Application of Plant Anatomy in Systematics

Plant systematic is a science that includes and encompasses traditional taxonomy; however, its primary goal is to reconstruct the evolutionary history of plant life. It divides plants into taxonomic groups using morphological, **anatomical**, embryological, chromosomal, molecular and chemical data. Anatomical characters of vegetative and floral parts of angiosperms have been successfully employed to solve taxonomic problems and for the elucidation of phylogenetic relationships.

Different anatomical data extensively used in plant systematic are as follows:

1. **Vegetative anatomy**

I. **Epidermis:**
   a. **Epidermal cells:** Shape, thickness, nature of sculpturing, inclusions of epidermal cells, etc;
   b. **Trichomes**: Present or absent, types of trichomes, etc.;
   c. **Stomata**: Types, structure, distribution, ontogeny, etc.

II. **Leaf anatomy**:
   a. **Mesophyll cells:** Structure and types
   b. **Storage parenchyma**
   c. **Mid vein** structure
   d. **Bundle sheath**
   e. **Secretory apparatus**
   f. **Sclerenchyma** pattern**,** etc.

III. **Stem anatomy**:
   a. **Stem ridges:** elevation
   b. **Collenchyma**: distribution, abundance, pattern of thickening
   c. **Endodermis:** nature
   d. **Pith:** nature
   e. **Sclerenchyma**: shape, size and distribution
   f. **Vascular Bundles**: arrangement and types
   g. **Fibres**: nature and distribution
   h. **Medullary rays**: width
   i. **Cortical** and **medullary bundles**; **anomalous secondary thickening**;
   j. **Cork**: position of origin, etc.

IV. **Petiole anatomy**

V. **Nodal anatomy**

VI. **Wood anatomy**:
   a. **Vessel elements:** distribution, diameter, frequency of vessels, perforation, thickening, tyloses;
   b. **Vascular rays**: cellular composition, ray width, dimension, wall thickness**;**
   c. **Axial parenchyma**: nature and distribution;
   d. **Storied wood**: presence or absence, nature.

VII. **Sclereids**: types and distribution

VIII. **Cell inclusions**: Presence or absence, types and distribution of Starch grains, Protein bodies, Silica bodies, Calcium oxalate crystals, cystoliths, Albuminoids, Secretory elements (Resin, oil, mucilage, tannin, etc), Laticiferous tissues, etc.

2. **Floral anatomy**

Some of the evidences of anatomical data solving problems in plant systematics are listed below.

a) **Study of Epidermal characters**:

1. Based on epidermal characters like outline of epidermal cells in surface view, types of hairs, structure of stomata Jain and Singh (1974) and Singh and Jain (1975) differentiated species of *Pyrus* and *Prunus*.

2. Rollins (1944, 1949) observed that two species of *Parthenium* viz. *P. ageratum* and *P. indicum* can be distinguished by **trichomes**. Trichomes of *P. ageratum* is T-shaped and that of *P. indicum* is whip like with a long thread. The hybrids between the species show intermediate type of trichomes. Ramayya (1969) developed generic key of Indian members of Compositae, based on trichome characteristics.

3. The transfer of *Nyctanthes* was suggested from Oleaceae to Verbenaceae. The ontogenic studies of **stomata** indicated that, like other members of Oleaceae, it posseses tetramesoperigenous and occasionally aperigenous stomata which differ from the diamesogenous stomata of Verbenaceae.

b) **Study of Leaf anatomy**:

Placement of *Thurnia* under family Thurniaceae.

Cutler (1965) showed members of *Thurnia* contain **inverted bundles in the leaves**. He separated it from Patateaceae and Juncaceae and placed it under family Thurniaceae.

c) **Study of Stem anatomy**:

Species of *Dubantia* and *Fitchia* have been distinguished on the basis of anatomical differences in pith anatomy of stem.

d) **Study of Petiole anatomy**:

Vascular structure of petiole is of diagonistic significance for species of *Phlomis* and *Eremostachys* of Labiatae as studied by Azizian and Cutler (1982). The petioles of Phlomis show two distinct groups-

Group I: 1-2 median arcs are noted in *Phlomis* and species of *Eremostachys*

Group II: numerous separate bundles are present and often form complete ring in some *Phlomis*.

The above observation establishes the distinction of two groups in *Phlomis* and its close relation with *Eremostachys.*

e) **Study of Nodal anatomy**:

Division of sub-family Icacinoideae- On the basis of nodal structure, the subfamily Icacinoideae of the family Icacinaceae has been divided into two distinct groups i.e., one section, which is characterized by tri-lacunar nodes, while the other section, which is characterized by unilacunar nodes.

f) **Study of Wood anatomy**:

Wood anatomy has played an important role in solving taxonomic problems.

1. Segregation of Parietales- The anatomical findings indicate that the order Parietales of Engler and Prantl (1889) is a heterogenous group and segregation of the order into Parietales and Guttiferales as done by Wettsein is justified.

2. Placement of *Degeneria*: The genus *Degenria* was placed under Magnoliaceae by Hutchinson (1959). **Wood anatomy** supported the segregation and placing it in a separate family **Degeneriaceae**. Thus, Degeneriaceae, Magnoliaceae and Eupomtiacee are the closely related families.

3. **Placement of *Illicum***: As ***Illicum*** contains **vessels**, so it should be removed from **Winteraceae** which is a **vessel less family**.

4**. Placement of Annonaceae**: The family Annonaceae is placed under order **Annonales** by **Hutchinson (1959)** and under **Magnoliales** by **Takhtajan (1969)**. **Wood anatomical studies** suggested that **Annonaceae** has much **advanced** type of **wood**. The findings support **Hutchinson**.

g) **Floral Anatomy:**

The floral anatomy has proved to be useful to solve problems related to taxonomy and phylogenetic studies.

1. **Placement of *Paeonia* in separate family, Paeoniaceae**: The genus Paeonia has been separated from the family Ranunculaceae and places in a separate family, Paeoniaceae, by the modern taxonomist based on floral anatomy.

The anatomical study shows:

- Other genera of Ranunculaceae have sepals with 3 and petals with 1 trace, but *Paeonia* have 2 to several traces.
- In other genera, stamen traces are derived independently, but in *Paeonia* stamen are supplied by few large trunk bundles.
- In other genera, development of stamen is centripetal, but it is centrifugal in *Paeonia.*

- In other genera the carpels have 3-traces, but *Paeonia* receives several traces.

The above differences justify the separation of *Paeonia* from Rannunculaceae and placed in a separate family of its own.

2. **Placement of *Trapa* under Trapaceae**: The genus *Trapa* has been included in Trapaceae, after removal from Onagraceae. This is justifyied by the following data based on vascular anatomy:

- The vascular plan of flowers in *Trapa* differs from other genera of Onagraceae.
- The inferior ovary of *Trapa* has been considered to be receptacular due to down turning of the receptacular bundles. On the other hand, in other genera of Onagraceae, the ovary has been regarded as appendicular due to fusion of the bundles present in the same radii.

3. **Transfer of *Hydrocotyle asiatica* to *Centella*** : The *Hydrocotyle asiatica* L. has been transferred to the genus *Centella* by Urban and named as *Centella asiatica* (L.) Urban. This was confirmed by Mittal (1955) based on floral anatomy supported by following observations:

- The inflorescence of *Hydrocotyle* is umbelose raceme, but in *H. asiatica* it is cyme like *Centella*.
- In other species of *Hydrocotyle*, the ovular traces are derived from the placental strands, but in *H. asiatica* they are derived from the alternate bundles in each carpel as in the genus *Centella*.

Q1. Write short note on application of plant anatomy in systematics. 5marks

Ans: Introduction paragraph

All listed characters/data used extensively in plant systematic

Try to give at least 3 examples of taxonomic problems solved with the help of anatomy.

Q2. Write short note on application of wood anatomy in plant systematics. 5 marks

Ans: Introduction

Wood anatomy characters/ data used in systematic

All examples of problems solved with wood anatomy.