Modern Trends in Taxonomy

1)CYTOLOGY AND SYSTEMATICS

Cytology has made an outstanding contribution to plant systematics. Cytological characters such as chromosome number, shape, size, behavior, and structure at meiosis and mitosis provides most significant data in the field of plant systematics.

1) **Chromosome number :**

i. Normally chromosome number is constant in a species, it is an important taxonomic character the lowest chromosome number is recorded in ***Haplopappus gracilis*** (2n = 4) and the highest in ***Poa litorosa*** (2n = 265). The **Ophioglossum** (Pteridophyte) has highest chromosome number in the plant kingdom (2n=1240). In several plants, polyploidy is found in various members of a group. The basic number of chromosome in ***Piper*** is 2n = 26, ***P. nigrum*** 2n = 52, ***P. betle*** 2n = 78 and in wild species 2n = 104. Whereas the number is variable in different species to species.

ii. Monocotyledons usually have larger chromosome number than dicotyledons.

2) **Chromosome morphology :**

i) Chromosome are variable in form, size, volume and in the amount of hetero-chromatin.

ii) In general, woody plants have smaller chromosomes than in their herbaceous members. The individual chromosomes of some taxa show marked difference in shape and size at mitotic metaphase.

iii) The karyotype of different plant species differ mainly in their chromosome number, size, relative length of arms, position of centromere etc. All these characteristics have significant role in plant systematics.

iv) In addition to the position and size of the centromere, the karyotypes can be differentiated on the basis of secondary constrictions and satellites.

3) **Chromosome behaviour of meiosis :**

i) Valuable taxonomic information observed in the behavior of chromosome during the process of meiosis. Abnormalities in meiosis such as non pairing, chromosome size, crossing over, translocations, bridge formation etc. all are proved to be great significance.

ii) Close relationship between the members of family **Cyperaceae** and **Juncaceae** observed on the basis of chromosome with non-localised centromeres and have show inverted meiosis.

4) **Cytological variation at family level:**

Cytological evidence is of most important in interpreting a classification and establishing relationships.

1. Taxonomic value of cytological data varies from group to group, they provided logical basis for improved arrangement of tribes and genera in families like **Ranunculaceae** and **Poaceae**.
2. The major sub-divisions of the family **Gramineae** as recognized currently on the basis of number and size of the chromosome.
3. On the basis of 5 long and 25 short chromosomes, the genera ***Agave*** and ***Yucca*** were placed in the separate families in **Amaryllidaceae** and **Liliaceae.**

5) Cytological variation at generic level :

There are several examples where chromosome number supports generic status.

i) The genus ***Cystus*** was previously included in ***Helianthemum*** on the basis of former chromosome number 8 and latter 9 this support the recognition of **Cystus** as a separate genus.

ii) The two genera, ***Physaria*** and ***Lesquerella*** of the Brassicaceae were recognized as a single genus. On the basis of cytological evidence, these two genera should remain separated.

iii) A great deal of cytological variation occurs at specific and infra-specific level.

2) PHYTOCHEMISTRY AND SYSTEMATICS

Chemical features of the plant are used in developing classification or solving taxonomic problems is also called Chemotaxonomy. Data from chemistry of plant products is termed as phytochemistry. It is also called chemical systematics that takes into account chemical variations

in the plant. This helps to improve existing systematics. It adds knowledge about phylogeny and evolutionary relationships of plants. Chemical characters are particularly of high taxonomic value when they are stable, unambiguous and not easily, if at all, changeable.

i) Chemical characters of plants have long been of practical value. For example, in the families **Umbelliferae** and **Labiatae**, a fragrant smell arise from crushed leaves and stem due to presence of essential oils is a quick means of identifying them.

ii) In the family **Asteraceae**, the two tribes **Tubiflorae** and **Liguliflorae** are classified on the basis of presence and absence of latex in them.

iii) Presence of various chemical compounds useful for taxonomic evidences. The various chemical compounds are most important in phytochemistry. For example, **Sesquiterpenoids** (Compositae), **Carotenoids** (Algae), **Cyanogenic compounds** (Ranunculaceae), **Free amino acids** (Leguminosae and Liliaceae), **Acetylenes** (Compositae and Umbelliferae) etc.

iv) There are a total of nearly 33 different groups of chemical compounds. Some of the important taxonomic sources are

1) Flavonoids :

These are largest group of naturally occurring phenolics and are most important in chemical systematics. Flavonoids present in cell sap various types of flavonoids like flavones, flavonones, isoflavones, flavonols, chalcones and biflavonyls etc help in taxonomy.

Flavonoids from vegetative parts and seeds provide more taxonomic evidence. The presence of leucoanthocyanin is occur in woody habits.

2) Amino acids :

The presence or absence of free amino acids and their quality and quantity are of great importance in chemical systematic.

Distribution of non-protein amino acids is significant in the family **Leguminosae**. In the genus ***Acacia***, the section **Gummiferae** has an unique amino acid content.

3) Alkaloids :

These are groups of heterogenous and highly complex organic nitrogen containing basic chemical compounds. Alkaloids are commonly occurs in plant families specially from **dicotyledons**. Abundant alkaloid content observed in the families like

Berbridaceae, Ranunculaceae, Legumonosiae and **Solanaceae.** e.g Nicotine in Solanaceae, ephedrine in Ephedraceae (Gymnosperms), Morphine in Papaveraceae (i.e. **Papaver**) etc. The study of alkaloids are useful in taxonomic studies in **Papaver** and **Argemone** of Papaveraceae.

4) Betalins :

Betacyanins and Betaxanthins are the two important Betanils. They differ from Flavonoids and other phenolic compounds in that they contain nitrogen in them. The betalins are functionally equivalent to phenolics. Thay are known as nitrogenous anthocyanins. These two pigments are commonly distributed in 10 families belonging to the order **Centrospermae.**

5) Terpenoids and carotenoids:

These are heterogenous groups of compounds. Carotenoids, an important terpenoids observed in the families **Leguminosae** and **Asteraceae.** Terpenes like Camphor (**Cinnamomum**), menthol (**Mentha**). **Carotenoids** are also of taxonomic value in the families **Carryaceae** and **Cornaceae**. Petal carotenoids may be helpful in the taxonomy of **Fabaceae**.

6) Other Chemical substances :

Chemical substances like starch grain and raphides character as tools of taxonomy. Starch grains is used for the classification of **Poaceae** whereas, presence or absence of raphides as an important character for the classification of the **Rubiaceae**.

3)Palynology in Relation to Taxonomy:

Palynology is the study of Pollen grains. Fossil spores are found in peat and other sediments, in lignite, coal and shales. They are evident since Pre-Cambrian times hundreds of millions of years ago.Pollen grains morphology plays an important role in taxonomic classification.Pollen grains may be vesiculate (with air sacs); saccate or non saccate, fenestrate or non-fenestrate, colpate (furrows or colpi present) or porate (apertures present at the poles). According to number, position and character of apertures (NPC) pollen are of different types

Number: 1-many

Position: proximal, distal, zonal or global

Character: Colpate (furrow), porate (circular) and inaperturate

Pollen characters considered for taxonomic analysis are:

(i) Pollen unit type,
(ii) Pollen grain polarity,
(iii) Pollen grain shape,
(iv) Pollen grain symmetry,
(v) Pollen grains nuclear state,
(vi) Pollen wall architecture,
(vii) Exine stratification,
(viii) Exine structure,
(ix) Exine sculpture,
(x) Aperture type,
(xi) Aperture number,
(xii) Aperture position,
(xiii) Aperture shape, and
(xiv) Aperture structure.

Pollen are generally associated in tetrads in Angiosperms. Among examples of the role of pollen grains in systematics is Nelumbo whose separation from Nymphaeaceae into a distinct family Nelumbonaceae is largely supported by the tricolpate pollen of Nelumbo as against the monosulcate condition in Nymphaeaceae. In family Salicaceae Salix has long narrowed 3-furrowed pollen, Populus has spherical pollen without apertures. Depending upon palynological studies two distinct phylogenetic stocks in the dicots have been suggested. One represented by Magnoliaceae with monocolpate type and the other represented by Ranunculaceae with tricolpate type of pollen grains. Monocots are considered to be closely related to magnolian stock on the basis of Monocolpate element. The Magnolian dicots are considered to be ancient palynologically as compared to Ranalian dicots where new apertural forms are present.