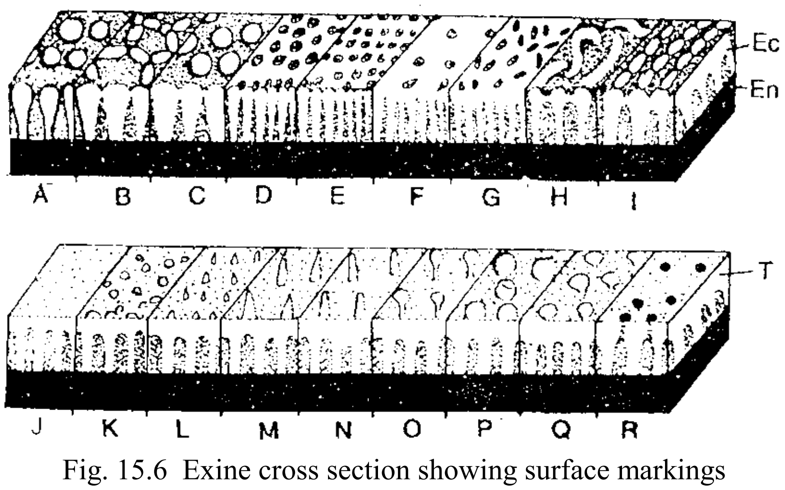

Fig. 15.6 Exine cross section showing surface markings
(a) Pilate, (b) Retipilate, (c) Arcolate, (d) Retianlate, (e) Foveolate, (f) Scrobiculate, (g)Fossulate, (h) Rugulate, (I) Striate, (ju) Psilate, (k) granulose, (l) Spinuloe, (m) spinose, (n) Baculate, (o) Clavate, (p) Verrucate, (q) Gemmate ® Punetate, (EC) Eoine, (En) Endine, (t) Tegillum.

15.6 POLLEN GRAINS OF SOME GENERA

15.6.1 Pollen grains of Hibiscus

1. Pollen grains radially symmetrical, spheroidal (70-120 μm in diameter), isopolar (proximal and distal faces of the exine are similar).

2. Pollen are pantoporate (five apertures) pores circular and arranged in 'S' (sigmoid) shaped manner.

3. Pore diameter 4-7 μm and interpolar distance is 20 μm.

4. Exine tectate, sexine thicker than nexine, baculae prominent.

5. Surface robust (very strong) and prominent with spines. Base of spines not bulbous, tip blunt, spines length 18 μm, inter spined area granulate.

6. Columellae at the base of spine and inbetween the spines are of the same size.

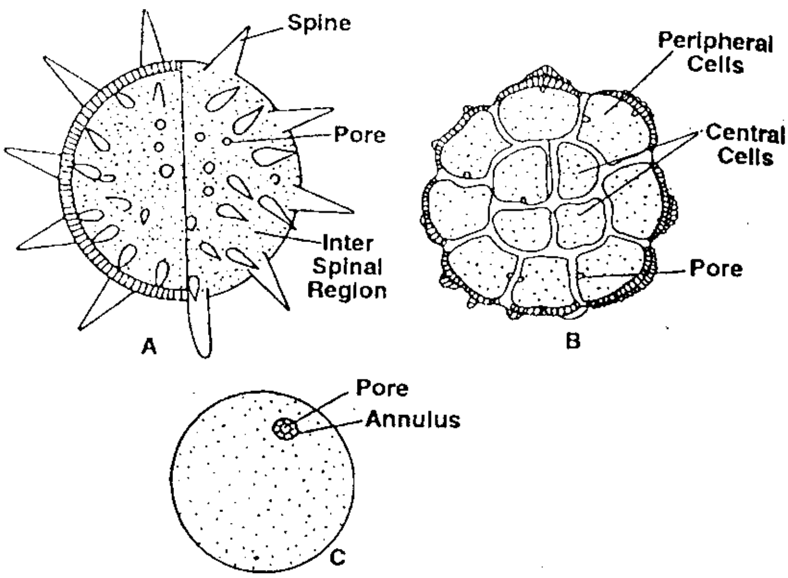

Fig. 15.7 Pollen morphology
(A) Hibiscus, (b) Acacia, (C) Grass

15.6.2 Pollen grains of Acacia sp. (Minosae)

1. Pollen grains radially symmetrical, arrange in polyads.

2. Polyad spheroidal to subspheroidal, 35-45 μm in diameter and 16-celled.
3. In polyad 8 grains centrally placed, 4 and 4 in two superimposed groups of four grains each.
4. Polar view of individual grain squarish, 12-15 μm in diameter.
5. Exine tectate, sexine as thick as nexine, baculate, trae, surface granular to fainted reticulata.

15.6.3 Pollen grains of Grass (Poaceae)

1. Pollen grains are radially symmerical, spheroidal, 40-105 μm in diameter, heteropolar.
2. Pollen grains are monoporate, pore circular (4 μm diameter), pore with prominent annulus.
3. Exine tectate, sexine as thick as nemine, nexine thickened at pores, surface psilate or faintly granular.

15.7 SUMMARY

The study of pollen grain structure and their morphological features is called as palynology. The size, shape, symmetry, polarity, apertures are some of the important morphological features of pollen grains. The classification proposed based on the number, position and character of pollen apertures (NPC system) plays an important role in classifying the plants. The wall of pollen grain is called sporoderm. Sporoderm consists of two layers – outer exine and inner intine. Intine is thin and made of cellulose. Exine is thick and made of sporopollenin. Exine is two layered outer sexine and inner nexine. In entemophilous plants the pollen grains have an additional layer called pollen kit. It consists of oils, lipids, carotenoids. The upper surface of exine shows ornamentations. They play form characteristic features to different taxa.

15.8 TECHNICAL TERMS

Palynology, geometrical, polar axis, equatorial axis, radial symmetry, bilateral symmetry, paroximal poles distal pole, porus, co;pus, pororate, colporate, treme, sporoderm, baculum, tectate, suprateigellum, pollen kit.

15.9 MODEL QUESTIONS

15.9.1 Essay Type Questions

1. Write an essay on palymology.
2. Describe the morphological features of pollen grains.

15.9.2 Short Answer Questions

1. Apertures
2. NPC system
3. Sporoderm
4. Pollen grains of Hibiscus
5. Pollen grains of Acacia
6. Pollen grains of Grass

15.10 REFERENCE BOOKS

1. **The Embryology of Angiosperms** – S.S. Bhojwani and S.P. Bhatnagar.
2. **Unified Course in Botany -** Khan and Khanum.

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S.V. PADMAJA

EMBRYOLOGY Unit-IV

Lesson 16

MICROSPOROGENESIS

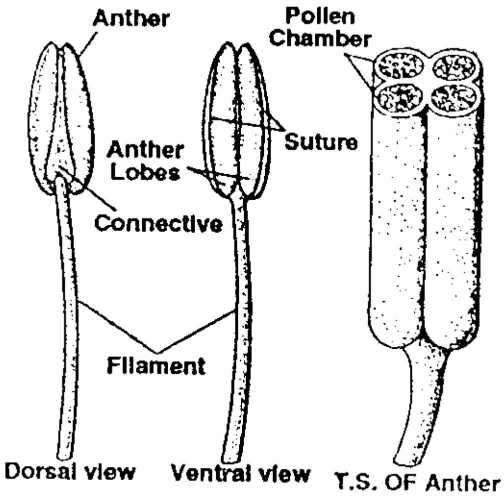
CONTENTS

16.1 OBJECTIVE

The main aim of this lesson is to know the development and structure of anther, formation of pollen grains, structure of pollen grain and development of male gametophyte.

16.2 INTRODUCTION

In angiospermic flower stamens are the male reproductive structures which may be arranged in one or more whorls. Each stamen consists of an elongated stalk, the filament and a fertile spore producing structure called anther at its end. In majority of angiosperms, the anthers are dithecous or bilobed. The two lobes are connected by a column of sterile tissue called the connective. Each lobe has two microsporangia or pollensacs separated by a strip of sterile tissue. Thus a typical anther is



tetrasporangiate. In Malvaceae, each anther has only one microsporangium (Monothecous).

Fig. 16.1 Structure of Stamen

16.3 MICROSPORANGIUM

Each anther lobe consists of two sacs, the microsporangia or pollen sacs. Microspores which constitute the male gametes are formed within the microsporangium. At maturity the two sporangia in a lobe become joined due to the breakdown of the partition between them. Thus mature dithecous anther shows only two sporangia. In a monothecous anther, there are two sporangia which finally fuse to form one sporangium.

A mature microsporangium consists of sporogenous tissue which is surrounded by a anther wall. The anther wall is distinguished in to epidermis, endothecium, wall layers and tapetum. The cells of primary sporogenous tissue either directly or after a few mitoses, act as microspore mother cells. Each microspore mother cell, by meiotic division gives rise to four haploid microspores or pollen grains.

16.4 DEVELOPMENT OF MICROSPORANGIUM

The development of microspangium is of ensporangiate type. A very young anther comprises a homogenous mass of meristematic cells, surrounded by an epidermis. During its development the anther assumes a four lobed appearance. In each lobe, a few hypodermal cells become differentiated by their large size, slight radial elongation, dense cytoplasm and conspicuous nuclei. These cells form the archesporium. Generally the archesporium consists of many vertical rows of cells and in transverse section of the anther it appears as a plate of cells. Rarely it is formed of a single vertical row of cells so that only a single archesporial cell can be seen in a cross-section of the anther. e.g: Asteraceae.

The archesporial cells divide periclinally giving rise to primary parietal cells toward the epidermis and primary sporogenous cells toward the inner side. The cells of the parietal layer divide further by periclinal and anticlinal divisions, giving rise to 2-5 concentric layers of anther wall. The primary sporogenous cells either directly or after a few mitoses, function as microspore mother cells.

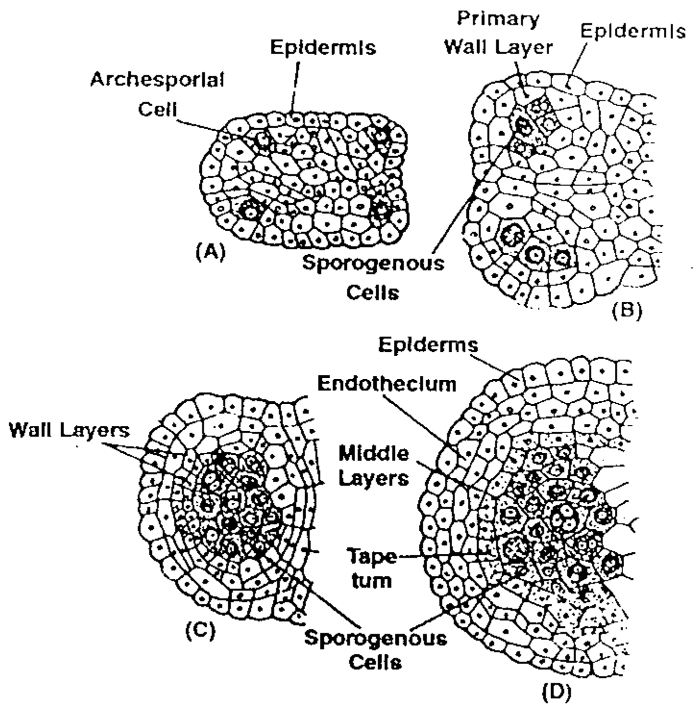


Fig. 16.2 Development of microsporangium in the Anther.

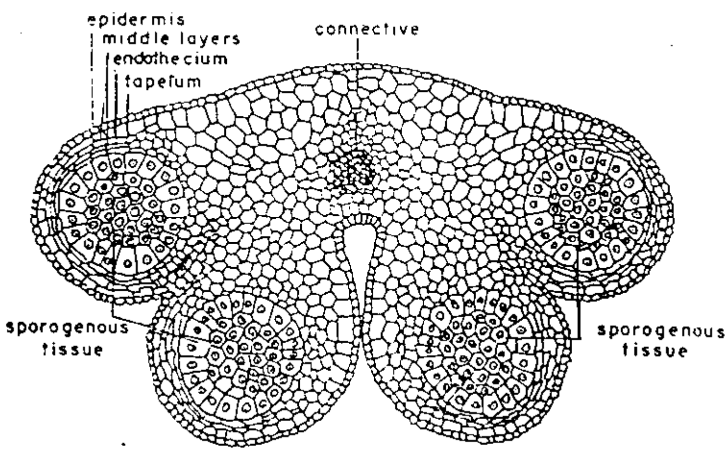


Fig. 16.3 T.S. of tetrasporangiate anther showing its various tissues.

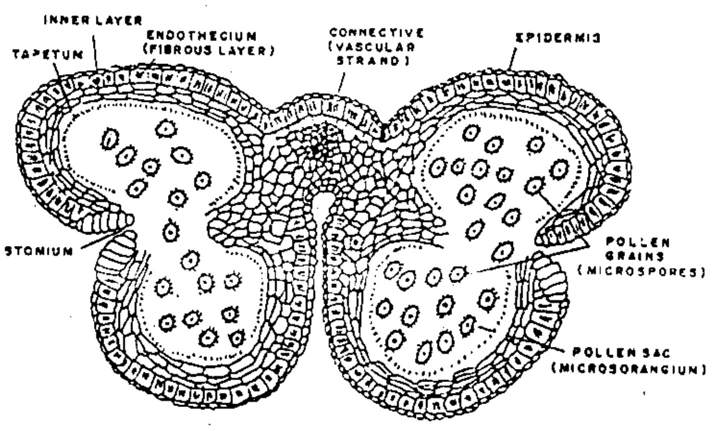


Fig. 16.4 T.S. of mature Anther

Young Anther

- Epidermis
  - Epidermis
- Archesporium
  - Primary parietal cells
    - Endothecium
    - Middle layers
    - Tapetum
  - Primary sporogenous cells
    - Microspore mother cells
      - Microspores

16.5 ANTHER WALL

The mature anther wall consists of an epidermis, a layer of endothecium, 2 or 3 middle layers and a single layer tapetum.

16.5.1 Epidermis

The outermost layer of cells in the anther wall constitute the epidermis. In a mature anther the epidermal cells are greatly stretched and flattened. The epidermis performs its usual protective function.

16.5.2 Endothecium

The endothecium originates from the parietal layer and it lies below the epidermis. Generally the endothecium is single layered, but in some plants it may become multi layered. The cells of this layer are radially elongated. This layer attains its maximum development when anther is ready to dehisce for the discharge of pollen. Cells of endothecium develop fibrous bands which arise from the inner tangential walls and run both upward and downward. The thickenings are composed of cellulose and are slightly lignified at maturity. These fibrous thickenings do not develop in the region of stomium. The presence of fibrous bands, differential expansion of the outer and inner tangential walls and the hygroscopic nature of the endothecial cells help in the dehiscence of anthers at maturity. In some cleistogamous flowers and in some members of Hydrocharitaceae the fibrous bands are altogether absent.

16.5.3 Middle layers

The cells of 2-3 layers below the endothecium constitute middle layers. The middle layers are ephemeral and become flattened and crushed during meiosis in the pollen mother cells. In many plants, the cells of the middle layers store food materials which get mobilized during later development of pollen.

16.5.4 Tapetum

Tapetum is the innermost layer of anther wall. It completely surrounds the sporogenous tissue and attains its maximum development at the tetrad stage of microsporogenesis. It is of considerable physiological significance because all the food material to the sporogenous tissue must pass through it. The tapetum is usually derived from the primary parietal layer. However, in some species, it is derived partly from parietal layer and partly from connective tissue. In a few species, the tapetal cells of different origin may also be different morphologically (dimorphic tapetum). Eg: Alectra thomsoni. Typically tapetum is composed of a single layer of cells. Sometimes tapetum is more than one layered. Eg: Nicotiana The tapetal cells are large in size with dense cytoplasm and prominent nuclei. Maheswari distinguished two types of tapetum on its behaviour.

(1) Amoeboid or periplasmodial tapetum
(2) Secretory or glandular tapetum

(1) Amoeboid tapetum

In this type the inner and radial walls of tapetal cells breakdown very early and their protoplast masses move into the anther cavity. The protoplast masses fuse together to form tapetal plasmodium. This type of tapetum is common in Alisma, Butomus, Tradescantia, Typha, Helianthus etc.

(2) Secretory tapetum

In this type of tapetum, the tapetal cells remain in their original position throughout the microspore development. They secrete their substances from their inner faces. Later on they disintegrate and their contents are absorbed by the developing microspores. This type of tapetum is more common among angiosperms.

Functions of tapetum

Tapetum plays a significant role in the development of pollen. Some of the important functions are:

1) It transports the nutrients to the sporocytes, present inside the anther locule.
2) It plays an important role in pollen wall formation. It contributes to sporopollenin of the exine through ubisch bodies.

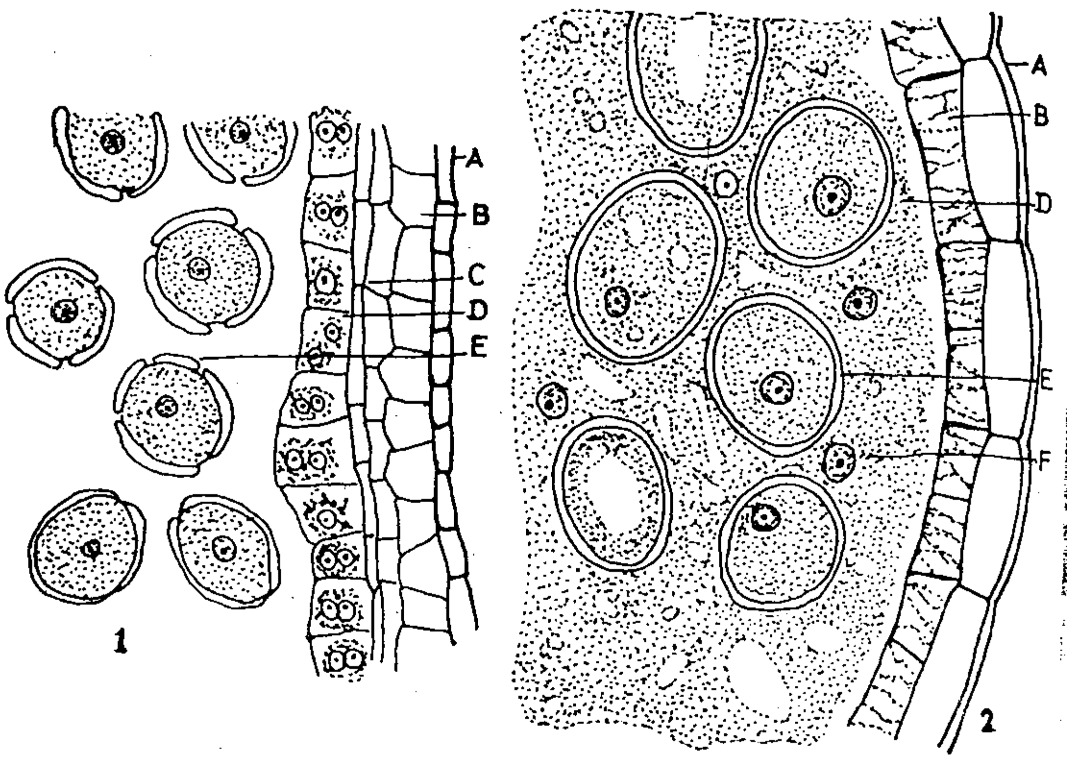


Fig. 16.5 Tapetum

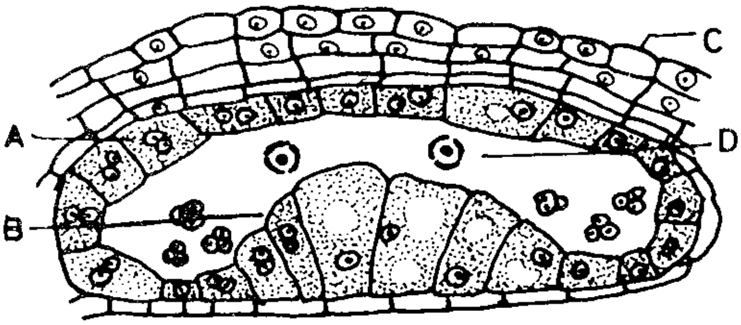


Fig. 16.6 Dimorphic tapetum

16.6 MICROSPOROGENESIS

The process of development of microspores (pollen grains) from microspore mother cell is termed as microsporogenesis.

The sporogenous cells may directly or after a few mitoses function as microspore mother cells, or pollen mother cells (MMC or PMC). Each microspore mother cell, by meiotic division gives rise to a group of four haploid microspores. The aggregate of four microspores are referred to as microspore tetrads. Based on the manner of wall formation during cytokinesis the pollen grains are formed in two ways.

1) Successive type

In this type, a wall is formed between two daughter nuclei immediately after the first meiotic division. The two daughter cells under go second meiotic division and walls are again formed resulting in a tetrad. The wall formation in this type is centrifugal. A cell plate is formed in the centre and extends laterally. This type is more common in monocots.

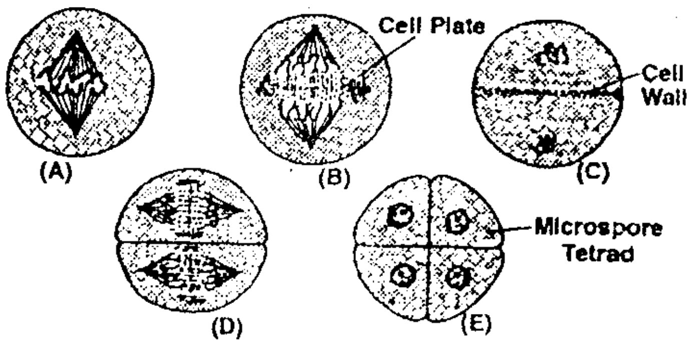


Fig. 16.7

2) Simultaneous type

In this type the first meiotic division is not followed by wall formation and results in binucleate cell. The two nuclei then undergo second meiotic division resulting in the formation of four haploid nuclei which lie in the common mass of cytoplasm of microspore mother cell. The walls are formed, centripetally by furrowing method after second meiotic division, giving rise to a tetrad. This type is more common in dicots.

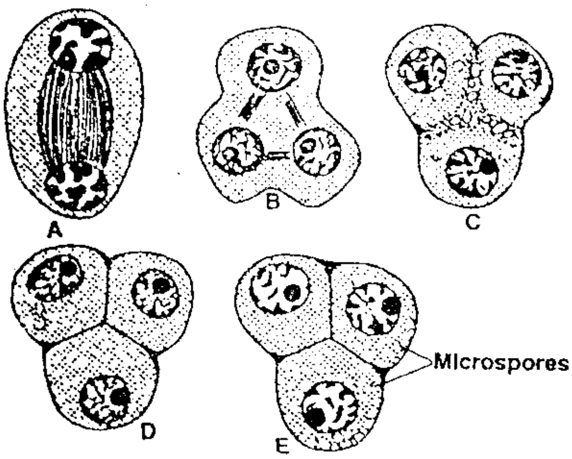


Fig. 16.8 Microsporogenesis – Simultaneous Method

16.7 MICROSPORE TETRADS

The microspores developed from a microspore mother cell are arranged variously in different species or even in the same species. On the basis of arrangement of microspores, five types of microspore tetrads are recognised. They are

1) Tetrahedral tetrad

It is the most common type of arrangement among angiosperms. The microspores are arranged in a tetrahedral manner, i.e., the four microspores form a triangular group, three below and one above.

2) Isobilateral tetrad

In this type, the microspores are arranged in one plane. This type is more common in monocots.

3) Linear tetrad

In this type, the microspores lie in a single row. Eg: Asclepiadaceae.

4) T-shaped tetrad

In this type, two microspores are arranged one above the other and remaining two opposite to each other. Eg: Aristolochia.

5) Decussate tetrad

In this type, the microspores are arranged in two pairs standing at right angles to each other. Eg: Magnolia.

After wall formation, the microspores usually separated from one another and lie free within the microsporangia. However in certain plants, the microspores in a tetrad remain together and form the compound pollen grains. Eg: Annona, Elodea, Typha etc. In Asclepiadauae and Orchidaceae, all the pollen grains of the microsporangium unite together to form a mass called as pollinium.

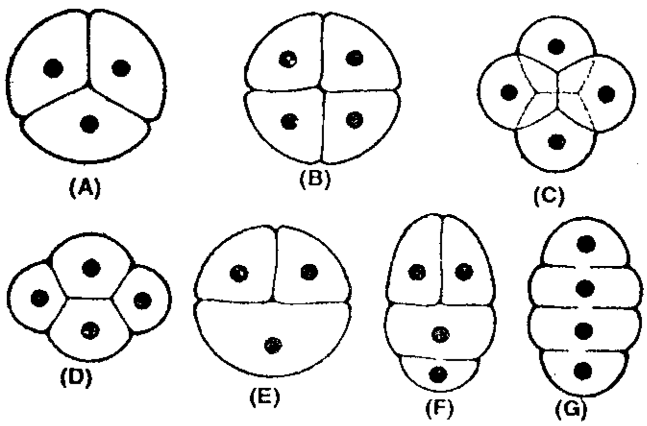


Fig. 16.9 Types of Pollen Tetrads

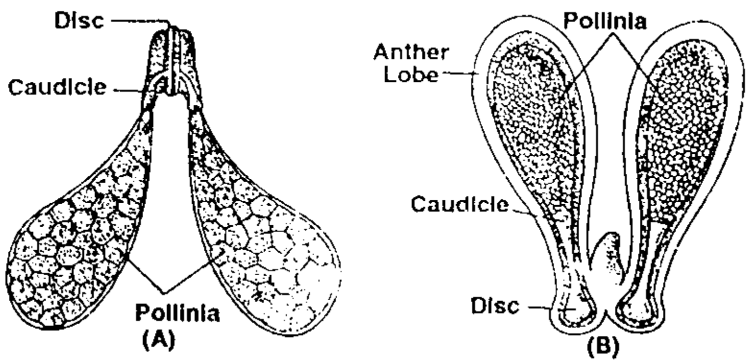


Fig. 16.10

16.8 POLLEN GRAIN STRUCTURE

The microspore or the pollen grain represents the first stage of the male gametophyte. The microspore is a minute, uninucleate cell and surrounded by a stratified wall called sporoderm. Sporoderm is made up of two layers. The outer one is called exine and the inner one is called intine. The exine is tough and made up of sporopollenin. The intine is thin and made up of cellulose and pectin substances. The exine shows unthickened areas called germ pores or apertures. The pollen grain has dense cytoplasm and a centrally placed nucleus.

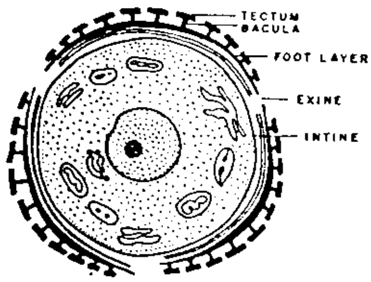


Fig. 16.11 Structure of microspore

16.9 DEVELOPMENT OF MALE GAMETOPHYTE

The microspore or the pollen grain is the first cell of the male gametophyte and its germination start within the microsporangium. In angiosperms, male gametophyte is a highly reduced structure consisting of two sperms and one vegetative cell. Only two mitotic divisions occur in the microspore. First divisions results in the formation of large vegetative cell and a small generative cell. The second division occurs in generative cell and it gives rise to two male gametes.

16.9.1 Formation of vegetative and generative cells

A freshly formed microspore is richly cytoplasmic with a prominent, centrally located nucleus. The microspore undergoes first mitotic division results in the formation of a large vegetative cell or tube cell and a small generative cell. The generative cell is initially attached to the wall of the pollen grain, but later it becomes free and comes to lie in the cytoplasm of the vegetative cell. Usually it is elliptical or lenticular in shape. The cytoplasm is highly reduced but it contains the usual cell organelles.

The vegetative cell cytoplasm appears hyaline and cell organelles increase in number as well as in size. RNA and protein contents also increase in the cell. The vacuole gradually disappears and nuclear envelope becomes highly convoluted. The nucleolus disappears at mature stage.

At this 2–celled stage (one vegetative cell + one generative cell) pollen grains are usually shed. In some cases, the generative cell may even divide into two male cells. So that the pollen is three celled (one vegetative cell + 2 sperms) at the time of liberation. The pollen is carried to the sigma by varies agencies where its further development occurs.

16.9.2 Formation of sperms

The generative cell divides mitotically to form two sperms. This may take place while the pollen grains are confined to the anther (Beta, Hordeum) or it may occur after the release of the pollen. In the former condition the pollen are shed at the 3-celled stage and in the latter at the 2-

celled stage. In those plants where the pollen are shed at 2-celled stage. The generative cell may divide inside the pollen grain after it has settled on the stigma (Holoptelea) or in the pollen tube before it reaches the embryosac (in most of the species). Rarely, the generative cells may divide after the pollen tube has reached the embryosac. (Euphorbia) Formerly, it was believed that if the generative cell divides in the pollen grain, the sperm cells were formed where as its division occurs in pollen tube, only male nuclei were formed.

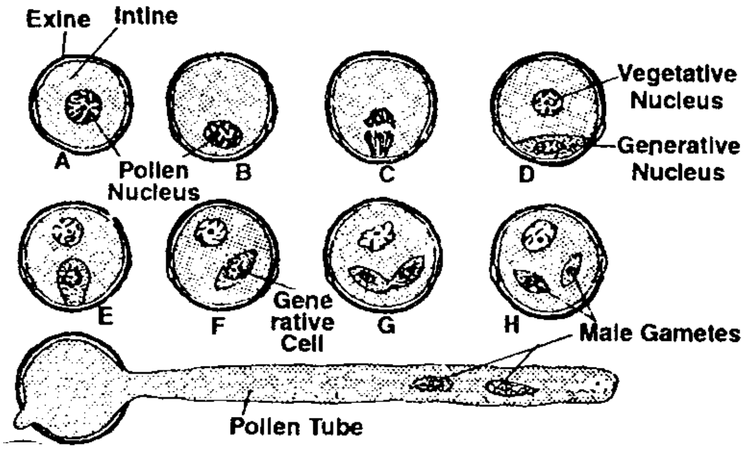


Fig. 16.12 Development of male gametophyte.

But recent studies revealed that in both cases sperm cells are formed. The cytoplasmic sheath surrounding them persists upto the time of fertilization.

The sperm cells vary in their size in different taxa. Each sperm cell consists of a large nucleus surrounded by a thin sheath of cytoplasm. Externally limited by a cell membrane. The cytoplasm of spermcells contain cells organelles like mitochondria, endoplasmic reticulum, golgi bodies, ribosomes, small vacuoles and plastids with reduced lamellar structure.

16.10 ABNORMAL FEATURES

In most of the angiosperms, the pollen mother cell divides by meiotic division forming four pollen grains. However, some deviations from this normal type of development has been observed in many species. Some of them are given here.

16.10.1 Pollen development in Cyperaceae

In the members of Cyperaceae, pollen mother cell, by meiotic division produces four haploid nuclei. Out of four nuclei only one nucleus is functional and it remains in the centre where as the other three non functional nuclei are pushed to one side of the cell. Later they cut off from the functional cell and gradually degenerate. The functional nucleus undergoes mitotic division and produces vegetative cell and generative cell. The generative cell produces two sperm cells.

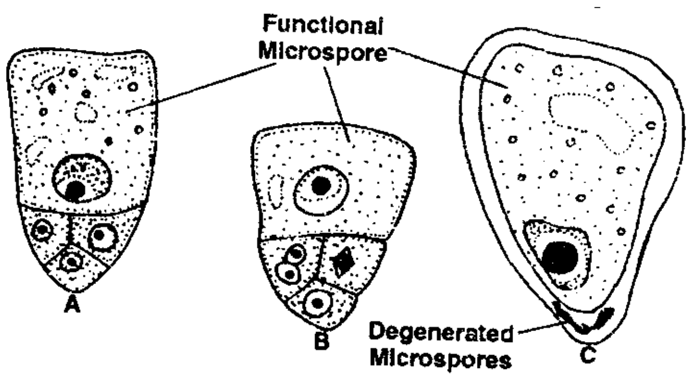


Fig. 16.13 Pollen development in Cyperaceae

16.10.2 Pollen Embryosacs (Nemec Phenomenon)

Usually a pollen grain contains two or three nuclei. But in some members of Liliaceae, Pollen grains with more number of nuclei have been observed. The increase in the number of nuclei lead to the formation of embryosac like structures in the pollen grains. It has been first reported in the petaloid anthers of Hyacinthus orientalis by Nemec. This was later confirmed by de Mol, Stow and Naithani. de Mol called it as Nemec phenomenon.

In Hyacinthus, some of the pollen grains enlarge and form sac like structures. The nucleus of these sac like spores divides by three successive mitotic divisions forming eight nuclei which organise themselves into an eight nucleate embryosac.

Stow observed that when these pollen embryo sacs were placed on agar medium along with normal pollen grains, the pollen tubes formed by normal pollen grains showed chemotropic response towards the pollen embryosacs.

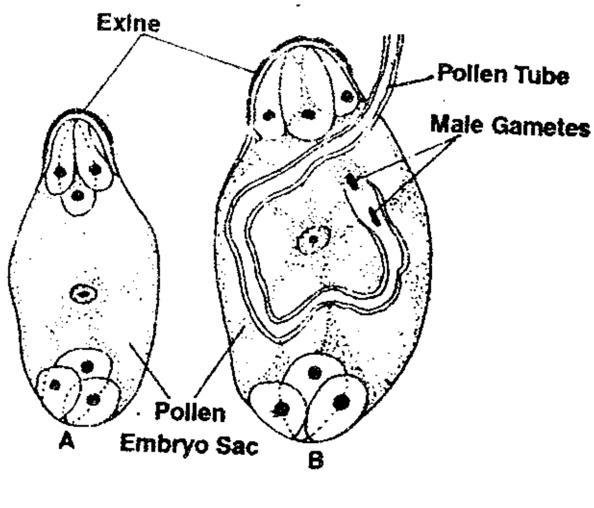


Fig. 16.14 NEMEC-PHENOMENON (Pollen embryosacs)

There are different views regarding the formation of pollen embryosac. Stow emphasized that this abnormal condition arises due to the secretion of necro hormone by the dead pollen grains. But according to Naithani, it is an effect of temperature.

16.11 SUMMARY

In angiosperms, the male reproductive structures are stamens. Each stamen consists of a stalk and anthers. Each anther is tetrasporangiate. Each microsporangium consists of 3-4 layered wall surrounding the pollen grain mother cells (PMCs). Each PMC by meiotic division gives rise to a group of four haploid microspores (Pollen tetrads). Microspore or pollen grain develops in to male gametophyte. The pollen grain nucleus divide mitotically to form two unequal cells – large vegetative cell and small generative cell. The generative cell again divide mitotically to form two male gametes. In angiosperms, thus the male gametophyte is highly reduced structure consisting of pollen tube, vegetative cell and two male gametes.

16.12 TECHNICAL TERMS

Tetrasporangiate, Endothecium, Tapetum, Pollen tetrads, Pollinia, male gametophyte, generative cell, male gametes.

16.13 MODEL QUESTIONS

16.13.1 Essay Type Questions

1. Describe the microsporogenesis.
2. Describe the development of male gametophyte in Angiosperms.

16.13.2 Short Answer Questions

1. Anther wall
2. Tapetum
3. Pollen tetrads
4. Nemce phenomenon

16.14 REFERENCE BOOKS

1. **The Embryology of Angiosperms –** S.S. Bhojwani and S.P. Bhatnagar.
2. **The Microsporangium –** N.N. Bhandari.
3. **An Introduction to the Embryology of Angiosperms –** P. Maheswari

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S.V. PADMAJA

Lesson 17

MEGASPOROGENESIS

CONTENTS

17.1 OBJECTIVE

The main aim of this lesson is to know the structure of ovule, formation of megaspores, development of different types of embryosacs and process of fertilization.

17.2 INTRODUCTION

In angiospermic flower gynoecium or the pistil is the female reproductive structure. It consists of one or more carpels which may be free or united. Each carpel consists of three parts – ovary, style and stigma. The swollen basal part called ovary may be one or many chambered and contains ovules. The style is the long, slender projection of the ovary and bears stigma at its terminal end.

17.3 OVULE OR MEGASPORANGIUM

In angiosperms, the megasporangium together with its protective coats, the integuments is called the ovule. It is attached to the placenta, on the inner wall of the ovary by a stalk called funiculus. It is attached to the body of the ovule at a point called the raphe. Ovule consists of nucellar tissue which is enveloped almost completely by the integuments, leaving a small opening called micropyle at the apical end. Micropyle is the main passage for the entry of pollen tube into the ovule. The basal region of the ovule is called chalaza. The female gametophyte or the embryosac is present in the nucellus.

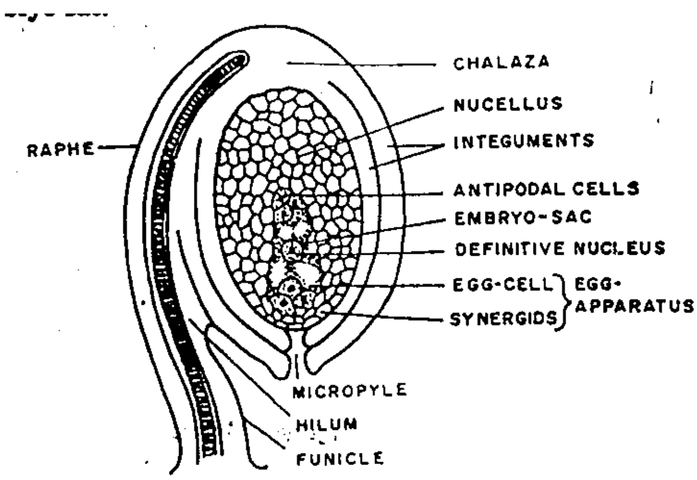

Fig. 17.1 Structure of megasporangium or Ovule

17.4 DEVELOPMENT OF OVULE

The ovule arises as a small protruberance of homongenous tissue on the placenta in the ovary. Two primordia arise as ring like projections arise as ring like projections at the base of this tissue which forms the nucellus in mature ovule. They grow around the nucellus and form the integuments. Although the integuments initiate later they grow faster than the nucellus and soon surround it completely except in the apical region, the micropyle.

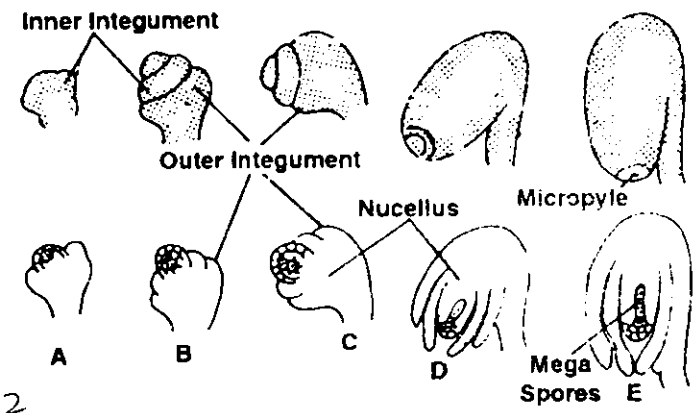

Fig 17.2 Stages in the development of an anatropous ovule

17.5 TYPES OF OVULES

Depending upon the relative position of the micropyle with respect to the funiculus, the mature ovules can be classified into six types.

(a) Orthotropous or atropous ovules

In this type the body of the ovule is straight so that the micropyle, chalaza and funiculus lie in one line. This is the most primitive type but rare occurrence. e.g.: Piperaceae, Polygonaceae.

(b) Anatropous or inverted ovule

In this type the body of the ovule bends due to unilateral growth of the funiculus. So that the micropyle and funiculus come close to each other. This is the most common type of ovule in angiosperms.

(c) Hemianatropous or hemitropous ovule

In this type the funiculus is at right angles to the nucellus and the integuments. e.g. Ranunculus.

(d) Campylotropous Ovules

In this type the body of the ovule shows curvature which is less than that in the anatropous ovule. e.g. Leguminosae, Capparidaceae.

(e) Amphitropous Ovules

In this type, the body of the ovule shows more prominent curvature which effects the embryosac. So that it becomes horse-shoe shaped. E.g. Alismataceae.

(f) Circinotropous Ovule

In this type, due to unilateral growth, the ovule first becomes inverted. As the curvature continues, the micropyle again comes upward in the fully formed ovule. The funiculus is long and it completely encircles the ovule. E.g. Cactaceae.

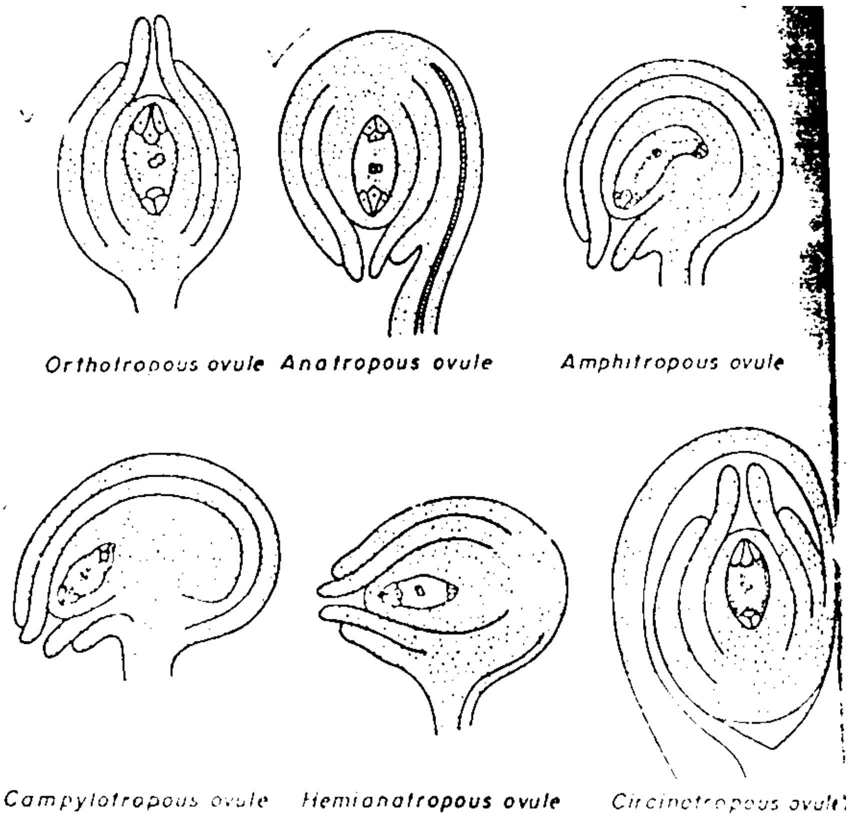

Fig. 17.3 Types of ovules

17.6 STRUCTURE OF OVULE

(a) Integuments

Generally ovules are surrounded by one or two integuments. Ovules with one integument are called unitegmic (E.g. Gamopetalae) and those with two integuments are called bitegmic (E.g. Polypetalae and monocots). In some members ovules lack an integument and they are called ategmic ovules. E.g. Olacaceae, Loranthaceae. In some members, the ovules have three integuments due to splitting of the outer integument. E.g. Ulmus.

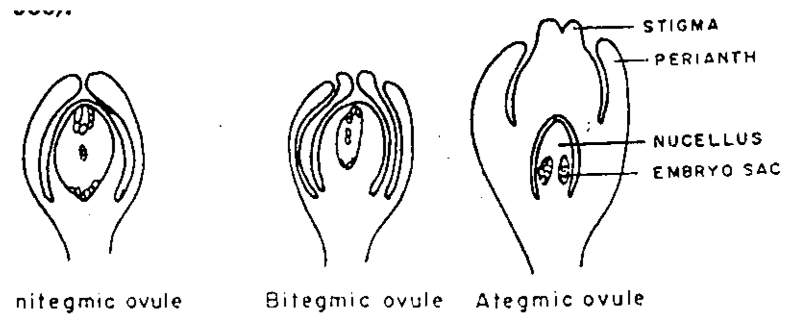

Fig. 17.4 Endothelium

(b) Endothelium

In most of the plants (sympetalae) the nucellus degenerates at an early stage of ovule development and the innermost layer of the integument becomes specialised to perform the nutritive function for the embryosac. This specialised tissue present around the embryosac is called endothelium or Integumentary tapetum. Endothelium is also seen in some plants with bitegmic ovules.

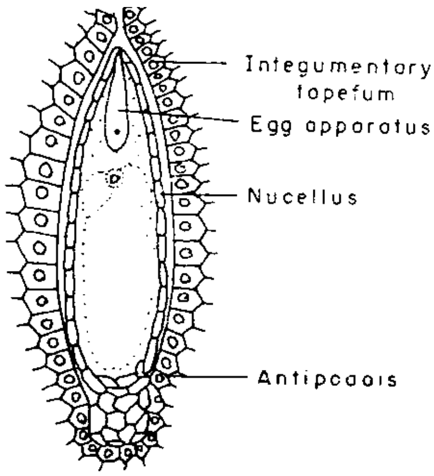

Fig. 17.5 Endothelium or Integumentary tapetum

The endothelium is usually single layered. In compositae it may become multilayered. The cells are radially elongated, rich in cytoplasm and store starch and fats.

(c) Nucellus

The body of the ovule consists of central mass of thin walled parenchyma called nucellus and it represents the wall of the megasporangium. The archesporial cell (sporogeneous cell) differentiates immediately below the nucellar epidermis. Depending on the extent of nucellar tissue around the sporogenous cell ovules are called tenuinucellate or crassinucellate.

1) Tenuinucellate ovules

In sympetalae, the archesporial cell directly functions as the megaspore mother cell. So that the sporogenous cell becomes hypodermal and the nucellar tissue remains single layered around it. Such ovules are called tenuinucellate ovules.

2) Crassinucellate ovules

In polypetalae and monocots, the hypodermal archesporial cell divides transversely cutting an outer parietal cell and an inner sporogenous cell. The parietal cell may under go few divisions to form perietal tissue. So that the sporogenous cell becomes embedded in the massive nucellus. The sporogenous cell may also become embedded in the nucellar tissue by divisions in the nucellar epidermis. Such ovules where the sporogenous cell becomes sub hypodermal, either due to the formation of parietal tissue or due to divisions in the nucellar epidermis, are called crassinucellate ovules. However, tenuinucellate condition is regarded as advanced character than crassinucellate condition. Generally the nucellus remains within the confines of the inner integument. Rarely it may project into the micropyle (Caryophyllaceae) or beyond it forming a nucellar beak (Euphorbiaceae). The nucellus is consumed by the developing embryosac or endosperm. But in some plants it persists in the seed as a nutritive tissue. The persistant nucellus is called perisperm.

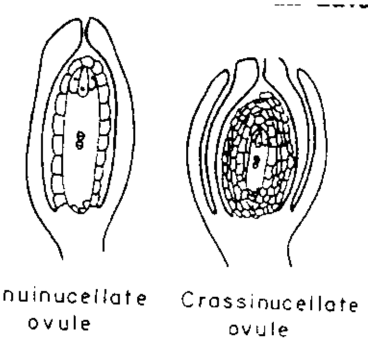

Fig. 17.6 Tenuinucellate and Crassinucellate ovules

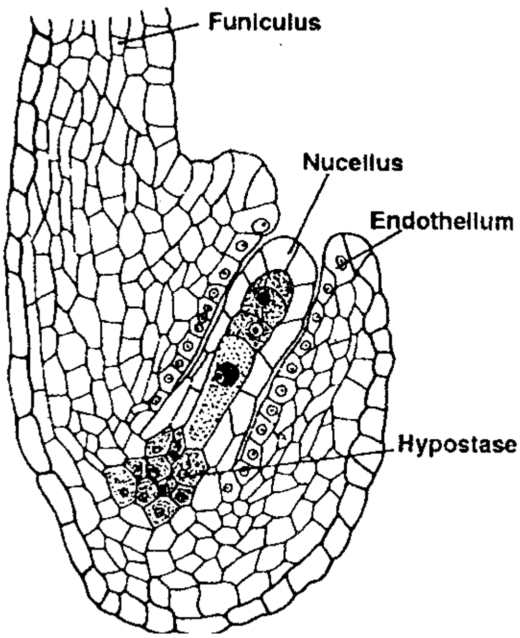

Fig. 17.7 L.S. of ovule showing Hypostage

(d) Hypostase

A group of specialised cells present just below the embryo sac and above the vascular supply to the funiculus is called hypostage. The cells become thick walled due to lignification, and are poor in cytoplasmic contents. Occasionally, the cells of the hypotase may surround a portion of the embryosac and may even extend into the micropylar half of the ovule. Hypostase occurs in many families such as Liliaceae, Malvaceae, Euphorbiaceae, Umbelliferae etc.

Functions

There are different views regarding the functions of hypostage.

1. According to Van Tieghem, it is a sort of barrier for the growing embryosac and prevents it from pushing into the base of the ovule.
2. According to Johansen, it stabilizes the water balance of resting seeds over the long period of dormancy during the hot, dry seasons.
3. According to Venkata Rao, it may help in transport of food materials from funiculus to embryosac.
4. It may produce certain enzymes or hormones or play a protective role in mature seeds.

(e) Epistage

A group of cells present above the embryosac in the form of cap like structure is called epistage. These are formed by the nucellar epidermis. The cells are radially elongated and thick walled. It may be nutritive in nature. It is also found in many families. e.g. Costus, Castalia.

(f) Obturator

Any ovular structure associated with directing the growth of pollen tube towards the micropyle is called as obturator. It may be developed from funiculus, placenta or integuments. The most common type of obturator is formed by local swelling of the funiculus. E.g. Acanthaceae, Anacardiaceae, Labiatae. In Euphorbiaceae, Cuscutaceae, obturator formed from placenta. In Thymeleaceae, the obturator develops from stylar canal.

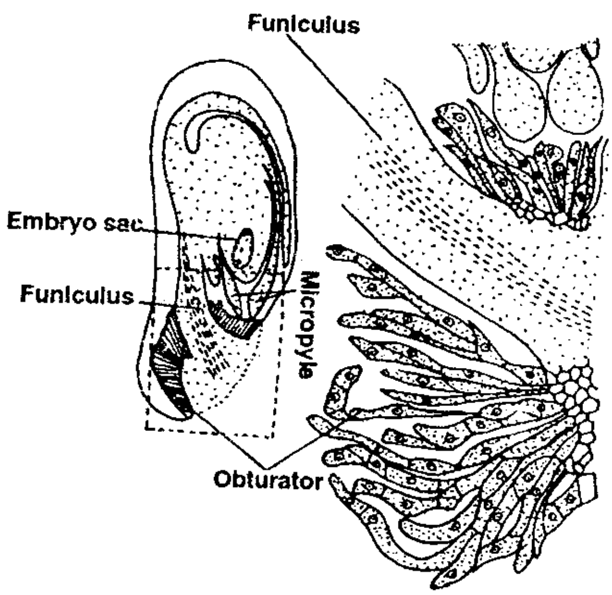

Fig. 17.8 L.S. of ovule showing obturator

17.7 MEGASPOROGENESIS

The process of formation of megaspores from megaspore mother cell is called megasporogenesis. In a ovule, a single hypodermal cell is differentiated as the archesporial cell in the nucellus. It becomes more prominent because of its larger size, dense cytoplasm and large nucleus. In tenuinucellate ovules the archesporial cell directly functions as megaspore mother cell whereas in crassinucellate ovules it divides periclinally into an outer primary parietal cell and an inner primary sporogenous cell. The sporogenous cell functions as the megaspore mother cell.

The megaspore mother cell undergoes meiotic division to form a linear row of four haploid megaspores. Of the linear tetrad of megaspores, usually the lower most one is functional while the remaining three degenerate. The functional megaspore develops into the embyrosac or the female gametophyte.

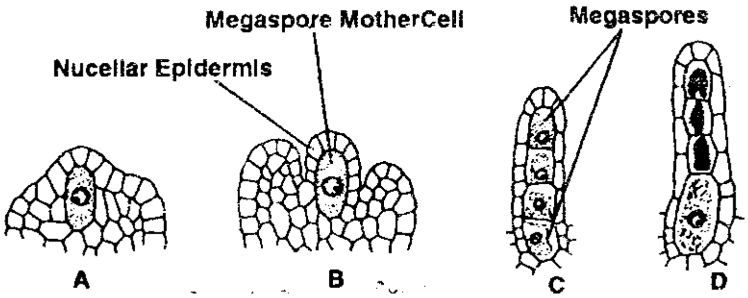

Fig. 17.9 Megasporogenesis in Tenninucellate Ovule

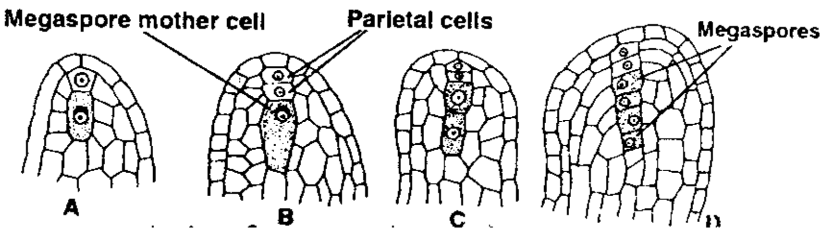

Fig. 17.10 Megasporogenesis Crassinucellate ovule

17.8 FEMALE GANETOPHYTE TO EMBRYOSAC

The female gametophyte or the embryosac is mostly a 7-celled structure. The embryo sac has three distinct groups of cells – egg apparatus, central cell and antipodals. The egg apparatus is situated in the micropylar end which consists of egg cell and two synergids. The central cell is nearly situated in the central region of the embryosac and consists of two polar nuclei. The antipodal cells are present at the chalazal end.

Development of Female Gametophyte

The functional megaspore develops into the female gametophyte or the embryosac. The development of embryosac begins with the elongation of the functional megaspore in the micropylal chalazal axis. The megaspore nucleus divides mitotically to form two daughter nuclei. A large central vacuole appears between the two daughter nuclei and as it expands, the nuclei are pushed toward opposite poles of the cell. Each nucleus at the pole divides twice forming four nuclei. Of the four nuclei at the micropylar end of the embryosac, three organise into egg apparatus and the fourth one move toward the centre of the embryosac. This is called as upper polar nucleus. Similarly, of the four nuclei of chalazal end, three form antipodalcells and the fourth one moves towards the centre and functions as lower polar nucleus. The two polar nuclei fuse together to form secondary nucleus.

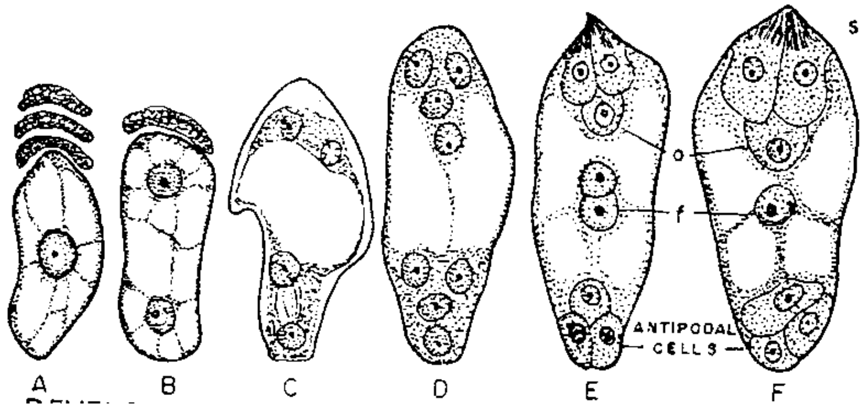

Fig. 17.11 Development of the Female gametophyte of the embryo sac

17.9 TYPES OF EMBRYOSACS OR FEMALE GAMETOPHYTE

The megaspore mother cell undergoes meiotic division to form four megaspores. Depending on the number of megaspore nuclei taking part in the development, the embryosacs of angiosperms may be classified into three main types: (1) Monosporic, (2) Bisporic, (3) Tetrasporic.

17.9.1 Monosporic type of embryosac

In this type only one megaspore take part in the development of embryosac. There are two types of monosporic embryosacs. (a) Polygonum type, and (b) Oenothera type.

(a) Polygonum type (8-nucleate)

This is the normal type of embryosac found in about 81 per cent families of angiosperms. This type of embryosac development was first described by Strasburger in Polygonum divaricatum. The megaspore mother cell by meiotic division produces a linear tetrad of megaspores. Of the four megaspores, the chalazal one is functional and develop into embryosac. The remaining three degenerate. The mature embryosac consists of 3 – called egg apparatus, three antipodal cells and a binucleate central cell.

(b) Oenothera type (4–nucleate)

This type of embryosac was first studied by Geerts in Oenothera lamarkiana. It is derived from the micropylar megaspore of the tetrad and is 4 nucleate. The functional megaspore nucleus undergoes two nuclear divisions forming four nuclei, all of which remain in the micropylar part. Of the four nuclei, three get organised into the egg apparatus and the fourth one functions as polar nucleus. So the mature embryosac consists of 3 – celled egg apparatus and uninucleate central cell.

17.9.2 Bisporic Embryosacs

In this type two megaspore nuclei take part in the development of embryosac. In plants bearing bisporic embryosacs, the first meiotic division is followed by a wall formation. So that a dyad is formed. Only one of the dyad cells undergoes second meiotic division and the other one degenerates. In the functional dyad cell wall formation does not occur after the second division, so that both the nuclei take part in the formation of embryosac. The two nuclei moves towards the opposite poles where they undergo two mitotic divisions. As a result four nuclei area formed at each end. The eight nuclei get organised in to 3 – celled eggapparatus, 3 antipodals and binucleate central cell as in Polygonum type.

Bisporic embryosacs are of two types. (a) Allium type (b) Endymion type.

(a) Allium type (8–nucleate)

This type was first described by Strasburger. In this type the embryosac is developed from chalazal dyad cell. The final organisation of the embryosac is similar to the polygonum type.

(b) Endymion type (8- nucleate)

This type of embryosac is developed from micropylar dyad cell. The development is same as in Allium type and the final organisation of the embryosac is similar to the polygonum type.

17.9.3 Tetrasporic Embryosacs

The embryosac derived from four megaspore nuclei is called tetrasporic embryosac. During megasporogenesis, the wall formation fails altogether, so that all the four nuclei remain in a common cytoplasm forming a coenomegaspore. All the four nuclei of the coenomegaspore take part in the formation of embryosac.

In tetrasporic embryosac the nuclear behaviour is quite variable. The four nuclei may get arranged in three different ways before the beginning of post – meiotic mitosis. They are:

(1) 2+2 arrangement: Two nuclei at the micropylar end and two at the chalazal end. E.g. Adoxa type.

(2) 1+1+1+1 arrangement: One nucleus at the micropylar end, one at the chalazal end and the other two place laterally, one on each side. E.g. Penaea type, Plumbago type, Pepromia type.

(3) 1+3 arrangment: One nucleus at the micropylar end and three at the chalazal end. E.g. Drusa type, Fritillaria type, Plumbagella type.

Depending on the number of post meiotic divisions and final organisation of the embryosac, tetrasporic embryosacs are of many types.

(1) Adoxa type (8–nucleate)

This type of embryosac was first described by Jonson in Adoxa moschatellina. Of the four nuclei formed in the megaspore mother cell after meiosis, two nuclei move towards the micropylar end and the other two to the chalazal end (2+2). The four nuclei undergo one mitotic division, so that eight nuclei are formed. These 8-nuclei get organised into 3-celled egg apparatus, 3-antipodal cells and binucleate central cell.

(2) Plumbago type

This type of embryosac was first described by Hampt in Plumbago capensis. The four nuclei get arranged in 1+1+1+1 manner and undergo one post-meiotic division. From each pair of nuclei one moves toward the centre, so that a tetraploid (4n) secondary nucleus is formed. Remaining four nuclei, one nucleus in the micropylar end organised into the egg cell and the other three degenerated.

(3) Penaea type (16-nucleate)

This type of embryosac was first described by Stephens in members of Penaeaceae. The four nuclei get arranged in 1+1+1+1 manner and undergo two post meiotic mitoses, So that 16-nuclei are formed. These nuclei get arranged in four groups of four nuclei each. From each group, one nucleus moves towards the centre form a tetraploid secondary nucleus (4n). The three nuclei situated at the micropylar end organise into egg apparatus.

(4) Peperomia type (16-nucleate)

This type of embryosac development was described by Campbell and Johnson in Peperomia pellucida. The four nuclei undergo the post-meiotic mitoses, so that 16-nuclei are formed. These nuclei are uniformly distributed in the cytoplasm of embryosac. The two nuclei lying in the micropylar end get organised into an egg and a synergid. Eight nuclei moves to the centre to from secondary nucleus (8n). Remaining 6 nuclei form antipodal cells at the chalazal end (2+8+6).

(5) Drusa type (16-nucleate)

This type of embryosac development was described by Hokansson in *Drusa opposilifolia*. After meiotic division in megaspore mother cell, the four nuclei formed get arranged in 1+3 manner. (one at the micropylar end and three at the chalazal end). These four nuclei undergo two post meiotic mitoses, so that 4 nuclei at micropylar end and 12 nuclei at chalazal end are formed. From each group one nucleus moves toward the centre to form secondary nucleus (2n). Remaining three nuclei at micropylar end get organised into egg apparatus and 11 nuclei at chalazal end into antipodals (3+2+11).

(6) Fritillaria type (8-nucleate)

This type of embryosac development was first reported in Fritillaria and in many angiosperms. After meiosis in megaspore mother cell, the four nuclei formed get arranged in 1+3 manner. The three nuclei in the chalazal end fuse together forming a single triploid (3n) nucleus. Now both the nuclei of coenomegaspore (one haploid nucleus at micropylar end and triploid nucleus at chalazal end) undergo two mitotic divisions forming four nuclei at each pole. From each quarter one nucleus moves toward the centre to form secondary nucleus. (4n) Remaining three nuclei at micropylar end get organised into egg apparatus and chalazal end into antipodal cells. (Triploid).

(7) Plumbagella type (4 nucleate)

This type of embryo sac development was first described by Fagarlind in *Plumbagella micrantha*. After meiosis, the four haploid nuclei get arranged in 1+3 manner. The three nuclei of chalazal end fuse together forming a single triploid nucleus. Now the nuclei of both the ends divide mitotically to form a pair of nuclei. Of the two haploid nuclei at the micropylar end one, organises into egg cell and other one moves to the centre. Of the two triploid nuclei at the chalazal end one moves to the centre and the other one organises into a single antipodal cell (3n).

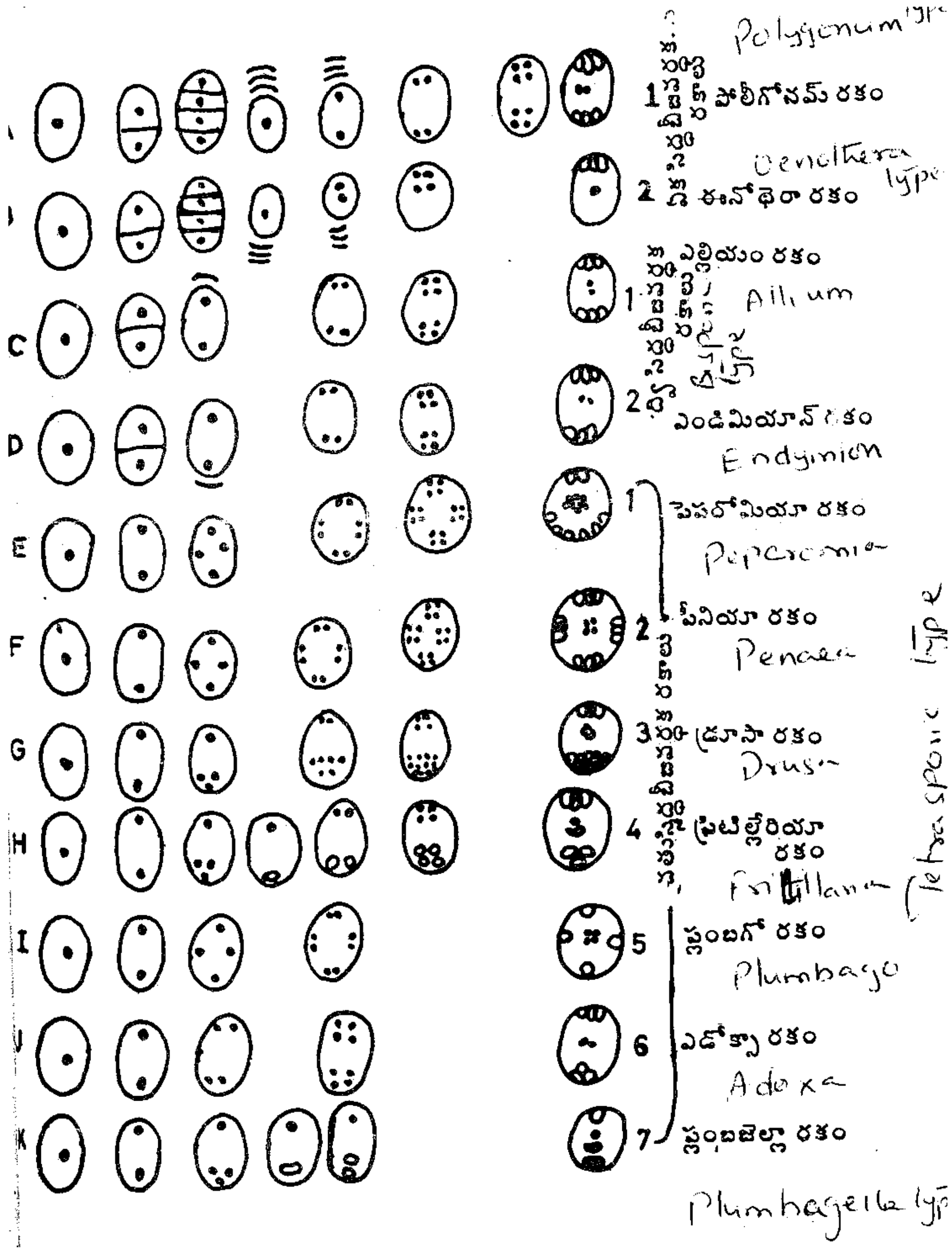

Fig. 17.12 Types of Embryosacs

17.10 STRUCTURE OF MATURE EMBRYOSAC

In angiosperms, the common type of embryosac is a 8-nucleate and 7-celled structure. The mature embryosac comprises 3-celled egg apparatus binucleate central cell, and 3-antipodal cells.

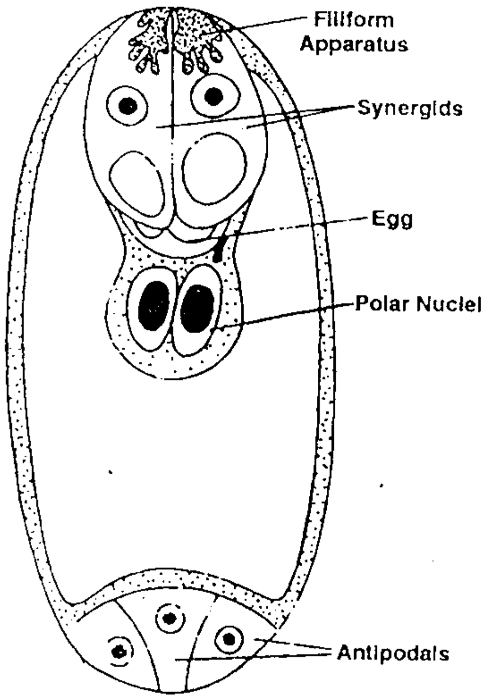

Fig. 17.13 Diagram of an organised embryosac

(1) Egg apparatus

The egg apparatus consists of central egg cell, two synergids. Rarely one synergid is present (peporomia type). Sometimes synergids are absent (Plumbago, Pulmbagella).

Egg Cell

The middle cell of egg apparatus is called the egg cell. It is vary in size and structure. The egg shows common walls with the two synergids and the central cell. The wall is thicker in the micropylar region but becomes thinner towards the chalazal side. The cell wall is absent at the chalazal end in cotton and maize. In Epidendrum sentella well developed wall is seen all over the egg cell.

The micropylar end of the egg cell is occupied by a large vacuole and dense cytoplasm and prominent nucleus are formed towards the chalazal side. The cytoplasm is rich in ribosomes, but the mitochondria are poorly developed. Plastids also occur in the egg cell.

In *Plumbago capens* is many finger like wall projections arise at the micropylar end of the egg cell. In *Cortoderia jubata*, rarely the egg may develop into an haustorium (Philipson, 1981).

Synergids

The synergids are elongated cells present at the micropylar end of the embryosac. Generally two synergids are present on either side of the egg cell and party embrance it. The synergids are pointed or hooked toward the micropyle.

The wall around the synergids is incomplete. There is a distinct wall towards the micropylar end and gradually disappears at the chalazal end. In this region the protoplast of the synergid is separated from that of the central cell by double membranes, one of the synergid and the other of the central cell.

In the micropylar end of each synergid, there is a mass of finger like projections of the wall in the cytoplasm. This structure is called filiform apparatus. Structurally, each projection of the filiform apparatus has a core of tightly packed microfibrils enclosed by a non fibrillar sheath.

The cytoplasm of the synergid is strongly polarised. The chalazal region of the cell is occupied by one large or many small vacuoles. The synergid cell consists of large amount of cytoplasm and a prominent nucleus in the micropylar region. The cytoplasm is rich in mitochondria, endoplasm reticulum, dictyosomes, which are especially concentrated near the filiform apparatus.

Synergids are ephemeral structures. In embryosacs with two synergids, one degenerate before the entry of the pollen tube into the embryosac, whereas the other one, degenerate soon after the embryosac has received the pollen tube discharge. This synergid is called persistent synergid.

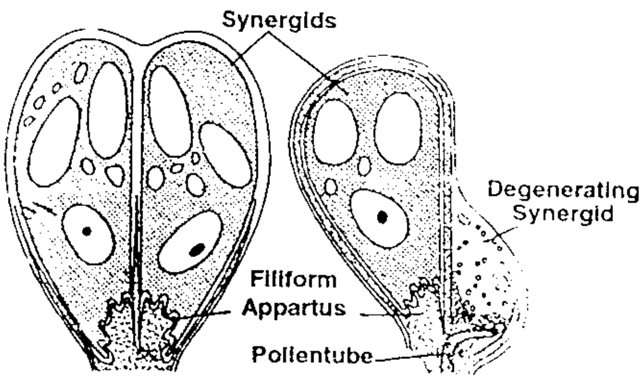

Fig. 17.14 Synergids with filiform apparatus
(A) Synergids at the time of pollination, (B) Synergid degenerating alter pollen tube discharge

As a rule, the synergids remain within the limits of the embryosac. In the compositae, however, they break through the embryosac and project into the micropyle. In some cases, the synergids break through the embryosacs and form elongated, haustoria. E.g. Cotula, Sedum, Quinchamalium, Cortaderia. These haustoria help the absorption and conduction of nutrients to the synergids.

Functions

There are different views regarding the functions of synergids.

The synergids play an important role in directing the pollen tube growth by secreting some chemotropically active substance.

The degenerating synergid forms the seat for the pollen tube discharge into the embryosac.

Jensen opined that the filiform apparatus may be aiding the synergid in the absorption and transportation of materials into the embryosac from the nucellus. However, the currently prevailing view is that metabolites enter the embryosac mainly through the chalazal end.

(2) Antipodal cells

The cells present at the chalazal end of the embryosac are called antipodal cells. Generally they are three in number, but however they show variation in number and ploidy. Usually they degenerate before or soon after fertilization. In some grasses, they present and multiply by mitotic divisions. The highest number of antipodal cells known is 300, recorded in *Sasa paniculata*. In maize, they are about 20 in number and each cell contains1-4 nuclei.

The cytology of antipodal cells resemble that of glandular tapetum and endothelium. Hence, they may have a nutritive role.

In many plants antipodal cells show haustorial behaviour. e.g. Grindelia, Haploppappus, Quinchamalium.

(3) Central Cell

It is the largest cell of the embryosac. After fertilization it gives rise to endosperm which is a nutritive tissue. The central cell consists of two polar nuclei, which are very large and each possesses a conspicuous nucleolus. These two polar nuclei fuse, before ordinary double fertilization to form the secondary nucleus. The number of polar nuclei vary from species to species.

The wall of the central cell is highly variable. It is thickest in the regions against the nucellus. It shows the common feature of partition wall where it is in contract with egg and synergids.

17.11 FERTILIZATION

The fusion of male and female gametes is called fertilization. In angiosperms, the male gametes are produced inside the pollen grains and the female gamete (egg cell) inside the embryosac.

The pollen grains liberated from the mature anthers are carried away by different agencies to the stigma of the same flower or other flowers. At the time of liberation, the pollen grains are usually 2-celled, rarely they may be 3-celled. The pollen grains absorb the exudates of the stigma and begin to germinate. During germination, the intine grows out through the germ pore in the form of long tube like structure called the pollen tube. The contents of the pollen grain pass into it. The pollen tube enters the tissue of style, passes through it and finally reaches the ovary. The pollen tube may enter the ovule through the micropyle (porogamy) or chalaza (Chalazogamy) or funiculus (mesogamy). Irrespective of the place of entry into the ovule, the pollen tube enters the embryosac only at the micropylar end.

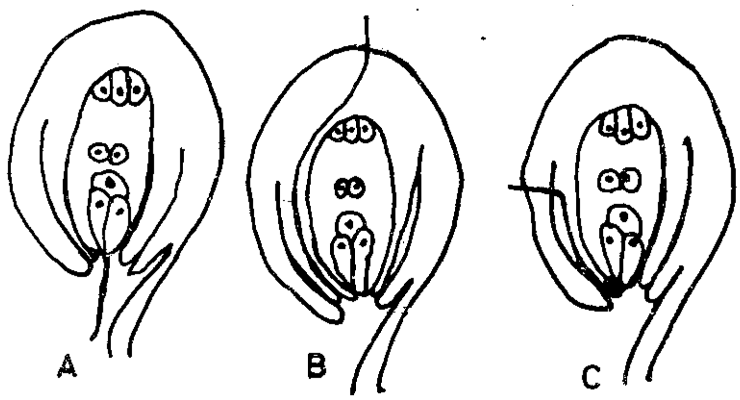

Fig. 17.15 Modes of pollen tube entry into ovule
A. Porogamy, B. Chalazogamy, C. Mesogamy

The pollen tube may enters the embryosac through the synergid or between the egg and one synergid or between the embryosac wall and a synergid. But recent studies revealed that the pollen tube enters into one of the synergids through the filiform apparatus.

The two sperms (male gametes) are discharged in to the synergid through a terminal pore in the pollen tube. One of the sperm reaches the egg and fuses with it to form zygote. This fusion of sperm nucleus with the egg nucleus is known as syngamy. The zygote gives rise to the embryo.

The other sperm reaches the secondary nucleus and fuses with it forming a triploid primary endosperm nucleus (PEN). As this fusion involves one sperm nucleus and two polar nuclei it is called triple fusion. The PEN gives rise to the nutritive tissue, the endosperm.

Double fertilization

In angiosperms both the male gametes are functional and are involved in fertilization. One of the male gamete fuses with egg to form zygote. This fusion is known as syngamy. It was first described by Strasburger (1884). The other male gamete fuses with the secondary nucleus to form primary endosperm nucleus. One sperm nucleus and two polar nuclei are involved in the fusion, So it is known as triple fusion and the resultant PEN is triploid. This phenomenon is known as double fertilization as the sperm nuclei are involved in two fertilization acts. It is a unique feature of angiosperms and was first demonstrated by Nawaschin (1898).

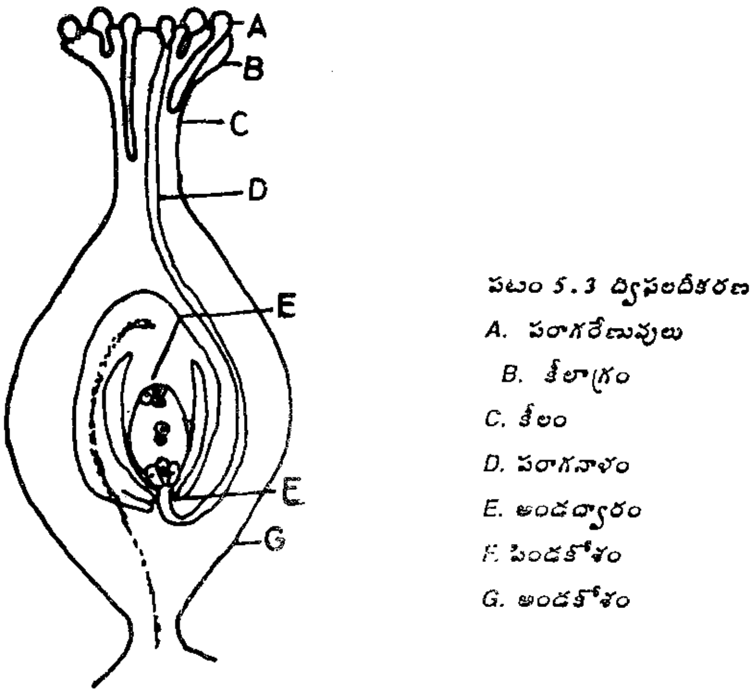

Fig. 17.16 Double Fertilization

Double fertilization is necessary for the production of viable seeds. The process of double fertilization serves as a stimulus to the secondary nucleus, for the development of the nutritive tissue, the endosperm. This is of advantage to the embryo, which needs nourishment for further growth.

17.12 SUMMARY

In angiosperms, the megasporangium together with its profective coats, the integuments is called the ovule. The thin walled parenchymatous tissue present in the ovule constitute nucellus. In the archesporial cell differentiates below the nucellar epidermis towards the micropylar region. This archesporial cell may directly act as megaspore mother cell or by transverse division forms megaspore mother cells. This megaspore mother cell undergoes meiotitic division and forms four megaspores. Of these three degenerate and one develops into embryosac. It is called monosporic embryosac. In some cases, two or four megaspores take part in the development of embryosacs. Such ones are said to be bisporic and tetrasporic embryosacs respectively.

Mature embryosac consists of an egg apparatus (2 synergids + 1 egg cell), central cell with two polar nuclei and 3 antipodal cells.

At the time of fertilization pollen tube enters the embryo sac through synergid and it discharges its contents which include some cytoplasm, two male gametes. Of the two male gametes one fuses with egg and forms zygote. Another one fuses with secondary nucleus and form primary endosperm nucleus. This phenomenon is called double fertilization which is unique feature of angiosperms.

17.13 TECHNICAL TERMS

Megasporangium, Endothelium, Hypostase, Epistase, Obturator, Megasporogenesis, Embryosac, Egg apparatus, double fertilization, porogamy, chalazagamy, mesogamy, syngamy, triple fusion.

17.14 MODEL QUESTIONS

Essay Type Questions

1. Give an account of development and structure of embryosac.
2. Give an account of different types of female gametophytes in Angiosperms.
3. Describe the detailed structure of ovule.

Short Answer Questions

1. Types of Ovules.
2. Endothelium
3. Megasporogenesis.
4. Monosporic Embryosac
5. Bisporic type of Embryosac.

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S.V. PADMAJA

Unit-IV

Lesson 18.1

ENDOSPERM

CONTENTS

18.1.1 OBJECTIVE

The aim of this lesson is to know the development, types and functions of endosperm.

18.1.2 INTRODUCTION

Endosperm is the most common nutritive tissue for the developing embryos in angiosperms. The endosperm is the product of fertilization. In Gymnosperms, the endosperm is formed before fertilization and it is haploid, whereas in Angiosperms, it is formed after fertilization and is triploid. The endosperm develops from primary endosperm nucleus (PEN) which is a fusion product of two polar nuclei and one male gamete. However, endosperm is not formed in the members of the families Orchidaceae, Podostemaceae and Trapaceae.

The chief function of the endosperm is to provide nourishment to the developing embryo. The endosperm is completely consumed by the developing embryo. Such seeds are called non-endospermic or exalbuminous seeds, e.g. Pea, beans etc. In some mature seeds, the endosperm may persist and continue to support the growth of the embryo during seed germination. Such seeds are called endospermic or albuminous seeds.

e.g. Cereals, Castor bean, coconut.

18.1.3 TYPES OF ENDOSPERM

The primary endosperm nucleus is normally located directly below the egg cell and undergoes division soon after its formation. The primary endosperm nucleus divides repeatedly forming several daughter nuclei. Depending upon its mode of development, three types of endosperm have been recognised. They are nuclear, cellular and Helobial.

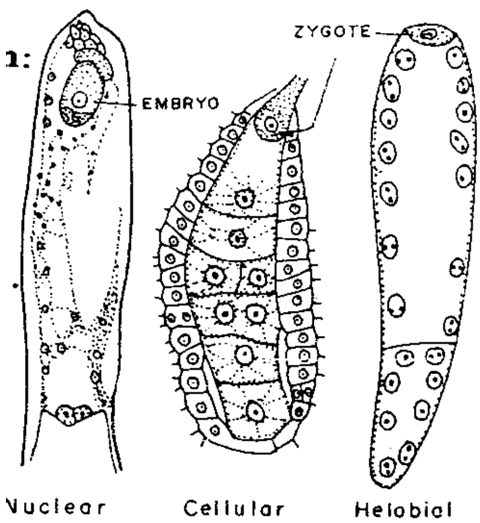

Fig. 18.1 Types of endosperm development

18.1.3.1 Nuclear Endosperm

This is the most common type of endosperm development. In this type, the primary endosperm nucleus undergoes free nuclear divisions. These divisions are not followed by wall formation. When several nuclei are formed, they arrange themselves peripherally in a layer of cytoplasm. Such a condition of endosperm may persist until it is consumed by the developing embryo or it may become cellular at a later stage. Normally the cell wall formation starts from periphery towards the centre or from apon towards base. However, the degree of cellularization varies a great deal.

Mostly the endosperm becomes completely cellular. But in Phaseolus, the cellularization occurs only around the embryo. In Crotalaria, the wall formation is confined to the upper region of the embryosac. The chalazal region remains free nuclear. This type of endosperm shows haustoria. The haustoria may be micropylar or chalazal. These haustoria penetrate into the surrounding tissue of embryosac and absorb nutrients.

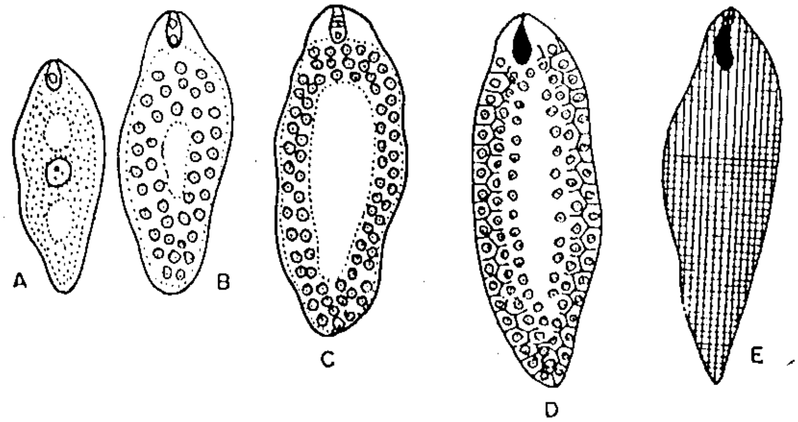

Fig. 18.2 Development of nuclear endosperm
A) Embryo sac with triploid primary endosperm nuclei
B) Embryo sac containing many nuclei
C) Embryo sac showing central vacuole and peripheral nuclei
D) Wall-formation in embryo-sac
E) Embryo sac filled and endosperm

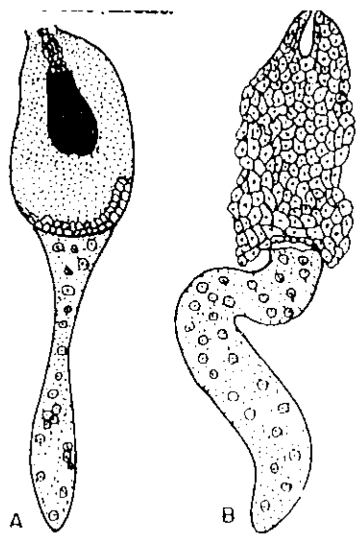

Fig. 18.3 Variations in nuclear endosperm
A) *Crotalaria* – upper part cellular and lower part free nuclear
B) *Grevillea* – upper part cellular and lower part worm like

In Grevillea, the chalazal endosperm haustorium is present and it remains free-nuclear, but, in coccinia and citrullus fistulosus, it becomes partitioned into multinucleate chambers. Endosperm haustoria have been reported in several members of the Cucurbitaceae, Leguminosae and Proteaceae. In Phaseolus, Crotolaria, free nuclear chalazal part form haustorium.

In Lomatia, besides the main chalazal haustorium, numerous single celled, finger like out growths develop all over the endosperm. This increases the absorptive surface of the endosperm.

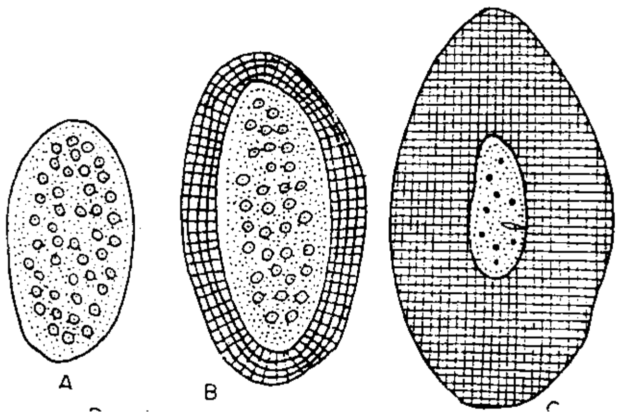

Fig. 18.4 Development of endosperm in Cocos

In coconut, the development of endosperm deserves special attention. The primary endosperm nucleus undergoes a number of free nuclear divisions. When the fruit is about 50 mm long, the embryosac is filled with liquid endosperm which contains many free nuclei and cytoplasm. At a later stage, the suspension shows, in addition to free nuclei, several cells each enclosing variable number of nuclei. Gradually, free nuclei become cellular. The cellular endosperm, thus formed is called coconut meat. Similar type of endosperm development is found in *Areca catechu*. The embryosac cavity is small and it becomes completely filled with endosperm. It later becomes extremely hard.

Scleria foliosa, a member of the family Cyperaceae shows both micropylar and chalazal haustoria.

18.1.3.2 Cellular endosperm

In this type of endosperm, development each division of the primary endosperm nucleus is followed by wall formation. The cellular endosperm is characterised by the absence of free nuclear stage. The first division of the primary endosperm nucleus is followed by a transverse wall resulting into two equal chambers subsequent nuclear divisions are followed by wall formation giving rise to cellular endosperm.

The occurrence of haustoria is a common feature of this type of endosperm. The haustoria may be micropylar or chalazal. Occasionally, both types of haustoria are present in the same plant.

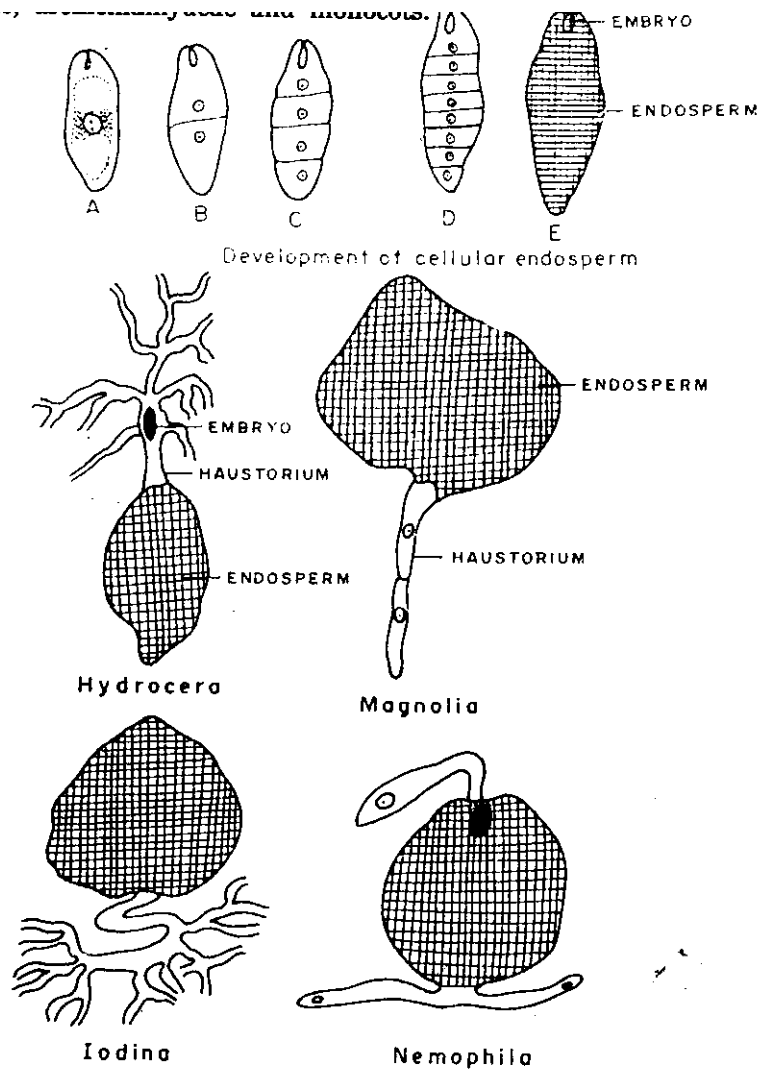

Fig. 18.5 Haustoria in Cellular endosperm

Micropylar haustoria are known to occur in *Impatiens roylei* and *Hydrocera triflora*. In *Magnolia obovata,* 2-celled chalazal haustorium is present. In *Melampyrum lineare* and *Blumenbachia insignis*, both micropylar and chalazal haustoria are present. In Melampyrum, the micropylar haustorium comprises a single, 4-nucleate cell with many tubular processes. One of these processes enlarge and enters the funiculus. The chalazal haustorium is a binucleate cell, broader above and narrow below.

In Nemophila, the primary endosperm nucleus divides transversely to form two equal chambers. The chalazal chamber forms haustorium. Sometimes branches also arise from it and penetrate into the funiculus to absorb nutrients. In *Iodina rhombifolia*, a very aggressive chalazal haustorium is formed. It is actually formed before fertilization. The primary endosperm nucleus divides transversely to form a micropylar chamber and a chalazal chamber. The endosperm is derived from the micropylar chamber alone whereas the chalazal chamber functions as an aggressive, haustorium. Profuse branching at the free end gives the haustorium a corolloid appearance.

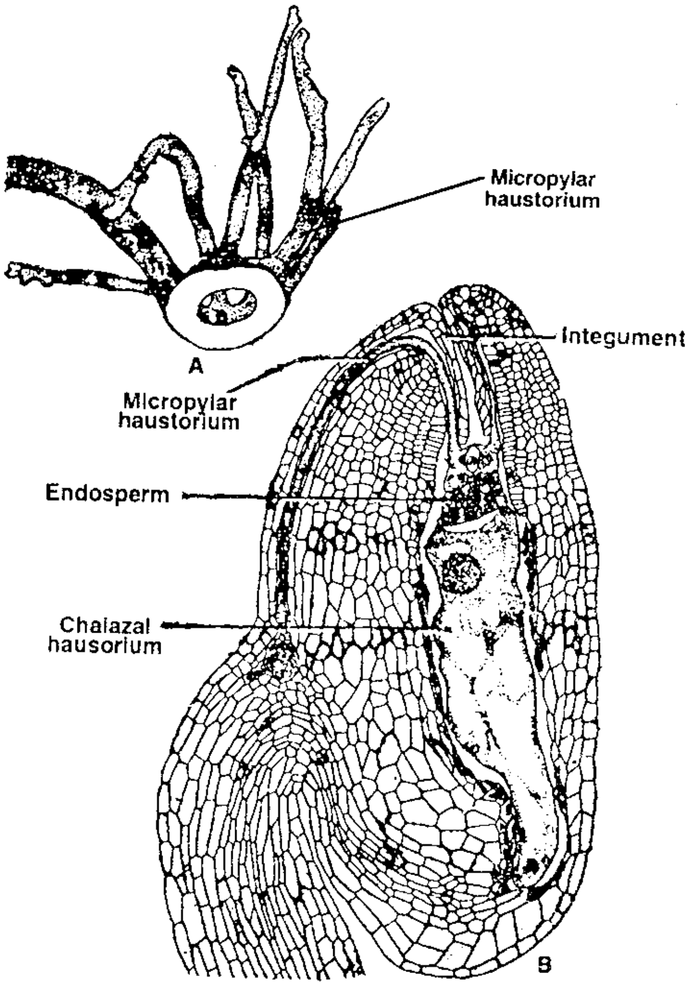

Fig. 18.6 Endosperm haustorium in Melampyrum
(A) Dissected out micropylar haustorium, (B) L.S. of Young seed

18.1.3.3 Helobial Endosperm

This type of endosperm is an intermediate type between nuclear and cellular endosperm. It is commonly found in monocotyledons.

The primary endosperm nucleus moves to the chalazal end of the embryosac. There it divides to form a large micropylar chamber and a small chalazal chamber. In the micropylar chamber several free nuclear divisions takes place. Cell wall formation, if any, start at a much later stage. In the chalazal chamber, the nucleus may or may not divide. If divide, the divisions are usually free nuclear. In *Phylidum lanuginosum*, it may become cellular.

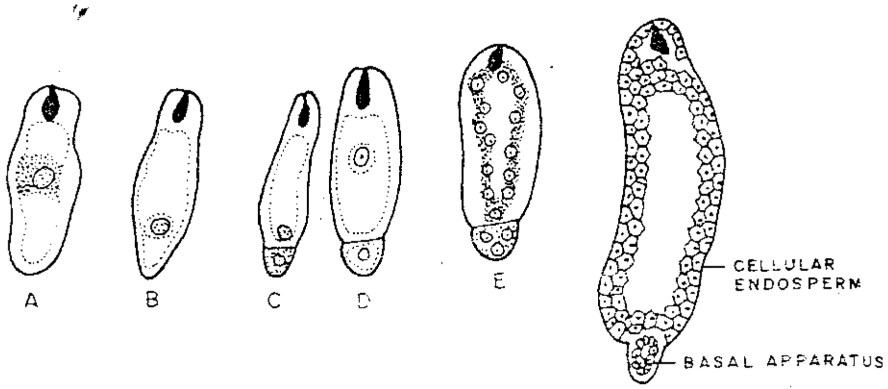

Fig. 18.7 Development of helobial endosperm

In this type of endosperm also haustoria can be seen in the micropylar or chalazal regions. In Asphodelus, the chalazal chamber grows into a hedge shaped haustorium. In Monochoria, the haustoria develop from the lateral sides of the micropylar chamber.

18.1.4 RUMINATE ENDOSPERM

Mature endosperm with any degree of irregularity and unevenness in its surface contour is called ruminate endosperm. Rumination starts at a late stage of endosperm development, and it may belong to nuclear, cellular or helobial type. Ruminate endosperm is found in 32 families of angiosperms.

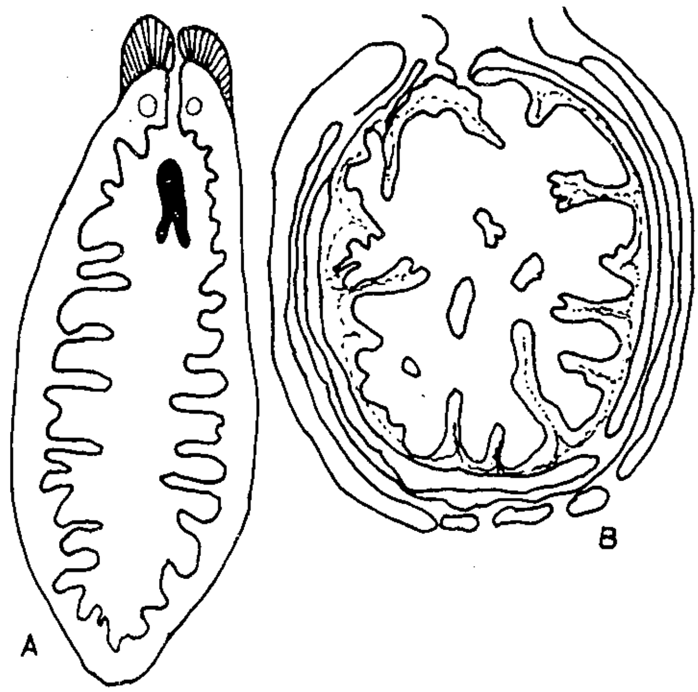

Fig. 18.8 Ruminate Endosperm
A. Annona squamosa, **B**. Myristica fragrance

Rumination is caused by the activity of the seed coat or by the endosperm itself. In the former case, the irregularities on the inner surface of the seed coat may arise by (a) unequal radial elongation of any one layer of the seed coat (*Passiflora calcarata*) or (b) definite ingrowth or infolding of the seed coat (Annonaceae, Aristolochiaceae).

In Myristica, Coccoloba, rumination of endosperm is by its own activity. In these plants, the endosperm increases in volume and comes in direct contact with the seed coat. During further growth of the endosperm, the irregular inner surface of the seed coat makes it ruminate.

In Andrographis and Elytraria, seed coat does not form infoldings but become consumed and pushed in an irregular manner by the unequal peripheral activity of the enlarging endosperm.

18.1.5 FUNCTIONS OF ENDOSPERM

1. In many seeds, the endosperm is the storage tissue rich in reserve food materials like carbohydrates, fats and proteins. During seed germination, these substances are digested and utilized for the growth of seedling.

2. The young endosperm is rich in growth hormones like auxins, gibberellins and cytokinins. The coconut and corn endosperm milk are rich in hormones and they are employed in tissue culture techniques. The young endosperm of maize contains a cytokinin called zeatin.

3. Apart from being a nutritive tissue, endosperm also regulates the precise mode of embryo development. In the absence of endosperm, very young embryos often fail to mature even in the richest artificial nutrient medium.

18.1.6 SUMMARY

Endosperm is a nutritive tissue developed from Primary Endosperm Nucleus (PEN) which is a product of triple fusion. Generally, it is a triploid tissue. It provides nourishment for the developing embryo. In angiosperms, three types of endosperm developments are recognised. They are nuclear, cellular and helobial type. All the three types of endosperm possess haustoria. These haustoria penetrate into the surrounding tissue of embryosac and absorb nutrients. The haustoria may be micropylar or chalazal.

In some families, the surface of endosperm shows irregularity and unevenees and it is called ruminate endosperm. Rumination may be caused by the activity of seed coat or by the endosperm itself.

Usually endosperm is completely consumed by developing embryo. So that seeds lack endosperm. Such seeds are called non-endospermic seeds. Some mature seeds have endosperm which support the embryo during seed germination. Such seeds are called endospermic seeds.

18.1.7 TECHNICAL TERMS

Endosperm, Albuminous seeds, nuclear type, cellular type, helobial type, haustoria, rumination, growth hormones, tissue culture technique.

18.1.8 MODEL QUESTIONS

Essay Type Questions

1. Describe the various types of endosperm development in Angiosperms.

Short Answer Questions

1. Ruminate Endosperm
2. Endosperm haustoria

18.1.9 REFERENCE BOOKS

1. **An Introduction to the Embryology of Angiosperms –** P. Maheswari.
2. **Endosperm - Its Morphology, Ultrastructure and Histochemistry –** S.P. Bhatnagar and V. Sawhney.
3. **Unified course in College Botany –** Khan and Khanum.

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S.V. PADMAJA

Unit-IV

Lesson 18.2

E M B R Y O

CONTENTS

18.2.1 OBJECTIVE

In Angiosperm, fertilization results in the formation of zygote. This zygote gives rise to an embryo. The main aim of this lesson is to know the development of zygote into embryo. The structure of embryo in dicots and monocots and developmental stages of embryo area also discussed in this lesson.

18.2.2 INTRODUCTION

In Angiosperms, the male and female gamete fuse, to form zygote. This fusion is called syngamy. The zygote gives rise to an embryo, which has the potentiality to form a complete plant. Depending upon the species, zygote gives rise to either dicotyledonous or monocotyledonous embryo. The monocot embryo differs from that of a dicot embryo mainly in having only one cotyledon. Although in dicots and monocots, embryo development begins in the same way but there is considerable in the stages.

18.2.3 ZYGOTE

After its formation, the zygote undergoes a period of dormancy which varies with species. Generally, this period is shorter where the endosperm is cellular than where it is nuclear. In Angiosperms, the zygote is situated towards the micropylar side of the embryosac. The basal portion of the zygote is attached to the embryosac wall, whereas the apical part projects into the central cell.

The size of the zygote is reduced due to the shrinkage of vacuole. The cytoplasm accumulates at the chalazal end where the first division of zygote takes place. The nucleus which is located at chalazal end is surrounded by the cell organelles like plastids, mitochondria ribosomes, endoplasmic reticulum etc. The micropylar end of the zygote is occupied by one or more vacuoles and the number of cell organelles in this region is extremely small.

18.2.4 DICOT EMBRYO

A typical dicot embryo comprises an embryonal axis with two catyledons attached to it laterally. The portion of embryonal axis above the level of cotyledons is called epicotyl and the portion below the level of cotyledons is known as hypocotyl. The epicotyl terminates into plumule (embryonic shoot) and the hypocotyl at its lower end bears radicle (embryonic root).

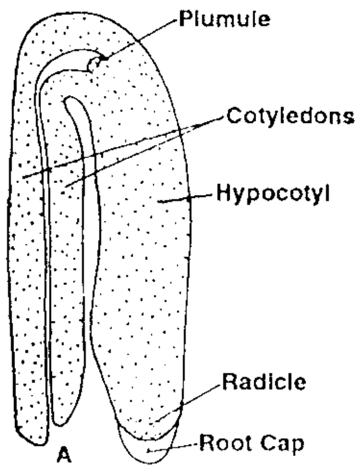

Fig. 18.9 Median longitudinal section of Mature dicot embryo

The zygote divides transversely into two cells. The small cell situated towards the chalazal end is called apical cell (ca) and the large cell situated towards the micropylar end is called basal cell (cb). From the 2-celled stage until the initiation of organs, the embryo is commonly called pro-embryo.

Based on the plane of division of the apical cell (ca) in the 2-celled proembryo and the contribution of the basal cell (cb) and apical cell in the formation of embryo proper, five types of embryogeny have been recognised by Maheswari in dictors.

(1) The apical cell of the 2-celled pro-embyro divides longitudinally:

(a) **Crucifer type or onagrad type:** The basal cell plays only a minor role or none in the development of the embryo. E.g. Annonaceae, Brassicaceae, Onagraceae, Ranunculaceae.

(b) **Asterad type:** Both apical and basal cells contribute to the development of the embryo.

E.g. Asteraceae, Vitaceae, Violaceae, Balsaminaceae.

(2) The apical cell and the 2-celled pro-embryo divides transversely:

(a) **Solanad type**: The basal cell usually forms a suspensor. E.g. Solanaceae, Theaceae, Linaceae, Companulaceae.

(b) **Caryophyllad type**: The basal cell does not divide further and if suspensor is present, it is derived from apical cell. E.g. Caryophyllaceae, Crassulaceae, Haloragaceae.

(c) **Chenopodiad type**: The basal and apical cells both contribute to the development of embryo.

E.g. Boraginaceae, Chenopodiaceae.

Johansen (1950) has recognised a sixth type of embryogeny called piperad type. This type of embryogeny occurs in those cases where first division of the zygote is vertical.

E.g. Loranthaceae, Piperaceae.

Generally, the type of embryogeny is constant throughout a family. But, rarely, the same species may show more than one type of embryo development.

E.g. Anemone rivularis. (Solanad and crucifer type occur).

18.2.4.1 Development of Embryo (Crucifer type)

The embryo development in Capsella bursa pastoris (Cruciferae) was first studied by Hanstein and Famintin. This represents the typical dicot and crucifer type of embryogenesis.

1. The zygote divides transversely forming a small apical cell (ca) and a large basal cell (cb).

2. The basal cell divides transversely forming two superposed cells ci and m. The apical cell divides vertically to form two jextaposed cells. Thus a '⊥' shaped 4-celled proembryo is formed.

3. The two cells of apical cell divide by another vertical division at right angles to the first division forming a quadrant 'q' (four cells). This is called as the quadrant stage.

4. In the four cells, a transverse division takes place, results in the formation of eight cells. They arranged in two tiers of four cells each. This stage is known as the octant stage.

5. Upper tier is known as epibasal tier (l) and lower tier is known as hypobasal tier (l_1). The cells of epibasal tier give rise to plumule and cotyledons whereas hypobasal tier gives rise the hypocotyl.

6. In the peripheral cells of proembyo periclinal divisions occur to form outer dermatogen cells and inner cells. The Outer dermatogen cells divide to form the epidermis of the embryo. The inner cells divide by vertical and transverse divisions to differentiate an outer layer of periblem and central plerome. The cells of periblem and plerome give rise to the cortex and stele respectively.

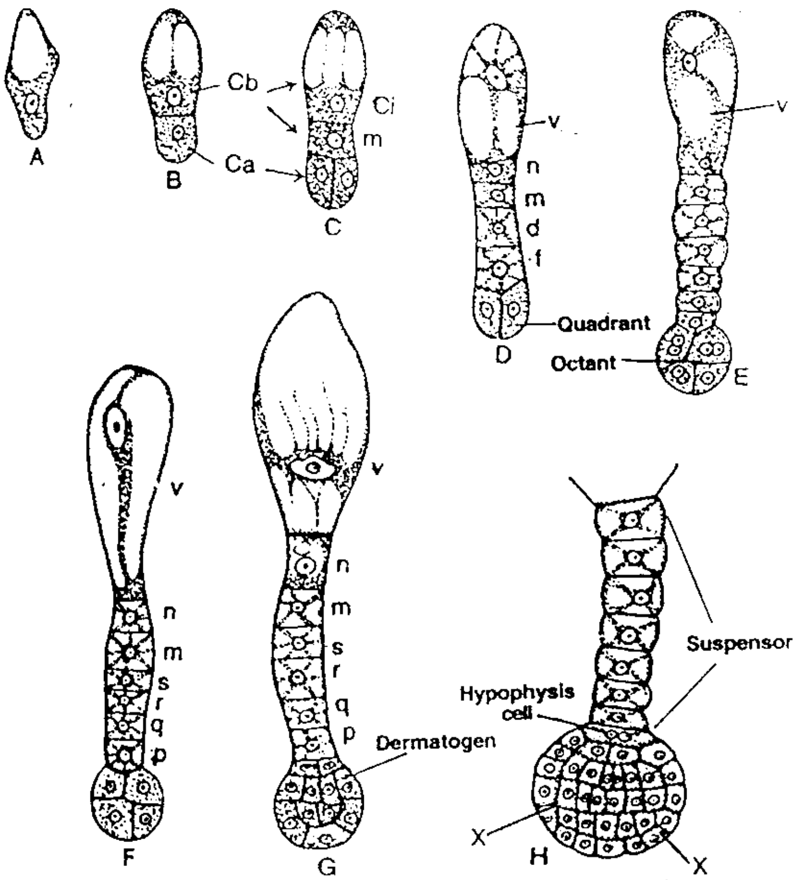

Fig.18.10 Crucifer type of Embryo sac-
Capseilia bursa pastoris **ca** – Apical cell, **cb** – Basal cell, **P to M** – suspensor, **V** – vesicle, **H -** hypopysis

7. As these developments are taking place, the two basal cells (m and ci) of the 4-celled proembryo divide transversely to form a 6-10 celled long filament called the suspensor. The suspensor pushes the growing embryo deep into the nourishing tissue of endosperm.

8. The basal cell of the suspensor (facing the micropyle) enlarges to form a vesicular cell (v), the haustorium.

9. The upper cell of the suspensor (lying adjacent to embryo proper) functions as the hypophysis cell. This cell by further divisions gives rise to the embryonic root and root cap.

10. In the cells of l and l_1 tiers of octant embryo, vertical divisions takes place to form a globular proembryo. In the cells tier 'l', active cell divisions occur soon at two places resulting in the formation of the lateral outgrowths for the cotyledons. A few cells situated at the base of the cotyledon primordia constitute the shoot apex. It is therefore terminal in position. The cells of tier 'l_1' divide and differentiate into the hypocotyl and the basal part of the cotyledons.

11. At the stage, the embryo becomes heart shaped as seen in longitudinal section. The hypocotyl as well as the cotyledons enlarge very much and the embryo becomes curved like a horse-shoe with the two cotyledons lying parallel to the long axis. Thus a mature dicot embryo shows two parallel cotyledons and a terminal stem tip.

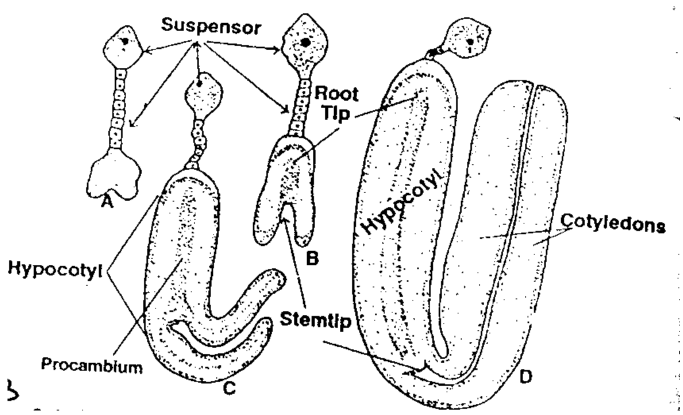

Fig. 18.11 Later stages in the development of embryo of *Capselia bursa pastoris*

18.2.5 MONOT EMBRYO

A typical monocot embryo is somewhat cylindrical and comprises a single cotyledon which is in terminal position and the shoot apex which occupies a lateral position. The embryo development in monocots is almost similar to dicots upto the octant stage, but the differences appear later. The main difference between the mature embryos of monocots and dicots is in the number of cotyledons and position of stem tip.

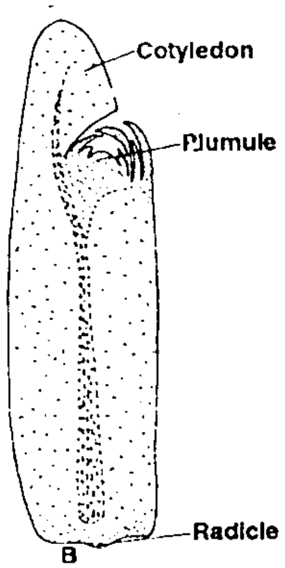

Fig. 18.12 Mature monocot embryo

18.2.5.1 Development of Monocot embryo

The embryo development in *Luzula forsteri,* a member of the family Juncaceae can be taken as typical of monocotyledons.

1. The zygote divide by transverse division results in a small apical cell (ca) and a large basal cell (cb).
2. The apical cell (ca) divides by a vertical wall forming two juxtaposed cells. The basal cell divides transversely forming two superposed cells ci and m. So that '⊥' shaped four called proembryo is formed.

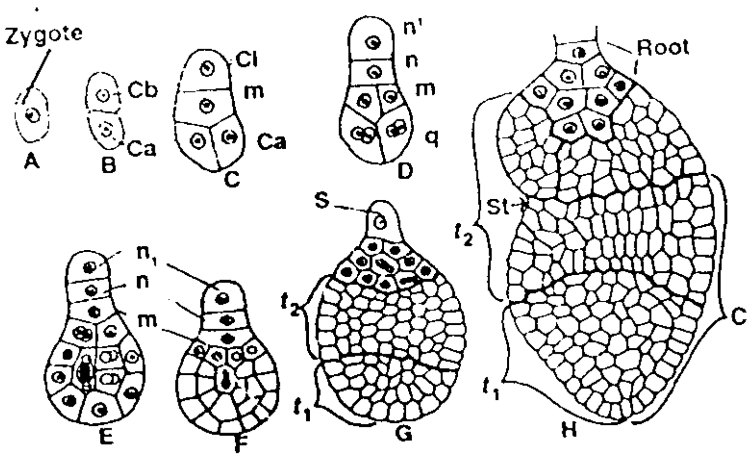

Fig. 18.13 Stages in the development of embryo in Luzula
C-Coctyledon, **St**-Stem tip, **S**-Suspensor

3. The two cells of Ca undergo another vertical division at right angles to the first, forming a quadrat (q).

4. Now the quadrant 'q' divides by periclinal division cutting four epidermal initials surrounding the four central cells.

5. By a transverse division, the quadrant becomes two tiered – l and l_1. The tier l gives rise to the lower half of the single large cotyledon. While the tier l_2 gives rise to the remaining part of the cotyledon, hypocotyl and the plumule.

6. Of the two cells of basal cell (cb), cell-m divides by vertical wall to form two juxtaposed cells and cell – ci by transversed division forms two cells n and n_1.

7. The tier - 'm' gives rise to the periblem and part of the root cap. n – to the remaining part of the root cap ad n_1 – to the short suspensor.

An important point in the embryogeny of Luzula is the differentiation of the epidermal initials. They cut off immediately after the quadrant stage while in other angiosperms this occur after the octants are formed.

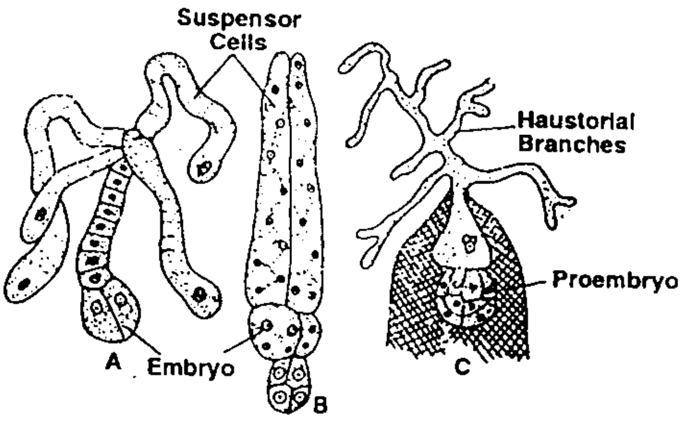

Fig. 18.14 Suspensor haustoria
(A) Dicraea, (B) Myriophyllum, (C) Sedium

18.2.6 SUSPENSOR

The formation of suspensor is a constant feature in the development of embryo in angiosperms. It develops as an ephemeral organ near the radicle. In majority of plants, it has no special function except that it pushes the embryo deep into the nutritive tissue of the endosperm. This helps in the continuous supply of food materials to the embryo at the time of seed germination.

In Loranthaceae, the embryo sac grows upto various heights in the style. The egg is fertilized at the tip of the embryo sac in the style. Hence in these plants, the suspensor is exceptionally to long so that it is able to bring the embryo down into the endosperm from the style.

In some plants, the suspensor cells become enlarged and give rise to prominent haustoria. Occurrence of suspensor haustoria was first observed by Lyod in some Rubiaceae members. Extensively developed suspensor haustoria were observed in families where emdosperm is absent.

E.g. Orchidaceae, Podostemaceae, Trapaceae, Suspensor haustoria are also commonly found in the families (rassulaceae, Fumariaceae, Leguminosac etc.)

In sedum (Crussulaceae), the apical cell of the 2-celled proembryo forms the embryo as well as the 4-celled suspensor. The basal cell elongates and forms a much branched and aggressive haustorium.

In Myriophyllum, the two celled proembryo consists of a small terminal cell and a large basal cell. The basal cell divides longitudinally forming two daughter cells, which expand laterally forming wing-shaped haustoria.

18.2.7 SUMMARY

In angiosperms fertilization results in the formation of zygote. The zygote develops into an embryo. Based on the number of cotyledons in an embryo, angiosperms are classified into dicotyledons and monocotyledons.

In a dicot embryo, there is an embryonal axis and two cotyledons on either side of it. The upper end of embryonal axis bears plumule and at lower end there is radical.

In monocot embryo, there is a single cotyledon which is in terminal position and the shoot apex which occupies a lateral position.

The monocot embryo differs from that of a dicot embryo mainly in having only one cotyledon and the position of stem tip.

The early stages embryo development is same in both dicots and monocot but it shows considerable differences in the later stages.

The formation of suspensor is a constant feature in the development of embryo in angiosperms. It develops as an ephemeral organ near the radicle and pushes the embryo deep into the nutritive tissue.

18.2.8 TECHNICAL TERMS

Embryogeny, Proembryo, embryonal axis, plumule, radicle, haustorium, suspensor.

18.2.9 MODEL QUESTIONS

Essay Type Questions

1. Describe the development of dicot embryo in angiosperms.
2. Describe the development of monocot embryo in angiosperms.

Short Answer Questions

1. Suspensor
2. Crucifer type of embryo development

18.2.10 REFERENCE BOOKS

1. **The Embryology of Angiosperms –** S.S. Bhojwani and S.P. Bhatnagar.
2. **Unified Course in College Botany,** Vol. II – Dr. Govind Prakash.

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S.V. PADMAJA

Unit-IV

Lesson 18.3

POLYEMBRYONY

CONTENTS

18.3.1 OBJECTIVE

The main aim of this lesson to know what is the polyembryony, causes for polyembryony, types of polyembryony. Significance of polyembryony is also discussed in this lesson.

18.3.2 INTRODUCTION

Polyembryony has been defined as the presence of more than one embryo in a seed. Polyembryony was first reported by Leeuwenhock (1919) in orange seeds. The name polyembryony was proposed by Braun (1859). Except for a few taxa (Citrus, Mangifera), polyembryony occurs only as an abnormal feature.

Additional embryos may be diploid or haploid Embryos developed from nucellus, integuments, zygote are in diploid condition where as those developed from synergids and andpodals are in haploid condition.

Classification of Polyembryony: Polyembryonic condition may arise spontaneously or it can be induced experimentally.

18.3.3 POLYEMBRYONY TYPES

Ernst divided spontaneous polyembryony into two types:

(a) **True polyembryony:** More than one embryo appears within one embryosac. Additional embryos may develop from zygote, proembryo, synergids, antipodal cells, nucellus or integument.

(b) **False polyembryony:** Development of embryos in more than one embryosac in the same ovule.

Yakovlev (1967) has proposed a classification of Polyembryony on genetic basis. He classified spontaneous polyembryony into two types.

(a) **Gametophytic:** Additional embryos arise from any gametophytic cell of the embryo sac after or without fertilization.

(b) **Sporophytic:** Additional embryos arise from the zygote, proembryo or the sporophytic cells of the ovule (nucellus and integuments).

18.3.4 POLYEMBRYONY IN ANGIOSPERMS

In angiosperms, the polyembryony may arise by any one of the following manner:

(1) Cleavage of proembryo (cleavage polyembryony).

(2) Formation of embryos from the cells of the embryosac other than the egg.

(3) Development of more than one embryosac within the same ovule.

(4) Activation of some sporophytic cells of the ovule (Adventive polyembryony)

18.3.4.1 Cleavage Polyembryony

Cleavage Polyembryony is simplest method by which the embryos increase in their number. The zygote or proembryo splits or cleaves into two or more units. Each unit develops into an embryo. Proliferation of zygote or its derivatives may also develop into embryos. All the developed embryos are identical.

Among gymnosperms, cleavage polyembryony is a common feature but in angiosperms, it is less frequent. Among angiosperms cleavage polyembryony is quite common in orchids. Swamy recorded three different modes of embryo formation in Eulophia epidendraea.

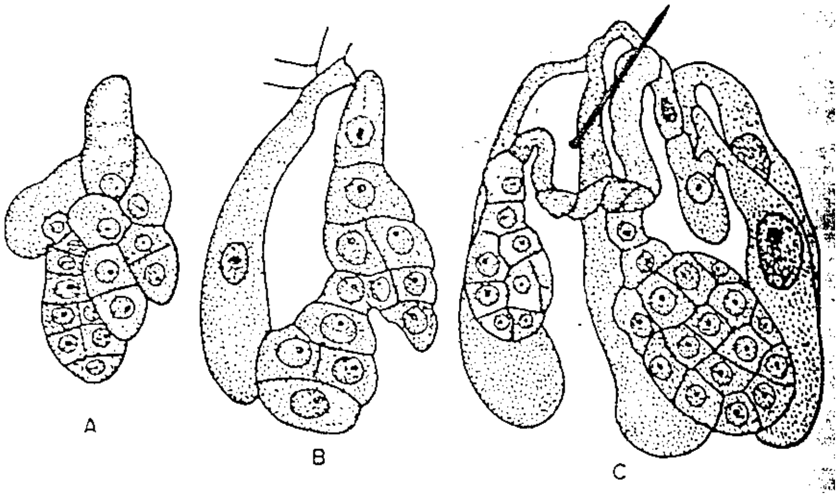

Fig. 18.15 Cleavage Polyembryony
A. Embryos arising from zygote, **B**. Bud arising from embryo,
C. Splitting of a single embryo into two.

1. The zygote divides irregularly to form a mass of cells, of which those lying toward the chalazal end grow simultaneously and give rise to multiple embryos.
2. The proembryo gives out small buds or outgrowths which themselves function as embryos.
3. The filamentous proembryo becomes branched, and each branch gives rise to an embryo.

Generally, polyembryonic condition arise during seed development in many orchids, but only in Vanda it arises during seed germination.

In Cymbidium bicolor, the zygote divides vertically or obliquely, the daughter cells get somewhat separated and divide further to form two independent proembryos.

Suspensor polyembryony

Suspensor polyembryony is a common feature in the members of Acanthaceae and Solanaceae. In Exocarpus (Santalaceae) as many as six embryos may develop simultaneously in an ovule by the proliferation of the suspensor cells. However, only one of them reaches maturity. In zygophyllum fabago, the suspensor embryos may develop up to the heart shaped stage.

18.3.4.2 Embryos from cells of the embryo sac other than the egg

Cells of embryosac other than the zygote may also develop into embryos, i.e., from synergids and antipodal cells.

(a) Embryos from synergids: The additional embryos may develop from synergids. Embryos developed forms fertilized synergids are diploid while unfertilized synergids are haploid.

In Aristolochia, Sagittaria and Poa one or both synergids are also get fertilized. This is brought about either by the entry of more than one pollen tube in the embryosac or by the presence of more sperms in the same pollen tube. In such a situation, the zygotic as well as the synergid embryos are diploid.

In some taxa, unfertilized synergids also develop into embryos. These embryos are haploid in nature. E.g. Argemone mexicana, Phaseolus vulgaris, Lilium and Plantago. The mechanism of stimulus that induces the unfertilized synergid to develop into an embryo is not yet clearly understood.

(c) Embryos from Antipodal cells: Formation of embryos from antipodal cells is a rare feature. It has been observed in *Paspalum scrobiculatum*, *Ulmus americana*, *V. glabra*. The antipodal cells may divide a few times to form proembryo like structures. However, they fail to grow into adult embryos. There is no suggestion of antipodals forming germinable embryos.

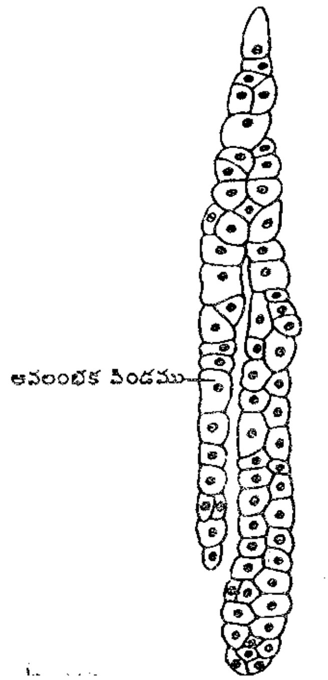

Fig. 18.16 Suspensor Polyembryony

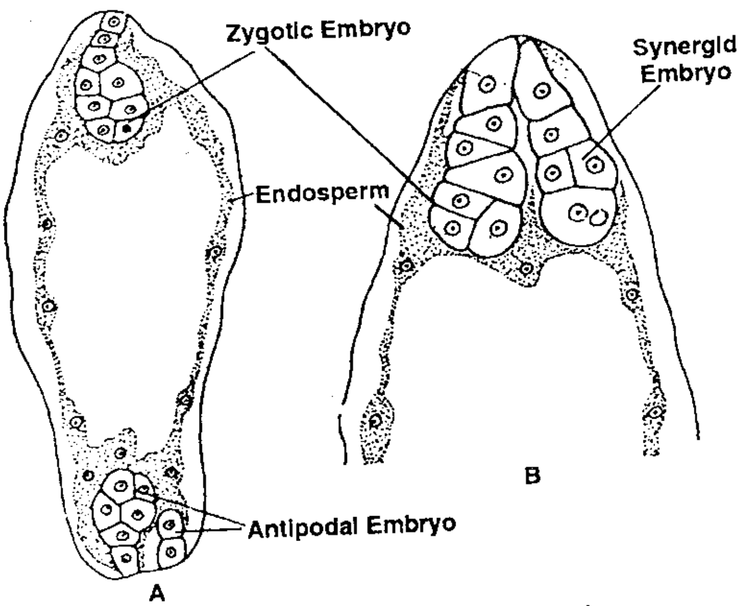

Fig. 18.17 Synergid and antipodal embryos
(A) Embryosac of Ulmus (B) Embryosac of Aristolochia

18.3.4.3 More than one embryosac in the ovule

Polyembryonic condition may also arise as a result of development of more than one embryosac within the same ovule. These multiple embryosacs in an ovule may arise from:

(a) Derivatives of the same megaspore mother cell.
(b) Derivatives of two or more megaspore mother cells.
(c) Nucellar cells.

Formation of twin embryo sacs within an ovule is known as Casuarina equisetefolia, Citrus, Poa pratensis. In *Pennisetum ciliare*, 22 per cent seeds contain twin embryos. The normal embryosac develops only upto 4-nucleate stage and the multiple embryos are formed by aposporous embryosacs.

In Loranthaceae, conventional ovules are absent. Numerous embryo sacs develop concurrently in the same ovary and their tips carrying the egg apparatus grow upto various heights in the style. After fertilization, the embryos grow downward and enter the composite endosperm in the ovarian cavity. All embryos except one collapse during seed development resulting in monoembryonate seeds. Occasionally, however, two or more embryos may mature (composite endosperm is formed as a result of fusion of endosperms of all the embryosacs in the ovary).

18.3.4.4 Adventive Polyembryony

Formation of embryos from sporophytic cells of the ovule. The embryos arising from the tissues outside the embryosac are called adventive embryos. These tissues are maternal sporophytic tissues, such as nucellus and integuments.

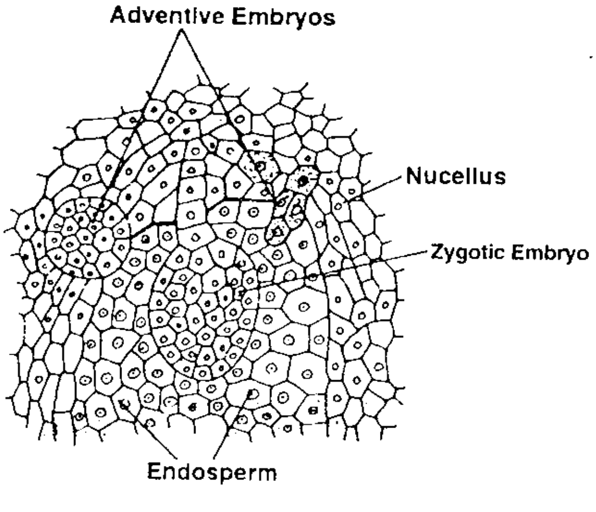

Fig. 18.18 Adventure polyembryony -Citrus

(a) Nucellar Polyembryony: Adventive embryos developed from nucellar tissue. E.g. Citrus, Mangifera, Opunlia, Trillium undulatum. Nucellar embryos arise from the micropylar half of the nucellus except in some plants like Trillium undulatum. The nucellar cells destined to form embryos, can be distinguished from other cells of the nucellus by their dense cytoplasm and starchy contents. The inception of nucellar embryos takes place outside the embryosac but they are gradually pushed into the embryosac cavity where they divide and differentiate into mature embryos.

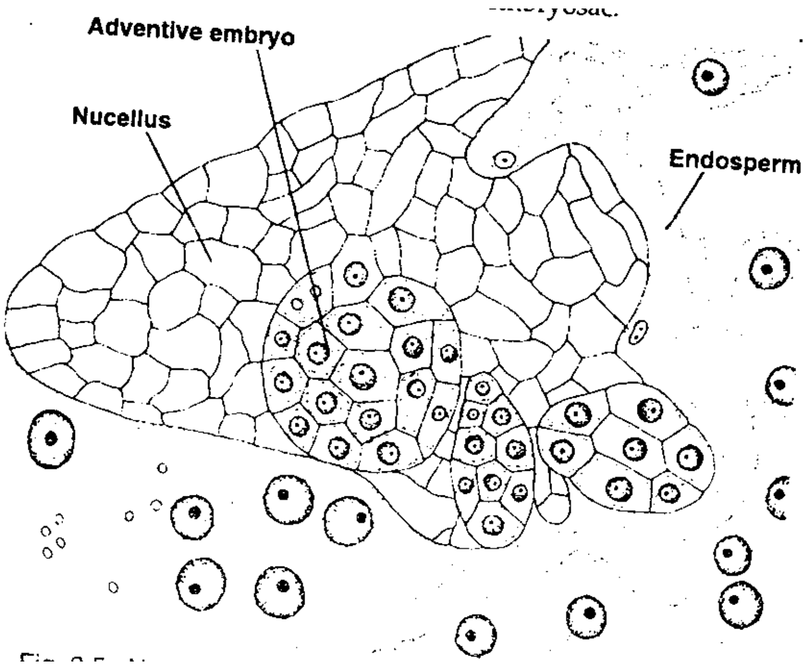

Fig. 18.19 Nuclear embryo growing into the embryosac cavity in *Mangifera indica.*

Nucellar embryos can be distinguished from the zygotic embryo by their lateral position in the embryosac, irregular shape and lack of suspensor. However, the nucellar embryos possess suspensor in *Citrus microcarpa*.

Some Citrus species are monoembryonate. E.g. C. grandis, C. lemon. While some are polyembryonate. E.g. C. microcarpa, C. reticulata. In C. unshiu, as many as 40 embryos have been reported in a single seed. In polyembryonate species, the adventive embryos arise by the proliferation of the nucellar cells.

In *Mangifera indica* also as many as 50 embryos have been observed in a single seed.

In *Opuntia dillenii* the egg degenerates at very early stage. Later several nucellar embryos develop and one of them reaches upto the mature stage.

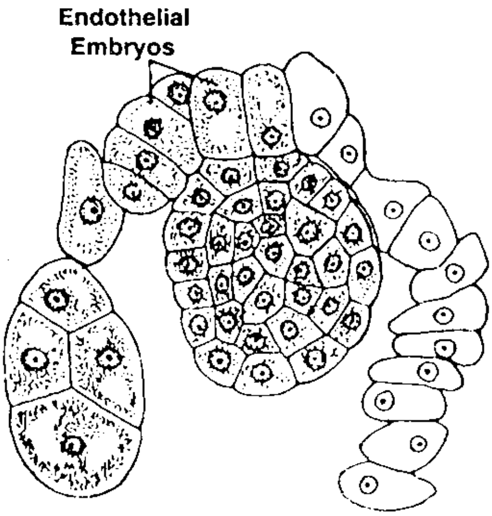

Fig. 18.20 Endothelial polyembryony in *Melampodium divaricatum*.

(c) Integumentary polyembryony: In this type, adventive embryos develop from the cells of integument. E.g. Spiranthus, Euonymus. Development of such embryos are not dependent on the fertilization of the egg.

In *Spiranthus cemua*, the cells of inner integument develop into embryos. Normally formed embryosac degenerates at 4-nucleate stage and the integumentary cells rich in cytoplasm divide to form 2-6 proembryos in the micropylar side. These pseudoembryos, however, do not differentiate further.

In Euonymus, the epidermal and subepidermal cells of the inner integument, both at the micropylar and chalazal regions develop into embryos.

In unitegmic, tenuinucellate ovules, the inner most layer of the inner integument differentiates as endothelium or integumentary tapetum. These endothelial cells may develop into proembryos. However, they never reach maturity.

E.g. *Melampoidum divaricatum, Carthamus finctorius.*

Naumova reported that nucellar polyembryony is commonly found in crassinucellate ovules (Citrus, Optuntia), while integumentary polyembryony is found in tenninucellate ovules. E.g. Euonymus.

18.3.5 CAUSES OF POLYEMBRYONY

Many theories have been put forward to explain the occurrence of polyembryony but none is sufficiently validated. Some of them are:

(1) **Nechrohormone theory:** It is proposed by Haberlandt. According to this theory, the degenerating cells of the nucellus is the source of stimulus for the adjacent cells to divide and form adventive embryos. However, due to lack of experimental proof, this theory was not accepted.

(2) Kappert (1933) and Maheswari and Rangaswami (1958) opined that polyembryony is a recessive character controlled by a series of multiple genes.

(3) Leroy (1947) also supported the view of Kappet. He thought that in mango polyembryony was caused by one or more recessive genes. He believed that monoembryonate condition is due to dominant gene, which is found in the primary centre of its origin, like India. The polyembryonate condition arose due to recessive genes and is found in places of secondary origin, like China, Sudan, Phillippines etc. This theory is not fully correct because some Indian varieties of mango viz., Bambai, Fazli and Langra are polyembryonate.

(4) Frasato *et al*., (1957) showed the embryo number in citrus seeds may be influenced by the following factors.

(a) Age of the tree increasing in older trees.
(b) Fruit set - higher in years of higher fruit-set.
(c) Nutritional status of the plant - decreasing with reduced food supply.
(d) Orientation of the branch of the tree – being higher on northern than on southern branches.

18.3.6 SIGNIFICANCE OF POLYEMBRYONY

Polyembryony plays an important role in horticulture, genetics and plant breeding. Nucellar adventive polyembryony is of great significance in horticulture because it provides uniform seedlings of the parental type which are obtained through vegetative propagation by cuttings. The nucellar polyembryony is the only method of raising virus free clones of citrus varieties. Desired genotypes may also be obtained through somatic embryos formed in cultures. Haploids are of great economic importance in genetics and plant breeding studies because homozygous diploids can be obtained from them by colchicin treatment.

18.3.7 SUMMARY

The presence of more than one embryo in a seed is called the polyembryony. Polyembryony was first reported by Lecuwenhock in orange seeds. In angiosperms polyembryony may be formed by any one of the following ways. The zygote or proembryo cleaves into units and each unit develops into an embryo. This is called cleavage polyembryony. Additional embryos may be formed from the cells of embryosac other than egg or from the sporophytic cells of the ovule (integment and nucellus). Additional embryos may be formed due to the presence of more than one embryosac in the same ovule.

Many theories have been put forward to explain the occurrence of polyembryony. Polyembryony plays an important role in horticulture and plant breeding. Adventive polyembryony is of great significance in horticulture because it provides uniform seedlings of the parental type.

18.3.8 TECHNICAL TERMS

True polyembryony, False polyembryony, cleavage, Polyembryony, adventive polyembryony, necrohormone.

18.3.9 MODEL QUESTIONS

18.3.9.1 Essay Type Questions

1. What is polyembryony? Describe various types of polyembryony in angiosperms.

18.3.9.2 Short Answer Questions

1. Cleavage polyembryony
2. Adventive polyembryony
3. Causes of polyembryony
4. Significance of polyembryony

18.3.10 REFERENCE BOOKS

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2. **College Botany –** Khan & Khanum.
3. **Unified Course in Botany, Vol. III –** Dr. Govind Prakash – Jai Prakash Nath Publications, Meerut.
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S.V. PADMAJA

Unit-III

UTILIZATION OF PLANTS

Food Plants

Rice or Paddy

Bot. name – *Oriza sativa* L.
Ver. names – Dhaan, Chawal, Vadlu
Family – Poaceae (Gramineae)
Morphology of useful product – Edible part is the Grain. It is called Caryopsis. This is the main staple food of large sections of world population. It is used as plain boiled rice, bran the important by product of rice milling industry is used as a cattle feed. Bran oil is used as edible oil rice straws is used as cattle feed.

Wheat

Botanical name – *Triticum aeaestium* Linn.
Family – Gramineae or Poaceae
Vernacular name – Wheat, Godhuma, Gehu
Morphology of useful product – Edible part is grain called Caryopsis.
Wheat and wheat products constitute an important source of carbohydrates in human diet. In India – 80-90% of it is used in the form of chapathies, roti, parota and poori etc. Industrically it is used in the manufacture of starch, gluten, malt, distilled spirit etc. Wheat straw is used as livestock feed stuff.

Maize

Botanical name – *Zea mays* L.
Ver. name –Maize, Corn, Mokkajonna
Family - Poaceae

Morphology of useful product – From tassel to root, the maize plant is useful. About half of the maize crop is fed to livestock as grain and fodder. Corn oil is used for cooking purposes and also in the manufacture of soaps, varnishes, paints and other similar products. Maize grains are fermented and distilled to get industrial products such as ethyl, butyl, and propylalcohals, acetaldihyde, acetone, glecerol, citric, acetic and lactic acids.

Potato

Botanical name – *Solanum tuberosum* Linn.
Ver. name – Alu, Urlagadda, Bangaladumpa
Family - Solanaceae
Morphology of useful product – The underground stem tuber is the most useful product.

Potatoes are mainly used as food, either boiled or roasted. Potatoes may be pulped and fermented to produce alcohol and potato spirits.

Sugarcane

Botanical name – *Saccharum officinarum* Linn.
Ver. name – Sugarcane, cheraku
Family - Poaceae

Morphology of useful product – Stem is used for the extraction of sugar. This plant is mostly used in the manufacture of 3 products. Jaggery, white sugar and Khandasari. The major byproduct during the manufacture of sugar is molasses. Press mud is used as a manure. Cane trash and cane tops are used as feed to cattle and elephants. Molasses is used as an important bye product of the cane sugar industry, is widely used as livestock feed for making alcoholic drinks such as rum and for the manufacture of a number of chemicals.

Fibre Yield Plants

Fibres are often grouped into 3 types according to their botanical origin.

1. Soft stem or bast fibres – Flax, Jute, hemp
2. Hard, leaf or structural fibres – Manila hemp.
3. Surface fibres – cotton, kapok.

Jute

Botanical name – *Corchorus* sps.
Ver. name – Bengal jute, Janumu
Family - Tiliaceae

Jute is an important textile fibre. The jute fibre is spun into yarn and are used for fabrics and package material. The jute fibre is obtained from the stem of two cultivated species - *C. capsularis* and *C. olitorious*.

The jute is used for the manufacture of hessian (coarse cloth), ropes etc. It is used in the manufacture of gunny bags, potato sacs etc. The woody material also used in different ways. The leaves and young shoots are used as vegetables in India, Europe, Sudan and Greece. The leaves are used in Ayurvedic medicine as a remedy for pains, dysentery, enterities, fever and turnors.

Cotton

Botanical name – *Gossypium* sp.
Ver. name – Kapas, Pathi
Family - Malvaceae

Cotton is one of the oldest fibre plants to be known. Today cotton is an important fibre crop, grown in 70 countries in the world. *G. hirsutum, G. orboreum, G. herbaceum, G. berbadense* are the some of the important species. The fibres are used for clothing, household and industrial articles. The articles of cloth include – shirtings, outer-wear, under-wear, gloves hosiery and hand kerchiefs. Hosuehold articles include bed sheets, pillow cases, towels, mosquito nets etc. Unspun and raw cotton is used for stuffing cushions, pillows, mattresses etc. Gun cotton is obtained by treating cotton with con nitric acid. Cotton seed oil is used in the manufacture of Vanaspathi, pharmaceutically cotton seed oil is used as a emollient.

Vegetable Oils

According to their ability to absorb oxygen from the atmosphere vegetable oils are generally classified into 3 types.

1. Non drying oils, 2. Semi drying oils, 3. Drying oils.

Groundnut

Botanical name – *Arachis hypogea* L. (n = 20)
Ver. name – Peanut, Verusenaga
Family - Fabaceae

Groundnuts are the second largest source of vegetable oils, the largest being the soyabean. The seeds are pressed to obtain oils. The oil is used for cooking; low grade oil is used in the manufacture of soaps. The oil cake of groundnut is a high-protein livestock feed. The green haulms make excellent fodder. Textile fibre “ardil” is manufactured from peanut protein. The shells of the pods and dried plant stocks are used as a boiler fuel. Medicinally the oil is used as a mild laxative.

Mustard oil

Botanical name – *Brassica nigra* sps.
Ver. name – Rai, Indian mustard, Avalu
Family - Brassicaceae

Mustard oil is used as a condiment in the preparation of pickles and for flavouring curries and vegetables. Oilcake is mostly used as livestock feed in India, and used as fertilizer in Japan and in India. Green leaves are used as leafy vegetable.

Coconut

Botanical name – *Cocos nucifera* L. (n = 16)
Ver. name – Coconut, Nariyal, Kobbari
Family – Palmae (Arecaceae)

Coconut oil serves as an edible oil, hair oil and as ingredient in soap manufacturing. It is also used in the manufacture of lubricants, detergents, cosmetic and hydraulic brake fluids for aeroplanes. Cake is used as a cattle feed and also as fertilizer. The coir is used in making ropes, twines, ophosstery, cushions, brooms, coir yarn and in hard boards. The fresh kernels are eaten raw and in the preparation of puddings, sweets, curries and chutneys. Coconut milk contains plant growth substances and so it is used in the experimental culture of plant tissues.

Wood Yielding Plants

The wood is used as fuel, as a raw material for paper and rayon industries and for construction purposes.

Teak

Botanical name – *Tectona grandis* Linn. f (n = 12, 18)
Ver. name – Teak, Rangoon or Burma Teak, Sagauon, Kalapa.
Family - Verbenaceae

Teak is very durable and hence is used as a standard for comparison for other timbers. It is the chief railway carriage and wagon wood of India. It is used for ship building, boats, masts and in the construction of bridges. It is used in house construction, cabinet making tables, chairs, sofas etc. It is also used for making agricultural implements and paper pulp. The flowers are used medicinally, for relieving kidney troubles.

Rosewood (Bombay Blackwood)

Botanical name – *Dalbergia latifolia*
Ver. name – Shisham, Chittegi, Irugu, Jittagi
Family - Fabaceae

Indian rosewood ranks among the finest woods for making furniture and cabinet work. It is also used for making railway sleepers, musical instruments, hammer handles, shoe heels, tobacco pipes etc. The leaves are used as fodder. The bark of the tree contains tannin. It is grown in coffee plantations as a shade tree.

Sandal wood

Botanical name – *Santalum album*
Ver. name – Sandal wood, Chandan, Gandha.
Family - Santalaceae

The heart wood is scented. The sandal is harvested invariably by uprooting but not by cutting. Snadalwood is one of the finest material for carving idols, figurina, caskets. The power is used in religious carmonies. Sandal wood oil is used in the manufacture of scented soaps, talcum powders, face powders, hair oil, creams and in perfumery industries.

Jangli Badam

Botanical name – *Terminalia catappa*
Ver. name – Badam, Indian almond, Hyrobalan
Family - Combretaceae

The timber is used in house-building, wheel-wrights and is used in general carpentry. The kernels of the nuts are eaten at dessert. The leaves act as sudorific and they are applied to rheumatic joints. The juice of the young leaves is used to prepare an ointment for scabies, leprosy and other cutaneous diseases.

Spices

Spices are aromatic vegetable products. They are generally used in a pulverised state. Besides imparting flavour to foods and drinks, they also stimulate apetite, increases the secretion and flow of gastric juices and help in digestion. Most of them are used in different medicines.

Ginger

Botanical name – *Zinger officinal*
Ver. name – Ginger, Adrak, Allamu
Family - zingiberaceae

Useful part is a Rhizome. The characteristic aroma of ginger is due to a volatile oil-ginger oil, with a pungent taste is due to the presence of non-volatile oleoresin-gingerone. It is extensively used in flavouring dishes, baked foods, soft drinks, liquors and processed meat. It is also used in medicine as carminative and digestive stimulant. It makes a valuable drug for rheumatism, piles, pulmonary diseases, dropsy, neuralgia etc.

Turmeric

Botanical name – *Curcuma longa*
Ver. name – Haldi, Pasupu
Family - Zingiberaceae
Useful product – Rhizome

A fine yellow powder is obtained by grinding Rhizomes. It is used largely as spike and a small amount is used for other purposes. It is used to flavour and colour butter, cheese, pickles and other foodstuffs. Medically it is used to aid digestion, and as a blood purifier. Boiled with milk and sugar and is taken as a remedy for common cold.

Cinnamon

Botanical name – *Cinnamomum zeylanicum* (Verum)
Ver. name – Cinnamon, Dalchini
Family – Lauraceae
Useful product – Dried inner Bark.

Cinnamon is commonly used as a spice to flavour various food items. The bark oil is used for flavouring confectionery, pharmaceuticals, soaps and dental preparations. Cinnamon leaf oil is generally preferred to clove oil for the synthesis of vanilla. The bark contains antiseptic and carminative properties. It also checks nausea.

Cloves

Botanical name – *Eugenia caryophyllus*
Ver. name – Cloves, Labanga, Laung, Lavangamu
Family - Myrtaceae
Useful product – Dried, highly aromatic, unopened flower buds.

The flower buds contain essential oil known as deum-caryophilli. It is a mixture of hydrocarbon and an oxygenated oil called Eugenol – a phenol. Clove oil is used in perfumes, in scenting soaps and as an ingredient of tooth paste and mouth washes. It is used for relieving tooth ache. Cloves are used for flavouring pickles, curries sauces and kotcheeps.

Black pepper

Botanical name – *Piper nigrum* L.
Ver. name – Kali Mirch, Miriyalu
Family - Piperaceae
Useful product – Dried unripe fruit

It is employed in the preparation of curry powder, pickles sausages, cakes and confectionery. It is also used for flavouring coffee liquors and tobacco. Medicinally it is a stimulant and carminative.

Savoury seeds

Aromatic cremocarpic fruits of family Apiaceae. The aroma of the umbelliferous species is due to the presence of volatile oils contains in the Vittae.

Caraway seed

Botanical name – *Carum carvi*
Ver. name – Jeera, Ajmoda, Vamu
Family - Umbellifereae
Useful product – Fruit cremocarp

It is used for culinary purposes and flavouring bread biscuits, cakes, cheese, apple sauce and cookies. Oil is used for flavouring soaps, as it seems to have antibacterial properties. Medicinally, caraway seeds act as a mild stomatic and carminative.

Cumin seed

Botanical name – *Cuminum cyminum*
Ver. name – Cumin, safed jeera, jeela karra

It has a strong distinctive pleasant odour. It contains an **volatile oil – 'oil of cumin'**. The dried fruits are commonly called as cumin seed. These are an important ingredient of curry powder and are used mainly in flavouring soups, sausages, pickels, cheese meat dishes, bread and cakes. They are used as stimulant, carminative and stomactic.

Fennel seed

Botanical name – *Foeniculum vulgare*
Ver. name – Fennel, Saunf, Sopu.

Dried seeds are an important ingredient of curry powders and are often used for flavouring soups, meat dishes, sauses, confectionery and also useful in preparation of pickles. It is also a good vermicide against hook worm.

Corinader

Botanical name – *Coriandrum sativum* L.
Ver. name – Coriander, Dhane, Dhaniyalu

Both fruits and leaves are aromatic and can be used for flavouring different food material. The leaves are used as a constituent of curry powders and other spice mixtures.

Medicinal Plants

Plants are one of the important sources of Medicine. Most of the drug plants are wild. Medicinal plants have their value in the chemical substances present in their tissues. The important of these are alkaloids, glucosides, essential and fatty oils resins, gums, mucilages, tannis etc.

Drugs obtained from the roots – Ashvagandha (winter cherry)

Botanical name – *Withania somnifera*
Ver. name – Pulivendrum, Purur gadda, Panneer, Asgand, Ashvagandha.
Family - Solanaceae

The roots have been recommended for high cough and female disorders. It is also useful in all types of skin lesions, ulcers and boils and in reducing pus formation and inflamation of joints and in certain paralytic conditions.

Punarnava

Botanical name – *Boerhaavia diffusa*
Ver. name – Atukamamidi, Punarnava
Family - Nyctaginaceae

Roots of this plant are medicinally important. It stimulate sex impulses. It is also used for relaxing the bronchial muscles during asthma and whooping cough.

Sarpagandha

Botanical name – *Rawvolfia serpentina*
Ver. name – Sarpagandha, Pathala garudi
Family - Apocynaceae

Extracts from roots are used in diarrhoea and dysentry snake-bite and as an anthelmintic. A small amount of rescipine in poultry feed, makes the chicken healthy and stronger.

Ginseng

Botanical name – *Panax ginseng*
Ver. name – Araliaceae
The Indian ginseng is obtained from the plant Trichopus Zeylanicus of Diascoriaceae.

Drugs obtained from Rhizomes

Rhubarb

Botanical name – *Rheum officinale*
Ver. name – Rhubarb
Family - Polygalaceae

Roots and Rhizome of Rhubarb are dried and used as tonic, location and in digestion. These are specially valuable in the disorders of children, such as diarrhoea etc.

Ginger

Botanical name – *Zingiber officinale*
Ver. name – Allamu, Adrak
Family - Zingiberaceae

It is used as spice in the preparation of food items. The rhizomes are carminative, stimulant and aromatic. It also relieves gastric disorders.

Turmeric

Botanical name – *Curcuma longa*
Ver. name – Pasupu, Haldi
Family - Zingiberaceae

It contains an alkaloid – Curcumin, which is having antimicrobial and anti-inflamatory properties. It also acts on common cold.

Drug obtained from Bulb

Garlic

Botanical name – *Allium sativum*
Ver. name – Velluli, Hahsan
Family - Lilliaceae

It has aphrodisiac, diuretic, thermogenic, inse cidal and expectorant properties. Medicinally it is useful in the treatment of colds, asthma, blood pressure and skin diseases.

Drugs obtained from Aerial stems

Ephedra

Botanical name – Ephedra
Ver. name – Ephedraceae

Ephedrine is an alkaloid and is obtained from the dried and fresh branches of stem. This hormone has a stimulatory action on the sympathetic nervous system. It is used for the relief of asthma, hayfever and colds. It is also used to control night wetting

Drugs obtained from Bark

Cinchona

Botanical name – *Cinchona officinalis*
Ver. name – Quinine tree, Fever bark tree
Family - Rubiaceae

The drug quinine is obtained from the thick bark of various species of Cinchoma, one of the most important drug. Quinine is obtained from the bark and is used as a rmedy for malaria. The bark of the tree, is the richest source of quinoline, alkaloids which includes quinine, quinidine, cinchonine, cinchonidine.

Kurchi Bark

Botanical name – *Holorrhena antidysentrica*
Ver. name – Apocynaceae
Family – Pala kodisa, Phala chettu

The bark contains alkaloids belonging to steroidal group. It is used for curing T.B., amoebic dysentry, rheumatism and tooth ache.

Ashoka

Botanical name – *Saraca asoca*
Ver. name – Ceasalpinaceae
Family - Asoka

The useful part is the bark, which is strongly astringent and uterine sedative. It acts directly on the muscular fibres of the uterus.

Drugs obtained from wood

Botanical name – *Pterocarpus marsuplum*
Ver. name – Yegisa, Pitasara, Vijaysar
Family - Fabaceae

The gum obtained from tapping stem is used in diarrhoea and for toothache.

Red sanders

Botanical name – *Pterocarpus santalinus*

Ver. name – Raktachandanam

Family - Fabaceae

The paste of the wood is used to cure inflammation and headache and skin disease.

Drugs obtained from leaves

Senna

Botanical name – *Cassia angustifolia*

Ver. name – Sena, Sunamukhi, Indian Senna

Family – Ceasalpinaceae

The drug is obtained from the dried leaves and is mostly used as laxative and purgative. It also cures skin diseases when mixed with venegar.

Stramonium

Botanical name – *Datura stramonium*

Ver. name – Thorn apple, Dhatura, Vummetta

Family - Solanaceae

It is used as pre-anaesthetic in surgery and obsterics.

Digitalis

Botanical name – *Digitalis purpurea*

Ver. name – Foxglove, Tilpushi

Family - Scrophulariaceae

Digitoxin – is a cardiotonic. It regulates the tone and rhythm of heart beat.

Ocimum

Botanical name – *Ocimum sanctum*

Ver. name – Tulasi

Family - Labiteae

The leaf extract is used as a cure for cold cough and asthma. It is also diureha and carminative.

Drugs obtained from Fruits

Emblica

Botanical name – *Emblica officinalis*

Ver. name – Amla, Racha

Family - Euphorbiaceae

Fresh fruits contains very high percentage of viet. C. 4 also contains a small percentage of tannis, glucose, fats, pectin and minerals. Amla is an ingredient of Chyavanaprash and Triphalachurna.

Nux-vomica

Botanical name – *Strychnos nux* - *Vomica*
Ver. name – Vishamusti, Kuchla, Kajra
Family - Loganiaceae

Alkaloid strychnine is obtained from the seeds. Proper dosage, it relieves paralysis and stimulates the central nervous system.

Drugs obtained from entire plant

Gymnema

Botanical name – *Gymnema sylvestre*
Ver. name – Podapatri, Madhunaseni
Family - Asclepiadaceae

The entire plant is medicinally important. The leaves contain an alkaloid – gymmemic acid. The acid prevents the function of taste buds on the tongue. It also helps in cases diabetis, fever, cough bronchitis.

Phyllauthus

Botanical name – *Phyllanthus amarus*
Ver. name – Nela Vusiri
Family - Euphorbiaceae

It is chiefly used for curing digestive disorders like dyspepsia, colia pain, diarrhoea and dysentry. It is also used in the treatment of dropsy and urinogenital disorders.

Vinca

Botanical name – *Vinca rosea* (*Catharanthus roscus*)
Ver. name – Billaganneru
Family - Apocynaceae

It contains the alkaloids like Ajamalicine, Serpentine, Lochnerin alkaloids. These alkaloids found to lower the white blood cells. Vincristine is one of the anti cancer drug.

Beverages

Tea

Botanical name – *Thea sinensis*
Ver. name – Chai, Tea, Tee
Family - Theaceae

Tea is the most popular non-alcoholic drink. The stimulative effect of tea is due to the pressure of the alkaloid, Theine (2-5%) and Caffeine (2-4%), Aroma and flavour is due to the presence of volatile oil, Theol.

Coffee

Botanical name – *Coffee arobica*

Ver. name – Coffee

Family - Rubiaceae

Coffee is mainly used as beverage prepared from roasted and powdered seeds. Excess use may cause disturbances in digestion.

Rubber Yielding Plants

Para Rubber Tree

Botanical name – *Hevea brasiliensis*

Ver. name –

Family - Euphorbiaceae

Large amounts of rubber are used for pneumatic tyres and tubes. It is also used for surgical appliances, electrical, telephone, radio and T.V. parts. It is also used in the preparation of photographic – adhesive tapes, rubber bands, erasers, combs, nipples etc.

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