ALAGAPPA UNIVERSITY

[Accredited with 'A+' Grade by NAAC (CGPA:3.64) in the Third Cycle
and Graded as Category–I University by MHRD-UGC]

KARAIKUDI – 630 003

DIRECTORATE OF DISTANCE EDUCATION

M.Sc. [Botany]

346 12

PLANT TAXONOMY

I - Semester

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SYLLABI-BOOK MAPPING TABLE

Plant Taxonomy

Syllabi	Mapping in Book
BLOCK-1: SCOPE AND APPLICATIONS OF PLANT TAXONOMY **Unit-1:** Scope and applications- Species concept, Biotype, Ecad, Ecotype-Binomial System of Nomenclature. **Unit-2:** Theories of Biological Classification- Structural, Biological and Molecular systematics. **Unit-3:** Historical Background, Plant classification- Plant classification systems: Bentham and Hooker, Engler and Prantl, Takhtajan and Hutchinson.	**Unit 1:** Scope and Applications of Plant Taxonomy **(Pages 1-17);** **Unit 2:** Biological Classification **(Pages 18-39);** **Unit 3:** Plant Classification **(Pages 40-64)**
BLOCK-2: TAXONOMIC STRUCTURE **Unit-4:** Taxonomic structure: Biosystematics, Chemotaxonomy, Numerical taxonomy-Modern inter-disciplinary approaches to Taxonomy. **Unit-5:** Botanical Nomenclature- Need for scientific names- Principles of ICBN. Type method, author citation, Publication of names, rejection of names. **Unit-6:** Principle of priority, limitations, conservation of names of species-Draft Biocode.	**Unit 4:** Taxonomic Structure **(Pages 65-80);** **Unit 5:** Botanical Nomenclature **(Pages 81-99);** **Unit 6:** Principles of Draft Biocode **(Pages 100-125)**
BLOCK-3: SALIENT FEATURES OF PLANT FAMILIES **Unit-7:** Study of the Monocotyledons: *Hydrocharitaceae* and *Dioscoreaceae* **Unit-8:** Study of the Monocotyledons: *Arecaceae* and *Cyperaceae*. **Unit-9:** Study of the Monochlamydeae families: *Polygonaceae* and *Amaranthaceae*. **Unit-10:** Study of the Monochlamydeae families: *Aristolochiaceae* and *Loranthaceae*.	**Unit 7:** Study of Monocoteledons **(Pages 126-142);** **Unit 8:** Monocoteledons: Arecaceae and Cyperaceae **(Pages 143-157);** **Unit 9:** Monochlamydeae Family : Polygonaceae and Amaranthaceae **(Pages 158-174);** **Unit 10:** Monochlamydeae Family: Aristolochiaceae and Loranthaceae **(Pages 175-187)**
BLOCK-4: SALIENT FEATURES OF PLANT FAMILIES **Unit-11:** Study of the Gamopetalae families: *Sapotaceae, Rubiaceae, Asteraceae, Apocynaceae*. **Unit-12:** Study of the Gamopetalae families: *Convolvulaceae, Bignoniaceae, Scrophulariaceae* and *Verbenaceae*. **Unit-13:** Study of the Polypetalae families: *Magnoliaceae, Menispermaceae, Papaveraceae, Polygalaceae* and *Tiliaceae*. **Unit-14:** Study of the Polypetalae families: *Geramiaceae, Mimosaceae, Myrtaceae, Meliaceae* and *Sapindaceae*.	**Unit 11:** Gamopetalae Families: Sapotaceae, Rubiaceae, Asteraceae and Apocynaceae **(Pages 188-211);** **Unit 12:** Gamopetalae Family: Convolvulaceae, Bignoniaceeae, Scrophulariaceeae and Verbenaceae **(Pages 212-234);** **Unit 13:** Polypetalae Familiy: Magnoliaceae, Menispermaceae, Papaveraceae and Tiliaceae **(Pages 235-251);** **Unit 14:** Polypetalae Familiy: Geramiaceae, Mimosaceae, Myrtaceae, Meliaceae and Sapindaceae **(Pages 252-270)**

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INTRODUCTION

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Plant taxonomy is the science that identifies, describes, classifies, and names plants. Thus making it one of the main branches of taxonomy. Plant taxonomy is closely allied to plant systematics, and there is no sharp boundary between the two. In practice, 'Plant systematics' involves relationships between plants and their evolution, especially at the higher levels, whereas 'plant taxonomy' deals with the actual handling of plant specimens. A plant can be identified with the help of books or papers on the subject, such as manuals, monographs, or revisions, or by comparing it with plants, the identity of which is already known, such as living plants in collections, or pressed and dried herbarium specimens. One must remember that identification, in the strict sense, has nothing to do with the correct name of the plant or with determining that name, since it is a function of nomenclature.

Nomenclature is a very different function. In practice, one usually finds that a specialist or an author has handled the nomenclatural part so that, when one comes to the end of the identification, there also is the correct name for the plant. Nomenclature has reference to the correct naming of the plant that has been identified. It is the part of taxonomy that tells us how to go about the determination of what name is correct, whether a particular name is only a synonym, or whether it has no standing at all. Botanical nomenclature deals only with the Latin names of plants.

Classification refers to placing of a plant in categories according to a particular system, and in conformity with a nomenclatural system. A very simple system of classification is that which divide. plants into such groups as trees, shrubs, and herbs. Another might divide them into ferns, conifers, dicots, and monocot. Classification is grouping together of those plants whose similarities are greater than their differences.

This book, *Plant Taxonomy*, is divided into four block, which is further divided into fourteen units which will help you understand basics of plant taxonomy, scope and applications (species concept, biotype, ecad, ecotype binomial system of nomenclature), theories of biological classification, historical background, plant classification (plant classification systems: Bentham and Hooker, Engler and Prantl, Takhtajan and Hutchinson), taxonomic structure (biosystematics, chemotaxonomy, numerical taxonomy) botanical nomenclature- need for scientific names, author citation, principle of priority, limitations, conservation of names of species, study of the Monocotyledons (*Hydrocharitaceae, Dioscoreaceae, Arecaceae Cyperaceae*), study of the Monochlamydeae families (*Polygonaceae, Amaranthaceae, Aristolochiaceae* and *Loranthaceae*), study of the Gamopetalae families (*Sapotaceae, Rubiaceae, Asteraceae, Apocynaceae, Convolvulaceae, Bignoniaceae, Scrophulariaceae* and *Verbenaceae*), study of the Polypetalae

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families (*Magnoliaceae, Menispermaceae, Papaveraceae, Polygalaceae, Tiliaceae, Geramiaceae, Mimosaceae, Myrtaceae, Meliaceae* and *Sapindaceae*).

The book follows the self-instruction mode or the SIM format wherein each unit begins with an 'Introduction' to the topic followed by an outline of the 'Objectives'. The content is presented in a simple and structured form interspersed with 'Check Your Progress' questions and answers for better understanding. A list of 'Key Words' along with a 'Summary' and a set of 'Self Assessment Questions and Exercises' is provided at the end of the each unit for effective recapitulation.

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BLOCK - I

SCOPE AND APPLICATIONS OF PLANT TAXONOMY

UNIT 1 SCOPE AND APPLICATIONS OF PLANT TAXONOMY

Structure

1.0 INTRODUCTION

Taxonomy is a science that treats of the identification, nomenclature, and classification of objects. The word can be defined as, 'the science of classifying plants, animals, and microorganisms into increasingly broader categories based on shared features'. When concerned with plants, it is often referred to as systematic botany. Traditionally, organisms were grouped by physical resemblances, but in recent times other criteria such as genetic matching have also been used.

More precisely, Plant Taxonomy can be defined as, the branch of biology which deals with the description, identification, classification, and naming of plants according to their resemblances and differences.

Taxonomy is considered as the mother of Biological Sciences. Before the man could study plant structures, the way plants grow, or could accurately record the plants, he had to know the names and characteristics of those plants. In gaining this knowledge he has tried to group plants together in accordance with their presumed affinities. Today, anyone dealing with plants in any way depends on the labors of the taxonomist.

In this unit, you will study about the scope and applications of plant taxonomy, species concept, biotype, ecad, ecotype, binomial system of nomenclature.

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1.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand the scope and application of plant taxonomy
- Discuss about the species concept
- Explain what biotype, ecad, ecotype is
- Understand the concept and significance of binomial system of nomenclature

1.2 HISTORY AND DEVELOPEMNT OF PLANT TAXONOMY

Taxonomy is a science that treats of the identification, nomenclature, and classification of objects. The word can be defined as, 'the science of classifying plants, animals, and microorganisms into increasingly broader categories based on shared features'. When concerned with plants, it is often referred to as systematic botany.Traditionally, organisms were grouped by physical resemblances, but in recent times other criteria such as genetic matching have also been used.

The early history of development of botanical science is nothing but a history of development of plant taxonomy. The herbalists and agriculturists of ancient times gathered some knowledge about plants which was passed on from generation to generation.

Theophrastus (372-287 BC), the Greek philosopher-scientist, placed this knowledge of plants on a scientific footing. In his 'Enquiry into Plants' he dealt with the plants at large and attempted to arrange the plants in several groups. He is, therefore, called the 'Father of Botany'.

Pliny compiled a monumental work entitled 'Historia Naturalis' where he incorporated all information about plants gathered up to that time and added much to the same collected by himself from his travels far and wide. Disocorides was a contemporary of Pliny and like him travelled a lot and gathered information about medicinal plants. He compiled his famous book 'Materia Medica' where he described about six hundred species of plants mentioning their local name and giving their medicinal properties.

For a long period after this there was no contribution in the study of plants worth mentioning till Albert Magnus in the 13th century wrote his 'De Vegetabilis' where the difference in the stem structure of Di-cotyledons

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and Monocotyledons was shown and the two groups were given the terms Tunicate and Corticate.

Foremost among them was Otto Brunfels who published his book 'Herbarium vivae Eiconis' in three volumes (1530-1536) which was profusely illustrated with good figures. Jerome Bock (1498-1554), another German herbalist, published his 'Nue Kreuterbuch' which contained accurate descriptions of about 600 species of flowering plants.

Andrea Caesalpino (1519-1603) also classified the plants on the character of their habit, i.e., trees, shrubs, and herbs but also took into account the characters of ovary, fruit, and seed. He became famous for his book 'De plants' in 16 volumes, the first of which contained his principles of classification.

Leonard Fuchs (1501-1566), Valerius Cordus (1515-1544), Mattias de L'Obel (1538-1616), John Gerard (1545- 1612), and Charles L'Ecluse (1526-1909) were others who also advanced the cause of botanical science by their observations and contributions. Then the Bauhin brothers came to the field.

The elder brother Jean (Johann) Bauhin (1541-1631) wrote a book entitled 'Historia plantarum universalis' which was published after his death. Gaspard (Caspar) Bauhin, the younger brother (1560-1624), published 3 botanical treatises the third one of which, i.e., 'Pinax theatri Botanici' became very popular. Both the Bauhins made use of the habit-character of plants in classifying them.

Gaspard Bauhin had formulated the idea of a genus and in many cases gave binary nomenclature to his plants. He also collected all names of plants published in different botanical works till his time and referred them as synonyms along with names he used as correct ones.

John Ray, an English naturalist (1628-1705), set himself seriously to the study of plants and gave much thought in proposing a system of classification of plants. He was the first to recognise 2 major taxa of flowering plants, i.e., dicotyledons and monocotyledons. He also tried to group the plants into several families which he called 'classes'. He divided the plant kingdom first into 2 groups, i.e., Herbae and Arbores. The Herbae were then divided into Imperfectae and Perfectae, the first of which included the Cryptogams and the second group, i.e., the Arbores included most of the flowering plants.

Joseph Pitton de Tournefort was a contemporary of John Ray and tried to work out a system of classification of flowering plants. He too divided the plant kingdom first into 2 groups as trees and herbs and used the character of inflorescence and flower for subdividing the latter group. He was the first to give a clear concept of a genus although Gaspard Bauhin mentioned it in his works. Tournefort's work proved very helpful in identifying the plants up to the species.

Then came Carl Linnaeus (1707-1778), a Swedish naturalist, gave a new impetus to the study of plants. He was professor of medicine and botany in the Upsala University. The discovery of numerous plants from all over the world led him to think about bringing an order into the existing chaos and set himself in grouping and classifying all the plants known till his time. He proposed a system of classification which was published in his 'Systema Naturae' (1735). In this system he used the character of stamens, i.e., the number and nature of stamens, to distinguish the 20 classes in which he divided the plant kingdom.

The 'Species plantarum' the first edition of which came out in 1753 contained an enumeration of all plants known to him till that date, accompanied by brief description of each species with distribution and previous reference. In this work he consistently used binary nomenclature for every species with a generic name followed by a specific epithet.

The modern taxonomists have agreed to consider the year 1753 as the starting point of nomenclature of Phanerogams, Pteridophyta, and Sphagnum. In his 'Philosophia Botanica' he laid down some principles which later formed the basis of the International Code of Botanical Nomenclature.

Owing to the efforts of Linnaeus the study of Botanical science entered the modern age and Linnaeus is rightly called the 'Father of Modern Botany'.

Check Your Progress

1. What is taxonomy?
2. What was the contribution of Theophrastus?
3. Who is called as the Father of Modern Botany?

1.3 SCOPE AND APPLICATION

To understand the scope and functions of taxonomy, it is necessary to understand what is meant by identification, nomenclature, and classification. It is necessary also to understand how each of these differs from the others and how they are interdependent.

Identification is what one does when keying out an unknown when determining the kind of a plant by comparing it with a plant of known identity, or with a description of such a plant. If someone tells you only the common name of a plant, he has identified it. The name given by this identification may not be correct, but the function or process remains the same. A plant may be identified by the aid of books or papers on the subject (such as manuals, fioras, monographs, or revisions), or by comparing it with plants, the identity of which is already known (such as living plants in collections, or pressed

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and dried herbarium specimens). One must remember that identification, in the strict sense, has nothing to do with the correct name of the plant or with determining that name, for the latter-as we soon shall see-is a function of nomenclature.

Nomenclature has reference to the correct naming of the plant that has been identified. It is the part of taxonomy that tells us how to go about the determination of what name is correct, whether a particular name is only a synonym, or whether it has no standing at all. Botanical nomenclature deals only with the Latin names of plants. It is not concerned with common or English names (sometimes referred to as vernacular names).

Classification is the placing of a plant (or group of plants) in categories according to a particular system, and in conformity with a nomenclature system. A very simple system of classification is that which divide. plants into such groups as trees, shrubs, and herbs. Another might divide them into ferns, conifers, dicots, and monocots. Classification is a grouping together of those plants whose similarities are greater than their differences. In practice, species of plants having many characters in common are united under the name of a genus, as the lilies are all treated as species of the genus Lilium.

Check Your Progress

4. What is identification?
5. How can we identify a plant?
6. What does botanical nomenclature deals with?
7. What is classification?

1.4 SPECIES CONCEPT

Biological Species Concept

In nineteen century the first who produced the most quoted definition of what he called 'biological species' was the zoologist Mayr (1942) who defined species as: 'groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups'. Thus groups of related plants which are distinct at the level of biological species do not interbreed when growing in the same area in nature. This explains simply what is called now the Biological Species Concept (BCS) which is a non-phylogenetic species concept because it is potentially interbreeding process with no references for ancestry. In another word a species is a group of reproducing natural populations incapable to effectively mate or breed with other such groups, and which inhabits a particular niche in nature (Mayr, 1982, Bisby and Coddington, 1995). Although this theory is so simple and

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obvious, it has mainly two disadvantages. First, it is inapplicable onto asexual organisms. Secondly, it is impractical in instances of allopatric populations (geographically isolated) (Cronquist, 1978, Stace, 1989).

Both isolating species concept and recognition species concept can be part of the biological concept or genetic concept because both see the species as a field for gene recombination. While the isolating concept stresses on reproductive isolation as the mechanism responsible for discontinuity between species (each species is reproductively isolated from all other species, precluding them from mixing their genes and their traits), recognition concept stresses on reproductive coherence as the factor responsible for continuity within species. They also have the same disadvantages as the biological concept inapplicable on asexual organisms and impractical on allopatric.

Morphological Species Concept (MSC)

Cronquist (1978) adopting this concept he defined species as the smallest groups that are constantly and determinedly distinctive and distinguishable by average means. Thus, species are the smallest natural populations permanently separated from each other by a distinct discontinuity in the series of biotype (Du Rietz, 1930, Bisby and Coddington, 1995). In other words, morphological species concept states that ‘a species is a community, or a number of related communities, whose distinctive morphological characters are, in the opinion of a competent systematist, sufficiently definite to entitle it, or them, to a specific name’ (Regan, 1926). It can be applied to sexual and asexual organisms and it is also useful for species concepts in the fossil record. However, sometimes morphological characteristics are subjective and depend on ‘expert’ opinion for key traits. And in some cases, the species are sympatric (morphologically indistinguishable) but are clearly different lineages.

Ecological Species Concept (ESC)

The ecological species concept is mainly about ecological competition. Van Valen (1976) stated: ‘A species is a lineage (or a closely related set of lineages) which occupies an adaptive zone minimally different from that of any other lineage in its range and which evolves separately from all lineages outside its range’. Colinvaux (1986) also wrote: ‘A species is a number of related populations the members of which compete more with their own kind than with members of other species’. In other words, when two organisms are similar to each other, their needs are more likely to overlap, therefore, they are expected to contest, and consequently the more likely that they are of the same species. Nevertheless, the *ecological species concept* has some complications subsequently it requires that the life histories for members of individual species are the same which practically is not always true. It also has a problem similar to the morphological species concept which is: 'at what point does one stop the process of splitting divergent forms into new species?.' Finally, it is not always significant to determine the degree to which two or more entities are competing ecologically.

Evolutionary Species Concept

An evolutionary species 'is a single lineage of ancestor-descendant populations of organisms which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate' (Wiley, 1981). This concept was developed by Simpson (1951) in order to include asexual organisms and extinct species whom the biological species concept could not be applied to. The problem in this evolutionary concept arose when the gaps in the fossil record levy prejudice limits between species, especially those which experiencing regular size/shape evolution.

Cohesion Species Concept

A cohesion species is 'an evolutionary lineage that serves as the arena of action of basic microevolutionary forces, such as gene flow (when applicable), genetic drift and natural selection' (Templeton, 1994). Thus the cohesion concept is similar to the evolutionary species concept in a way that a population genetic stress on the origins of phenotypic similarity within species.

Phenetic Species Concept

Based on the idea that species concept shouldn't be bound to any precise theory Ridley (1993) gave this definition: 'A species is a set of organisms that look similar to each other and distinct from other sets'. Thus, it would clarify some particular degree of phenetic resemblance, and similarity would be measured by a phenetic remoteness statistic.

Practically, the phenetic concept measures as many characters as possible in as many organisms as possible, and then identifies phenetic clusters by multivariate statistics. The smallest unit in these clusters has sufficient similarity to be called a species. The theory of phenetic species concept can be opposed on the bases of that, to a specific degree, there is a resemblance between any two objects in the universe. Moreover, members of the same species can be significantly different (especially in polytypic species) and individuals of various species may look more related to each other than members of the same species. Therefore, to achieve a better classification based on phenetic similarity some principals should be followed (Stace, 1989).

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Phylogenetic Species Concept (PSC)

With the presence of Darwin and Wallace theory of evolution, the rediscovery of G. Mendel's laws of inheritance in 1900 and the development of the modern theory of chromosome, all these led to the cladistic speciation. Simply it defines species as a group of organisms that share an ancestor. In other words species are individuals show a high degree of resemblances in many unique traits which give a monophyletic clusters based on discriminative phenotypes. This concept integrates character- based concepts that emphasize the presence of an apparent organism attribute with history based concepts that emphasize the degree of relatedness of a new isolate to previously characterized organism. Comparing with BCS this concept is applicable to both sexual and allopatric populations. However, it runs into two great practical problems, it is rarely possible to reconstruct with certainty the past evolutionary pathway; and if so, it is hardly possible to devise a satisfactory method of designation a branching pattern by means of a single linear sequence which is so important in flora and systematic treatment. However, many attempts have been made to produce such a system, the aim being to construct a sequence starting with the most primitive and ending with the most advanced; ensuring that each taxon recognized is a monophyletic or polyphyletic (Stace, 1989, Agapow et al., 2004).

Pluralistic Species Concept

When a given species concept is favored in given conditions, that does not mean it could be universally applicable. For understanding all species living at all times, a broader concept of species should be applied. A comprehensive concept larger than any species concept indicated above. The need to use more than one species concepts in order to be applicable arose the idea of a pluralistic species concept. This recognizes, basically, that 'the factors that are most important for the cohesion of individuals as a species vary' (Campbell and Reece, 2002).

Conclusion

These species concepts mentioned above are some of the others present in taxonomic world. There are many others (for example, composite, internodal, genetic, etc.). With this large number of concepts it is not an easy or simple decision to adapt one. Generally, it depends on the criteria and the aim of each project. For example, biological, isolation and recognition concepts can be used if the organisms were sexual breeding and from same community or geographical area. In addition, if a study is concerned on the similarity of a group of plant with enough information of characters (morphology, anatomy, cytology) with no need to a lineage, a morphological concept could be adapted. Sometimes more than one concept can be used, for example the ecological concept can be used with the morphological one.

1.4.1 Ecotype

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Life on Earth is a wondrous thing. It will do everything it possibly can, to make sure it survives. Every organism in this world has a wonderful ability to adapt to changes in it's surroundings. This adaptation is what allows it to tolerate small changes in it's environment; be in temperature, humidity or salinity changes. But what happens when an organism is taken and transported to a completely new environment? What if the conditions there are vastly different from it's native habitat?

Every species has a specific range within which it can tolerate ecological changes. This range is called ecological amplitude. Within this amplitude, an organism has three broad responses.

1.4.2 Ecad

These are otherwise called ecads or morphologically-changed forms. When a species is transported to a new environment, it's first response will be to develop abilities to survive there. For example, when a European comes to the tropics, the immediate response is increased production of melanin-his skin becomes darker. Such changes are quite common in plants. For example, a species of grass called *Euphorbia hirta* has two different ecophenes; one that has adapted to grow in dry, hard soils and the other that grows in places that have been heavily trampled.

You can see examples of this in humans as well; an American living in Africa, and one living in northern Europe will have differences in the features.

These differences among ecophenes and not permanent. They are just temporary variations to survive the new conditions. The body of the organism assumes that it is going to be in these new conditions for a short while only. Therefore, ecophenes from different habitats, when brought together, become similar. If that American from Africa was to move to northern Europe, he would start to grow fairer.

This reversibility is because there has been no change in the genetics of the two separate ecophenes. However, if two of these ecophenes were to remain in their new habitat for too long, these morphological (physical) changes will start becoming permanent.

Likewise, the grass *Euphorbia hirta* (Refer Figure 1.1 and 1.2) has two ecotypes as well. One that has permanently adapted to surviving in moist conditions, and the other adapted to surviving in dry conditions.

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Fig. 1.1 *Euphorbia hirta growing in dry conditions*

Fig. 1.2 *Euphorbia hirta growing in moist conditions*

Ecospecies

Now, if two ecotones have been separated from each other for a very long time. The adaptations become a permanent part of the genes. They are still the same species, but their difference physically and genetically are very distinct. In fact, two ecospecies cannot produce viable off-springs (which the ecophenes and ecotones can). These ecospecies, left alone for many, many generations, then develop sufficient changes in them to become a separate species. That's the long version of how new species are born.

The current extinction crisis is because of this very reason. The organisms are unable to adapt quickly because their amplitude is limited, with respect to the changing environment.

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Check Your Progress

8. What does evolutionary species mean?
9. What is choesion species?
10. What did Ridley do?

1.5 BIONOMIAL SYSTEM OF NOMENCLATURE

A system through which organisms, including plants, animals, microorganisms and other living things are given distinct scientific names is called Nomenclature.

In biology, each group of organisms, be it plants or animals or microorganisms, is already classified under special divisions, according to the similarities and features. Therefore these living organisms should also have a common naming system that makes it easier to understand them better. A common system of naming is essential so that it makes it widely accepted throughout the world. And therefore there evolved a system called the binomial nomenclature. This helped to a great extent in maintaining the standardization in naming living things.

Binomial Nomenclature

Binomial Nomenclature is a two-term naming system which uses two different terms to name the species, plants, animals and living organisms. Binomial Nomenclature is also known as Binary Nomenclature. The two terms consist of generic epithet which is genus (category) of that species, and specific epithet which indicates the species itself. This two-term naming system can also use some other different languages to create such scientific names. These scientific names are unique and help in identifying organisms anywhere in the world.

The Binomial Nomenclature system is a formal system of naming that was introduced by a scientist Carl Linnaeus. He is regarded as the founder of modern taxonomy. His books are considered as the beginning of modern biological nomenclature. They outlined the rules for allocating names to plants and animals in a certain format.

In this system, there are certain rules that are followed while naming organisms. This standard set of rules is applicable to plants and animals while giving them unique names within a given system.

According to this system, each organism is known my two names – the Genus name and the species name. These names are all written in Latin. The genus name and species name of an organism written together are called its scientific name. Some rules that are followed while writing these names are mentioned hereunder.

- The name of the genus always begins with a capital letter.
- The species name begins with a small letter.
- The scientific names are always italicized.
- When handwritten, the genus name and species name have to be underlined.
- A few examples of names of organisms written in this system
- *Homo sapiens* (Human Beings)
- *Helianthus annuus* (Sunflower Plant)
- *Panthera tigris* (Tiger)
- *Mangifera indica (Mango Plant)*

Check Your Progress

11. Define nomenclature.
12. How are organisms classified?
13. Why is common system of naming essential?

1.6 ANSWERS TO CHECK YOUR PROGESS QUESTIONS

1. Taxonomy is a science that treats of the identification, nomenclature, and classification of objects.
2. Theophrastus (372-287 BC), the Greek philosopher-scientist, placed this knowledge of plants on a scientific footing. In his 'Enquiry into Plants' he dealt with the plants at large and attempted to arrange the plants in several groups. He is, therefore, called the 'Father of Botany'.
3. Linnaeus is rightly called as the 'Father of Modern Botany'.
4. Identification is what one does when keying out an unknown when determining the kind of a plant by comparing it with a plant of known identity, or with a description of such a plant.
5. A plant can be identified by the aid of books or papers on the subject, or by comparing it with plants, the identity of which is already known (such as, living plants in collections, or pressed and dried herbarium specimens).

6. Botanical nomenclature deals only with the Latin names of plants.
7. Classification is the placing of a plant (or group of plants) in categories according to a particular system, and in conformity with a nomenclature system.
8. An evolutionary species 'is a single lineage of ancestor-descendant populations of organisms which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate' (Wiley, 1981).
9. A cohesion species is 'an evolutionary lineage that serves as the arena of action of basic micro evolutionary forces, such as gene flow (when applicable), genetic drift and natural selection' (Templeton, 1994).
10. Based on the idea that species concept shouldn't be bound to any precise theory Ridley (1993) gave this definition: 'A species is a set of organisms that look similar to each other and distinct from other sets'.
11. A system through which organisms, including plants, animals, microorganisms and other living things are given distinct scientific names is called Nomenclature.
12. In biology, each group of organisms, be it plants or animals or microorganisms, is already classified under special divisions, according to the similarities and features.
13. A common system of naming is essential so that it makes it widely accepted throughout the world.

1.7 SUMMARY

- Taxonomy is a science that treats of the identification, nomenclature, and classification of objects. The word can be defined as, 'the science of classifying plants, animals, and microorganisms into increasingly broader categories based on shared features'.
- Theophrastus (372-287 BC), the Greek philosopher-scientist, placed this knowledge of plants on a scientific footing. In his 'Enquiry into Plants' he dealt with the plants at large and attempted to arrange the plants in several groups. He is, therefore, called the 'Father of Botany'.
- Foremost among them was Otto Brunfels who published his book 'Herbarium vivae Eiconis' in three volumes (1530-1536) which was profusely illustrated with good figures.
- Jerome Bock (1498-1554), another German herbalist, published his 'Nue Kreuterbuch' which contained accurate descriptions of about 600 species of flowering plants.

- John Ray, an English naturalist (1628-1705), set himself seriously to the study of plants and gave much thought in proposing a system of classification of plants.
- To understand the scope and functions of taxonomy, it is necessary to understand what is meant by identification, nomenclature, and classification. It is necessary also to understand how each of these differs from the others and how they are interdependent.
- Identification is what one does when keying out an unknown when determining the kind of a plant by comparing it with a plant of known identity, or with a description of such a plant.
- In nineteen century the first who produced the most quoted definition of what he called 'biological species' was the zoologist Mayr (1942) who defined species as: 'groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups'.
- Groups of related plants which are distinct at the level of biological species do not interbreed when growing in the same area in nature.
- Cronquist (1978) adopting this concept he defined species as the smallest groups that are constantly and determinedly distinctive and distinguishable by average means.
- The ecological species concept is mainly about ecological competition. Van Valen (1976) stated: 'A species is a lineage (or a closely related set of lineages) which occupies an adaptive zone minimally different from that of any other lineage in its range and which evolves separately from all lineages outside its range'.
- Colinvaux (1986) also wrote: 'A species is a number of related populations the members of which compete more with their own kind than with members of other species'.
- An evolutionary species 'is a single lineage of ancestor-descendant populations of organisms which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate' (Wiley, 1981).
- A cohesion species is 'an evolutionary lineage that serves as the arena of action of basic microevolutionary forces, such as gene flow (when applicable), genetic drift and natural selection' (Templeton, 1994).
- Based on the idea that species concept shouldn't be bound to any precise theory Ridley (1993) gave this definition: 'A species is a set of organisms that look similar to each other and distinct from other sets'. Thus, it would clarify some particular degree of phenetic resemblance, and similarity would be measured by a phenetic remoteness statistic.

- With the presence of Darwin and Wallace theory of evolution, the rediscovery of G. Mendel's laws of inheritance in 1900 and the development of the modern theory of chromosome, all these led to the cladistic speciation.
- Life on Earth is a wondrous thing. It will do everything it possibly can, to make sure it survives. Every organism in this world has a wonderful ability to adapt to changes in it's surroundings. This adaptation is what allows it to tolerate small changes in it's environment; be in temperature, humidity or salinity changes.
- If two ecotones have been separated from each other for a very long time. The adaptations become a permanent part of the genes. They are still the same species, but their difference physically and genetically are very distinct.
- A system through which organisms, including plants, animals, microorganisms and other living things are given distinct scientific names is called Nomenclature.
- Binomial Nomenclature is a two-term naming system which uses two different terms to name the species, plants, animals and living organisms.
- Binomial Nomenclature is also known as Binary Nomenclature. The two terms consist of generic epithet which is genus (category) of that species, and specific epithet which indicates the species itself.
- This two-term naming system can also use some other different languages to create such scientific names. These scientific names are unique and help in identifying organisms anywhere in the world.

1.8 KEY WORDS

- **Gene flow:** Gene flow is the transfer of genetic variation from one population to another.
- **Genetic drift:** Genetic drift is the change in the frequency of an existing gene variant (allele) in a population due to random sampling of organisms.
- **Phenotype:** The phenotype of an organism is the composite of the organism's observable characteristics or traits, including as its morphology or physical form and structure, developmental processes, biochemical and physiological properties.
- **Phenetic species concept:** Phenetic species concept is a set of organisms that are phenotypically similar and that look different from other sets of organisms.

- ***Euphorbia hirta:*** *Euphorbia hirta* is a pantropical weed, possibly native to India. It is a hairy herb that grows in open grasslands, roadsides and pathways.
- **Ecological amplitude:** Every species has a specific range within which it can tolerate ecological changes. This range is called ecological amplitude.
- **Nomenclature:** A system through which organisms, including plants, animals, microorganisms and other living things are given distinct scientific names is called Nomenclature.
- **Genus:** A genus is a taxonomic rank used in the biological classification of living and fossil organisms, as well as viruses, it comes above species and below family.

1.9 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a note on plant taxonomy.
2. Brief about the histrory of plant taxonomy.
3. Write a short note on classification.
4. What is ESC?
5. Write a short note on Cohesion Species Concept
6. Give a brief note on PSC.
7. What is ecad?

Long Answer Questions

1. What is the history of plant taxonomy?
2. Write a detailed note on scope and application of plant taxonomy.
3. Give a detailed overview on species concept.
4. Write a note on phenetic species concept.
5. Explain about ecotype , ecospecies and ecad in detail.
6. Discuss about the binomial system of nomenclature.

1.10 FURTHER READINGS

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NOTES

UNIT 2 BIOLOGICAL CLASSIFICATION

NOTES

Structure

2.0 INTRODUCTION

Biological classification is defined as the ordering or ranking of organisms into groups on the basis of similarities or closeness or relationship. As there are large numbers of plants and animals in the world, so it is easier to study them after they are arranged in some small or large groups. Biological classification

Biological classification is the arrangement of organisms into categories that express their phylogeny, or line of descent, based on information such as, structure, development, biochemical or physiological functions, and evolutionary history of organisms. The purpose of such a classification is to provide a clear and practical way to organize and communicate information about organisms. Classification can show relationships between different ancient and modern groups, indicate the evolutionary pathways along which present-day organisms may have developed, and provide a basis for comparing experimental data about different plant and animal groups. Organisms included in a group share a common genetic heritage in their DNA, and they must be more closely related to each other than they are to the members of other groups of the same rank. However, classifications of organisms are modified as ideas of their phylogeny change.

In this unit, you will study about the biological classification, structural systematics, biological systematics and molecular systematics and its significance.

2.1 OBJECTIVES

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After going through this unit, you will be able to:

- Understand the concept of biological classification
- Discuss about structural systematics
- Explain what biological systematics is
- Discuss about the molecular systematics and its significance

2.2 BIOLOGICAL CLASSIFICATION AND HISTORY

Biological classification is defined as the ordering or ranking of organisms into groups on the basis of similarities or closeness or relationship. As there are large numbers of plants and animals in the world, so it is easier to study them after they are arranged in some small or large groups. Biological classification.

Taxonomy is the theory and practice of classifying organisms. It is a branch of systematics, the study of the diversity of organisms. The first scheme for classifying animals into logical groupings may have been proposed by Aristotle more than 2,000 years ago. Since that time, many new classification systems have been proposed; none, however, has succeeded in fitting all plants, animals, and microorganisms into a single, completely satisfactory scheme. For example, some taxonomists classify algae with the protista or consider them plants. Recently, biotechnological techniques have enabled researchers to compare the DNA of various organisms to decipher the phylogeny of some organisms and helped to distinguish some closely related species with similar appearance.

History

Aristotle (384-322 BC) is often called the father of biological classification. His classification scheme referred to readily apparent groups, such as, birds, fishes, whales, and bats, and he recognized the need for groups and group names in the study of the animal kingdom. John Ray (1627-1705) used anatomical differences as the prime criterion for classification, bringing out both the resemblances and differences between groups—for example, lung breathing or gill breathing. This is still a preferred method for identification of organisms.

The standard and universal binomial nomenclature for species is attributed to Carl Linnaeus (1707-1778). He applied it consistently to plants in *Species Plantarum* (1753), and to animals in *Systema Naturae* (10th ed., 1757). Linnaeus' system was readily applicable to the new concept of evolution of Charles Darwin, which was published in On the Origin of

Species (1859). Darwin proposed the theory that organisms evolve by the process of natural selection. The theory had no immediate effect on existing classifications themselves, but it provided a new explanation, nearness of descent, for the natural grouping of organisms. This approach is fundamental to modern classification schemes.

Linnaean System

Linnaeus arranged classification categories as a series of nested sets. His sequence from broadest to smallest category is: kingdom, class, order, genus, and species. Related groups of organisms were determined by the many shared characteristics; he stressed especially those having to do with sustenance, feeding, and digestion.

The basic Linnaean unit in the classification of living forms is the species (plural, species). Each species is given a unique, two part name in Latin; the name is always underlined or italicized in print. The name consists of the Genus, which is a group of species more closely related to one another than to any other group, followed by the specific name, which identifies a particular species within a genus. The first letter of the genus is capitalized, while the specific name is in lowercase, as in *Homo sapiens* (human) and *Sciurus carolinensis* (gray squirrel). The binomial species name replaced the much longer descriptive phrases of earlier classifications.

Linnaeus named groups of organisms for the complex of defining characters. For example, he gave the name Mammalia to the group of animals that possess mammary glands and secrete milk to nourish their young. He also recognized that monkeys are most nearly like humans, and as a logical consequence of strictly biological classification, humans would be grouped not only in the class Mammalia but in the same ordinal division with the monkeys and apes.

Higher Groupings

The smallest unit of classification is usually the species, the only taxonomic unit with clear biological meaning to the organisms. A species includes all organisms that can interbreed and produce fertile offspring in nature. Thus, the genes of one species cannot be transferred to another through sexual reproduction. A species is usually divided into many local populations, with limited interbreeding occurring among members of different local populations to maintain genetic continuity among the species. The genetic differences between species may be differences in anatomy, behavior, ecology, physiology, and cellular chemistry. Categories above the species level indicate nearness of relationship and thus common descent, but they are not biologically equivalent, i.e., a family of rodents may not be comparable to a family of flowering plants. No rank above the species level can be defined in absolute terms.

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As the number and diversity of known organisms increased, the classification levels of phylum and family were added to Linnaeus's original five. Other categories were formed by adding the prefixes super-, sub-, and infra- to the names of main categories. Species that are closely related are grouped together into a genus (plural, genera). Genera with similar characteristics and origins are grouped into families. Families are grouped into orders, orders into classes, and classes into phyla in animals and into divisions in plants. Related phyla or divisions are placed together into kingdoms.

Major Kingdoms

Originally, organisms were divided between two kingdoms, the Plantae (including bacteria, fungi, and algae) and the Animalia (including protozoa). The wealth of new data generated by the new technologies of molecular biology and electron microscopy led to the five-kingdom system proposed by R. H. Whittaker in the 1950s. In Whittaker's system, organisms are classified according to whether they are prokaryotic, i.e., single-celled, like bacteria, with neither internal membranes nor organelles, or eukaryotic, i.e., composed of one or more cells containing membrane- bound nuclei and organelles. The five kingdoms are Monera, Fungi, Protista, Plantae, and Animalia.

The Monera include the various kinds of bacteria and the photosynthetic cyanobacteria. These are prokaryotes; their single cells are surrounded by a noncellulose wall and lack membranous internal organelles. In the remaining four kingdoms, the cells of organisms are eukaryotic; the DNA is combined with proteins in chromosomes and surrounded by a double nuclear membrane; and the cells contain energy powerhouses called mitochondria. The Protista, which include Amoeba, Paramecium, and Euglena, are primarily unicellular and aquatic. Most protista live in marine and freshwater environments, although some live in the tissue fluids of other organisms. Their variety is immense and the true number of protista species is not known. Algae may be placed here or in the kingdome Plantae.

The kingdom Fungi, which includes mushrooms, yeast, and the fungi that cause athlete's foot, are characterized by cell walls of chitin and other non-cellulose polysaccharides. Most fungi excrete powerful enzymes to break down food into molecules that are absorbed. They are tough and resist drying out.

The kingdom Plantae consists of many-celled organisms that live by photosynthesis. Plants are characterized by cells that are surrounded by a wall of cellulose and other polysaccharides. The cells in photosynthetic parts contain chloroplasts with light-absorbing pigments called chlorophylls. Some plants, such as, mosses and liverworts, lack vascular transport tissues and cling to the ground. Vascular plants, such as, ferns, conifers, and flowering plants, have tubular systems of xylem and phloem cells that transport water up from the ground and circulate nutrients dissolved in water.

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The defining characteristic of all members of the Animalia kingdom is their development from a blastula, the hollow ball of cells that arises from mitosis of a fertilized egg. Animal cells have no surrounding wall and are usually organized into multicellular tissues. Most animals ingest food. The kingdom encompasses the greatest diversity of forms, including sponges, mollusks, insects, and humans.

Homology and Analogy

An outcome of the Darwinian revolution is that classifications of organisms are based on their phylogeny. The creation of a phylogeny for organisms involves identification of species followed by assessment of their similarities and differences to determine probable relationship. However, similarity alone is not an adequate basis for assessing relatedness. Characteristics are said to be homologous if they are inherited through common descent, no matter what their form and use, for example, finger bones in primates and bats. Within a group, unique homologous similarities may indicate close relationship through common ancestry, as in the single pair of gnawing incisors in the upper dentition of all rodents.

Characteristics are analogous if they serve the same function but cannot be traced back to the same feature in the common ancestor, as in the wings of birds and bats. Similar characteristics may indicate relationship, or they may simply reflect a primitive common heritage seen also outside the group under study. For example, all humans have backbones, but so do fish, frogs, and birds. Similarities may also indicate anatomical or physiological convergence through adaptation to the same environment. For this reason, kangaroos and jerboas were originally united in a single taxon, though the former are marsupials and the latter placental rodent.

Forms of Biological Classification

Two distinct forms of classification are:

i) Classification of Overlapping Sequences or Keys.

ii) Classification following Taxonomical Hierarchy.

The Basis of Biological Classification

i) Biological classification initially was based on superficiality morphological characteristics.

ii) With the development of a natural system of classification, the morphological characteristics were considered in every minute detail, along with that, there was also the consideration of the reproductive features.

iii) The phylogenetic system of biological classification considered is the gradual evolution of organisms and their phylogenetic relationships.

iv) The modern system considers all the relevant data from other branches of biology and it is developed by adequate computation.

Purposes of Biological Classification

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i) Biological classification helps in the arrangement of living plants and animals.
ii) It provides explanation for the diversity of organisms.
iii) It keeps proper knowledge of evolution of organisms.
iv) It gives the scope for the discovery of new spaces.
v) It helps in the storage of data about living organisms in the form of key and utilise them whenever necessary.
vi) It is a tool for identifying organisms.

Types of Biological Classification

There are mainly three types of classification system; those are artificial system, natural system and phylogenetic system of classification.

Artificial System

This system is based on one or two superficial characteristic without considering any morphological details or phylogenetic relationships.

Merits: It was the first novel attempts of classification of living organisms and therefore it have some importance of the history of biological classification.

Demerits: In this system closely related species may be placed distinctly apart and distant species might be placed together. The evolutionary relationships were not understood by this type of classification.

Natural System

This is the system of biological classification which is based on several natural characteristics. These simplest organisms are placed early while the complex ones are placed latter in this system. This system relied on the constancy of spaces. George Bentham and J. D. Hooker proposed system in 1862 and 1883 respectively. Several morphological characters were taken into consideration in these system and for this reason it is widely accepted and glands are arranged according to this system in many organised botanical Gardens.

Merits: This system of biological classification gives an easy means of identification of plants which are unknown. Morphological characters of plants have been studied before placing them in their respective positions. It has been widely accepted due to an original novel attempt describing 97,205 spaces.

Demerits: Gymnosperms were wrongly placed between dicotyledonous and monocotyledonous plants. There was no phylogenetic consideration in this system and some of the closely related species are placed distantly while distant places are placed close to each other.

NOTES

Phylogenetic System

This system of biological classification is based on evolutionary sequence and genetic relationships taken in consideration. After the publication of Darwin's theory in 1859 the system was actually developed and along with the natural morphological characteristics which are inputs from fossils records the genetic constitutions were also considered. Due to this it is largely accepted by modern biologist.

Merits: This system gives the phylogenetic relationship and has resulted in the development of experimental taxonomy. It has the estimated hollowness and is widely accepted by the biologist.

Check Your Progress

1. Define the term biological classification.
2. What is taxonomy?
3. Give two distinct forms of classification.
4. What is the purpose of biological classification?
5. What is the basis of artificial classification?

2.3 SYSTEMATICS

Systematics is the branch of science that studies the biological diversity and organizes the information into a classification. The first classification appeared in Ancient Greece, notably with Aristotle. In 1758, Linnaeus created the hierarchical system of classification still employed in taxonomy. With the advent of Darwin's theory of evolution in the 19th century, biological diversity began being explained as the result of the divergence of species from a common ancestor. The phylogenetic systematics, established by Hennig between the decades of 1950 and 1960, incorporated this paradigm, changing the principles of biological classification. Taxonomy started to reflect ancestry, and the systems of classification to accept only monophyletic taxa (groups of organisms with a common and exclusive ancestor). Morphology was largely used to reconstruct the evolutionary history of organisms. Morphological characters have been useful to the recognition of large groups, as well as to the description of families, genera and species, constituting the basis of any classification. However, with the advent of molecular biology, countless techniques to access genetic material were developed, among them the immunological assays, the electrophoresis of enzymes and proteins, the hybridization of DNA and the DNA Polymerase Chain Reaction (PCR). More recently, the sequencing of specific regions of DNA has opened new opportunity to access DNA information, allowing comparisons between individuals representing different taxonomic levels.

2.3.1 Molecular Systematics

Molecular systematics is the use of molecular genetics to study the evolution of relationships among individuals and species. The goal of systematic studies is to provide insight into the history of groups of organisms and the evolutionary processes that create diversity among species.

For thousands of years, naturalists have looked at the world and attempted to describe and explain biological diversity. This attempt to examine and classify is called systematics - a system for imposing order on the seeming chaos of nature. In 1758 Swedish naturalist Carolus Linnaeus devised a hierarchical classification system using two-part Latin names to categorize plants and animals. This system is still used today. Linnaeus was opposed to the theory of evolution, and his system was originally based on morphological features of structure and form. However, evolutionists rapidly adopted the Linnaean system and developed it into a classification based on phylogenetics, the evolutionary development of species. By 1866, German zoologist Ernst Haeckel had published a collection of detailed phylogenetic 'trees' depicting what was then known about the evolutionary history of life.

Interest in phylogeny waned over much of the nineteenth century, replaced by an emphasis on genetics, physiology, and geographic variances. That began to change with the work of botanist Walter Zimmerman in the 1940s, and German zoologist Willi Hennig, in the 1950s and 1960s. These scientists pioneered the definition of objective criteria for determining the shared genetic attributes of living and fossil organisms. A revolution in molecular biology took place in the 1960s. Methods for determining the molecular structure of proteins and amino acids allowed biologists to begin to estimate phylogenetic relationships. The exponential growth of molecular systematics in the late twentieth century is due to a combination of increased sophistication in molecular biology techniques, and computer advances in hardware and software that allow scientists to model large and complex data sets.

Molecular systematists use a variety of techniques to derive phylogenetic trees. Polymerase Chain Reaction (PCR) is used to investigate variations of DNA on a large scale. Gene amplification is also fundamental to new approaches to DNA fingerprinting. Scientists can use 'molecular clocks' to predict both past and future molecular divergences in genes. This theory claims that molecular change is sufficiently constant to determine how current genetic lineages branch off from a common ancestor and to determine when the branching occurred. Genetic markers are used to make inferences about relationships between environment and morphology, as well as physiology and behavior.

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The importance of phylogenetic trees, or estimates of evolutionary history, are that they allow biology to be predictive. Much as a chemist can use the periodic table of elements to predict chemical reactions, biologists can use phylogenetic trees to analyze biological variation and make predictions about behavior, morphology, and physiology, as well as biomolecular structure and other biological attributes.

The applications of molecular systematics in medicine are particularly important. The ability to predict the course of evolution allows scientists to track epidemic pathogens , research zootonic viruses (animal viruses that are transmissible to humans), understand the evolution of pharmaceuticals and drug resistance, and make predictions about emerging diseases. For example, phylogenetic studies of a form of influenza called influenza A have revealed reliable evolutionary behavior that can be used to predict how the viruses that cause influenza will evolve. This allows scientists to prepare vaccines for future strains in advance. Research into when simian immunodeficiency virus began to be transmitted to humans is vital to understanding how the transmission occurred and perhaps to prevent future zootonic transmissions.

Phylogeny is also an integral part of interpreting any coevolutionary relationships, such as host and parasite. In the example of the coevolution of insects and their host plants, the plants evolve chemical defenses against the insects, who then evolve resistances to the chemicals. Because there are a limited number of chemical defenses available to the plants, researchers looked at whether insects are more likely to stay with the same plant as it evolves, or to switch to plants that contain chemicals to which they are already adapted. Studies of beetle phylogeny shows a closer match to plant chemistry than to plant phylogeny, indicating that the beetles have learned to switch plants as the host evolves new defenses.

Behavioral ecologists use phylogeny to reconstruct the evolution of behaviors. Molecular data can clarify the connections between animals previously thought to be unrelated. For example, flying foxes (*Pteropus*, also known as fruit bats), in contrast to other bats, have been shown to share significant features of brain organization with primates. These shared features lead scientists to believe that wings and flying evolved independently in these two lineages.

Evolution is not something that just happened in the past. It can be observed in the present and used to predict the future, by employing molecular systematics to compare data across genes, individuals, populations, and species.

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2.3.2 Biological Systematics

Biological Systematics (also called Biological Taxonomy) is the study of the systematic classification and naming of living organisms due to biological similarities and evolutionary relationships. The traditional classification ranks are of Kingdom, Phylum, Class, Order, Family, Genus, and Species (in order from broadest to most specific). In addition, phylogenetics utilizes phylogenetic trees (or trees of evolutionary descent) to describe and visualize evolutionary relationships and genetic similarities. This subject is closely related to the topic of biodiversity, and many of these resources may also be helpful in discovering a scientific or common name associated with a given species.

Biological systematics encompasses three distinct activities: taxonomy, classification (which may or may not be a reasonable reflection of phylogeny) and nomenclature (Refer Figure 2.1). Although systematists rigorously and distinctly practice these three components, they are often amalgamated under the term 'taxonomy'. While the breadth of 'taxonomy' is clearly understood among most practitioners, it can obscure the methodology and practices of modern systematics to others. On the other hand, not all systematists work across the full breadth of systematics. For example, they can be engaged in the study of molecular phylogenies without applying the results of their studies to the nomenclature of the group. Similarly, the resolution of nomenclatural issues can be carried out without a phylogenetic study of the species or the generation of a new classification, but usually not without extensive library resources.

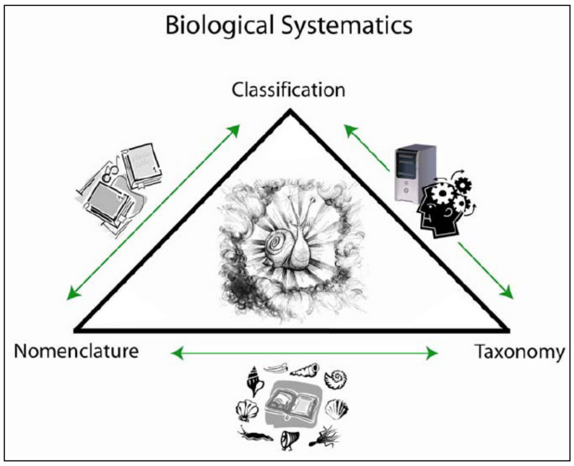

Fig 2.1 *Biological Systematics a Summary Showing the Relationship Between Taxonomy, Classification, and Nomenclature*

The three components of biological systematics can be described as follows:

Taxonomy

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Taxonomy is a process. In this process, a classification can be referred to but its focus is on the study and description of the objects being classified. It includes the examination of individual organisms and the description, analysis and quantification of taxa by way of the characters they possess. Characters can be taken from morphology (gross morphology to cellular ultrastructure) and at different life history stages (cell division cycles to adults with indeterminate growth). Molecular characters underlie this morphology and scale from base pair to genome. Because of this complexity, character analysis of semaphoronts is critical for the accurate scoring of character states whether it is the homology of morphological structures or the alignment of gene fragments.

The practice of taxonomy requires an extraordinary understanding of a taxon and the ability to rigorously extract and evaluate the necessary character information. To do this systematists may require access to microscopy, imaging, histological and molecular facilities, or some subset of them. For extinct taxa, access to isotopic, thin-section and 3D reconstruction technologies may also be necessary. Unfortunately, and often not from necessity, the taxonomy of many groups is based on little more than a handful of traditional characters.

Taxonomy interacts with both nomenclature and classification (Refer Figure 2.1). The taxonomic study describes the characters, and their states, of a taxon or taxa. Through interaction with nomenclature a name can be attached to specimens (grouped as taxa) with unique sets of character states.

The interaction of taxonomy with classification requires an additional step – an analysis of the character states, preferably an algorithmic one. There are three major kinds of analysis: evolutionary systematics, phenetic and cladistic. In evolutionary systematics the analysis is largely dependent on the systematists intimate knowledge of the group to produce an evolutionary scenario. Similarly, cladistic techniques can be applied without using computers but modern phenetic and cladistic analysis use numerical algorithms and are more computational. Phonetics uses clustering techniques based on overall similarity of the data (for example, UPGMA and neighbor joining) while cladistic and other phylogenetic reconstruction methods use special similarity (for example, parsimony) or require an evolutionary model and parameters (for example, maximum likelihood or Bayesian analysis). Regardless of the method of analysis of the taxonomic data, the process produces a classification.

Classification

Like the term taxonomy, classification is commonly used outside the biological systematic community as almost any animate or inanimate object, place, concept or event can be classified according to some criteria or scheme. It is the act of assigning individuals to a class or classes based on some common relations or affinities. Biological classifications, produced by phenetic and cladistic computations, are trees of hieratical relationships. In evolutionary systematics classifications may be represented by assignment of 'taxonomic' rank (species, genera, families, superfamilies, orders, etc.) or by evolutionary scenarios. Classifications may or may not reflect putative evolutionary relationships (phylogenies) and when characters are heavily weighted or the groupings are based on algorithms that feature overall similarity, there is a far greater probably that the classifications will not reflect evolutionary history.

Classification interacts with both taxonomy and nomenclature (Refer Figure 2.). With classifications that provide trees, the tips and nodes can be formally named following nomenclatural practices. Classifications provide predictions that can be tested by examining additional taxa or characters. Previously unstudied taxa can be predicted to have certain character states while the discovery of homoplasy may necessitate reexamination of the study taxa to document putative convergences.

Classification also provides an important interface to other biological enterprises. The benefits of using classifications that reflect the evolutionary history (phylogeny) of a taxon in research, conservation and economic ventures is being increasingly recognized throughout the biological sciences. Unfortunately, the replacement of existing classifications by new classifications that reflect phylogeny often require name changes at various taxon levels that can cause short term angst, but the classification is not the problem. Name changes are nomenclatural (see below). The tips of the trees in classifications may be an individual, a composite taxon (population, species, genus, etc.), or a grade. They do not necessarily have or need formal names and a tree of microcentrifuge tube numbers may be all that is necessary to test competing hypotheses.

Nomenclature

Nomenclature in biological systematics is the assigning of formal names to all or some of the tips and nodes of a hierarchical classification. The International Code of Zoological Nomenclature (ICZN) provides rules on how taxa will be named and how conflicts in nomenclature (not classification) will be resolved. Recently, alternative systems of nomenclature have been proposed, but neither have yet gained general acceptance.

Nomenclature interacts with classification by providing names (and typically ranks1) for the different groupings present in the classification and with taxonomy by providing unique names to distinct taxa with certain combinations of character states as discussed above. This latter interaction is well illustrated by the common association of character states and nomenclature in classic dichotomous keys.

Nomenclature provides a relatively stable name governed by a set of rules (unlike the adoption of so called 'common names') which allows non-specialists for example, conservation and economic communities) and specialists to communicate. Stable or trackable nomenclature is critical to both communities. For example, listing of species for environmental protection requires a 'scientific name' and the units used to estimate biodiversity are almost always formal scientific names parsed by rank (for example, species, generic, familial diversity). Names of invasive species must be globally understood to be effective in restricting movement. Likewise for the recognition of parasite vectors and patents for natural compounds and the regulation of commercial and sport fisheries.

2.3.3 Structural Systematics

One of the primary responsibilities of systematic biology is the development of our biological nomenclature and classifications. Nomenclature is not an end to systematics and taxonomy but is a necessity in organizing information about biodiversity. Nomenclature functions to provide labels (names) for all taxa at all levels in the hierarchy of life.

Biological nomenclature is, to some degree, the parlance of systematic biology. It derives from the binomial (or binominal) nomenclature that was originally codified in the works of Linnaeus, *Species Plantarum* (1753) and *Systema Naturae,* 10th Edition (1758). These publications are the decided starting points for the modern biological nomenclature in most groups of plants and animals.

Together with the presentation of the consistent binomial system of naming, Linnaeus also developed a system of organizing the diversity of life in a hierarchical classification. Latin was the important language of the time of Linnaeus and continues to be a critical language for international communication. As will be seen below the various Codes for nomenclature consider Latin to be an essential language.

- Taxa at the level of species are named with binomials, consisting of generic and specific epithets or names that together equal the species name.
- Taxa above the level of species are supra-specific taxa and are uninominals.
- Taxa below the level of species are subspecies are trinominals.

The binomial system has been a successful system because it is functional, has been the only system that has been universally accepted, and has been used over the last 250 of nomenclature.

Biological nomenclature is a language that we use to communicate ideas and information about the diversity of life. It is an information retrieval system conveying information about diversity and relationships.

NOTES

Common vs Scientific Names

Common Names: These names are for species having common words in the language of the layperson. These names can often be misleading and has the following disadvantages.

Disadvantages

- They are not useful to people with a different language or dialect.
- Some species have several common names.
- Some species share the same common name.
- Some species may not have a common name.

Scientific Names: These are Latin or Latinized names that are standardized by a series of rules and are applicable worldwide.

Linnaean Hierarchy

This is a system of categories that connote taxonomic rank. The same thing could be achieved through a system of indentation (Refer Figure 2.3) or a system of numbers connoting rank in a hierarchy. However, these latter systems are generally more difficult to represent and remember by the user.

With the Linnaean system one only needs to know the general categories and know rank order in the hierarchy!

The original Linnaean system had a limited set of categories that successfully reflected a nested set of groups within groups.

Figure 2.2 illustrates the Linnaean hierarchy as defined in the 10th Edition of Systema Naturae (1758).

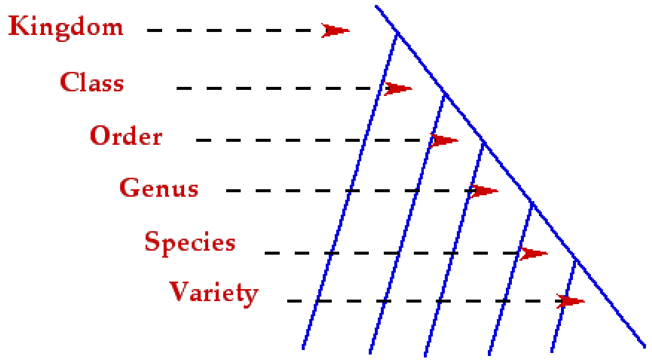

Fig. 2.2 *Linnaean Hierarchy in 10th Edition of Systema Naturae (1758)*

Later many authors began to incorporate categories above and below these original categories. Some modern classifications contain the following 10 different categories, as shown in Figure .

NOTES

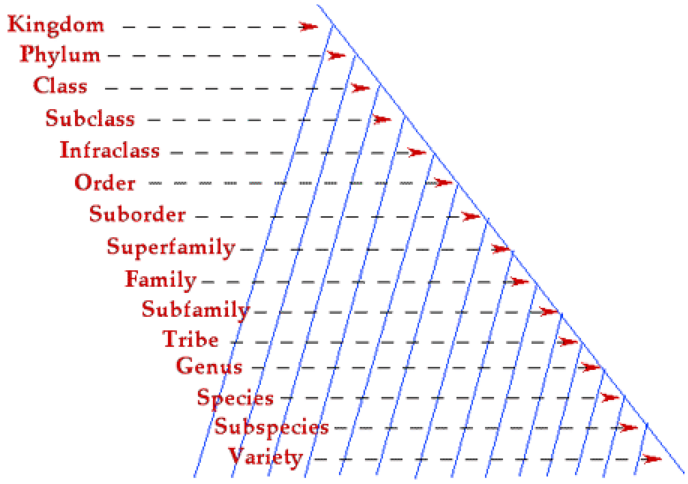

Fig.2.3 Categories Used in Modern Classifications

Proper Usage of Taxonomic Categories

Taxonomic Category	Singular	Plural
Kingdom	Kingdom	Kingdoms
Phylum	Phylum	Phyla
Class	Class	Classes
Order	Order	Orders
Family	Family	Families
Genus	Genus	Genera
Species	Species	Species

Binomial Classification

The binomial classification system proposed by Linnaeus allowed him and others to group organisms together based on common structures, functions, and resulting behaviors, which led to the science of taxonomy or classification.

Check Your Progress

6. Define systematics.
7. What is molecular systematics?
8. What feature does one need to study taxonomy?
9. What is nomenclature?
10. Give some disadvantages of common names.
11. Distinguish between scientific name and common name.

2.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. Biological classification is defined as the ordering or ranking of organisms into groups on the basis of similarities or closeness or relationship.
2. Taxonomy is the theory and practice of classifying organisms. It is a branch of systematics, the study of the diversity of organisms.
3. Two distinct forms of classification are:
   i) Classification of Overlapping Sequences or Keys.
   ii) Classification following Taxonomical Hierarchy.
4. Purposes of Biological Classification
   i) Biological classification helps in the arrangement of living plants and animals.
   ii) It provides explanation for the diversity of organisms.
   iii) It keeps proper knowledge of evolution of organisms.
5. Artificial System is based on one or two superficial characteristic without considering any morphological details or phylogenetic relationships.
6. Systematics is the branch of science that studies the biological diversity and organizes the information into a classification.
7. Molecular systematics is the use of molecular genetics to study the evolution of relationships among individuals and species.
8. The practice of taxonomy requires an extraordinary understanding of a taxon and the ability to rigorously extract and evaluate the necessary character information.
9. Nomenclature in biological systematics is the assigning of formal names to all or some of the tips and nodes of a hierarchical classification. The International Code of Zoological Nomenclature (ICZN) provides rules on how taxa will be named and how conflicts in nomenclature (not classification) will be resolved.
10. Disadvantages of common names
    - They are not useful to people with a different language or dialect.
    - Some species have several common names.
    - Some species share the same common name.
    - Some species may not have a common name.

NOTES

11. Scientific names are Latin or Latinized names that are standardized by a series of rules and are applicable worldwide, whereas common names are for species having common words in the language of the layperson. These names can often be misleading and has the following disadvantages.

2.5 SUMMARY

- Biological classification is defined as the ordering or ranking of organisms into groups on the basis of similarities or closeness or relationship.
- Taxonomy is the theory and practice of classifying organisms. It is a branch of systematics, the study of the diversity of organisms.
- Since that time, many new classification systems have been proposed; none, however, has succeeded in fitting all plants, animals, and microorganisms into a single, completely satisfactory scheme.
- Recently, biotechnological techniques have enabled researchers to compare the DNA of various organisms to decipher the phylogeny of some organisms and helped to distinguish some closely related species with similar appearance.
- Aristotle (384-322 BC) is often called the father of biological classification. His classification scheme referred to readily apparent groups, such as, birds, fishes, whales, and bats, and he recognized the need for groups and group names in the study of the animal kingdom.
- John Ray (1627-1705) used anatomical differences as the prime criterion for classification, bringing out both the resemblances and differences between groups—for example, lung breathing or gill breathing.
- The standard and universal binomial nomenclature for species is attributed to Carl Linnaeus (1707-1778). He applied it consistently to plants in *Species Plantarum* (1753), and to animals in *Systema Naturae* (10th ed., 1757).
- Linnaeus' system was readily applicable to the new concept of evolution of Charles Darwin, which was published in On the Origin of Species (1859).
- Darwin proposed the theory that organisms evolve by the process of natural selection. The theory had no immediate effect on existing classifications themselves, but it provided a new explanation, nearness of descent, for the natural grouping of organisms.

NOTES

- Linnaeus arranged classification categories as a series of nested sets. His sequence from broadest to smallest category is: kingdom, class, order, genus, and species.
- Related groups of organisms were determined by the many shared characteristics; he stressed especially those having to do with sustenance, feeding, and digestion.
- The basic Linnaean unit in the classification of living forms is the species (plural, species). Each species is given a unique, two part name in Latin; the name is always underlined or italicized in print.
- The name consists of the Genus, which is a group of species more closely related to one another than to any other group, followed by the specific name, which identifies a particular species within a genus.
- The first letter of the genus is capitalized, while the specific name is in lowercase, as in *Homo sapiens* (human) and *Sciurus carolinensis* (gray squirrel). The binomial species name replaced the much longer descriptive phrases of earlier classifications.
- The smallest unit of classification is usually the species, the only taxonomic unit with clear biological meaning to the organisms. A species includes all organisms that can interbreed and produce fertile offspring in nature.
- A species is usually divided into many local populations, with limited interbreeding occurring among members of different local populations to maintain genetic continuity among the species.
- Categories above the species level indicate nearness of relationship and thus common descent, but they are not biologically equivalent, i.e., a family of rodents may not be comparable to a family of flowering plants.
- Originally, organisms were divided between two kingdoms, the Plantae (including bacteria, fungi, and algae) and the Animalia (including protozoa).
- The wealth of new data generated by the new technologies of molecular biology and electron microscopy led to the five-kingdom system proposed by R. H. Whittaker in the 1950s.
- In Whittaker's system, organisms are classified according to whether they are prokaryotic, i.e., single-celled, like bacteria, with neither internal membranes nor organelles, or eukaryotic, i.e., composed of one or more cells containing membrane- bound nuclei and organelles.
- The five kingdoms are Monera, Fungi, Protista, Plantae, and Animalia.

NOTES

- The Monera include the various kinds of bacteria and the photosynthetic cyanobacteria. These are prokaryotes; their single cells are surrounded by a non-cellulose wall and lack membranous internal organelles.
- In the remaining four kingdoms, the cells of organisms are eukaryotic; the DNA is combined with proteins in chromosomes and surrounded by a double nuclear membrane; and the cells contain energy powerhouses called mitochondria.
- The Protista, which include Amoeba, Paramecium, and Euglena, are primarily unicellular and aquatic. Most protista live in marine and freshwater environments, although some live in the tissue fluids of other organisms.
- Natural System of biological classification which is based on several natural characteristics. These simplest organisms are placed early while the complex ones are placed latter in this system. This system relied on the constancy of spaces. George Bentham and J. D. Hooker proposed system in 1862 and 1883 respectively.
- Phylogenetic System of biological classification is based on evolutionary sequence and genetic relationships taken in consideration. After the publication of Darwin's theory in 1859 the system was actually developed and along with the natural morphological characteristics which are inputs from fossils records the genetic constitutions were also considered.
- Systematics is the branch of science that studies the biological diversity and organizes the information into a classification.
- The first classification appeared in Ancient Greece, notably with Aristotle. In 1758, Linnaeus created the hierarchical system of classification still employed in taxonomy.
- With the advent of Darwin's theory of evolution in the 19th century, biological diversity began being explained as the result of the divergence of species from a common ancestor.
- The phylogenetic systematics, established by Hennig between the decades of 1950 and 1960, incorporated this paradigm, changing the principles of biological classification.
- Taxonomy started to reflect ancestry, and the systems of classification to accept only monophyletic taxa (groups of organisms with a common and exclusive ancestor).
- Morphology was largely used to reconstruct the evolutionary history of organisms. Morphological characters have been useful to the recognition of large groups, as well as to the description of families, genera and species, constituting the basis of any classification.

- However, with the advent of molecular biology, countless techniques to access genetic material were developed, among them the immunological assays, the electrophoresis of enzymes and proteins, the hybridization of DNA and the DNA Polymerase Chain Reaction (PCR).
- Molecular systematics is the use of molecular genetics to study the evolution of relationships among individuals and species. The goal of systematic studies is to provide insight into the history of groups of organisms and the evolutionary processes that create diversity among species.
- Molecular systematists uses a variety of techniques to derive phylogenetic trees. Polymerase Chain Reaction (PCR) is used to investigate variations of DNA on a large scale.
- Gene amplification is also fundamental to new approaches to DNA fingerprinting. Scientists can use 'molecular clocks' to predict both past and future molecular divergences in genes.
- Biological Systematics (also called Biological Taxonomy) is the study of the systematic classification and naming of living organisms due to biological similarities and evolutionary relationships.
- In addition, phylogenetics utilizes phylogenetic trees (or trees of evolutionary descent) to describe and visualize evolutionary relationships and genetic similarities.
- Nomenclature in biological systematics is the assigning of formal names to all or some of the tips and nodes of a hierarchical classification. The International Code of Zoological Nomenclature (ICZN) provides rules on how taxa will be named and how conflicts in nomenclature will be resolved.

2.6 KEY WORDS

- **Biological classification:** Biological classification is defined as the ordering or ranking of organisms into groups on the basis of similarities or closeness or relationship.
- **Taxonomy:** Taxonomy is the theory and practice of classifying organisms. It is a branch of systematics, the study of the diversity of organisms.
- **Phylogenetics:** Phylogenetics is the study of evolutionary relationships among biological entities - often species, individuals or genes (which may be referred to as taxa).
- **Zootonic:** Zootonic is a disease that can be transmitted from animals to people or, more specifically, a disease that normally exists in animals but that can infect humans.

NOTES

- **Coevolution:** Coevolution is the evolution involving successive changes in two or more ecologically interdependent species (as of a plant and its pollinators) that affect their interactions.
- **Scientific Names:** These are Latin or Latinized names that are standardized by a series of rules and are applicable worldwide.
- **Common Names:** These names are for species having common words in the language of the layperson. These names can often be misleading and has the following disadvantages.

2.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a short note on biological classification.
2. Write about history of biological classification.
3. Write a short note on Linnaeus system.
4. Write a short note on major kingdoms.
5. What is the basis of biological classification?
6. How many types of biological classifications are there? Describe them.
7. Write the merits and demerits of natural system.

Long Answer Questions

1. Write a detailed note on biological classification and its history.
2. Describe in detail about Linnaeus system, higher groupings, major kingdom.
3. Write a detailed note on forms, basis, purpose and types of biological classification.
4. Write a detailed note on systematics.
5. Describe about molecular systematics.
6. Discuss about biological systematics in detail.
7. Give a detailed overview of structural systematics.

2.8 FURTHER READINGS

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UNIT 3 PLANT CLASSIFICATION

NOTES

Structure

3.0 INTRODUCTION

Plants are living organisms belonging to the kingdom Plantae. They include familiar organisms such as trees, herbs, bushes, grasses, vines, ferns, mosses, and green algae. About 350,000 species of plants, defined as seed plants, bryophytes, ferns and fern allies, are estimated to exist currently. As of 2004, some 287,655 species had been identified, of which 258,650 are flowering and 18,000 bryophytes. Green plants, sometimes called metaphytes or viridiplantae, obtain most of their energy from sunlight via a process called photosynthesis.

The classification scheme provides a mechanism for bringing together various species into progressively larger groups. Taxonomists classify two species together in the same genus - the plural is genera. For example, the horse Equus caballus and the donkey Equus assinus are both placed in the genus Equus. Similar genera are brought together to form a family. Similar families are classified within an order. Orders with similar characteristics are grouped in a class. Related classes are grouped together as divisions or phyla (the singular is phylum). Divisions are used for plants and fungi, while phyla are used for animals and animal-like organisms. The largest and broadest category used to be the kingdom, but this has been usurped by the taxonomic category domain.

In this unit, you will study about the historical background of plant classification, plant classification system, Bentham and Hooker classification, Engler and Prantl classification, Takhtajan and Hutchinson classification in detail.

3.1 OBJECTIVES

NOTES

After going through this unit, you will be able to:

- Understand the historical background of plant classification
- Discuss about plant classification systems
- Describe about Bentham and Hooker classification
- Understand Engler and Prantl classification
- Discuss Takhtajan and Hutchinson classification

3.2 HISTORY OF PLANT CLASSIFICATION IN INDIA

The history of plant classification in India is divided in 5 periods, they are:

- Rig Veda Period
- The Greek Period
- The Roman Period
- The Dark Age, Herbals and the Transition Period
- Modern Period

3.2.1 Rig Veda Period

According to Majumdar history of botany and plant taxonomy in India can be traced back to the period of Rig Veda 3000 B.C. (and earlier) and later Hindu literature including Manu, Agni Purana, Vrikshayarveda, ,etc. A broad classification of plants into trees, shrubs, herbs and creepers is to be found in the mantras (hymns) of Rig Veda.

Plants were further classified into those that produced fruits and flowers and those without fruits and flowers. Thus as early as 3000 B.C. we come across a classification approaching Phanerogamia and Cryptogamia of Eichler. Manu classified the plants more distinctly.

They are:

1. Oshadhis – annual plants.
2. Vanaspatis – trees bearing fruits without evident flowers.
3. Vrikshas – trees bearing flowers and fruits.
4. Guccha – bushy or shrubby plants.
5. Gulmas – succulent shrubs.

6. Trinas – grasses.
7. Pratnas – procumbent and decumbent herbs.
8. Vallis – twiners.

NOTES

Charaka in his Charak-Samhita also gives a classification similar to the above. Sushruta also follows a similar pattern. Apart from the above, the ancient Indians also classified plants according to their medicinal properties and dietic properties, for example the ayurvedic systems of Charaka, Sushruta and others.

Sushruta classified medicinal plants under thirty seven ganas or sections. Plant classification, based upon their dietic properties was also attempted by Charaka and Sushruta.

Regarding the system of nomenclature the ancient Indian system adopted double names – one based upon external features and the other based upon some special medicinal, dietic or other properties. This system of double naming is of course not synonymous with the binomial system devised by Linnaeus.

3.2.2 The Greek Period

Theophrastus (370-287 B.C.) was a student and contemporary of Aristotle and was particularly interested in plants. His work is entitled De Historia Plantarum in which he described about 480 kinds of plants and divided them primarily on the basis of habit into trees, undershrubs, herbs, cultivated and wild plants. Theophrastus followed the Platonic method of logical division, i.e., any given object is either A or not A.

His main point of enquiry was - What is the essential nature and difference? After Theophrastus we do not get any notable name in the field of botany or as a matter of fact in any of the branches of science. It seems the Greek civilization degenerated and died out towards the beginning of the Christian era.

3.2.3 The Roman Period

With the advent of the Roman civilization we come across certain important works towards plant classification.

Pliny the Elder (23-79 A.D.) He was a Roman naturalist and mentioned nearly a thousand plants in his ‘Historical Naturalis’. This is a series of 37 books dealing with plants on the basis of medicinal properties, timber and practices of horticulture.

Dioscorides (first century A.D.) was a physician of Rome and worked in the military of Emperor Nero.

He complied De Materia medica in which he described about 600 species and gave their accounts and practical uses. The book included perfumes, oils, spices, cereals, condiments, wines, etc. He even got the idea of groups such as the Labiates and Umbellifers. The book was documented with original illustrations increasing its value and usefulness greatly.

3.2.4 The Dark Age, Herbals and the Transition Period

NOTES

During the middle age a dark period descended over Europe and there was no significant botanical work. Most workers copied the work of Dioscorides without much addition. Wood cut of plants were prepared for illustrating them. Such were the herbals and included Albertus Magnus, Brunfels, Bock, Fuchs, Bauhin, etc.

Albertus Magnus (1193-1280) – He was bishop of Ratisbon and is believed to have first differentiated monocots from dicots on the basis of stem structure.

Otto Brunfels (1464-1434) – He was first to describe and to some extent illustrate plants and distinguish perfecti and imperfecti groups of plants on the presence and absence of flowers.

Jerome Bock (1498-1554) – He was a herbalist and classified plants as herbs, shrubs and trees providing suitable notes on natural distribution of many plants. His famous work 'New Krenterbuch' gave some fine description of plants.

Caesalpinia (1519-1637) – Wrote the book 'De Plantis' consisting of sixteen books with description of 1500 plant species. His classification was also based upon herbs, shrubs and trees but within these he recognised the significance of fruit and seed characters. Caesalpinia is remembered by the genus Caesalpinia in the family Fabaceae.

Jean Bauhin (1541-1631), a French and Swiss physician, His important contribution was 'Historia Plantarum Universalis', in which he dealt about 5000 plants.

Gaspard Bauhin (1560-1624), brother of Jean Bauhin. Gaspard published 'Pinax' (1623) containing names and synonyms of about 6000 species. He was the first to distinguish nomenclaturally between species and genus.

Joachim Jung (1587-1657), a German mathematician and the first terminologist. He was the first to define the following terms – nodes and internodes; blade and petiole; simple and compound leaf; stamens and styles, etc.

John Ray (1627-1705) was an English philosopher and naturalist. In his 'Methodus Plantarum' 18000 species were classified. He established for the first time the presence of one or two cotyledons in the angiosperms classification.

NOTES

His classification of the major groups was as follows:

I. Herbae

A. Imperfectae, i.e., flowerless (the cryptogams).

B. Perfectae, i.e., flowering plants.

Dicotyledones- embryo with 2 cotyledons.

Monocotyledones- embryo with 1 cotyledon.

II. Arbores, i.e., trees and shrubs

Dicotyledons.

Monocotyledons.

Pierre Magnol

Pierre Magnol (1638-1715) was a French botanist. He divided the plants into groups, what he called families. He was the first to give the concept of modern families. His name was commemorated by generic name Magnolia.

Joseph Pitton de Tournefort

Joseph Pitton de Tournefort (1656-1708). He recognised petal bearing and non-petal bearing flowers, corollas with separate and with united petals and regular and irregular corollas.

Rudolf Camerarius

Rudolf Camerarius (1665-1721). He was professor and director of botanical garden at Germany. He established the fact of sexuality in flowering plants.

3.2.5 Modern Period

The modern period of classification starts with Linnaeus and continues even today. During this period numerous systems have been proposed. Broadly speaking they belong to the pre-Darwinian period and post-Darwinian period. Before Darwin the concept of evolution was not an accepted principle and the general belief was in the fixity of species.

In the post-Darwinian period evolutionary theory brought about a fundamental change in the concept of classification. Generally speaking in the pre-Darwinian period the systems proposed were either artificial or natural.

An artificial system is one which plants classifies according to a few convenient characters for the purpose of identification without paying any attention to affinities. Linnaeus sexual system is an example of artificial system.

In fact all classifications prior to Linnaeus were also artificial. A natural system is one which is based upon overall resemblances between plants and groups taking external morphology as the main criterion. Systems of classifications after Linnaeus but prior to Darwin are supposed to be natural systems.

A phylogenetic system on the other hand tries to determine evolutionary relationships of plants and groups and arrange them accordingly. Thus those plants which were evolutionarily more related would stand closer together than those which were distantly related. Such systems as those of Endlicher, Eichler, Engler, Rendle and Hutchinson would come under this category.

Check Your Progress

1. In how many periods history of plant classification divided ? Name them.
2. What happened in Rig Veda Period?
3. What happened in dark age period?
4. Who was Jean Bauhin?

3.3 CLASSIFICATION OF PLANTS

Plants are classified in several different ways, and the further away from the garden we get, the more the name indicates a plant's relationship to other plants, and tells us about its place in the plant world rather than in the garden. Usually, only the Family, Genus and species are of concern to the gardener, but we sometimes include subspecies, variety or cultivar to identify a particular plant.

Starting from the top, the highest category, plants have traditionally been classified as follows. Each group has the characteristics of the level above it, but has some distinguishing features. The further down the scale you go, the more minor the differences become, until you end up with a classification which applies to only one plant (Refer Table 3.1).

Table 3.1 *Classification of Plants*

CLASS	Angiospermae (Angiosperms)	Plants which produce flowers
	Gymnospermae (Gymnosperms)	Plants which don't produce flowers
SUBCLASS	Dicotyledonae (Dicotyledons, Dicots)	Plants with two seed leaves
	Monocotyledonae (Monocotyledons, Monocots)	Plants with one seed leaf
SUPERORODER	A group of related Plant Families, classified in the order in which they are thought to have developed their differences from a common ancestor. There are six superorders in the Dicotyledonae (Magnoliidae, Hamamelidae, Caryophyllidae, Dilleniidae, Rosidae, Asteridae), and four superorders in the Monocotyledonae (Alismatidae, Commelinidae, Arecidae, Liliidae) The names of the Superorders end in **-idae**	

NOTES

ORDER	Each superorder is further divided into several Orders. The names of the Orders end in **-ales**
FAMILY	Each Order is divided into Families. These are plants with many botanical features in common, and is the highest classification normally used. At this level, the similarity between plants is often easily recognisable by the layman. Modern botanical classification assigns a type plant to each Family, which has the particular characteristics which separate this group of plants from others, and names the Family after this plant. The number of Plant Families varies according to the botanist whose classification you follow. Some botanists recognise only 150 or so families, preferring to classify other similar plants as sub-families, while others recognise nearly 500 plant families. A widely-accepted system is that devised by Cronquist in 1968, which is only slightly revised today. The names of the Families end in **-aceae**
SUBFAMILY	The Family may be further divided into a number of sub-families, which group together plants within the Family that have some significant botanical differences. The names of the Sub-families end in **-oideae**
TRIBE	A further division of plants within a Family, based on smaller botanical differences, but still usually comprising many different plants. The names of the Tribes end in **-eae**
SUBTRIBE	A further division, based on even smaller botanical differences, often only recognisable to botanists. The names of the subtribes end in **-inae**
GENUS	This is the part of the plant name that is most familiar, the normal name that you give a plant - Papaver (Poppy), Aquilegia (Columbine), and so on. The plants in a Genus are often easily recognisable as belonging to the same group. The name of the Genus should be written with a capital letter.
SPECIES	This is the level that defines an individual plant. Often, the name will describe some aspect of the plant - the colour of the flowers, size or shape of the leaves, or it may be named after the place where it was found. Together, the Genus and species name refer to only one plant, and they are used to identify that particular plant. Sometimes, the species is further divided into sub-species that contain plants not quite so distinct that they are classified as Varieties. The name of the species should be written after the Genus name, in small letters, with no capital letter.

VARIETY	A Variety is a plant that is only slightly different from the species plant, but the differences are not so insignificant as the differences in a form. The Latin is varietas, which is usually abbreviated to var. The name follows the Genus and species name, with **var.** before the individual variety name.
FORM	A form is a plant within a species that has minor botanical differences, such as the colour of flower or shape of the leaves. The name follows the Genus and species name, with **form (or f.)** before the individual variety name.
CULTIVAR	A Cultivar is a cultivated variety, a particular plant that has arisen either naturally or through deliberate hybridisation, and can be reproduced (vegetatively or by seed) to produce more of the same plant. The name follows the Genus and species name. It is written in the language of the person who described it, and should not be translated. It is either written in single quotation marks or has **cv.** written in front of the name.

NOTES

Example of Classification

The full botanical classification of a particular Lesser Spearwort with narrow leaves is (Refer Table 3.2).

Table 3.2 *Botanical Classification*

Category	Scientific Name	Common Name
CLASS	Angiospermae	Angiosperms
SUBCLASS	Dicotyledonae	Dicotyledons
SUPERORDER	Magnoliidae	Magnolia Superorder
ORDER	Ranunculares	Buttercup Order
FAMILY	Ranunculaceae	Buttercup Family
SUBFAMILY	Ranunculoideae	Buttercup Subfamily
TRIBE	Ranunculeae	Buttercup Tribe
GENUS	Ranunculus	Buttercup
SPECIES	(Ranunculus) flammula	Lesser Spearwort
SUBSPECIES	(Ranunculus flammula) subsp. flammula	Lesser Spearwort
VARIETY	(Ranunculus flammula subsp. flammula) var. tenuifolius	Narrow-leaved Lesser Spearwort

The traditional ways of classifying plants have been based on the visible physical characteristics of the plant. However, since the discovery of DNA, plant scientists have been trying to classify plants more accurately, and to group them according to the similarities of their DNA. This has led to major changes in plant classification, as scientists have discovered that some plants have more in common with other plants which do not look the same, and that other plants which look similar have very different DNA make-up.

3.3.1 Bentham and Hoocker's System

- This system was represented by two scientists in a book with three volumes named as 'Genera Plantarum'
- George Bentham (1830-1884) was an English scientist and a well-trained botanist.
- Sir Joseph Hooker (1817-1911) was Director of Royal Botanical Garden at Kew, was more plant explorer.
- Bentham and Hooker's classification deals with seed and flowering plants.
- It described 202 families grouped into cohorts.
- Total number of spp was some 97,205 of seeded plants.

They divided seed plants of Phanerogams into three categories

(i) Dicotyledons

(ii) Gymnospermae

(iii) Monocotyledons

Class I Dicotyledonae

Seeds of dicotyledonous plants contain two cotyledons. Leaves show reticulate venation (Refer Figure 3.1).

Flowers are tetramerous or pentamerous having four or five members in various floral whorls respectively.

It includes three sub-classes – Polypetalae, Gamopetalae and Monochlamydeae.

Sub-class I Polypetalae

Plants having flowers with free petals come under polypetalae. The flowers are with distinct calyx and corolla.

It is further divided into three series – Thalamiflorae, Disciflorae and Calyciflorae.

Series (i) Thalamiflorae

It includes plants having flowers with dome or conical thalamus. Ovary is superior.

Thalamiflorae includes 6 orders and 34 families. The family Malvaceae is placed in the order Malvales.

Series (ii) Disciflorae

It includes flowers having prominent disc shaped thalamus below the ovary.

Ovary is superior. Disciflorae is divided into 4 orders and 23 families.

Series (iii) Calyciflorae

It includes plants having flowers with cup shaped thalamus. Ovary is superior or inferior sometimes half inferior.

NOTES

Calyciflorae includes 5 orders and 27 families.

Sub-class 2. Gamopetalae

Plants having flowers with petals, which are either partially or completely fused to one another are placed under Gamopetalae.

The sepals and petals are distinct. Gamopetalae is further divided into three series – Inferae, Heteromerae and Bicarpellatae.

Series (i) Inferae

The flowers are epigynous and ovary is inferior. Inferae includes 3 orders and 9 families.

Series (ii) Heteromerae

The flowers are hypogynous and ovary is superior with more than two carpels. Heteromerae includes 3 orders and 12 families.

Series (iii) Bicarpellatae

The flowers are hypogynous and ovary is superior with two carpels only. Bicarpellatae includes 4 orders and 24 families. The family Solanaceae is placed in the order Polemoniales.

Sub-class 3. Monochlamydeae

Plants having flowers with single whorl of perianth are placed under Monochlamydeae.

Flowers are incomplete. The sepals and petals are not distinguished and they are called perianth. Tepals are present in two whorls. Sometimes both the whorls are absent. Monochlamydeae includes 8 series and 36 families. The family Euphorbiaceae is placed in the series unisexuals.

Class 2 Gymnospermae

The members of this class have naked ovules or seeds. Ovary is absent and gymnospermae includes three families – Gnetaceae, Coniferae and Cycadaceae.

NOTES

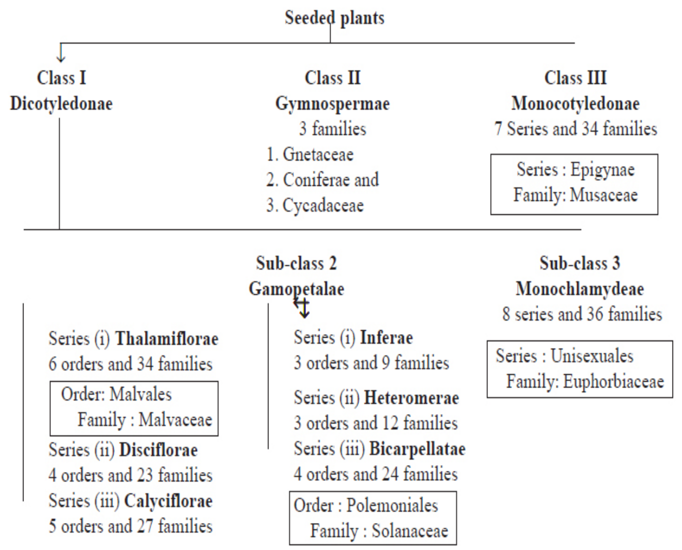

Fig. 3.1 *Outline of Bentham and Hooker's Classification of Plants*

Class 3 Monocotyledonae

Seeds of monocotyledonous plants contain only one cotyledon. Leaves show parallel venation. Flowers are trimerous having three members in various floral whorls. The plants have fibrous root system. The Monocotyledonae has 7 series and 34 families. The family Musaceae is placed in the series Epigynae.

Merits of Bentham and Hooker's System

- The description of families and genera is very accurate.
- The system is very handy for identification purposes.
- The system is of great practical convenience. The British and Commonwealth herbaria therefore still adopt this system in arrangement of families.
- Each family had a synopsis at the beginning which is very useful in identification.
- The system starts from Ranales, which are now universally considered to be most primitive living
- Larger genera subdivided into subgenera and sections.
- They believed in evolution through reduction and hence placed monocots after dicots; even in dicots, the dichlamydeous polypetalae and gamopetalae were placed before the uniseriate Monochlamydeae.
- The gamopetalae placed after polypetalae is justified since union of petals is considered to be an advanced feature.

NOTES

- The polypetalae includes Thalamiflorae and Calyciflorae of de Candolle. But Bentham and Hooker distinguished a new series Disciflorae which includes orders which cannot be assigned to Thalamiflorae or Calyciflorae.
- The 3 series – Thalamiflorae, Disciflorae and Calyciflorae show gradual evolutionary advance from marked hypogyny to epigyny.
- Treating Cucurbitaceae and Umbelliferae (Apiaceae) at the end of Polypetalae as connecting links between poly- and gamopetalous families.
- Creation of Monochlamydeae at the end of Dicots.
- Disputed families included in Ordines anomali.
- Placing of unisexual monocot families after bisexual families, for example Palmae and Araceae after Liliaceae.
- The series Glumaceae with extremely reduced flowers and inflorescences, placed at the end of the flowering plants.
- The system was never conceived by its authors on the basis of phylogeny. The theory of organic evolution (theory of descent) was announced independently by Darwin and Wallace in 1859. So, any criticism of the system on the basis of phylogeny is not too justified.

Demerits of Bentham and Hooker's System

- The system does not give any idea as to the evolutionary history of any genus, family or order.
- In this system grouping of plants is mainly based on single and artificial characters; with the result, that closely allied families are placed widely apart.
- The group 'Monochlamydeae' is entirely artificial.
- Gymnospermae is placed between the Dicotyledones and Monocotyledones, which is extremely anomalous.
- The system does not show any phylogenetic relationship. The main demerit is that this system does not give us any idea as to the evolutionary history of any genus, family or order nor does it give any idea of phylogenetic relationship between them.
- Compositae (Asteraceae) is a highly advanced family and placed in Inferae at the beginning of Gamopetalae.
- Advanced families like Orchidaceae and Scitamineae are treated in the beginning of monocots.
- Liliaceae and Amaryllidaceae were kept apart though they are very closely related.

- The Amaryllidaceae is more allied to Liliaceae but is clubbed with Scitamineae in series Epigynae, on account of inferior gynoecium.
- The position of series Apocarpae is unsatisfactory due to its free and superior carpels.

NOTES

3.3.2 Engler and Prantl System

Engler (1844-1930) and Prantl (1849-1893) were two German botanists who published their work in the form of a book.

Engler considered the monocot to be more primitive than dicot.

Engler and Pranth's system was warmly adopted by American and European scientists but not by British. They were following Bentham and Hooker's system in the light of modifications produced by Bossey and Hutchinson.

According to Engler and Prantl

- The most primitive plants are wind pollinated and most advanced plants are insect pollinated.
- Unisexual plants are more primitive and with the passage of time, number of sepals and petals are increased. Bisexual flowers are highly advanced flower, i.e., bisexual flower is originated from the unisexual flower.
- Free sepals, free petals, free stamen, and carpels are the signs of primitive plants; where United is the sign of advanced plants.
- If calyxes are united it means that the plant is primitive. If calyx and corolla are united it means that plant is advanced whereas the union of all parts of flowers represents the most advanced stage.
- From various groups of gymnosperms, angiosperms are evolved monocots and then dicots. From angiosperms first evolved monocots and then dicots. It means that dicots are advanced whereas monocots are primitive.
- Engler united polypetalae and monochlamydeae into a separate group called Archichlamydeae in which dicot plants are included and in which the sepals and petals are free.
- Metachilamydae plants are evolved from Archichlamydeae.
- Female flowers evolve from megasporophyll and male from microsporophyll.
- Monocots have been divided and classified into 11 orders, 45 families and dictos are divided into 44 orders and 261 families (Refer Figure 3.2).

NOTES

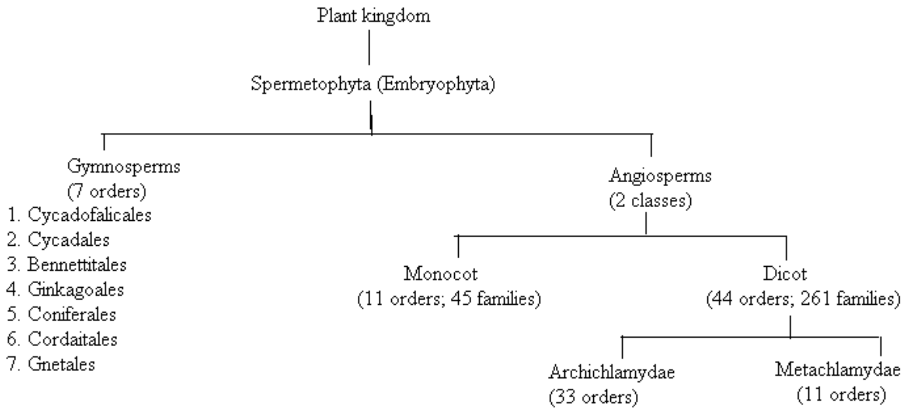

Fig. 3.2 *Classification of Plant Kingdom*

Merits and Demerits of This System

Merits:

- The chief merit lies in the broad treatment of the entire plant kingdom.
- It gives an excellent illustration and phylogenetic arrangement of many groups.
- Joining up of Polypetlae and Monochlamydae into Archichlamydae
- Archiaceae is placed at the end of dicots because they are slightly evolved.
- Juncaceae, Eridecae, Amarylliaceae, are placed close to Filiaceae.
- Gymnsperms treated separately in this system.
- This system is accepted all over the world.

Demerits:

- The union of choropetalae and opetalae is important over that of Bentham and Hooker's system but in other respect not so. It is the system that far carry from the salix to buttercup.
- Amentiferae and Centrospermae are placed in the beginning of dicot even before Ranales. The folia nature of carpel is settle to the primitiveness of cryopylacae with two whorls of perianth.

Table 3.3 *Comparison of Bentham and Hooker with Engler and Prantl System of Classification*

BENTHAM & HOOKER	ENGLER & PRANTL
1. This system is a natural one and is based on several common and constant natural characters of the plant.	1. This system is Phylogenetic and is based on the idea of evolution from less specialized to more specialized groups in ascending order.

NOTES

2. Spermatophytes (seed plants) are classified into dicotyledons, gymnosperms and monocotyledons. The origin of angiosperms is not established and position of a gymnosperm is anomalous, i.e., between the dicotyledons and monocotyledons.	2. Spermatophytes are divided into gymnosperms and angiosperms. The origin of angiosperms is from hypothetical gymnosperms like coniferales. The position of gymnosperms in not anomalous. Angiosperms are considered to be polyphyletic.
3. Dicotyledons are placed before monocotyledons and probably dicotyledons are considered to be more primitive than monocotyledons. In all 202 families are recognized..	3. Monocotyledons are placed first as they are thought to be more primitive than the dicotyledons. The evolution of dicots and monocots have taken place parallel from hypothetical gymnosperms. In all 303 families in 55 orders are recognized.
4. Monocotyledons are divided into 7 series beginning with Microspermeae and ending in Glumaceae	4. Monocotyledons are divided into 12 series beginning with Pandanales and ending in Microspermae.
5. Arborous and herbaceous habit are not considered as important in the classification of angiosperms.	5. like Bentham & Hooker's system.
6. This system is light modification of de Condolle's system of classification.	6. This system is based on Eichler's system of classification.
7. The work of Bentham and Hooker was published in Genera Plntarum.	7. The work of Engler and Prantl was published in Die Natürlichen Pflanzenfamilien

3.3.3 Takhtajan and Hutchinson System

John Hutchinson, a British botanist and formerly the office holder of museum of Royal Botanical Garden, Kew, England has given the classification of plants based on the principles followed by Bessey his classification was published in his famous book families of flowering plants in two volumes. Volume-I published in 1926 dealing with dicotyledons and volume-II published in 1934 on monocotyledons.

The system of classification was revised in British flowering plants (1948) and again the second edition of the families of flowering plants (1959) It is underlying principles are more like the besseeyan syatem than the englerian system.

This phyogenetic system is based on the assumption that:

- Plants with petals and sepals associated with other floral and anatomical character are primitive and more ancient than the plants without sepals.
- Free floral parts are more primitive than the agnate or connate parts.
- Spiral arrangement of floral parts sepals petals and stamens are more primitive than cyclic arrangement.

- Hermaphrodite condition and free stamens are primitive over the unisexual flowers and connate stamens.
- A regular or actinomorphic flower is primitive with zygomorphic flowers.
- Solitary flower is more primitive than the inflorescence flowers.
- Hypogyny is more primitive than epigyny and perigyny conditions.
- A flower with indefinite number of floral parts is primitive over few numbers of floral parts.
- Complete flower are primitive than incomplete flowers.

NOTES

Principle's of Hutchinson's Classification

Hutchinson's classification is based on flowing principles which has been supported by others. The principles are outlined under 24 point which are as follows:

- The evolution is both upward and downward, the former tending towards preservation and the later to their reduction and degeneration of characters.
- Evolution does not necessarily involve call organs at one time or simultaneously.
- Aquatic plants are derived from terrestrial and saprophytes parasites epiphytes are more recent.
- Trees and shrubs are more primitive than herbs.
- Perennials are more primitive than biennials and annuals.
- Plants with vascular bundles arranged in a ring are more primitive those in which vascular bundlers are scattered.
- Spiral phyllotaxy is primitive than whorled and opposite phyllotaxy.
- Dioecious plants are more advanced than bisexual flowers.
- Unisexual flower are more primitive than bisexual flowers.
- Petalod flowers are more primitive than bisexual flowers.
- Gamopetally is more advanced than polypetalae.
- Zygomorphic flower are more advanced than actinomorphic flowers.
- Hypogyny is more primitive than perigyny and epigyny.
- Simple leaves are more primitive than compound leaves.
- Solitary flower is more primitive than inflorescence flowers.
- Spirally imbricate floral parts are more primitive than whorled and valvate arrangement.
- Apocarpy is more primitive than syncarpy.

- Polycarpy precedes oligocarpy.
- Endospermic seeds with small embryo are more primitive than non endospermic seeds with large embryo.
- Flowers with numerous stamens are more primitive than those with fewer stamens.
- Free stamens precede the fused ones.
- Aggregate fruits are more evolved than single fruit and capsule preceedes berry or drupe.
- Parietal placentation is more primitive than axial and free central placentation.
- Trees or arboreal habit are more primitive than climbers are twiners in any one family or genus.

(A) Sub-phylum – I – Dicotyledonae

i) Embryo with two cotyledons
ii) Tap root system
iii) Reticulate veination of leaves
iv) Pentamerous floral parts

This sub phylum further divided into two divisions.

Division (I) : Lignosae

i) Trees and shrubs, woody plants.
ii) It includes 54 orders which begins with magnoliales and ends with verbenales.

Order – 1 – Magnoliales – (Magnoliaceae)

Order – 2 – Anonales – (Annonaceae)

Order – 6 – Rosales – (Rosaeae)

Order – 7 – Leguminales – (Mimosae, Fabaceae)

Order – 30 – Cucurbitales – (Cucubitaceae)

Order – 33 – Maivales – (Malvaceae)

Order – 52 – Rubiales – (Rubiaceae)

Order – 54 – Verbenales – (Verbenaceae)

Division –II Herbaceae

i) It includes all herbaceous plants.
ii) Plants may be annuals or biennials or perennials.
iii) This division includes 28 orders which start with ranales and ends with lamiales.

Order – 55 – Ranales – (Rannunculaceae, Nymphaceae)

Order – 59 – Rhoedales – (Papaveraceae)

Order – 60 – Cruciales (Pareitales) - Cruciferae

Order – 72 – Umbellales – Umbelliferal (Apiaceae)

Order – 76 – Asterales – Compositae (Asteraceae)

Order – 77 – Solanales – (Solanaceae, convolvulaceae)

Order – 78 – Personales – (Acanthaceae, Scorephulariaceae)

Order – 82 – Lamiales – (Labiatae)

NOTES

Sub-phylum – 2- Monocotyledonae

i) Embryo with one cotyledon
ii) Fibrous adventitious root system
iii) Parallel veination of leaves
iv) Closed and scattered vascular bundles
v) Trimerous flowers

This sub – phylum divided into three divisions

Division – I – Calyciferae

i) Flowers with distinct calyx and corolla
ii) Sepals green in colour, petals coloured variously.
iii) It includes 12 orders, starting with butamales and ends with zingiberales.

Order – 1 – Butamales – (Butamaceae)

Order – 8 – Commelinales – (Commelinaceae)

Order 12 – Zingiberales – (Zingiberaceae; musaceae)

Division – II – Corolliferae

i) Both calyx and corolla are not distinct in colourantion.
ii) Sepals may be coloured other than green.
iii) Petals and sepals present in different whorl.

It includes 14 orders begins with Liliales and end with Orchidales

Order – 13 – Liliales – Liliaceae

Order – 15 Aeales – Araceae

Order – 17 – Amaryllidales – Amaryllidaceae

Order – 21 – Palmales - Palmales – Palmae (Arecaceae)

Order – 26 – Orchidales – Orchidaceae

Division – III – Glumiflorae

i) Flower with reduced perianth

ii) Neither sepal not petal is distinct and reduced to membranous lodicules.

This includes 3 orders and six families

Order – 27 – Juncales – Juncaceae

Order – 28 – Cyperales – Cyperaceae

Order – 29 – Graminales – Graminae (Poaceae)

Merits of Hutchinson's Classification

- It is most phylogenetic system of classification based on natural characteristic of plants.
- This system is based on evolutionary tendencies and interrelationship among angiospermic plants.
- Magnoliales representing arborescent plants and ranales representing herbaceaous plants which shows parallel evolution.
- Several big orders have been broken into small orders like rosales, paritales, malveles, leguminales, etc.
- Many families have been raised to the rank of orders, leguminosae famile raised to order leguminales.
- Reshuffling or genera and families
- Origin of monocots from dicots and placement of first dicot and then monocot families is correct in all respect.
- Placing of gymnosperms before angiosperms in flowering plants.

Check Your Progress

5. What is superorder?
6. How does the names in subtribes end?
7. What are polypetalae?
8. What are gamopetalae?

3.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The history of plant classification in India is divided in 5 periods, they are:
   - Rig Veda Period
   - The Greek Period

- The Roman Period
- The Dark Age, Herbals and the Transition Period
- Modern Period

2. In Rig Veda Period plants were further classified into those that produced fruits and flowers and those without fruits and flowers.
3. During the middle age a dark period descended over Europe and there was no significant botanical work. Most workers copied the work of Dioscorides without much addition. Wood cut of plants were prepared for illustrating them. Such were the herbals and included Albertus Magnus, Brunfels, Bock, Fuchs, Bauhin, etc.
4. Jean Bauhin (1541-1631) was a French and Swiss physician, His important contribution was 'Historia Plantarum Universalis', in which he dealt about 5000 plants.
5. Superorder is a group of related Plant Families, classified in the order in which they are thought to have developed their differences from a common ancestor.
6. The names of the subtribes end in -inae.
7. Plants having flowers with free petals come under polypetalae.
8. Plants having flowers with petals, which are either partially or completely fused to one another are placed under Gamopetalae.

3.5 SUMMARY

- According to Majumdar history of botany and plant taxonomy in India can be traced back to the period of Rig Veda 3000 B.C. and later Hindu literature including Manu, Agni Purana, Vrikshayarveda, etc.
- A broad classification of plants into trees, shrubs, herbs and creepers is to be found in the mantras (hymns) of Rig Veda.
- Plants were further classified into those that produced fruits and flowers and those without fruits and flowers.
- Sushruta also follows a similar pattern. Apart from the above, the ancient Indians also classified plants according to their medicinal properties and dietic properties, for example the ayurvedic systems of Charaka, Sushruta and others.
- Sushruta classified medicinal plants under thirty seven ganas or sections. Plant classification, based upon their dietic properties was also attempted by Charaka and Sushruta.
- Theophrastus (370-287 B.C.) was a student and contemporary of Aristotle and was particularly interested in plants. His work is entitled

De Historia Plantarum in which he described about 480 kinds of plants and divided them primarily on the basis of habit into trees, undershrubs, herbs, cultivated and wild plants.

NOTES

- Theophrastus followed the Platonic method of logical division, i.e., any given object is either A or not A.
- Pliny the Elder (23-79 A.D.) He was a Roman naturalist and mentioned nearly a thousand plants in his 'Historical Naturalis'. This is a series of 37 books dealing with plants on the basis of medicinal properties, timber and practices of horticulture.
- Dioscorides (first century A.D.) was a physician of Rome and worked in the military of Emperor Nero.
- He complied De Materia medica in which he described about 600 species and gave their accounts and practical uses. The book included perfumes, oils, spices, cereals, condiments, wines, etc.
- He even got the idea of groups such as the Labiates and Umbellifers. The book was documented with original illustrations increasing its value and usefulness greatly.
- During the middle age a dark period descended over Europe and there was no significant botanical work. Most workers copied the work of Dioscorides without much addition.
- Wood cut of plants were prepared for illustrating them. Such were the herbals and included Albertus Magnus, Brunfels, Bock, Fuchs, Bauhin, etc.
- Albertus Magnus (1193-1280) – He was bishop of Ratisbon and is believed to have first differentiated monocots from dicots on the basis of stem structure.
- Otto Brunfels (1464-1434) – He was first to describe and to some extent illustrate plants and distinguish perfecti and imperfecti groups of plants on the presence and absence of flowers.
- Jerome Bock (1498-1554) – He was a herbalist and classified plants as herbs, shrubs and trees providing suitable notes on natural distribution of many plants. His famous work 'New Krenterbuch' gave some fine description of plants.
- Caesalpinia (1519-1637) – Wrote the book 'De Plantis' consisting of sixteen books with description of 1500 plant species. His classification was also based upon herbs, shrubs and trees but within these he recognised the significance of fruit and seed characters. Caesalpinia is remembered by the genus Caesalpinia in the family Fabaceae.

NOTES

- Jean Bauhin (1541-1631), a French and Swiss physician, His important contribution was 'Historia Plantarum Universalis', in which he dealt about 5000 plants.
- Gaspard Bauhin (1560-1624), brother of Jean Bauhin. Gaspard published 'Pinax' (1623) containing names and synonyms of about 6000 species.
- Joachim Jung (1587-1657), a German mathematician and the first terminologist. He was the first to define the following terms – nodes and internodes; blade and petiole; simple and compound leaf; stamens and styles, etc.
- John Ray (1627-1705) was an English philosopher and naturalist. In his 'Methodus Plantarum' 18000 species were classified. He established for the first time the presence of one or two cotyledons in the angiosperms classification.
- Pierre Magnol (1638-1715) was a French botanist. He divided the plants into groups, what he called families. He was the first to give the concept of modern families. His name was commemorated by generic name Magnolia.
- Joseph Pitton de Tournefort (1656-1708). He recognised petal bearing and non-petal bearing flowers, corollas with separate and with united petals and regular and irregular corollas.
- The modern period of classification starts with Linnaeus and continues even today. During this period numerous systems have been proposed. Broadly speaking they belong to the pre-Darwinian period and post-Darwinian period.
- Before Darwin the concept of evolution was not an accepted principle and the general belief was in the fixity of species.
- In the post-Darwinian period evolutionary theory brought about a fundamental change in the concept of classification. Generally speaking in the pre-Darwinian period the systems proposed were either artificial or natural.
- An artificial system is one which plants classifies according to a few convenient characters for the purpose of identification without paying any attention to affinities. Linnaeus' sexual system is an example of artificial system.
- A phylogenetic system on the other hand tries to determine evolutionary relationships of plants and groups and arrange them accordingly.
- Plants are classified in several different ways, and the further away from the garden we get, the more the name indicates a plant's relationship to other plants, and tells us about its place in the plant world rather than in the garden.

NOTES

- Usually, only the Family, Genus and species are of concern to the gardener, but we sometimes include subspecies, variety or cultivar to identify a particular plant.
- Starting from the top, the highest category, plants have traditionally been classified as follows. Each group has the characteristics of the level above it, but has some distinguishing features.
- The further down the scale you go, the more minor the differences become, until you end up with a classification which applies to only one plant.

3.6 KEY WORDS

- **Cryptogam:** A cryptogam (scientific name Cryptogamae) is a plant that reproduces by spores, without flowers or seeds.
- **Superorder:** Superorder is a taxonomic category below subclass and above order.
- **Polypetalae:** Polypetalae refers to a botanical group of plants, while polypetalous refers to flowers of a distinct type
- **Thalamiflorae:** Thalamiflorae is a historical grouping of dicotyledons, arranged in the De Candolle system and in the Bentham and Hooker system.
- **Coniferae:** Coniferae is a large order of cone bearing plants. From this order we obtain the different varieties of pine, hemlock and spruce from which the various preparations of turpentine have been obtained
- **Ranales:** The Ranales are an obsolete taxon of the Dicotyledons, with rank of order typified by Ranunculus (Ranunculaceae).
- **Gamopetalae:** Gamopetalae is an artificial group used in the identification of plants based on Bentham and Hooker's classification system.
- **Epigyny:** Epigyny A floral arrangement in which the ovary is completely enclosed by the receptacle so that the stamens and perianth arise above it, from the top of the receptacle, i.e., the ovary is inferior.
- **Hypogyny:** Hypogyny In flowers, the condition in which the calyx, corolla, and stamens are inserted on the receptacle or axis, below and free from the ovary.
- **Glumaceae:** Glumaceae is a descriptive botanical name. It was used in the Bentham & Hooker system (volume of 1883) for the order including the grass family.

- **Microsporophylls:** A leaflike structure that bears microsporangia, such as those of in the strobili of lycophytes or in the male cones of conifers. The stamens of flowering plants are highly modified microsporophylls.
- **Spermatophytes:** The spermatophytes, also known as phanerogams (taxon Phanerogamae) or phaenogams (taxon Phaenogamae), comprise those plants that produce seeds, hence the alternative name seed plants.
- **Perigyny** A floral arrangement in which the ovary is situated in a cup-shaped or flattened receptacle, from the margin of which the perianth and stamens arise.

NOTES

3.7 SELF ASSESSEMNT QUESTIONS AND EXERCISES

Short Answer Questions

1. Give a brief account on historical background of plant classification.
2. Write a brief note on rig veda period.
3. What happened in roman period?
4. What were the classifications in dark age period?
5. Write a brief note on Darwin's period.
6. Write a short note on plant classification.

Long Answer Questions

1. Discuss the historical background of plant classification.
2. Explain a note on dark age period and the various classifications that were in this period..
3. Explain about the plant classification.
4. Write about Bentham and Hoocker's System in detail.
5. Write about Engler and Prantl System in detail.
6. Give a comparison of Bentham and Hooker with Engler and Prantl system of Classification.
7. Write a detailed note on Takhtajan and Hutchinson System.

3.8 FURTHER READINGS

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BLOCK - II

TAXONOMY STRUCTURE

NOTES

UNIT 4 TAXONOMIC STRUCTURE

Structure

4.0 INTRODUCTION

Taxonomy is the method by which scientists, conservationists, and naturalists classify and organize the vast diversity of living things on this planet in an effort to understand the evolutionary relationships between them. Modern taxonomy originated in the mid-1700s when Swedish-born Carl Linnaeus published his multi-volume Systema naturae, outlining his new and revolutionary method for classifying and, especially, naming living organisms. Prior to Linnaeus, all described species were given long, complex names that provided much more information than was needed and were clumsy to use. Linnaeus took a different approach: he reduced every single described species to a two-part, Latinized name known as the 'binomial' name. Thus, through the Linnaean system a species such as the dog rose changed from long, unwieldy names such as *Rosa sylvestris inodora seu canina* and *Rosa sylvestra alba cum rubore, folio glabro* to the shorter, easier to use Rosa canina. This facilitated the naming of species that, with the massive influx of new specimens from newly explored regions of Africa, Asia, and the Americas, was in need of a more efficient and usable system.

NOTES

In this unit, you will study about taxonomic structure and its parts, i.e., cytotaxonomy, chemotaxonomy, numerical taxonomy and cladistics taxonomy in detail.

4.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand what taxonomic structure is
- Discuss about various parts of taxonomic structures
- Explain what is cytotaxonomy
- Describe about chemotaxonomy
- Understand what numerical taxonomy is
- Describe what cladistics taxonomy is

4.2 TAXONOMY STRUCTURE

Taxonomy, in a broad sense the science of classification, but more strictly the classification of living and extinct organisms, i.e., biological classification. The term is derived from the Greek taxis ('arrangement') and nomos ('law'). Taxonomy is, therefore, the methodology and principles of systematic botanyand zoology and sets up arrangements of the kinds of plants and animals in hierarchies of superior and subordinate groups.

Biologists, however, have attempted to view all living organisms with equal thoroughness and thus have devised a formal classification. A formal classification provides the basis for a relatively uniform and internationally understood nomenclature, thereby simplifying cross-referencing and retrieval of information.

The usage of the terms taxonomy and systematics with regard to biological classification varies greatly. American evolutionist Ernst Mayr has stated that 'taxonomy is the theory and practice of classifying organisms' and 'systematics is the science of the diversity of organisms', the latter in such a sense, therefore, has considerable interrelations with evolution, ecology, genetics, behaviour, and comparative physiology that taxonomy need not have.

Taxonomy further is divided into 4 branches

- Cytotaxonomy
- Chemotaxonomy

- Numerical Taxonomy
- Cladistics Taxonomy

4.2.1 Cytotaxonomy (Biosystematics)

It is classification based on information provided by comparative cytological studies, number of chromosomes, structure and meiotic behavior of chromosomes. It is known that fewer and larger chromosomes have been formed in many cases by fusion of smaller chromosomes. Herbaceous plants have larger chromosomes than those of woody plants. Naturally, herbaceous plants are more advanced than the woody plants.

In many genera, the same basic chromosome number has been found in different species,for example 12 in Solanum species and 9 in Chrysanthemum species.

Human beings have 46 chromosomes while apes have 48. A reduction in a number of chromosomes has been achieved through whole arm translocation between two acrocentric chromosomes. Apparently, humen have evolved from ape-like ancestors. The pairing of chromosomes during meiosis helps to bring out relationships between species.

4.2.2 Chemotaxonomy (Biochemical Systematics)

The system of classification is based on the characteristics of various chemical constituents of organisms like amino acids, proteins, DNA sequences, alkaloids, crystals, betacyanins, etc. Chemical constituents of plants are generally specific and stable.

They do not change easily. Ancient medical men based their identification of plants on fragrance, taste and other chemical characteristics. Crystals of calcium oxalate like raphides are restricted to 35 families. Similarly, certain alkaloids are restricted to a few related families, for example benzylisoquinoline alkaloid in Papaveraceae, Berberidaceae, and Ranunculaceae.

The Table 4.1 below shows the difference between cytotaxonomy and chemotaxonomy.

Table 4.1 *Difference between Cytotaxonomy and Chemotaxonomy*

1. It is taxonomy based on comparative cytological studies. 2. Presence of similar banding pattern of chromosomes indicates close similarity. 3. Lincage can be traced with the help of chromosome studies, e.g., humans from apes.	1. It is taxonomy based on characteristics of chemical constituents. 2. Presence of certain specific chemicals in certain groups of organisms show close relationships. 3. DNA analysis and protein tests are useful in knowing relationships.

4.2.3 Numerical Taxonomy

It evaluates resemblances and differences or primitiveness and advancement through statistical methods based on a large number of characters obtained from all disciplines of biology.

This is followed by assigning them number and codes of computer like plus (+), minus (-), θ (data not available), followed by computer analysis. It establishes the numerical degree of relationship among individuals. The relationship or affinity values are then used to erect taxonomic categories.

However, its effectiveness depends upon the judgement of the biosystematics in selecting characters and current knowledge about them.

4.2.4 Cladistics Taxonomy

It searches similarity due to common phylogeny or origin from a common ancestor. These are two types of characters, ancestral and derived. Ancestral characters are traits of basic body design which would be present in an entire group.

Derived characters are those traits whose structures and functions differ from those of ancestral characters. They appear during evolution and cause the formation of new subgroups. One or more derived characters would be shared by an entire subgroup.

In cladistics taxonomy (cladistics) each evolutionary step produces a branching. All the members of a branch would possess the derived character. It will be absent below the branch point.

Arranging organisms on the basis of they're shared similar or derived characters that differ from ancestral characters, will produce a phylogenetic tree called cladogram. Depending upon the type of system of classification, organisms are classified into two kingdoms or three kingdoms, four kingdoms, five kingdoms and now into six kingdoms.

Check Your Progress

1. Define taxonomy.
2. What is cytotaxonomy?
3. What is chemotaxonomy?
4. Define numerical taxonomy.

4.3 MODERN APPROACH TO TAXONOMY

The following points highlight the eight current approaches in taxonomy. The approaches are:

- Morphological Approach
- Embryological Approach
- Ecological Approach
- Behavioural Approach
- Genetical Approach
- Biochemical Approach
- Numerical Taxonomy
- Differential Systematics

4.3.1 Morphological Approach

Morphological characters such as wings, antennae, mouth parts, genitalia etc. mainly among arthropods and insects in particular are still of immense taxonomic importance. New techniques have, however, been developed to understand the time structures of some morphological characters which would be more reliable.

The use of scanning electron microscope (SEM), transmission electron microscope (TEM), ultraviolet rays, etc. have helped the cause of new systematics. The use of SEM has provided excellent minute information (three-dimensional pictures) in insects, mites, ticks and other smaller arthropods, which could not be adequately studied under stereo-microscopes. These highly magnified three dimensional figures helped in the discovery of new characters.

These characters would lead to the discovery of new species and also prepare dichotomous keys. TEM is also of great value in groups like Protozoa where features appear to be few. The pattern of ultraviolet reflection on the wings of butterflies has been used as taxonomic characters in some butterflies. It can be of great help in the recognition of sibling and closely related species.

4.3.2 Embryological Approach

During embryonic development individuals pass through quite different morphological stages. Thus, the taxonomic identification is based not only on the morphological characters of the adult but rather it is based on the sum total of all characters of all stages.

A very good example, where the character of the immature stages is useful in classification, is Anopheles maculipennis. This species has a number of sibling species and their identification is based on the basis of their egg structure.

Another example is Dacus oleae and Ceratitis capitata, the two economically important fruit flies that show superficial similarity in the shape and size of their eggs. However, the fine structural analysis of their egg shells reveals distinct structural differences of anterior pole, studied under SEM.

The egg shell of C. capitata has very thick vitelline membrane and the endo-chorionic complex is composed of two trabecular layers and is inverted in respect to each other. In case of D. oleae the vitelline membrane is thin and the endo-chorionic layer is compact with only one trabecular layer.

4.3.3 Ecological Approach

It is an established fact that each species has its own niche in nature, differing from one another on its closest relative in preferences of food, breeding season, tolerance to various physical factors etc. If two species coexist in the same habitat, they avoid inter-specific competition by their species-specific niche characteristics, with each species subsiding on different types of food.

For example, although the larvae of Drosophila mulleri and D. aldrichi, both live on the decaying pulp of cactus (Opuntia lind-heimeri) fruits, yet both have specialities in their preferences for certain bacteria and yeast. Another example is the sibling species of Anopheles maculipennis, which are broken into six different species based on their ecological differences.

4.3.4 Behavioural Approach

The use of behavioural characteristics is one of the most important sources in animal systematics. Comparative ethology has proved very useful in improving the classification of insects (particularly bees, wasps, some beetles and cricket), fishes, frogs, birds etc.

These behavioural characteristics play a vital role in isolating mechanisms and initiating new adaptations. The characteristics are genetically determined and are passed on from generation to generation like morphological and physiological characteristics.

Various sound recording devices are used. Ultrasonic sounds are produced by a number of animals in both intra- and interspecific communications. These sounds can be exploited (through sound spectrograms) in the discovery of not only sibling species but also in the separation of closely related species and simplification of classification.

A few examples are:

- Alexander (1962) discovered about 40 species of crickets in North America on the basis of sound analysis.
- Barber (1951) distinguished 18 sibling species in the genus Photuris (fire flies) in North America on the basis of the height and length of the marks indicating intensity and pattern of flashes.
- Van der Kloot and Williams (1953) classified spiders on the characteristics of their web construction.

NOTES

- Depending on the materials used in the construction of nests, the bee genera Anthidium and Dianthidium can easily be separated. The former genus uses cottony plant fibres, while the latter of resinous plant exudations and sand or small pebbles.
- Schmidt (1955) separated the various species of the termite genus Apicotermes, on the basis of their nest structure.
- In molluscs, the way in which the materials are attached to the shells provide useeful taxonomic characters in classifying the species, particularly in the genus Xenophora.

4.3.5 Genetical Approach

The DNA Complement

Deoxyribonucleic acid is the essential material for heredity, is a known fact. It is possible that if the DNA complement of all species is known, then their evolutionary course would become quite apparent. We know that the amount of DNA per chromosome set is constant for each species and this can be used in the identification of species.

DNA Hybridization

'Hybridization' between single stranded DNA components from different origins can provide a physicochemical means for assessing genetic relatedness among species. The DNA from one organism is extracted and made to hybridize in vitro with the cell-lines of other organisms. Such DNA matching techniques hold much promise in solving complex taxonomic problems.

Karyological Studies

By using various staining techniques, the number, shape and banding of chromosomes can be determined. Such karyotype is a definite and constant character of each species. Chromosomal taxonomy can be quite useful both in determining the phylogenetic relationships among taxa as well as in the segregation of sibling or cryptic species. Such reliable karyotypes are now available for about 1,000 species of mammals, several hundred species of birds, reptiles, amphibians and fishes.

For example, on the basis of the shape and number of chromosomes, Grewal (1982) separated some important fruit fly species (Refer Figure 4.1). Similarly, Patterson and Stone (1952) were able to differentiate 16 species of the genus Drosophila on the basis of number and shape of chromosomes.

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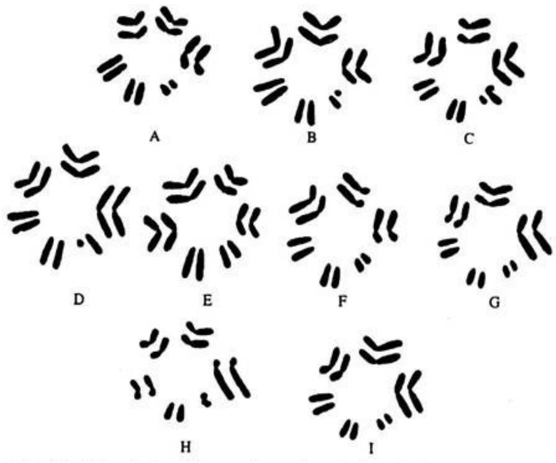

Fig. 4.1 Species of Fruit Fly

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Closely related species may show considerable rearrangement of chromosomes and sometimes the reverse may also occur. Reproductively isolated species may also have similar chromosomal structure and differ only in their gene content.

Geographical races of many insect species may differ in their banding patterns of their polytene chromosomes. Therefore, to solve systematic problems, karyomorphology cannot be treated as the only answer. It can only be used in selective cases.

4.3.6 Biochemical Approach

Biochemical approach has been extensively studied in plants than in animals. Animals contain a large number of complex compounds like hormones, enzymes and protein molecules comprising of peptides, nucleic acids, amino acids etc.

The primary work of a biochemical taxonomist is concerned with the comparison and contrasting of compounds of the same class and performance of similar functions in different animal species, in respect to their properties as well as their distribution in different body organs.

Based on the above, taxonomy can be:

Protein Taxonomy

Protein taxonomy was coined by Crick (1958), as species can be differentiated based on the sequence of amino acids in the proteins of an organisms. Thus, species differ in the differences of their amino acid sequences.

NOTES

Molecular Taxonomy

Molecular taxonomy, the term coined by Lahni (1964), was primarily based on the nucleotide sequences of polynucleotides. When trying to measure degrees of genetic relationship it is very important to look for the genetic material they are composed of and this is when molecular taxonomy comes into play. It is also believed that the changes in the enzyme structure can help in the discovery of new species.

Turner in 1966 divided molecular taxonomy into –

- Micro-molecular taxonomy
- Macromolecular taxonomy

Micro-Molecular Taxonomy

It lays stress upon the distribution and biosynthetic interrelationships of small molecular weight compounds like free amino acids, alkacids, terpenes, flavonoids etc. These are commonly referred to as secondary compounds. This type of approach is particularly useful in resolving systematic problems where hybridization has been a factor.

Macromolecular Taxonomy

Macro molecular taxonomy is concerned with the polymeric molecules. It is more or less close to the core of hereditary information that is the DNA sequence, RNA, polysaccharides and proteins. This approach is useful in solving some of the more intractable systematic problems, especially those involving relationships among higher categories. Biochemical characters have been found to be extremely useful in solving various taxonomic problems.

A few examples are:

- Phylogenetic relationship among various orders of birds have been demonstrated by Basu Chaudhary and Chatterjee (1969), based on the quantative analysis of ascorbic acid. Ascorbic acid is produced by some birds (Anseriformes, Columbiformes etc.) in the kidney; in some (piciformes) it is produced in the liver; while in some in both liver and kidney, and in some of the more evolved passerine birds, it is completely lost.
- Using the biochemical characters of the unique venoms of fire ants, Brand (1972) were able to establish the phylogeny of a group of fire ants. Although the biochemical approach is helpful in solving many taxonomical problems, yet in many cases they are not useful.

Moreover, such studies are not possible in extinct organisms and, therefore, it is difficult to trace the course of evolutionary history through this process. However, proteins and nucleic acids provide a much reliable estimate of the degree of genetic homology among animals.

NOTES

The distribution of free amino acids in different organs of insects is of greater taxonomic value. Similarly, in mammals, the classification of species, based on the amino acid sequences, are in accordance to the accepted one based on the morphological data. Such biochemical studies are conducted in five ways — immunological, chromatographic, electrophoresis, infra-red spectrophotometry and histochemical studies.

4.3.7 Numerical Taxonomy

Instead of Numerical Taxonomy, some workers prefer to use the terms 'Taximetrics', 'Taxonometrics' and 'Taximetry'. Degree of similarity was one of the basic criteria on which the recognition of taxa had been based. The first comprehensive effort to develop a new theoretical and practical approach to biological systematics was put forward by Robert R. Sokal and P.H.A. Sneath (1963), illustrated in their book Principles of Numerical Taxonomy.

It is based on an operational attitude where objects are compared 'at face value'. The numerical concept refuses to incorporate into taxonomy dubiously retrievable phylogenetic informations and the philosophy has been defined as phenetic or directly dependent on the overall similarity of the characters (the phenotypes).

Numerical phenetics is the methodology of assembling individuals into taxa on the basis of an estimate of un-weighted overall similarity. This concept is, thus, based on the use of maximum number of characters and all the characters are given equal weightage. The larger the number of taxonomic characters, the better is the result.

The characters not necessarily be derived only from external or internal morphology, but it may include any attributes of the operational taxonomic units or OTUs (biochemical, behavioural, cytological, ecological, developmental, etc.).

However, there are differences in opinion of the number of characters used in this approach. Sokal and Sneath (1963), prefer the use of at least 60 characters, Moss (1967) prefers 135 to 146 characters, while Steyskal (1968) prefers at least 1000 characters (particularly in insects).

However, in phenetic analysis there is no place for homology or for history-dependent concepts, such as ancestry or evolutionary changes. That taxonomy should be freed of all theoretical implications, led pheneticists to reject in their work any reference of species. They were replaced by the concept of the OTU. However, OTUs are very heterogeneous class of entities and may be individuals, populations and some may be historical entities.

The branching diagrams found in the works of phenetics are not phylogenies of species, but simply dendrograms made due to the clustering together of OTUs. This work with matrices and branching diagrams cannot be developed by hand.

It requires the use of several algorithms and computer programs, developed to carry out the calculations. The technical advantages of numerical techniques, thus, have proved to be a more lasting contribution to systematics.

However, Blackwelder (1967) and many other taxonomists doubt the usefulness of numerical methods, due to:

- The use of large number of characters probably tends to reduce the effect of homoplasy on the result.
- The approach is exposed to a great risk of reaching unsound classification, as in giving equal weightage to all characters it does not allow for mosaic evolution, special adaptations, convergence, parallelism, development and genetic homeostasis and also evolutionary, genetic and developmental phenomena.
- The use of complex mathematical and statistical methods by numerical taxonomists has led to great difficulties to follow them, by the biological taxonomists.

In spite of the above difficulties it is believed that today all systematics is to some extent numerical. Computers and numerical taxonomic programmes are now standard resources in every museum and systematics laboratory. One of the very useful software is NTSYS.

4.3.8 Differential Systematics

Womble in 1951, proposed differential systematics as a method for summing up the rates of change with distance (differential) for several characters to show zones of differentiation within a taxon. However such laborious procedures to obtain the differential set of characters have been out-rightly rejected by a number of biologists.

However, with the advent of modern technologies, like the use of computer, such drawbacks can be eliminated.

Check Your Progress

5. What are the different types of approaches in taxonomy?
6. What happens if two species coexist in same habitat ?
7. What is behavioural characteristics ?
8. What is Deoxyribonucleic acid ?
9. Who coined molecular taxonomy?

4.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. Taxonomy, in a broad sense the science of classification, but more strictly the classification of living and extinct organisms, i.e., biological classification.
2. Cytotaxonomy is the classification based on information provided by comparative cytological studies, number of chromosomes, structure and meiotic behavior of chromosomes
3. Chemotaxonomy is the system of classification is based on the characteristics of various chemical constituents of organisms like amino acids, proteins, DNA sequences, alkaloids, crystals, betacyanins, etc. Chemical constituents of plants are generally specific and stable.
4. Numerical taxonomy evaluates resemblances and differences or primitiveness and advancement through statistical methods based on a large number of characters obtained from all disciplines of biology.
5. The following points highlight the eight current approaches in taxonomy. The approaches are:
   - Morphological Approach
   - Embryological Approach
   - Ecological Approach
   - Behavioural Approach
   - Genetical Approach
   - Biochemical Approach
   - Numerical Taxonomy
   - Differential Systematics
6. If two species coexist in the same habitat, they avoid inter-specific competition by their species-specific niche characteristics, with each species subsiding on different types of food.
7. The use of behavioural characteristics is one of the most important sources in animal systematics. Comparative ethology has proved very useful in improving the classification of insects (particularly bees, wasps, some beetles and cricket), fishes, frogs, birds etc.
8. Deoxyribonucleic acid is the essential material for heredity, is a known fact. It is possible that if the DNA complement of all species is known, then their evolutionary course would become quite apparent.
9. Molecular taxonomy, the term coined by Lahni (1964), was primarily based on the nucleotide sequences of polynucleotides.

4.5 SUMMARY

NOTES

- Taxonomy, in a broad sense the science of classification, but more strictly the classification of living and extinct organisms, i.e., biological classification. The term is derived from the Greek taxis ('arrangement') and nomos ('law').
- Taxonomy is, therefore, the methodology and principles of systematic botanyand zoology and sets up arrangements of the kinds of plants and animals in hierarchies of superior and subordinate groups.
- Cytotaxonomy is classification based on information provided by comparative cytological studies, number of chromosomes, structure and meiotic behavior of chromosomes. It is known that fewer and larger chromosomes have been formed in many cases by fusion of smaller chromosomes.
- Herbaceous plants have larger chromosomes than those of woody plants. Naturally, herbaceous plants are more advanced than the woody plants.
- In many genera, the same basic chromosome number has been found in different species,for example 12 in Solanum species and 9 in Chrysanthemum species.
- Human beings have 46 chromosomes while apes have 48. A reduction in a number of chromosomes has been achieved through whole arm translocation between two acrocentric chromosomes.
- Apparently, humen have evolved from ape-like ancestors. The pairing of chromosomes during meiosis helps to bring out relationships between species.
- Chemotaxonomy is system of classification is based on the characteristics of various chemical constituents of organisms like amino acids, proteins, DNA sequences, alkaloids, crystals, betacyanins, etc. Chemical constituents of plants are generally specific and stable.
- Numerical taxonomy evaluates the resemblances and differences or primitiveness and advancement through statistical methods based on a large number of characters obtained from all disciplines of biology.
- Cladistics taxonomy searches similarity due to common phylogeny or origin from a common ancestor. These are two types of characters, ancestral and derived. Ancestral characters are traits of basic body design which would be present in an entire group.
- Morphological characters such as wings, antennae, mouth parts, genitalia etc. mainly among arthropods and insects in particular are still of immense taxonomic importance.

- During embryonic development individuals pass through quite different morphological stages. Thus, the taxonomic identification is based not only on the morphological characters of the adult but rather it is based on the sum total of all characters of all stages.
- Ecological approach is an established fact that each species has its own niche in nature, differing from one another on its closest relative in preferences of food, breeding season, tolerance to various physical factors etc.
- If two species coexist in the same habitat, they avoid inter-specific competition by their species-specific niche characteristics, with each species subsiding on different types of food.
- Behavioural Approach is theuse of behavioural characteristics is one of the most important sources in animal systematics. Comparative ethology has proved very useful in improving the classification of insects (particularly bees, wasps, some beetles and cricket), fishes, frogs, birds etc.
- Deoxyribonucleic acid is the essential material for heredity, is a known fact. It is possible that if the DNA complement of all species is known, then their evolutionary course would become quite apparent.
- 'Hybridization' between single stranded DNA components from different origins can provide a physicochemical means for assessing genetic relatedness among species.
- The DNA from one organism is extracted and made to hybridize in vitro with the cell-lines of other organisms. Such DNA matching techniques hold much promise in solving complex taxonomic problems.
- Biochemical approach has been extensively studied in plants than in animals. Animals contain a large number of complex compounds like hormones, enzymes and protein molecules comprising of peptides, nucleic acids, amino acids etc.
- Womble in 1951, proposed differential systematics as a method for summing up the rates of change with distance (differential) for several characters to show zones of differentiation within a taxon.

4.6 KEY WORDS

- **Cytotaxonomy:** Cytotaxonomy is the branch of biology dealing with the relationships and classification of organisms using comparative studies of chromosomes during meiosis.
- **Chemotaxonomy:** Chemotaxonomy is the method of biological classification based on similarities in the structure of certain compounds among the organisms being classified.

- **Cladistics:** Cladistics is a method of hypothesizing relationships among organisms. In other words, a method of reconstructing evolutionary trees.
- **Berberidaceae:** The Berberidaceae are a family of 18 genera of flowering plants commonly called the barberry family. This family is in the order Ranunculales.
- **Acrocentric chromosome:** Acrocentric chromosome: A chromosome in which the centromere is located quite near one end of the chromosome. Humans normally have five pairs of acrocentric chromosomes.
- **Cladogram:** A cladogram is a diagram used to represent a hypothetical relationship between groups of animals, called a phylogeny.

4.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a short note on taxonomy.
2. Write a note on cytotaxonomy.
3. What is biochemical systematics?
4. Give difference between cytotaxonomy and chemotaxonomy.
5. Write about numerical taxonomy.
6. Write a brief note on ecological approach,
7. Give a brief note on biochemical approach.
8. Write about molecular taxonomy and its types.

Long Answer Questions

1. Give a detailed overview of taxonomic structure.
2. Write a detailed note on cytotaxonomy and chemotaxonomy.
3. What are the modern approaches to taxonomy? Discuss in detail.
4. Explain about embryological approach and ecological approach.
5. Give a detailed note on genetic approach.
6. Explain biological approach.
7. Discuss about numerical taxonomy.

4.8 FURTHER READINGS

NOTES

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UNIT 5 BOTANICAL NOMENCLATURE

NOTES

Structure

5.0 INTRODUCTION

Botanical nomenclature is the formal naming of plants, from a scientific point of view. It has a long history, going back perhaps to the ophrastos, but anyway back to the period when Latin was the scientific language throughout Europe. The keystone event was Linnaeus' adoption of binary names for plant species in his Species Plantarum (1753). This gave every plant species a name which remained the same no matter what other species were placed in the genus, and thus separated taxonomy from nomenclature. These species names of Linnaeus together with names for other ranks, notably the rank of family (not used by Linnaeus), can serve to express a great many taxonomic viewpoints. In this unit, you will study about Botanical nomenclature, need for scientific name, principles of ICBN, type methods, author citation, publication of names, rejection of names, etc. in detail.

5.1 OBJECTIVES

After going through this unit, you will be able to-

- Understand what is botanical nomenclature
- Discuss about the need for scientific name
- Explain the principles of ICBN
- Understand what are type methods, author citation

- Understand the need of publication of names
- Analyse what is rejection of names

NOTES

5.2 BOTANICAL NOMENCLATURE

Botanical nomenclature is the formal naming of plants, from a scientific point of view. It has a long history, going back perhaps to Theophrastos, but anyway back to the period when Latin was the scientific language throughout Europe. The keystone event was Linnaeus' adoption of binary names for plant species in his Species Plantarum (1753). This gave every plant species a name which remained the same no matter what other species were placed in the genus, and thus separated taxonomy from nomenclature. These species names of Linnaeus together with names for other ranks, notably the rank of family (not used by Linnaeus), can serve to express a great many taxonomic viewpoints.

5.2.1 Need For Scientific Names

In the nineteenth century it became increasingly clear that there was a need for rules to govern scientific nomenclature and initiatives were taken to come to a body of laws. These were published in successively more sophisticated editions. For plants the key dates are 1867 (lois de Candolle), 1906 (International Rules of Botanical Nomenclature, 'Vienna Rules') and 1952 (International Code of Botanical Nomenclature, 'Stockholm Code').

Another development was insight into delimitation of the concept 'plant'. Linnaeus held a much wider view of what a plant is than is acceptable today. Gradually more and more groups of organisms are recognised as being independent of plants. Nevertheless the formal names of most of these organisms are governed by the *International Code of Botanical Nomenclature (ICBN)*, even today. A separate Code was adopted to govern the nomenclature of Bacteria, the ICNB.

At the moment all formal botanical names are governed by the *ICBN*. Within the limits set by the *ICBN* there is a separate set of rules, the *International Code of Nomenclature for Cultivated Plants (ICNCP)*. Within the group of plants that have been deliberately altered or selected by humans there are those that require separate recognition, known as cultivars. Within the limits set by the ICNCP there is a separate set of rules for orchid hybrids.

Nomenclature refers to the naming of things. **Botanical nomenclature is (surprise) about naming plants.** Bear in mind that plant names refer to abstract entities - the collection of all plants (past, present, and future) that belong to the same group. As you will recall, taxonomy is about grouping. Botanical nomenclature is about applying names to taxonomic groups.

NOTES

Scientific names of plants reflect the taxonomic group to which the plant belongs. One must first decide on the groups to be recognized; only then does one start to be concerned about assigning an appropriate name to the plant. Common names, at least those that are genuinely common names, usually reflect some conspicuous or valuable characteristic of the plant, not its taxonomic group. The following comments are about scientific names.

Scientific names are never misleading. No matter where you are, every plants has only one correct name. *so long as its taxonomic treatment is not in dispute*. This last is a major reservation, but we can ignore it for now. The universality of scientific names means that even English speaking people can find out what species grow in China or Saudi Arabia by reading a technical flora of these countries. Not only are the names the same, they are always written in the Latin alphabet (which is the same alphabet as these notes).

Pronunciation

There is as little point about worrying over the 'correct' pronunciation of scientific names as there is in worrying over which is the correct pronunciation of English words. It may be difficult to recognize a scientific name if it is spoken by someone from another part of the world BUT one can always recognize it when it is written out. In this, scientific names are no different from other words. Think how hard it can be to understand different versions of English. Nevertheless, it is advantageous to use the same pronunciation as the other people you work with. Just be prepared to modify your pronunciation if you move to another part of the world.

Taxonomy refers to forming groups. Plants that belong to the same group have the same name. The taxonomic decisions concerning how a group is to be treated (what goes in the group, what rank it should be recognized as) MUST be made before it can be assigned a name. It does not matter how you decide what its affinities are (unless, of course, you want others to support and use your treatment), but you must make these decisions before you can decide on an appropriate name for the group. So remember, taxonomy first. If people are going to communicate around the world, there needs to be an internationally accepted system of nomenclature. Creating such a system was not, and is not, an easy task. It was not until 1930 that agreement was reached on an International Code had become standard around 1753. There were, however, many areas where there was widespread agreement in practice, with some of the practices dating back to before Linnaeus. For reasons that you will learn later, Linnaeus is taken as the starting point for botanical nomenlcature. Let's consider for a moment some of the areas of agreement that existed before there was formal agreement on an International Code of Botanical Nomenclature.

Towards an International Code

Pre-Linnaean Practices

1. Names were formed like Latin words. The reason is quite straightforward; Latin was the common language among all European peoples - and plant taxonomy as we know it has its origins in Europe.
2. Once a name had been attached to a plant group, it should not be given another name.
3. When commenting on how a name was to be interpreted, one should list the names of others that had used it.
4. It helps to mention some specimens that one has seen.

The first attempt at developing an international agreement was made in Paris in 1867. At this meeting, it was decided that a) the first edition of Linnaeus' *Species Plantarum*, which was published in 1752, would serve as the starting point of botanical nomenclature and b) if two names had been given to the same plant group, the older name would be the correct name. In addition, various rules were laid down as to what was required to valid publication - a phrase that means 'published in such a manner that the name counts'. For instance, publication of new names in horticultural catalogs used to be acceptable, but it is not any longer.

Other Codes

In 1892, a group of US botanists held a meeting in Rochester at which they presented some additions and modifications that they considered more objective (a great phrase in science). Among the changes that they proposed were that a) when publishing a new name one should cite at least one herbarium specimen representing the plant group concerned and b) that, when a species was moved from one genus to another it should, if possible, keeps its specific epithet (it is not possible if that epithet has already been used for another species in the new genus). Some of the new rules conflicted with those proposed in Paris, and the modified version being used at Kew, a major taxonomic center in England.

Agreement, at last

In 1930, taxonomists finally agreed on a single International Code of Botanical Nomenclature. This Code is revised every 6 years, but the goals of all the revisions are always to achieve stability in scientific nomenclature and or to clarify problems. The revisions are published in Taxon, the journal of the International Society of Plant Taxonomists, then voted on at a meeting that is held immediately prior to an International Botanical Congress. The last edition of the Code was published in 2000. There is a copy in the herbarium.

Limitations of the Code

Before considering what the Code says, it is important to know what it does, and does not, attempt to do.

It does state what to do when you wish to assign a new name to a plant group, how the names of plant groups are to be informed, how to inform people about new names, and how to choose between two (or more) names that have been given to the same plant group.

It does not provide any information on how to decide whether a group of plants should be given a scientific name or what rank a group should have. These activities are taxonomic, not nomenclatural.

5.2.2 Proposing A New Name Or New Combination

If you have to publish a new name or combination, the Code requires that you follow certain rules (which it calls articles). The key requirements are that:

1. The new name or combination be published in a normal botanical outlet (not the Herald Journal or Statesman), copies of which are sent to at least two botanical institutions.
2. If the name is for a new taxon, the distinguishing characteristics of the taxon, and preferably a full description, must be given *in Latin* and a holotype specified.
3. If the name is simply a new combination, perhaps reflecting the transfer of a species from one genus to another or its demotion to a subspecies, there must be a clear and complete reference to the place where the original name was first published.

5.2.3 Why Do Scientific Names Get Changed ?

1. Discovery of an older name for the taxon that has been overlooked. In the last decade, it has become possible to conserve the name actually being used if one can show that the earlier name has never become established. This is a *nomenclatural*, not taxonomic reason, for changing a name.
2. Discovery that the name being used for a particular taxon had been applied earlier to some other taxon. This is a *nomenclatural*, not taxonomic reason, for changing the name.
3. A decision that a species belongs in a different genus, or that a taxon needs to be split, or that the rank of the taxon needs to be changed. These are all *taxonomic* decisions.

Most name changes reflect taxonomic decisions, but people that do not agree with the decision may continue to use the existing name. This is what non-taxonomists find frustrating, if not infuriating. Such people often become even more frustrated when told that there is no set of criteria nor any governing board that determines at what rank a taxon should be recognized at, or what its boundaries should be. There are stronger and weaker arguments, but there is not even complete agreement on which are strong arguments and which are weak. Taxonomy is not a field for those that require certainty in their life.

Other Names

Plants are often known by many different names. The names *Convolvulus arvensis*; Bindweed, Field bindweed, Common bindweed, Small bindweed, Morning glory, and Liseron des champs all refer to the same species. The scientific name is *Convolvulus arvensis*. The other names are what are called *common names* or *vernacular names.* I prefer the phrase 'vernacular name' because many so-called common names are simply names constructed to satisfy the demand for a name in a familiar language - they are not names in common use.

Although many people like 'common names', there are many problems associated with them. For instance, Indian ricegrass (*Achnatherum hymenoides)* is not a close relative of either rice or wild rice (two very different species), but it was used for food by Native Americans and looks something like short grain rice. I regard it as a genuine common name - among English speaking people. But the species was an important component of the diet of the Native Americans in Utah and the west. I rather doubt that it is called Indian Ricegrass in any Native American language.

Sometimes, the common name is the same, or partly the same as the scientific name. Many of you probably have no problem understanding Penstemon and Delphinium, but both of these are scientific names. If you grew up in England or Australia, you would also be familiar with Capsicum as a common name, but in North America the commonly encountered species of Capsicum are called bell peppers or chili peppers. Despite their American names, species of bell peppers and chili peppers are more closely related to potatoes, eggplant, and nightshades than the kind of pepper that we use in pepper grinders.

Problems arise when vernacular names have been created based on scientific names, but the meaning of the scientific name changes. For instance, all species in the genus *Agropyron* were given common names that incorporated the word 'wheatgrass'. The trouble is that most of these species have since been kicked out of *Agropyron*. It is not a huge problem, but it does point up how artificial so many 'common names' are.

Another problem with common names is that they may apply to more than one species. Corn used to the name for the grain most used for flour. In England, corn meant wheat; in Scotland, it meant rye or barley; in these two countries what Americans call corn was known as maize. With the increasing dominance of American English, corn is now generally interpreted as meaning *Zea mays* - otherwise known as maize. Similarly 'Bluebell' forms part, or all, of the name of many different plants. I learned of it as referring to monocots that are sold here as Wood hyacinths. In Scotland, it applies to what I would call a Harebell. but the northern Utah flora refers to as Arctic bellflower. This same work gives Bluebell as the common name for *Mertensia*, a third genus and a third family. The USDA PLANTS database lists 18 different species as having Bluebell as part of their common name.

Common names have local value; scientific names have universal value. in this class, we focus on scientific names.

Official Names

In some countries, one or more government agencies creates plant names in the country's native or official language which they require their employees and contract employees to use. Some of these names are what I would refer to as the *truly* common names, but many are just extensions of a true common name to other species, often by translating the specific epithet. Official names can be useful in talking to non-botanists, but the result is often a parallel system of nomenclature. The U. S. A. is one such country. Indian ricegrass appears to be a genuine common name, that is, one that ordinary people coined and used, for the species that used to be known as *Oryzopsis hymenoides.* Unfortunately, the USDA decided that all species of the genus *Oryzopsis* should be called ricegrasses so the official name of *O. kingii* became King Ricegrass and *O. asperifolia* became Roughleaved ricegrass although neither of these species has ever been used as a source food for humans. The problem with this approach to creating official names (which are generally called common names) is that taxonomic study shows that neither *Oryzopsis hymenoides* nor *O. kingii* belongs in *Oryzopsis. Oryzopsis hymenoides* is now placed in either *Achnatherum* or *Stipa* (there is taxonomic disagreement) while *O. kingii* is placed in the genus *Ptilagrostis*. Should the official name of *P. kingii* be changed from King Ricegrass? If so, to what?

There are other problems with having official names. For instance, several years ago, the old Soil Conservation Service sent out an updated list of approved common names for Utah's plants. Among other idiocies, it was proposed that people should stop referring to penstemons (unless using a scientific name) and start referring to the species involved as beardtongues even thought the vast majority of the official names (which were called common names) were basically a translation of the binomial. In my opinion, it makes more sense to teach people to refer to Eatons Penstemon rather than Eatons Beardtongue. At least that way they learn half the scientific name.

Relationship to taxonomy

Botanical nomenclature is closely linked to plant taxonomy, and botanical nomenclature serves plant taxonomy, but nevertheless botanical nomenclature is separate from plant taxonomy**.**

Botanical nomenclature is merely the body of rules prescribing which name applies to that taxon (see correct name) and if a new name may (or must) be coined.

Plant taxonomy is an empirical science, a science that determines what constitutes a particular taxon (taxonomic grouping, plural: taxa): 'What plants belong to this species? " and "What species belong to this genus?'). Where taxonomists differ in opinion more than one name may be used for one and the same plant. Within any taxonomic viewpoint only one name can be correct, but somebody holding a different taxonomic viewpoint may be using a different name, although for him too there is only one correct name (in his taxonomic viewpoint).

This means that in case of confusion:

- If confusion is nomenclatural (for example an older name is discovered which has priority and threatens to displace a well-known name), the Code offers means to set things right (at least sometimes): see conservation.
- If confusion is taxonomic (taxonomists differ in opinion on the circumscription or the relationships of taxa), then only more scientific research can settle this.

5.2.4 The International Code of Botanical Nomenclature (ICBN)

The International Code of Botanical Nomenclature (ICBN) is the set of rules and recommendations dealing with the formal botanical names that are given to plants. Its intent is that each taxonomic group ('taxon', plural 'taxa') of plants has only one correct name that is accepted worldwide. The value of a scientific name is that it is an identifier; it is not necessarily of descriptive value, or even accurate.

The guiding principle in botanical nomenclature is priority. **The ICBN sets the formal starting date of plant nomenclature at 1 May 1753, the publication of Species Plantarum by Linnaeus** (or at later dates for specified groups and ranks).

A botanical name is fixed to a taxon by a type. This is almost invariably dried plant material and is usually deposited and preserved in a herbarium, though can be an image. Some type collections can be viewed online at the websites of the herbaria in question.

Both these principles are regulated and limited. To avoid undesirable effects of priority, conservation of a name is possible. Above the taxonomic rank of family very few hard rules apply.

The ICBN can only be changed by an International Botanical Congress (IBC), with the International Association for Plant Taxonomy providing the supporting infrastructure. The present edition is the Vienna Code (2006), based on the decisions of the XVII IBC at Vienna 2005. This was preceded by the St Louis Code (2000) and the Tokyo Code (1994), both available online. Each new edition supersedes the earlier editions and is retroactive back to 1753, except where expressly limited.

The ICBN applies not only to plants, as they are now defined, but also to other organisms traditionally studied by botanists. This includes blue-green algae (Cyanobacteria); fungi, including chytrids, oomycetes, and slime moulds; photosynthetic protists and taxonomically related non-photosynthetic groups. There are special provisions in the ICBN for some of these groups, as there are for fossils.

For the naming of cultivated plants there is a separate code, the *International Code of Nomenclature for Cultivated Plants*. This gives supplementary rules and recommendations.

5.2.5 Principles of International Code of Botanical Nomenclature, (ICBN)

I. Botanical nomenclature is independent of zoological nomenclature. The code applies equally to names of taxonomic groups treated as plants whether or not these groups were originally so treated (Plants do not include Bacteria).

II. Application of names of taxonomic groups is determined by means of nomenclature types.

III. The nomenclature of a taxonomic group is based upon priority of publication.

IV. Each taxonomic group with a particular circumscription, position, and route can bear only one correct name, the earliest that is in accordance with the rules, except in specific cases.

V. Scientific names of taxonomic groups are treated as Latin regardless of their derivation.

VI. The rules of nomenclature are retroactive unless expressly limited.

The Principles were laid down in 1983.

Preamble of ICBN 1983

1. Botany requires a precise and simple system of nomenclature used by Botanists in all countries, dealing, on the one hand, with the terms

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which denote the ranks of taxonomic groups or units, and on the other hand with the scientific names which are applied to the individual taxonomic groups of plants.

The purpose of giving a name to a taxonomic group is not to indicate its character or history, but to supply a means of referring it and to indicate its taxonomic rank. The code aims at the provision of a stable method of naming taxonomic groups, avoiding and rejecting the use of names which may cause error or ambiguity or throw science into confusion. It avoids the useless creation of names.

2. The Principles form the basis of the system of Botanical Nomenclature.
3. The detailed provisions are divided into Rules and Recommendations. Examples are added to the rules and the recommendations to illustrate them.
4. The object of the Rules is to put the nomenclature of the past into order and to provide for that of the future, names contrary to a rule cannot be maintained.
5. The Recommendations deal with subsidiary points, their object being to bring about greater uniformity and clearness, especially in future nomenclature, names contrary to a recommendation cannot, on that account, be rejected, but they are not examples to be followed.
6. The provisions regulating the modification of this code from its last decisions.
7. The Rules and Recommendations apply to all organisms treated as plants (except Bacteria), whether fossil or non-fossil. Nomenclature of Bacteria is governed by the ICNB. Special provisions are needed for certain groups of plants. The International Code of Nomenclature of cultivated plants (1980) was adopted by the International Commission for the Nomenclature of Cultivated Plants; provisions for the names of hybrids appear in Appendix I.
8. The only proper reason for changing a name is either a more profound knowledge of the facts resulting from adequate taxonomic study or the necessity of giving up nomenclature that is contrary to the rules.
9. In the absence of a relevant rule or where the consequences of rules are doubtful, established custom is followed.
10. This edition of the code supersedes all previous editions.

Division III. Governance of the Code

1. The code may be modified only by action of a plenary session of an International Botanical Congress on resolution moved by the nomenclature section of the congress.

2. Permanent Nomenclature Committees are established under the auspices of the International Association for Plant Taxonomy. Members are elected by an International Botanical Congress. The Committees have power to co-opt and to establish sub-committees.
3. The Bureau of Nomenclature of International Botanical Congress its officers are:
   (a) The president
   (b) The recorder
   (c) The rapporteur-general
   (d) The vice-rapporteur
4. The voting on nomenclature proposals is of two kinds:
   (a) Preliminary guiding mail vote
   (b) Final and binding vote at the nomenclature section of the International Botanical Congress

Some Important Rules and Recommendations

1. All those plants which belong to one genus must be designed by the source generic name.
2. All those plants which belong to different genera must be designated by different generic names.
3. He who establishes a new genus should give it a name.
4. Those generic names are best which show essential characters of plants or its appearance.
5. Generic names one and a half foot long or difficult to pronounce or unpleasant are to be avoided.
6. The specific name must distinguish a plant from all its relatives.
7. Size does not distinguish species.
8. The original place of plant does not give specific difference.
9. A generic name must be applied to each species.
10. The specific name should always follow the generic name.

In accordance with the ICBN some traditional names of the families are changed to their alternate names as:

- Compositae is now known as Asterceae.
- Gramineae is now known as Poaceae.
- Labiatae is now called as Lamiaceae.
- Palmae is now called as Arecaceae.
- Umbelliferae is now known as Apiaceae.

A unique exception to article 52 of the code is that the name Leguminosae is sanctioned only as long as it includes all three subfamilies Papilionoideae, Caesalpinoideae and Mimosoideae. If the subsfamilies are upgraded to family status the Papilionaceae shall be called Fabaceae.

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5.2.6 Author Citation

A name cannot be complete without an author's name. The author's name is abbreviated, for example Linneaus is abbreviated as Linn or L, Benthm as Benth; Hooker as Hook, Roxburgh as Roxb, Lamark as Lamk, etc.

According to Article 46 the indications of name of a taxon are to be accurate and complete. It is necessary to cite the name of the author who first validly published the name. If the author's name is too long it should be abbreviated. For example, Hibisus L., Indigofera grandulosa var. Syskessi Baker, Solarium nigrum Linn etc.

According to Article 49 when a genus or taxon of a lower rank is altered in upper rank but retains its name or epithet, the author who first published this as a legitimate name or epithet must be cited in parentheses; followed by the name of the author was effected the alternation for example, Citrus auranium var. grandis L; when raised to rank of species it become Citrus grandis (L) Obseck. Here L is the first author and Osbeck altered it.

Similarly, when a subdivision of a genus or a species is transferred to another genus or placed under another generic name (Article 54 and 55), it will be written as:

(i) Saponaria section vaccaria DC when transferred to Gypsophila, it becju.es Gypsophila sec. vaccaria (DC) Godr.

(ii) Limonia aurantifolia Christm, when transferred to Citrus it becomes Citrus aurantifolia (Christm) Swingle.

In case of infraspecific changes it is, Alysicapus nummularifolius DC when reduced to variety it becomes Alysicarpus viginalis var. nummularifolius (DC) Baker.

The names of two authors are linked by ex. when the first author proposed a name but was validly published only by second author, the first author failing to satisfy all requirements of the code.

Cerasus cornuta Wall ex. Royle. When two or more authors publish a new species their names are linked by et, for exampleDelphinium viscosum Hook.F. et Thomson. When the first author publishes a new species or name in a publication of another author, in is used, for example Carex kashmirensis Clarke in Hook. F, it means Clarke published the new species in Hooker's Flora of British India.

The names of two authors are linked using emend (emendavit) or person making amendment or correction in the diagnosis or circumscription of a taxon without altering the type, for example Phyllanthus Linn, emend. Mull.

When a name was already suggested but it is before 1753, i.e., the starting of binomial system, the name of the author will be put in brackets ([ ]), for example Lupinus [Tourne] Linn, here Tournefort suggested the name in 1719, i.e., before 1753 (Species Plantarum).

In the citation of infraspecific taxon both authorities are called as Acasia nelotica (Linn) Del. ssp indica (Benth). In case of autonym, the infraspecific epithet does not bear author's name since it is based on same type as the species, for example , Acacia nelotica (Linn.) Del. ssp nelotica.

Publication of Names:

The name of a Taxon should fulfill certain requirements before its effective publication, for example,

(1) Formulation

It should indicate:

(a) sp. nov (species nova) for a new species

(b) Comb, nov (combination nova) for change in the epithet of basionym The name of the original author should be kept in Parantheses.

(c) Nom. nov (Nomen novum) when the original name is completely replaced.

(2) Latin diagnosis

Name of New Taxa should have a Latin diagnosis, i.e., translation of all features in Latin language.

(3) Typification

Holotype should be designated. The name of new Taxon is valid only when the type of the name is mentioned after January 1, 1990. The name of the taxon whose type is a specimen or unpublished illustration; the herbarium or institution in which the type is conserved must be specified.

(4) After January 1, 1996 the name of new taxon of fossil should be accompanied by a Latin or English description of character.

Article 32, 1-2 or Tokyo Code (ICBN) is amended as new names of plants and Fungi will have to be registered in order to be validly published after January 1, 2000.

5.2.7 Rejection of Names

The rules for rejection of names are:

(i) Nomen nudunm (nom. nud): Name without description, without typification and Latin diagnosis etc. is rejected.

(ii) Tautonym: Botanical nomenclature does not allow tautonym (repetition of generic name), for example Malus malus. Repetetion of specific epithet in infra specific epithet does not constitute tautonym.

(iii) Later homonym: If a name which is already existing is given to another taxa once again then the later homonym is rejected.

(iv) Nomen ambiguum (nom. ambig): The name is rejected if it is used in different sense by different authors.

(v) Nomen confusum (nom. confus): The name should not be confusing.

(vi) Nomen dubium (non. dub): Dubious name, i.e., with uncertain applications is also rejected.

Types of Taxon

Names of different taxonomic groups are based on the type method.

The principles and articles of the ICBN provide that all taxonomic groups will be based on nomenclatural types, meaning thereby that all names are permanently attached with some taxon or specimen designated as type. For species (and infraspecific taxa) the type is a specimen or in some circumstances only an illustration. The name of the first author should be attached.

Name of the taxa above the level of species, i.e., section, subgenus, genus, tribe, and family etc., are based on the name of immediately next lower taxon on which the group was originally based, i.e., Lamiaceae was based on genus Lamium. Orchidaceae was based on genus Orchis etc.

When a new species is described, the author of new species has one or more specimen having characters are distinctive enough to be segregated into new species.

Different Kinds of Types

(i) Holotype: Single specimen, may be whole plant or a part of it with which the name of taxon is permanently attached, is known as holotype.

(ii) Isotype or Cotype: Fragments from the same plant from which the Holotype is made or plants with same field number are isotypes.

(iii) Paratype: Specimen other than holotype and Isotype is called Paratype. The specimen may bear a different field number as it is collected from different localities by different collectors.

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(iv) Syntype: The specimen which is the basis of new taxon when no holotype is designated by author is known as syntype. If author studies collection from different localities and by different collectors and decides to establish a new species, labels all of them as types, all these specimen become syntype.

(v) Lectotype: It is type chosen to serve as Holotype, when either an earlier designated holotype was lost or destroyed or Holotype was never designated and from the Isotype, Paratype or Syntype a specimen is chosen by a specialist to serve as the type.

(vi) Neotype: If Holotype, Isotype, Paratype or Syntype are lost or not available a Neotype is selected from other specimens, to serve as Type. Some taxonomists call it Standard Specimen.

(vii) Topotype: When no original type material is available and a specimen is collected from type locality is chosen to serve as type it is called Topytype.

(viii) Epitype: Specimen is selected to serve as an interpretive type when the holotype, lectotype, Neotype etc. could not effectively be identified to name the taxon, it is called Epitype.

Check Your Progress

1. What is botanical nomenclature?
2. What is ICBN?
3. How are names of two authors linked?
4. Who can change the ICBN?

5.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Botanical nomenclature is the formal naming of plants, from a scientific point of view.
2. The International Code of Botanical Nomenclature (ICBN) is the set of rules and recommendations dealing with the formal botanical names that are given to plants.
3. The names of two authors are linked using emend (emendavit) or person making amendment or correction in the diagnosis or circumscription of a taxon without altering the type, for example Phyllanthus Linn, emend. Mull.
4. The ICBN can only be changed by an International Botanical Congress IBC), with the International Association for Plant Taxonomy providing the supporting infrastructure.

5.4 SUMMARY

NOTES

- Botanical nomenclature is the formal naming of plants, from a scientific point of view. It has a long history, going back perhaps to Theophrastos, but anyway back to the period when Latin was the scientific language throughout Europe.
- The keystone event was Linnaeus' adoption of binary names for plant species in his Species Plantarum (1753). This gave every plant species a name which remained the same no matter what other species were placed in the genus, and thus separated taxonomy from nomenclature.
- These species names of Linnaeus together with names for other ranks, notably the rank of family (not used by Linnaeus), can serve to express a great many taxonomic viewpoints.
- In the nineteenth century it became increasingly clear that there was a need for rules to govern scientific nomenclature and initiatives were taken to come to a body of laws. These were published in successively more sophisticated editions.
- For plants the key dates are 1867 (lois de Candolle), 1906 (International Rules of Botanical Nomenclature, 'Vienna Rules') and 1952 (International Code of Botanical Nomenclature, 'Stockholm Code').
- Another development was insight into delimitation of the concept 'plant'. Linnaeus held a much wider view of what a plant is than is acceptable today. Gradually more and more groups of organisms are recognised as being independent of plants.
- Nevertheless the formal names of most of these organisms are governed by the *International Code of Botanical Nomenclature (ICBN)*, even today. A separate Code was adopted to govern the nomenclature of Bacteria, the ICNB.
- At the moment all formal botanical names are governed by the *ICBN*. Within the limits set by the *ICBN* there is a separate set of rules, the *International Code of Nomenclature for Cultivated Plants (ICNCP)*.
- Within the group of plants that have been deliberately altered or selected by humans (see cultigen) there are those that require separate recognition, known as cultivars. Within the limits set by the ICNCP there is a separate set of rules for orchid hybrids.
- Nomenclature refers to the naming of things. Botanical nomenclature is (surprise) about naming plants. Bear in mind that plant names refer to abstract entities - the collection of all plants (past, present, and future) that belong to the same group. As you will recall, taxonomy is about grouping. Botanical nomenclature is about applying names to taxonomic groups.

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- Scientific names of plants reflect the taxonomic group to which the plant belongs. One must first decide on the groups to be recognized; only then does one start to be concerned about assigning an appropriate name to the plant. Common names, at least those that are genuinely common names, usually reflect some conspicuous or valuable characteristic of the plant, not its taxonomic group. .
- Scientific names are never misleading. No matter where you are, every plants has only one correct name. *so long as its taxonomic treatment is not in dispute*. This last is a major reservation, but we can ignore it for now. The universality of scientific names means that even English speaking people can find out what species grow in China or Saudi Arabia by reading a technical flora of these countries.
- Taxonomy refers to forming groups. Plants that belong to the same group have the same name. The taxonomic decisions concerning how a group is to be treated (what goes in the group, what rank it should be recognized as) MUST be made before it can be assigned a name. It does not matter how you decide what its affinities are (unless, of course, you want others to support and use your treatment), but you must make these decisions before you can decide on an appropriate name for the group.
- So remember, taxonomy first. If people are going to communicate around the world, there needs to be an internationally accepted system of nomenclature. Creating such a system was not, and is not, an easy task.
- The first attempt at developing an international agreement was made in Paris in 1867. At this meeting, it was decided that a) the first edition of Linnaeus' *Species Plantarum*, which was published in 1752, would serve as the starting point of botanical nomenclature and b) if two names had been given to the same plant group, the older name would be the correct name.
- In addition, various rules were laid down as to what was required to valid publication - a phrase that means 'published in such a manner that the name counts'. For instance, publication of new names in horticultural catalogs used to be acceptable, but it is not any longer.
- In 1892, a group of US botanists held a meeting in Rochester at which they presented some additions and modifications that they considered more objective (a great phrase in science). Among the changes that they proposed were that a) when publishing a new name one should cite at least one herbarium specimen representing the plant group concerned and b) that, when a species was moved from one genus to another it should, if possible, keeps its specific epithet.

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- Most name changes reflect taxonomic decisions, but people that do not agree with the decision may continue to use the existing name. This is what non-taxonomists find frustrating, if not infuriating. Such people often become even more frustrated when told that there is no set of criteria nor any governing board that determines at what rank a taxon should be recognized at, or what its boundaries should be.
- There are stronger and weaker arguments, but there is not even complete agreement on which are strong arguments and which are weak. Taxonomy is not a field for those that require certainty in their life.
- Botanical nomenclature is closely linked to plant taxonomy, and botanical nomenclature serves plant taxonomy, but nevertheless botanical nomenclature is separate from plant taxonomy.
- Botanical nomenclature is merely the body of rules prescribing which name applies to that taxon (see correct name) and if a new name may (or must) be coined.
- The International Code of Botanical Nomenclature (ICBN) is the set of rules and recommendations dealing with the formal botanical names that are given to plants. Its intent is that each taxonomic group ('taxon', plural 'taxa') of plants has only one correct name that is accepted worldwide. The value of a scientific name is that it is an identifier; it is not necessarily of descriptive value, or even accurate.

5.5 KEY WORDS

- **Botanical nomenclature:** Botanical nomenclature is the formal naming of plants, from a scientific point of view.
- **Taxonomy:** It refers to forming groups. Plants that belong to the same group have the same name.
- **ICBN:** The International Code of Botanical Nomenclature (ICBN) is the set of rules and recommendations dealing with the formal botanical names that are given to plants.

5.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Brief a note on botanical nomenclature.
2. Why is scientific name important?

3. What is ICBN? Write a brief note.
4. What is author citation?

Long Answer Questions

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1. Write a elaborated note on botanical nomenclature.
2. Explain why scientific names are important?
3. Discuss about proposing a new name.
4. Write a elaborated note on ICBN.
5. Discuss the principles of ICBN.
6. Explain about author citation.
7. What is rejection of names? Expalin.

5.7 FURTHER READING

Dikshit, Anupam, M.O. Siddiqui and Ashutosh Pathak. 2016. *Taxonomy of Angiosperms: Basic Concepts, Molecular Aspects & Future Prospects*, 1st Edition. Delhi: Studera Press.

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UNIT 6 PRINCIPLES OF DRAFT BIOCODE

NOTES

Structure

6.0 INTRODUCTION

Biology as a science is unusual in that the objects of its study can be named according to five different *Codes* of nomenclature (Hawksworth 1995). The rules governing the names of animals and plants, respectively the *International Code of Zoological Nomenclature (ICZN)* (Ride *et al.* 1985) and the *International Code of Botanical Nomenclature (ICBN)* (Greuter *et al.* 1994), have origins that diverged in the mid-19th century. Although based on essentially the same principles, notably that there should be a unique name for each taxon and that the choice of competing names should be determined by precedence in date of publication, the two sets of rules have diverged in detail over their 150 or so years of separate existence. A third set of rules, the *Bacteriological Code (BC)* (Lapage *et al.* 1992), first developed in 1953 (published in 1958), started essentially as a derivative of the *ICBN* and 1973 developed what amounted to a new starting date through the establishment of an 'Approved List of Bacterial Names'. The *International Code of Nomenclature for Cultivated Plants (ICNCP)* originated in 1953 and represents a set of rules subordinate to those of the *ICBN* and applicable specifically to cultivated plants. The most recent (6th) edition (Trehane *et al.* 1995) clarifies the complementary role of the *ICNCP* relative to the *ICBN*. The naming of viruses and sub-viral agents (prions etc.) will be covered by the draft *International Code of Virus Classification and Nomenclature*, currently being developed from the current *Rules of Virus Classification and Nomenclature* by the International Committee for the Taxonomy of Viruses (ICTV) of the International Union of Microbiological Societies (IUMS).

In this unit, you will study about principle of priority, limitations, conservation of names of species - Draft BioCode in detail.

6.1 OBJECTIVES

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After going through this unit, you will be able to:

- Understand the principle of priority
- Discuss about the limitations of draft BioCode
- Expalin about conservation of names of species
- Describe what draft BioCode is

6.2 PRINCIPLE OF PRIORITY

1. Botany requires a precise and simple system of nomenclature used by botanists in all countries, dealing on the one hand with the terms which denote the ranks of taxonomic groups or units, and on the other hand with the scientific names which are applied to the individual taxonomic groups of plants. The purpose of giving a name to a taxonomic group is not to indicate its characters or history, but to supply a means of referring to it and to indicate its taxonomic rank. This Code aims at the provision of a stable method of naming taxonomic groups, avoiding and rejecting the use of names which may cause error or ambiguity or throw science into confusion. Next in importance is the avoidance of the useless creation of names. Other considerations, such as absolute grammatical correctness, regularity or euphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their undeniable importance, are relatively accessory.
2. The Principles form the basis of the system of botanical nomenclature.
3. The detailed provisions are divided into Rules, set out in the Articles, and Re-commendations. Examples are added to the rules and recommendations to illustrate them.
4. The object of the Rules is to put the nomenclature of the past into order and to provide for that of the future; names contrary to a rule cannot be maintained.
5. The Recommendations deal with subsidiary points, their object being to bring about greater uniformity and clearness, especially in future nomenclature; names contrary to a recommendation cannot, on that account, be rejected, but they are not examples to be followed.
6. The provisions regulating the modification of this Code form its last division.

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7. The Rules and Recommendations apply to all organisms treated as plants (including fungi), whether recent or fossil, with the exception of the bacteria. Nomenclature of bacteria is governed by the International Code of Nomen-clature of Bacteria (1976). Special provisions are needed for certain groups of plants: The International Code of Nomenclature of Cultivated Plants-1969 was adopted by the International Commission for the Nomenclature of Cultivated Plants; provisions for the names of hybrids appear in Appendix I.

Division I. Principles

Principle I Botanical nomenclature is independent of zoological nomenclature.

The Code applies equally to names of taxonomic groups treated as plants whether or not these groups were originally so treated*.

Principle II The application of names of taxonomic groups is determined by means of nomenclatural types.

Principle III The nomenclature of a taxonomic group is based upon priority of publication.

Principle IV Each taxonomic group with a particular circumscription, position, and rank can bear only one correct name, the earliest that is in accordance with the Rules, except in specified cases.

Principle V Scientific names of taxonomic groups are treated as Latin regardless of their derivation.

Principle VI The Rules of nomenclature are retroactive unless expressly limited.

*For the purposes of this Code, the word ‘plants’ does not include the bacteria.

General Considerations and Guiding Principles (Art. 1—9).

Art. 1. Botany cannot make satisfactory progress without a precise system of nomenclature, which is used by the great majority of botanists in all countries.

Art. 2. The precepts on which this precise system of botanical nomenclature is based are divided into principles, rules and recommendations. The principles (Art. 1—9, 10—14, 15—19[1]) form the basis of the rules and recommendations. The object of the rules (Art. 19—74) is to put the nomenclature of the past into order and to provide for that of the future. They are always retroactive: names or forms of nomenclature contrary to a rule (illegitimate names or forms) cannot be maintained. The recommendations deal with subsidiary points, their object being to bring about greater uniformity and clearness in future nomenclature; names or forms contrary to a recommendation cannot on that account be rejected, but they are not examples to be followed.

Art. 3. The rules of nomenclature should be simple and founded on considerations sufficiently clear and forcible for everyone to comprehend and be disposed to accept.

Art. 4. The essential points in nomenclature are: (1) to aim at fixity of names; (2) to avoid or to reject the use of forms and names which may cause error or ambiguity or throw science into confusion.Next in importance is the avoidance of all useless creation of names.

Other considerations, such as absolute grammatical correctness, regularity or euphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their un-deniable importance are relatively accessory.

Art. 5. In the absence of a relevant rule, or where the consequences of rules are doubtful, established custom must be followed.

Art. 6. Botanical nomenclature is independent of zoological nomenclature in the sense that the name of a plant is not to be rejected simply because it is identical with the name of an animal. If, however, an organism is transferred from the animal to the plant kingdom, its validly published names are to be accepted as botanical nomenclature in the form prescribed by the rules of botanical nomenclature, and if an organism is transferred from the plant to the animal kingdom, its names retain their status in botanical nomenclature.

Art. 7. Scientific names of all groups are usually taken from Latin or Greek. When taken from any language other than Latin, or formed in an arbitrary manner, they are treated as if they were Latin. Latin terminations should be used so far as possible for new names.

Art. 8. Nomenclature deals with: (1) the terms which denote the rank of taxonomic groups (Art. 10—14); (2) the names which are applied to the individual groups (Art. 15—72).

Art. 9. The rules and recommendations of botanical nomenclature apply to all classes of the plant kingdom, recent and fossil, with certain distinctly specified exceptions.

Chapter II. Categories of taxonomic groups, and the terms denoting them

(Art. 10—14, Rec. I, II).

Art. 10. Every individual plant, interspecific hybrids and chimaeras excepted, belongs to a species (species), every species to a genus (genus), every genus to a family (familia), every family to an order (ordo), every order to a class (classis), every class to a division (divisio).

Art. 11. In many species, varieties (varietas), forms (forma), and races or biological forms (forma biologica) are distinguished; in parasitic species special forms (forma specialis), and in certain cultivated species modifications still more numerous; in many genera sections (sectio) are distinguished, in many families tribes (tribus).

Recommendation I. In parasites, especially parasitic fungi, authors who do not give specific value to forms characterized from a biological standpoint but scarcely or not at all from a morphological standpoint, should distinguish within the species special forms (forma specialis) characterized by their adaptation to different hosts.

Art. 12. Finally, if a greater number of intermediate categories are required, the terms for these subdivisions are made by adding the prefix sub (sub) to the terms denoting the categories. Thus subfamily (subfamilia) denotes a category between a family and a tribe, subtribe (subtribus) a category between a tribe and a genus,etc. The classification of subordinated categories may thus be carried, for wild plants, to twenty-three degrees in the following order: Regnum vegetabile. Divisio. Subdivisio. Classis. Subclassis. Ordo. Subordo. Familia. Subfamilia. Tribus. Subtribus. Genus. Subgenus. Sectio. Subsectio. Species. Subspecies. Varietas. Subvarietas. Forma. Forma biologica. Forma specialis. Individuum.

If this list of categories is insufficient it may be augmented by the intercalation of supplementary categories, provided that this does not introduce confusion or error Examples: Series and subseries are categories which may be intercalated between subsection and species.

Recommendation II. The arrangement of species in a genus or in a subdivision of a genus is made by means of typographic signs, letters or numerals.

The arrangement of subspecies under a species is made by letters or numerals; that of varieties by the series of Greek letters α, β, γ, etc. Groups below varieties and also half-breeds are indicated by letters, numerals or typographic signs at the author's will.

Art. 13. The definition of each of these categories varies, up to a certain point, according to individual opinion and the state of the science; but their relative order, sanctioned by custom, must not be altered. No classification is admissible which contains such alterations. Examples of inadmissible alteration: a form divided into varieties, a species containing genera, a genus containing families or tribes, for example Huth (in Engl. Bot. Jahrb. XX, 337: 1895) divided the subgenera of Delphinium into "tribes".

Art. 14. The fertilization of one species by another may give rise to a hybrid (hybrida); that of a modification or subdivision of a species by another modification of the same species may give rise to a half-breed (mistus).

6.2.1 Principles of Priority

Principles of Priority are concerned with the selection of a single correct name of taxonomic group. Only legitimate names should be retained while the illegitimate names should be rejected.

According to article 11-12 rules for priority are:

(i) Each family or taxon of lower rank with a particular circumscription, position and rank can bear only one correct name (Art. 11).

(ii) For any taxon from family to genus inclusive, the correct name is the earliest legitimate one, validly published with the same rank (Art. 11).

(iii) A name of a taxon has no status under this code unless it is a validly published (Art. 12).

(iv) The application of both conserved and rejected names is determined by nomenclatural type (Art. 14).

(v) 'When a name proposed for conservation has been provisionally approved by the general committee, botanists are authorized to retain it pending the decision of a later International Botanical Congress'.

Valid Publication of names is usually considered beginning in May 1753, the date of publication of Species plantarum vol. I by Linneaus.

With many names of a taxon, the valid will be the earliest name which is regarded as correct name. Rule of Priority provides stability to his name.

The principle that seniority is fixed by the date of valid publication is known as Principle of Priority.

Example 1:

Nymphea nouchali Burm F. 1768; N. Pubescence Willd 1799 and N.torus Hook T; 1872 are names of the same species but if rule of Priority is applied the first name is the correct name and other two are synonyms.

Example 2:

Loureiro described a plant and named it Physkium nataus in 1790. A.L.de Jussieu transferred it in genus Vallisneria in 1828. He instead of nutans gave the specific name as V. physkium. It is superfluous name. Graebner (1912) described the same plants as V.gigantee and Miki (1934) named as V.asiatica. Harg while studying Asiatic species confirmed that all these names are synonymous.

There is no legitimate combination based on Physikium natans (Leru) existed. He made V.natans Hara in 1974. The correct name of the specimen is now the recent name, but it is based on earliest basionym, others will be synonym. V.gigantea and V.asiatica will be known as nomenclatural synonyms or homotypic synonyms. V.gigantea and V.asiatica are the names based on separate types. Such synonyms are known as taxonomic synonyms or heterotypic synonyms.

6.2.2 Limitations of Principles of Priority

NOTES

1. **Starting dates:**

   Principles of Priority starts with the Species Plantarum of Linnaeus published on 1-5-1753.

2. **Limited only upto family ranks:**

   This principle does not apply over family rank.

3. The corrected name should not be outside the rank. Only when a correct name in the taxon is not available, a combination with other rank is allowed.

4. The application of Principles of Priority resulted in numerous name changes. To avoid it a list of conserved generic and family names has been prepared and Published in the code with some changes. Such Nomina conservanda (non. cons) are to be used as correct name replacing earlier legitimate name, for example, Sesbania scop, 1777 is the conserved genus as against Sesban adam 1763 and Agati adam 1763.

   Priority is a fundamental principle of modern botanical nomenclature and zoological nomenclature. Essentially, it is the principle of recognising the first valid application of a name to a plant or animal. There are two aspects to this:

   1. The first formal scientific name given to a plant or animal taxon shall be the name that is to be used, called the valid name in zoology and correct name in botany.
   2. Once a name has been used, no subsequent publication of that name for another taxon shall be valid (zoology) or validly published (botany).

   There are formal provisions for making exceptions to this principle. If an archaic or obscure prior name is discovered for an established taxon, the current name can be declared a nomen conservandum(botany) or conserved name (zoology), and so conserved against the prior name. Similarly, if the current name for a taxon is found to have an archaic or obscure prior homonym, the current name can be declared a nomen protectum (zoology) or the older name suppressed (nomen rejiciendum, botany).

History

The principle of priority has not always been in place. When Carl Linnaeus laid the foundations of modern nomenclature, he offered no recognition of prior names. The botanists who followed him were just as willing to overturn Linnaeus's names. The first sign of recognition of priority came in 1813, when A. P. de Candolle laid out some principles of good nomenclatural practice. He favoured retaining prior names, but left wide scope for overturning poor prior names.

In botany

During the 19th century, the principle gradually came to be accepted by almost all botanists, but debate continued to rage over the conditions under which the principle might be ignored. Botanists on one side of the debate argued that priority should be universal and without exception. This would have meant a one-off major disruption as countless names in current usage were overturned in favour of archaic prior names. In 1891, Otto Kuntze, one of the most vocal proponents of this position, did just that, publishing over 30000 new combinations in his Revisio Generum Plantarum.He then followed with further such publications in 1893, 1898 and 1903.His efforts, however, were so disruptive that they appear to have benefited his opponents. By the 1900s, the need for a mechanism for the conservation of names was widely accepted, and details of such a mechanism were under discussion. The current system of "modified priority" was essentially put in place at the Cambridge Congress of 1930.

Principles of Priority

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According to article 11-12 rules for priority are:

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Draft Biocode

'Biology as a science is unusual in that the objects of its study can be named according to five different *Codes* of nomenclature' (Hawksworth 1995). The rules governing the names of animals and plants, respectively the *International Code of Zoological Nomenclature (ICZN)* (Ride *et al.* 1985)

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and the *International Code of Botanical Nomenclature (ICBN)* (Greuter *et al.* 1994), have origins that diverged in the mid-19th century. Although based on essentially the same principles, notably that there should be a unique name for each taxon and that the choice of competing names should be determined by precedence in date of publication, the two sets of rules have diverged in detail over their 150 or so years of separate existence. A third set of rules, the *Bacteriological Code (BC)* (Lapage *et al.* 1992), first developed in 1953 (published in 1958), started essentially as a derivative of the *ICBN* and 1973 developed what amounted to a new starting date through the establishment of an 'Approved List of Bacterial Names'. The *International Code of Nomenclature for Cultivated Plants (ICNCP)* originated in 1953 and represents a set of rules subordinate to those of the *ICBN* and applicable specifically to cultivated plants. The most recent (6th) edition (Trehane *et al.* 1995) clarifies the complementary role of the *ICNCP* relative to the *ICBN*. The naming of viruses and sub-viral agents (prions, etc.) will be covered by the draft *International Code of Virus Classification and Nomenclature*, currently being developed from the current *Rules of Virus Classification and Nomenclature* by the International Committee for the Taxonomy of Viruses (ICTV) of the International Union of Microbiological Societies (IUMS).

For the general user of scientific names of organisms, there is inherent confusion in many aspects of this situation: different sets of rules have different conventions for citing names, provide for different forms for names at the same rank, and, although primarily each is based on priority of publication, they differ somewhat in how they determine the choice of correct name. This diversity of *Codes* can also create more serious problems as, for example, in the determination of which *Code* to follow for those organisms that are not clearly plants, animals or bacteria, the so-called ambiregnal organisms, or those whose current genetic affinity may be well established but whose traditional treatment has been in a different group (for example, the cyanobacteria, alias the blue-green algae). Moreover, the development of electronic information retrieval, by often using scientific names without clear taxonomic context, accentuates the problem of divergent methods of citation and makes homonymy between, for example, plants and animals a source of trouble and frequently confusion.

The desirability of seeking some harmonization of all biological codes has been appreciated for some time (see Hawksworth 1995) and an exploratory meeting on the subject was held at Egham, U.K. in March 1994. A report of that meeting was published by IUBS as a Special Issue of *Biology International* (Hawksworth *et al.* 1994a). The key decisions of the meeting are summarized by Hawksworth (1995). Recognizing the crucial importance of scientific names of organisms in global communication, these decisions included not only agreement to take steps to harmonize terminology and procedures, but also that it would be highly desirable to work towards a unified system of biological nomenclature. The *Draft BioCode* is the first public expression of this.

Following review by the members of the IUBS/IUMS International Committee on Bionomenclature who had prepared the initial draft in 1995, and by others involved in committees dealing with biological nomenclature, the *Draft BioCode* is now being made available to the general scientific public. It was published in the May 1996 issue of *Taxon*(45: 349-372) and can be consulted electronically through a Listserver at University of California, Berkeley, U.S.A., and on the World Wide Web at the Royal Ontario Museum, Toronto, Canada . The first direct public discussion of the *BioCode* intended for biologists of all disciplines will take place during ICSEB V (17-24 August 1996) in Budapest, Hungary. The Session is entitled 'The New Nomenclature' and is scheduled from 15:45 to 19:45 on Wednesday, 21 August. Discussions are also planned during the IUMS Congress of Bacteriology and Mycology that takes place in Jerusalem, Israel, in the same week.

Scope of the *BioCode*

(*i*) *Coverage*

From the very first discussions on harmonization of *Codes*, it was evident that the botanical and zoological *Codes*, in particular, had diverged so extensively over the years, that any attempt to provide a unified *Code* for the names of the past would involve so extensive change in scientific names as to be totally unacceptable. What has proven feasible, however, is to provide a common *Code* for the future, despite the divergent past. It is proposed, in general, that the provisions of the *BioCode* will apply to the names of all taxa published on or after a date to be determined. The *Draft BioCode* specifies 1 January 2000, but this should be viewed as a target date to focus thought, rather than a firm proposal. Implementation will only come about with the approval of the international authorities responsible for the existing *Codes* of bionomenclature.

Delimitation of coverage in relation to the current *Codes* is defined in Pre. 2-3, where it is made explicit that the *BioCode* is intended to govern only the nomenclature of the future. This means that: (a) names existing prior to the starting-point date for the *BioCode* will not (except in specified cases) be affected by the new rules, and (b) the current *Codes* for the major groups of organisms will remain operational for pre-*BioCode* names.

(*ii*) *Retroactivity*

Rules governing the form of names (for example, whether nouns or adjectives) must, however, be fully retroactive. The form of existing names may, therefore, be affected by such rules insofar as they deviate from those in one of the current *Codes.* To minimize change, and to respect, in so far as possible, traditions of long standing, different standardization rules may be permitted for the different major groups (notably for the spelling of epithets); such provisions would be covered in a future special Annex, foreshadowed in Art. 37.8-9. Differences in the terminations at the higher ranks will remain (Art. 25-26), adding to those already in existence between fungi, algae, and other plants.

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Also retroactive are the rules governing the choice, in making taxonomic changes, between competing names in order to establish which name is to be accepted for a taxon in a given circumscription, position, and rank (Art. 19).

The new (across-kingdom) homonymy rule (Art. 18) would not, however, be retroactive.

(*iii*) *Harmonization of Terminology*

One of the mandates of the 1994 Egham meeting, arising from the XXIV IUBS General Assembly held in Amsterdam in 1991, was to consider how to harmonize the terminology of biological nomenclature (see also Hawksworth *et al.* 1994b). The need for this is clear when one realises that when a botanist or bacteriologist describes a name as valid, he is applying it to a name that a zoologist would call available, a term that in turn a botanist would equate with something close to the zoologist's 'potentially valid'. By contrast, the zoologist's 'valid name' is the botanist's and bacteriologist's 'correct name'. Indeed, one of the first things that the participants at the Egham meetings had to do among themselves was to acquire a knowledge of the terminology of the other *Codes*, for example to allow botanists and bacteriologists to understand what we quickly came to call 'zoospeak', and, conversely to ensure that 'botspeak' was intelligible to zoologists. The need for a new 'biospeak' was self-evident and Table 1 of the *Draft BioCode*, is one result.

The principles under which the new nomenclatural terminology was chosen were as follows. In all cases of confusion (such as the use of 'valid' and 'available' mentioned above), a new term would be adopted, if possible one whose meaning was identical to, or was encompassed by, the everyday meaning of the word. In the more numerous cases in which there was different usage but no inherent confusion, the more generally understandable term was adopted. If no such distinction appeared to exist, a choice was made such as to maintain approximately equal number of usages from the different *Codes*.

New terms are, therefore, being proposed for many of the familiar nomenclatural expressions used in Botany such as 'effectively published' , 'validly published' , 'legitimate' and 'correct' , and some in Zoology such as 'available', 'valid' and 'senior' and 'junior'. In this way, it is hoped in the future to avoid the ambiguity that results, under the current *Codes*, from use of the same terms in a different meaning, or of different terms for the same concept. Interestingly, the International Commission for the Nomenclature

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of Cultivated Plants has found it possible to adopted the new terminology in the most recent edition of the *International code of nomenclature for cultivated plants*.

(*iv*) *Relationships to the Codes covering viruses and cultivated plants*

Confusion arising from the existence of different *Codes* is essentially confined to applications of the bacteriological, botanical and zoological *Codes*. As noted above, the *ICNCP* supplements the botanical *Code* by providing for special ranks covering "plants whose origin or selection is primarily due to the intentional actions of mankind". The different form of virus names has hitherto precluded confusion with names of non-virus organisms. The relationships of the *BioCode* to these *Codes* is outlined in Pre. 5 & 6, and special provisions to prevent future confusion with virus names are enacted in Art. 25.6, 26.2 and 28.1.

Status of the *BioCode*

Providing a novel basis for a unified nomenclature of organisms for the future may at first sight seem a revolutionary, even reckless enterprise, but given the current strong unifying trends in biology, particularly in teaching and dealing with environmental crises such as that related to biodiversity, it can be better understood as an appropriate and timely response by biological systematics to the challenges of a rapidly changing scientific and intellectual environment. The enormous savings of non-scientific time and effort, currently devoted to interpreting old names and studying old literature, that would come with lists of accepted names and a new *Code* for the future, seem reason enough in themselves to explore the *BioCode* options vigorously.

Much thought has already gone into the *Draft BioCode*, although further refinement is still necessary. Many questions that come readily to mind have been taken care of, but this may not be immediately obvious. To facilitate an understanding of the *BioCode*, a comparison with existing *Codes* is provided below. Meanwhile questions and comments regarding the *BioCode* and its provisions are solicited. These can deal with the broad issues of desirability and need, as do two of the three contributions in the 'Points of View' column of the May 1996 issue of *Taxon*, or with trends and directions within a *BioCode* or its specific provisions, as did the third, on citation of authors of scientific names.

At present the *BioCode* is a draft for active discussion; how it will be implemented is discussed separately below.

Comparison of the *BioCode* with existing *Codes* of bionomenclature

The typographical layout of the current *Draft BioCode* will be more familiar to botanists than to zoologists, bacteriologists and others. This is because it conforms to that of the *International Code of Botanical Nomenclature*

(Tokyo Code) (ICBN). This should not be taken as implying that the *Draft BioCode* rests more heavily on the principles of the *ICBN* than it does on that of other *Codes*. It is simply an artifact of the availability to the Egham group in 1995 of an electronic version of the *Tokyo Code*, which conveniently became a technical template for the new *BioCode*. In fact the *Draft BioCode* seeks to integrate elements of the existing *Codes*, most notably the *ICBN* and the *ICZN*. The ways in which this is done and the main differences between the *Draft BioCode* and the existing *Codes* are discussed below.

NOTES

The portion that follows is in large part a generalization of the "Introductory comments on the *Draft BioCode* from a botanical point of view" by Greuter and Nicolson (1996).

(*i*) *General points*

Understandably, though perhaps regrettably, no examples are listed in the *Draft BioCode*. While some may be supplied at a later stage, authentic examples will not be possible for many of the provisions, which deal exclusively with future names and situations. Notes and Recommendations have also been omitted at the present stage, although some will no doubt be needed.

Many provisions of existing *Codes* are not included in the *Draft Biocode*, either because they refer solely to situations of the past, or because they were found to be inapplicable or inappropriate in the new context. This is very clear when one compares the *Draft BioCode* with the botanical *Tokyo Code*, used as the electronic template, from which a very considerable number of articles and paragraphs were dropped, for example the *Draft BioCode* has only 41 Articles, whereas the *Tokyo Code* has 74.

(*ii*) *Ranks, priority*

The present ranks of the botanical *Code* are maintained in the *Draft BioCode,* and a few tentatively added: domain (above kingdom), in use for the pro-/eukaryotes, superfamily (in widespread use in zoology), and the option of adding the prefix super- to rank designations that are not already prefixed (Art. 3-4). In turn, from a zoological perspective, this implies that ranks additional to those of the species-group, genus-group and family-group will be governed by the *BioCode*, although to none of these additional ranks does the principle of precedence apply.

The *Draft BioCode* recognizes six groups of ranks (Art. 9.3); these are important because the principle of mandatory precedence (priority) is to operate only within three of them (Art. 19.8), and because vertical transfers of names across the boundaries of the groups is to be precluded (Art. 9.3). Both features would be major innovations for botanical nomenclature.

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The three rank groups with mandatory precedence are those presently covered by the zoological *Code* (which does not deal with ranks outside these groups): family-group, genus-group, and species-group. For botany, the principle of precedence is to remain facultative at the suprafamilial ranks, and to become so at ranks of subdivisions of genera other than subgenus and at infraspecific ranks other than subspecies (this provision would have retroactive effect). There can be little doubt that the removal of mandatory precedence, when considered in the light of Principles VII and VIII, will have a stabilizing effect on nomenclature at these ranks.

Transfers of names across the subgenus-section and subspecies-variety boundary, hitherto standard in botanical usage, would no longer be possible, although former such transfers would remain 'valid' under the botanical *Code*.

(*iii*) *Coordinate status*

It is proposed that the rule presently prevailing in zoology be extended to botany and bacteriology. This would mean that in the family-group, genus-group, and species-group, establishment of any name will automatically establish coordinate names, with the same authorship and date, at all other ranks of the same group. This rule, which would not, of course, operate retroactively, would replace the present autonym rule in botany, and differ from it in two major respects: (a) the date of establishment of the 'autonym equivalent' would usually be earlier (and more easily ascertained), and (b) the 'autonym equivalent' would be established in an upward as well as downward direction in the taxonomic hierarchy, for example the establishment of the name of a new subspecies would, at the same time, establish the same name at species rank.

Introducing coordinate status in the genus group has one major consequence: since any new subgeneric name will simultaneously be established at generic rank, its epithet must have the same form as a generic name and no longer can be a plural adjective, as is currently permitted under the botanical *Code*. This rule (Art. 28.2), concerning the form of names, should logically be retroactive and, if so, would lead to the disestablishment (devalidation) of former subgeneric names of which the epithets are adjectival (Art. 28.3). Negative effects of this rule, if any, might be minimized by a minor change, whereby such names, rather than losing their nomenclatural status, would remain valid but become unranked (and infra-subgeneric).

(*iv*) *Publication*

Some possible innovations, to account for recent progress in publication technology, have been tentatively incorporated into Art. 5.2. They would not of course be retroactive.

(*v*) *Establishment of names*

Establishment (valid publication) under the *BioCode* includes registration as a last step after fulfilment of the present requirements for valid publication (Art. 8.1(e), 13). This is nothing new for botanists, being already foreshadowed in the *Tokyo Code* (Art. 32.1-2, 45.2), and an analogous provision requiring indexing by the *Zoological Record* within five years of publication was included in the draft 4th edition of the *ICZN*. Procedures and mechanisms of registration are yet to be worked out and would be detailed in a special Annex; these may well be to some extent independent for the various major groups of organisms. Ultimate responsibility for the registration system is assigned to the International Committee on Bionomenclature in Div. III.7, but international disciplinary organizations such as the IAPT, although not now explicitly mentioned, are likely to play an active role in the registration of names of taxa.

NOTES

At present, the requirement of Latin descriptive matter for the validation of names of new taxa (if non-fossil) is a unique feature of the botanical *Code.* The *Draft BioCode* (Art. 8.2) opts for a compromise between zoology (any language) and botany (Latin only), and follows the solution pioneered by palaeobotany in that a Latin or an English description is currently required for publication of names of plant fossils (*Tokyo Code* Art. 36.3). The draft 4th edition of the *ICZN* suggests a restriction to languages using the Latin alphabet.

Art. 8.3 would introduce the additional requirement of a clearer statement of intent for the establishment of names. Zoologists have proposed such a provision in the forthcoming 4th edition of their *Code,* and this seems a good idea in botany too, minimizing the risk of "inadvertent" establishment of new names when, in future, the Latin requirement no longer serves as a filter.

(*vi*) *Limitations of precedence (priority)*

Adopted lists of names in current use, a much debated issue in botanical nomenclature, would become a newly available option (Art. 21), analogous to what the draft version of the next zoological *Code* proposes to rule. For the conservation of names (Art. 20), rank limitations would be abolished, by analogy to the current zoological *Code* and as a logical consequence of coordinate status of future names within rank groups. The difference with respect to the present situation in botany is in fact minimal, since limitation of precedence makes sense only in rank groups with mandatory precedence. Conservation and rejection procedures would remain largely the same as at present (Div. III.9). The botanical process of sanctioning concerns old names only and need not be provided for in a future *BioCode* (see also Art. 19.1, last sentence).

NOTES

(*vii*) *Homonymy*

The major change with respect to the homonymy rule would be that, in the future, it would operate across the kingdoms (Art. 18.1). In order that this provision be applicable, it is necessary that lists of established generic names of all organisms be publicly available, ideally in electronic format; most such, apparently, already exist, but are not yet generally accessible. A list of across-kingdom generic homonyms in current use is being prepared, and, as a next step, a list of binomina in the corresponding genera is planned, so that future workers may avoid the creation of new (illegal) homonymous binomina. Existing across-kingdom homonyms would not lose their status of acceptable names, but would be flagged for the benefit of biological indexers and users of indexes.

As mentioned above, Pre. 5, Art. 25.6, 26.2 and 28.1 would, for future names, preclude homonymy and confusability between names of organisms and those of viruses. Existing names are not affected by the proposed rules.

(*viii*) *Secondary Homonymy*

'Secondary Homonymy' is the term given by the *ICZN* to situations in which species-group names established for different nominal taxa (i.e., taxa based on different types) under different generic names are brought together under the same generic name. The zoological practice is to give precedence to the first published name regardless of the date upon which the names are brought into homonymy by taxonomic decision. Botanical practice does not distinguish 'secondary homonymy' and considers that a homonym would only be created with the publication of the 'new combination', the binomen in the genus into which the species are being brought together. The *BioCode* follows botanical practice in this regard, restricting precedence to the binomina *per se*, so that an established name can never be altered as a result of a later taxonomic decision.

(*ix*) *Spelling and gender of names*

Lively discussions are taking place among zoologists, aiming at the abolishment of gender of generic names and the maintenance of the original or a later termination of adjectival epithets upon transfer. Essentially this would remove the long-standing provision in all three *Codes*, retained in the *Draft BioCode* (Prin. VI), that scientific names are Latin or deemed to be Latin. This might ultimately result (taking a zoological example) in *Passer domesticus* (L.), based on *Fringilla domestica* L., having to become known as *Passer domestica.* To those who have any familiarity with Latin (an increasingly small number, we are told), and presumably to those many biologists fluent in modern Romance languages, such a change would be very disturbing (to put it mildly). It would also detract from one element of the "predictability" of names, forcing users of names to check the original nomenclatural source, or at least to consult an authoritative compendium.

An alternative might be the provision of fool-proof recipes to users and inventors of names, at three levels: (1) authoritative guidance on the appropriate gender of generic names (Art. 39.2-3) - already present for a substantial share of botanical names in *NCU-3*; (2) similar guidance on the appropriate form, spelling and declination of epithets and word elements used in their formation (Art. 37.5-10); and (3), perhaps somewhat less urgently, guidelines on the appropriate genitive singular termination to be used in compounding and in the formation of suprageneric names. Concomitantly, an effort to standardize a number of presently allowed variant spellings might be possible, so as to make the appropriate spelling of scientific names of organisms more predictable than at present (Art. 37.8-9). For future names, the registration procedure would offer an excellent opportunity to prevent incorrect usage of gender, or non-standard spellings, from spreading (see Art. 37.2, 39.4).

(*x*) *Author citation*

The *Draft BioCode* signals a departure from the botanical tradition of laying great emphasis on the use of author citations, even in contexts where such citations are neither informative nor really appropriate. This may be a timely change, since botanical attitude is showing signs of cracking. Art. 40.1 is so worded as to reflect this new attitude. Zoological tradition has never been friendly toward the authors of new combinations. Under Art. 41, mention of the (post-parenthetical) author of a transfer would become optional. Otherwise, the draft rules for author citation closely follow the wording of Art. 46 of the *Tokyo Code*.

(*xi*) *Ambiregnal organisms*

While many of the provisions of the *BioCode* will come as a relief to workers in ambiregnal groups, they will not completely solve their problems. Inevitably some rules will remain that are different for different groups of organisms, however defined. Borderline problems are notoriously difficult to solve, and are in fact insoluble unless and until a consensus is reached, among workers in the groups concerned, as to which is the appropriate borderline. As experience tells, such difficulties are surmountable if they can be dealt with under a single *Code:* there has never been a problem, under the botanical *Code,* in delimiting fungi from algae, algae from other plants, or fossil from non-fossil taxa, and there used to be no problems with the 'blue-green algae' so long as bacteria and algae were dealt with under the same *Code.*It will be the task and privilege of a future *BioCode* to define which rules apply to dinophytes and dinoflagellates, to euglenids, trichomonads and trypanosomes. Div. III.4 provides the necessary mechanisms for doing so, and there is no reason to doubt that they will work and lead to generally acceptable solutions.

(*xii*) *Hybrids*

NOTES

The Appendix for Hybrids in the botanical *Code* is replaced by a single Article in the *Draft BioCode,* Art. 34. This extreme simplification should in no way disrupt present and future usage of hybrid designations, but has some philosophical changes as its basis. Most importantly, taxonomy and nomenclature are disentangled, in conformity with Principle I: nothing remains of the former statement on appropriate rank, or of the requirement of a single hybrid taxon per hybrid combination. The condensed formulae designating intergeneric hybrids are restricted to usage as surrogates of generic names in the formation of binomina. The danger that, in view of that quasi-generic function, they might have to be considered for purposes of homonymy (and thus indexed) has been avoided by the proposed convention of considering the multiplication sign as part of these names.

(*xiii*) *Special topics*

Art. 25.1 endeavours to introduce a clearer definition of what the botanical *Code* calls descriptive names , at the suprafamilial ranks. Such names being generally used in zoology, much more widely than in botany, the clarification was needed. As worded, it appropriately reflects current botanical and zoological practice.

Implementation of the BioCode

The *Draft BioCode* includes, as its final item, a Division III on authority and mechanisms showing how and under which procedural rules the *BioCode* can become operational. The pertinent international scientific Unions (IUBS and IUMS) intend to play, much more directly in the future, the leading role in governing bionomenclature, which is theirs by tradition. However, the immediate patrons of the current *Codes* are given the right to veto the whole change.

It must thus be assumed that the Nomenclature Section of the XVI International Botanical Congress meeting in St Louis in late July 1999 will be faced with the request to authorize authority transfer from the botanical *Code* to the *BioCode,* conditional upon approval of similar requests by the two other bodies concerned. These are the International Commission on Zoological Nomenclature, which is meeting at ICSEB V in Budapest in August 1996, to consider the Draft 4th edition of the *ICZN*, and would normally meet again at the XXVI General Assembly of IUBS, scheduled to take place in Taipei in 1997, and at subsequent General Assemblies of IUBS which are held every 3 years, and the International Committee on Systematic Bacteriology, which will also meet in August 1996, but in association with the International Microbiological Congress in Israel; it will meet thereafter at the next IMC, scheduled for 1999.

The date on which such transfer of authority may take effect will be decided by the new *de facto* nomenclatural authority, an international committee in which botanists will be represented with two of nine members. As noted above the fatefu date, 1 January 2000, whose prominence in the *BioCode* has apparently caused some concern that implementation would be effected with undue haste, is a notional date rather than a plausible projection.

Assuming all this will happen, the role of the existing bacteriological, botanical and zoological *Codes* will change but will continue. They will still rule the names of the past, although their provisions on the formation of new names will see their effect limited in time, and relevant Recommendations may presumably be scrapped. Several editorial changes, including new notes and examples, will presumably be needed. It may be desirable, and would certainly be feasible, to produce a combined edition, or combined editions for each discipline, integrating the old and new rules in a single body of text.

Independently of the ultimate fate of the *BioCode,* a worthwhile consideration may be whether any of the provisions of its draft are attractive enough to be incorporated into existing *Codes* on their own merits. Following the example of the *ICNCP*, terminology would be an obvious candidate, as would the removal of mandatory priority (precedence) from certain ranks.

NOTES

Abbreviations

To help all interested biologists who wish to compare the proposed new rules with the corresponding entries in the three current *Codes* involved *(BC, ICBN, ICZN)*, cross-references are provided at the end of each paragraph of the *Draft BioCode*, preceded by a dash. The following, largely self-explanatory abbreviations have been used:

BC	*International Code of Nomenclature of Bacteria (Bateriological Code).* (Lapage *et al.* 1992).
ICBN	*International Code of Botanical Nomenclature (Tokyo Code).* (Greuter *et al.* 1994).
ICNCP	*The International Code of Nomenclature for Cultivated Plants* - 1995. (Trehane *et al.* 1995).
ICZN	*International Code of Zoological Nomenclature*. (Ride *et al.* 1985).

App. = Appendix;	*Pre.* = Preamble;
Art. = Article;	*Prin.* = Principle;
G.C. = General Consideration;	*Rec.* = Recommendation.

NOTES

Equivalences between technical terms used in this *Draft* and those that appear in the current *Codes* of biological nomenclature: *BC, ICBN, ICZN,* and the *ICNCP*. Terms used in the draft 'International code of virus classification and nomenclature' (prepared by the International Committee for the Taxonomy of Viruses) parallel the usages of the bacteriological *Code,* but, as they are primarily defined on the basis of taxonomic acceptability, are not their exact equivalents and so are not included.

Check Your Progress

1. What is nomenclature?
2. What does botany require?
3. Why is giving a name to a taxonomic group important?
4. Who governs the Nomenclature of bacteria ?
5. What is principle of priority?

6.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Nomenclature is a system of names or terms, or the rules for forming these terms in a particular field of arts or sciences.
2. Botany requires a precise and simple system of nomenclature used by botanists in all countries, dealing on the one hand with the terms which denote the ranks of taxonomic groups or units, and on the other hand with the scientific names which are applied to the individual taxonomic groups of plants.
3. The purpose of giving a name to a taxonomic group is not to indicate its characters or history, but to supply a means of referring to it and to indicate its taxonomic rank.
4. Nomenclature of bacteria is governed by the International Code of Nomen-clature of Bacteria (1976). Special provisions are needed for certain groups of plants
5. Principles of Priority are concerned with the selection of a single correct name of taxonomic group.

6.4 SUMMARY

- Botany requires a precise and simple system of nomenclature used by botanists in all countries, dealing on the one hand with the terms which denote the ranks of taxonomic groups or units, and on the other hand with the scientific names which are applied to the individual taxonomic groups of plants.

- The purpose of giving a name to a taxonomic group is not to indicate its characters or history, but to supply a means of referring to it and to indicate its taxonomic rank.
- This Code aims at the provision of a stable method of naming taxonomic groups, avoiding and rejecting the use of names which may cause error or ambiguity or throw science into confusion. Next in importance is the avoidance of the useless creation of names.
- Other considerations, such as absolute grammatical correctness, regularity or euphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their undeniable importance, are relatively accessory.
- The detailed provisions are divided into Rules, set out in the Articles, and Re-commendations. Examples are added to the rules and recommendations to illustrate them.
- The object of the Rules is to put the nomenclature of the past into order and to provide for that of the future; names contrary to a rule cannot be maintained.
- The Recommendations deal with subsidiary points, their object being to bring about greater uniformity and clearness, especially in future nomenclature; names contrary to a recommendation cannot, on that account, be rejected, but they are not examples to be followed.
- The Rules and Recommendations apply to all organisms treated as plants (including fungi), whether recent* or fossil, with the exception of the bacteria.
- Nomenclature of bacteria is governed by the International Code of Nomen-clature of Bacteria (1976). Special provisions are needed for certain groups of plants: The International Code of Nomenclature of Cultivated Plants-1969 was adopted by the International Commission for the Nomenclature of Cultivated Plants; provisions for the names of hybrids appear in Appendix I.
- Botanical nomenclature is independent of zoological nomenclature in the sense that the name of a plant is not to be rejected simply because it is identical with the name of an animal.
- If, however, an organism is transferred from the animal to the plant kingdom, its validly published names are to be accepted as botanical nomenclature in the form prescribed by the rules of botanical nomenclature, and if an organism is transferred from the plant to the animal kingdom, its names retain their status in botanical nomenclature.

NOTES

- In many species, varieties (varietas), forms (forma), and races or biological forms (forma biologica) are distinguished; in parasitic species special forms (forma specialis), and in certain cultivated species modifications still more numerous; in many genera sections (sectio) are distinguished, in many families tribes (tribus).
- The definition of each of these categories varies, up to a certain point, according to individual opinion and the state of the science; but their relative order, sanctioned by custom, must not be altered. No classification is admissible which contains such alterations. Examples of inadmissible alteration: a form divided into varieties, a species containing genera, a genus containing families or tribes.
- Loureiro described a plant and named it Physkium nataus in 1790. A.L.de Jussieu transferred it in genus Vallisneria in 1828. He instead of nutans gave the specific name as V. physkium. It is superfluous name. Graebner (1912) described the same plants as V.gigantee and Miki (1934) named as V.asiatica. Harg while studying Asiatic species confirmed that all these names are synonymous.
- There is no legitimate combination based on Physikium natans (Leru) existed. He made V.natans Hara in 1974. The correct name of the specimen is now the recent name, but it is based on earliest basionym, others will be synonym. V.gigantea and V.asiatica will be known as nomenclatural synonyms or homotypic synonyms. V.gigantea and V.asiatica are the names based on separate types. Such synonyms are known as taxonomic synonyms or heterotypic synonyms.
- The application of Principles of Priority resulted in numerous name changes. To avoid it a list of conserved generic and family names has been prepared and Published in the code with some changes. Such Nomina conservanda (non. cons) are to be used as correct name replacing earlier legitimate name, for example, Sesbania scop, 1777 is the conserved genus as against Sesban adam 1763 and Agati adam 1763.
- The principle of priority has not always been in place. When Carl Linnaeus laid the foundations of modern nomenclature, he offered no recognition of prior names. The botanists who followed him were just as willing to overturn Linnaeus's names.
- The first sign of recognition of priority came in 1813, when A. P. de Candolle laid out some principles of good nomenclatural practice. He favoured retaining prior names, but left wide scope for overturning poor prior names.
- During the 19th century, the principle gradually came to be accepted by almost all botanists, but debate continued to rage over the conditions under which the principle might be ignored. Botanists on one side of the

debate argued that priority should be universal and without exception. This would have meant a one-off major disruption as countless names in current usage were overturned in favour of archaic prior names. In 1891, Otto Kuntze, one of the most vocal proponents of this position, did just that, publishing over 30000 new combinations in his Revisio Generum Plantarum.

NOTES

- He then followed with further such publications in 1893, 1898 and 1903.His efforts, however, were so disruptive that they appear to have benefited his opponents. By the 1900s, the need for a mechanism for the conservation of names was widely accepted, and details of such a mechanism were under discussion. The current system of "modified priority" was essentially put in place at the Cambridge Congress of 1930.
- Biology as a science is unusual in that the objects of its study can be named according to five different *Codes* of nomenclature' (Hawksworth 1995). The rules governing the names of animals and plants, respectively the *International Code of Zoological Nomenclature (ICZN)* (Ride *et al.* 1985) and the *International Code of Botanical Nomenclature (ICBN)* (Greuter *et al.* 1994), have origins that diverged in the mid-19th century.
- Although based on essentially the same principles, notably that there should be a unique name for each taxon and that the choice of competing names should be determined by precedence in date of publication, the two sets of rules have diverged in detail over their 150 or so years of separate existence. A third set of rules, the *Bacteriological Code (BC)* (Lapage *et al.* 1992), first developed in 1953 (published in 1958), started essentially as a derivative of the *ICBN* and 1973 developed what amounted to a new starting date through the establishment of an 'Approved List of Bacterial Names'.
- The *International Code of Nomenclature for Cultivated Plants (ICNCP)* originated in 1953 and represents a set of rules subordinate to those of the *ICBN* and applicable specifically to cultivated plants. The most recent (6th) edition (Trehane *et al.* 1995) clarifies the complementary role of the *ICNCP* relative to the *ICBN*.
- The naming of viruses and sub-viral agents (prions, etc.) will be covered by the draft *International Code of Virus Classification and Nomenclature*, currently being developed from the current *Rules of Virus Classification and Nomenclature* by the International Committee for the Taxonomy of Viruses (ICTV) of the International Union of Microbiological Societies (IUMS).

NOTES

6.5 KEY WORDS

- **Taxon:** A taxon (plural taxa; back-formation from taxonomy) is a group of one or more populations of an organism or organisms seen by taxonomists to form a unit.
- **Nomenclature codes**: Nomenclature codes or codes of nomenclature are the various rule books that govern biological taxonomic nomenclature, each in their own broad field of organisms.
- **Nomenclature:** Nomenclature is a system of names or terms, or the rules for forming these terms in a particular field of arts or sciences.
- **Fertilization:** Fertilization is the fusion of haploid gametes, egg and sperm, to form the diploid zygote.

6.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a short note on principle of priority?
2. What are the limitations of principle of priority?
3. Write a short note on history of principle of priority?
4. Write in brief about Draft BioCode.
5. Brief about the status of the *BioCode*

Long Answer Questions

1. What is principle of priority? Elaborate.
2. List the limitations of principle of priority?
3. Explain the principles of priority?
4. List the limitations of principle of priority?
5. Write a elaborated note on Draft BioCode.
6. Explain about the scope of Draft BioCode.

6.7 FURTHER READINGS

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NOTES

BLOCK - III

SALIENT FEATURES OF PLANT FAMILIES

NOTES

UNIT 7 STUDY OF MONOCOTELEDONS

Structure

7.0 INTRODUCTION

Monocotyledons or monocots are a major group of flowering plants - angiosperms whose members typically have one cotyledon, or embryonic leaf, in their seeds, and whose flowers generally have parts in threes or multiplies of threes. Flowering plants that are not monocotyledons are designated as dicotyledons, a traditional flowering plant group whose seed typically contains two cotyledons, and whose flower parts are generally in fours or fives.

As a member of the angiosperms or flowering plants, monocots and dicots bear their reproductive organs in a structure called a flower and cover their seeds by including them in a true fruit. The ovule is enclosed within a carpel, the female reproductive organ of a flower, which will lead to a fruit. Angiosperms are a major group of land plants, with 250,000 species, and are one of two groups in the seed plants. The other seed plant group is gymnosperms, in which the ovule is not enclosed at pollination and the seeds are not in a true fruit.

In this unit, you will study about monocotyledons, *Hydocharitaceae* and *Dioscoreaceae* in detail.

7.1 OBJECTIVES

NOTES

After going through this unit, you will be able to:

- Understand what are monocotyledons
- Discuss about monocotyledons types
- Explain about *Hydocharitaceae*
- Describe about *Dioscoreaceae*

7.2 MONOCOTELEDONS

Monocotyledons or monocots are a major group of flowering plants (angiosperms) whose members typically have one cotyledon, or embryonic leaf, in their seeds, and whose flowers generally have parts in threes or multiplies of threes. Flowering plants that are not monocotyledons are designated as dicotyledons, a traditional (but paraphyletic) flowering plant group whose seed typically contains two cotyledons, and whose flower parts are generally in fours or fives.

As a member of the angiosperms or flowering plants, monocots (and dicots) bear their reproductive organs in a structure called a flower and cover their seeds by including them in a true fruit. (The ovule is enclosed within a carpel, the female reproductive organ of a flower, which will lead to a fruit.) Angiosperms are a major group of land plants, with 250,000 species, and are one of two groups in the seed plants. The other seed plant group is gymnosperms, in which the ovule is not enclosed at pollination and the seeds are not in a true fruit.

Monocots dominate great parts of the earth and comprise the majority of agricultural plants in terms of biomass produced. There are between 50,000 and 60,000 species within this group. Not only are monocots important ecologically, commercially, and as a food staple, but they also offer aesthetic values.

The largest family in this group (and in the flowering plants) are the orchids (usually taken to be the family Orchidaceae, but sometimes treated at the rank of order), with about twenty thousand species. These have very complex (and striking) flowers, adapted for highly specific insect pollination.

The economically most important family in this group (and in the flowering plants) are the grasses, family Poaceae (Gramineae). These include all the true grains (rice, wheat, maize, etc.), the pasture grasses, and the bamboos. This family of the true grasses has evolved in another direction, becoming highly specialized for wind pollination. Grasses produce much smaller flowers, which are gathered in highly visible plumes (inflorescences).

A further noteworthy and economically important family is the palm family Arecaceae (Palmae).

NOTES

Monocotyledon, by name monocot, one of the two great groups of flowering plants, or angiosperms, the other being the eudicotyledons (eudicots). There are approximately 60,000 species of monocots, including the most economically important of all plant families, Poaceae (true grasses), and the largest of all plant families, Orchidaceae (orchids). Other prominent monocot families include Liliaceae (lilies), Arecaceae(palms), and Iridaceae (irises). Most of them are distinguished by the presence of only one seed leaf, or cotyledon, in the embryo contained in the seed. Eudicotyledons, in contrast, ordinarily have two cotyledons.

Physical Characteristics

Monocot plants are marked by seeds with a single cotyledon, parallel-veined leaves (Refer Figure 7.1), scattered vascular bundles in the stem, the absence of a typical cambium, and an adventitious root system. Flower parts typically come in multiples of three, and the pollen grains characteristically feature a single aperture (or furrow).

Fig. 7.1 *Banana leaf (Musa species) With Parallel Venation*

The roots of a monocot lack a vascular cambium (the area of secondary xylem and phloem, or secondary vascular tissue, development) and therefore have no means of secondary thickening. In other structural respects, monocot roots are essentially similar to those of eudicots. Many eudicots have a taproot or several strong roots, with several orders of branch roots, all originating eventually from the embryonic root (radicle). The taproot or primary roots in such a system have a vascular cambium and are thickened by secondary growth. This kind of root system is not available to monocots. Instead, the primary root that originates from the radicle of the embryo soon aborts or is undeveloped so that no primary root is produced. The root system of monocots is thus wholly adventitious, i.e., the roots originate laterally from the stem or from the hypocotyl (the region of transition between the root and the stem in the embryo). The roots are all slender, and the plant is said to be fibrous-rooted.

NOTES

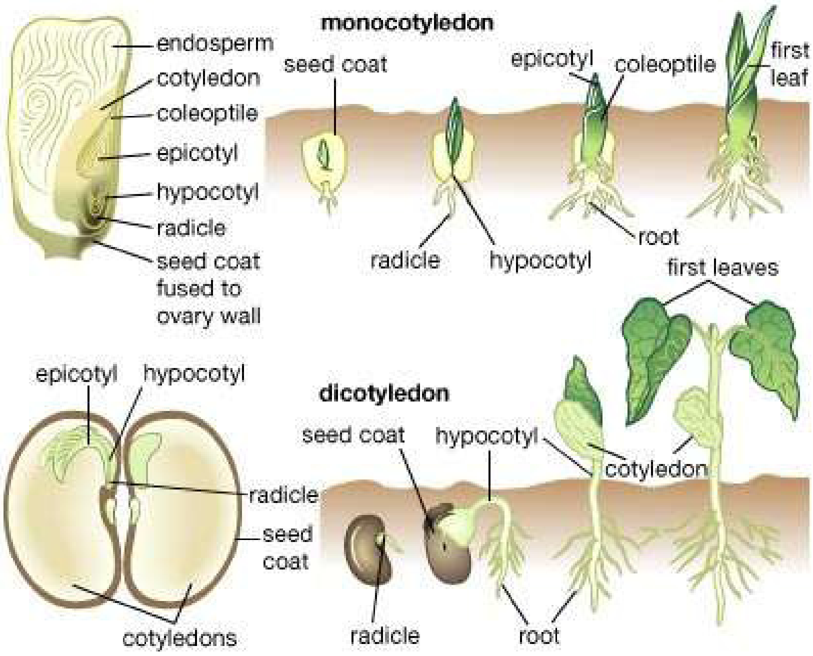

Fig. 7.2 *Seed Germination*

The above Figure 7.2 explains the germination of a monocot and a eudicot. (Top) In a corn seed (monocot), nutrients are stored in the cotyledon and endosperm tissue. The radicle and hypocotyl (region between the cotyledon and radicle) give rise to the roots. The epicotyl (region above the cotyledon) gives rise to the stem and leaves and is covered by a protective sheath (coleoptile). (Bottom) In a bean seed (eudicot), all nutrients are stored in the enlarged cotyledons. The radicle gives rise to the roots, the hypocotyl to the lower stem, and the epicotyl to the leaves and upper stem.

Flowers of monocots differ from those of eudicots mainly in the number of parts of each kind. Monocot flowers most often have the parts in sets of three, occasionally four, but almost never five. The numbers are especially characteristic of the sepals and petals. The stamens and pistils may be numerous even when the perianth is trimerous (in sets of three), or the single ovary may have only two carpels instead of three. Often there are six stamens, representing two whorls of three. Figure 7.3 and 7.4 shows the three flower parts in each whorl and a wheat plant.

NOTES

Fig. 7.3 Hemerocallis Flower With Three Flower Parts in each Whorl.

Fig. 7.4 Wheat - Economically Important Monocot

The traditionally listed differences between monocotyledons and dicotyledons are as follows. This is a broad sketch only, not invariably applicable, as there are a number of exceptions. The differences indicated are more true for monocots versus eudicots, as per the Angiosperm Phylogeny Group II (APG II) system:

Flowers: In monocots, flowers are trimerous (number of flower parts in a whorl in threes), while in dicots the flowers are tetramerous or pentamerous (flower parts are in fours or fives).

Pollen: In monocots, pollen has one furrow or pore while dicots have three.

Seeds: In monocots, the embryo has one cotyledon, while the embryo of the dicot has two.

Stems: In monocots, vascular bundles in the stem are scattered; in dicots, they are arranged in a ring.

NOTES

Roots: In monocots, roots are adventitious (developing on a part other than the radical, such as on stems and leaves), while in dicots they develop from the radicle (primary root and its lateral roots).

Fig. 7.5 *Slice of Onion Showing Parallel Veins.*

Leaves: In monocots, the major leaf veins are parallel (Refer Figure 7.5), while in dicots they are reticulate.

However, these differences are not hard and fast—some monocots have characteristics more typical of dicots, and vice-versa. This is in part because 'dicots' are a paraphyletic group with respect to monocots, and some dicots may be more closely related to monocots than to other dicots. In particular, several early-branching lineages of 'dicots' share 'monocot' characteristics, suggesting that these are not defining characters of monocots. When monocots are compared to eudicots, the differences are more concrete.

History and Taxonomy

The monocots are considered to form a monophyletic group arising early in the history of the flowering plants. The earliest fossilspresumed to be monocot remains date from the early Cretaceous period. Hahn (1997) notes that a singular origin is generally accepted for the monocots.

Taxonomists have considerable latitude in naming this group, as the monocots are a group above the rank of family. Article 16 of the I*nternational Code of Botanical Nomenclature (ICBN)* allows either a descriptive name or a name formed from the name of an included family.

NOTES

Fig. 7.6 Grass Sprouting

The above Figure 7.6 shows the grass sprouting on Left (a monocot), showing a single cotyledon. Compared to a dicot (right)

Historically, the monocotyledons were named:

- Monocotyledoneae in the de Candolle system and the Engler system.
- Monocotyledones in the Bentham & Hooker system and the Wettstein system.
- Class Liliopsida in the Takhtajan system and the Cronquist system.
- Subclass Liliidae in the Dahlgren system and the Thorne system (1992).
- Clade monocots in the APG system and the APG II system.

Each of the systems mentioned above use their own internal taxonomy for the group. The monocotyledons are famous as a group that is extremely stable in its outer borders (it is a well-defined, coherent group), while its internal taxonomy is extremely unstable (historically no two authoritative systems have agreed with each other on how the monocotyledons are related to each other).

According to the World Conservation Union (International Union for the Conservation of Nature and Natural Resources or IUCN), there are 59,300 species of monocots.

NOTES

Check Your Progress

1. Define monocotyledons.
2. Define dicotyledons.
3. Why there is no secondary thickening in monocot roots?
4. What kind of root system does monocots possess?
5. What type of flowers does monocots have?

7.3 *HYDROCHARITACEAE*

Hydrocharitaceae, the frog's-bit family of monocotyledonous flowering plants, with some 18 cosmopolitan genera of submerged and emergent freshwater and saltwater aquatic herbs. The largest genera are *Najas* (37–40 species), *Ottelia* (some 21 species), *Lagarosiphon* (9 or 10 species), *Blyxa* (9 or 10 species), *Halophila* (some 10 species), *Vallisneria* (6–10 species), and *Elodea* (5 or 6 species). The three genera *Thalassia* (2 species), *Enhalus* (1 species), and *Halophilaare* marine plants, and the rest grow in fresh or brackish water. The family is a member of the order Alismatales.

Members of Hydrocharitaceae are generally dioecious (individuals are either male or female) and produce radially symmetrical flowers. The female flowers have an inferior ovary (i.e., positioned below the attachment point of the sepals and petals), and the inflorescences are usually subtended by two bracts (modified leaves). The leaves are produced in whorls or clusters at numerous points along the stems, which may be erect or floating. Many species have rhizomes(modified rootlike stems) or stolons and can reproduce asexually.

The family is notable for the unique pollination mechanism of some genera (for example, El*odea, Enhalus, Hydrilla,* and *Vallisneria*). The male flowers become detached and float about until they encounter and transfer pollen to a female flower, which has reached the surface of the water by means of an elongated stalk. After pollination, the developing fruit is drawn under the water to finish ripening.

Other genera are pollinated by wind, insects, or water. Many produce special stems with turions (leaflike buds) that drop off and spend the winter in the bottom mud as a form of asexual reproduction (i.e., *Hydrocharis, Stratiotes,* and *Elodea*).

Several members of the family are cultivated or are otherwise economically important. Elodea, for example, is used in aquariums as an ornamental plant and in schools as an experimental plant. The common frog's-bit (*Hydrocharis morsus-ranae*), from which the family receives its common

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name, is an ornamental rootless water plant with round or heart-shaped floating leaves and small attractive three-petaled white flowers. The water soldier (*Stratiotes aloides*) bears rosettes of tough sharp-edged leaves that float in summer but sink and decay in the autumn. Vallisneria spiralis and V. americana are two eelgrasses commonly used as aquarium plants. Turtle grass (*Thalassia* species) is often washed ashore in such quantities following storms at sea that it is collected and used as a fertilizer. Hydrilla verticillata, the sole member of its genus, is a troublesome aquatic weed in many places.

Dioscoreaceae, the yam family of the flowering plant order Dioscoreales, consisting of 4 genera and 870 species of herbaceous or woody vines and shrubs, distributed throughout tropical and warm temperate regions. Members of the family have thick, sometimes woody roots or tuber-like underground stems and net-veined, often heart-shaped leaves that sometimes are lobed. The small green or white flowers of most species are borne in clusters in the leaf axils. The fruit is a winged capsule or a berry. Several species of yams (vines of the genus *Dioscorea*) are grown for their edible tuberous roots, such as Chinese yam, or cinnamon vine (D. *batatas*); air potato (D. *bulbifera*); and yampee, or cush-cush (D. *trifida*).

A few species are cultivated as ornamentals. Black bryony (*Tamus communis*) is a European perennial vine with yellow flowers, poisonous red berries, and poisonous blackish root tubers. *Dioscorea* is a principal raw material used in the manufacture of birth-control pills.

Check Your Progress

6. What is *Hydrocharitaceae?*
7. What are the members of *Hydrocharitaceae?*
8. Give feature of female plant of *Hydrocharitaceae.*
9. How are the leaves of *Hydrocharitaceae?*

7.4 *DIOSCOREACEAE* - YAM FAMILY

Plants in the Yam Family (*Dioscoreaceae*) are herbaceous vines with twining stems, usually tuberous roots, simple or palmately compound leaves, unisexual flowers, and fruit in the form of longitudinally opening, 3-lobed or 3-angled seed capsules.

Listed below (Refer Figure 7.7) is Hawaiian plants in this family.

NOTES

Fig. 7.7 *Dioscorea Dioscorea bulbifera – Air Yam*

Plant Name

Scientific Name: *Dioscorea bulbifera*

Synonym: *Dioscorea latifolia*

Common Names: Air Yam, Air Potato, Bitter Yam, Aerial Yam, Potato Yam, Hoi, Pi`oi

Plant Characteristics

- **Duration:** Perennial
- **Growth Habit:** Vine, Herb/Forb
- **Hawaii Native Status:** Introduced. This naturalized Polynesian canoe plant and weed is native to Africa, Asia, and Australia.
- **Flower Color:** Pale green (female), White aging to purple (male)
- **Flowering Season:** Late summer, Early fall
- **Height:** Climbing up to 100 feet (30 m) tall
- **Description:** The plants are dioecious with male and female flowers on separate plants, however these plants rarely bloom. When present, the tiny flowers are in slender, pendent spikes or panicles at the leaf axils. The female flowers are followed by seed capsules that are only winged on the basal side. The leaves are large, green, hairless, untoothed, alternate, palmately veined from the leaf base, long-petioled, and broadly heart-shaped. The slender, twining, hairless, green to purple-flecked stems climb to the left (clockwise), are round to slightly angled in cross section, and have no spines. Rounded, up to 5 inch (13 cm) in diameter, potato-like bulbils (aerial tubers) are formed on the stems at the leaf axils. The plants sometimes also have small underground

tubers. Even when the plants are not producing seeds, they can be propagated by both the bulbils and tubers. Here in Hawaii, Air Yam grows in disturbed mesic (moderately wet) forests at lower elevations.

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The similar Uhi or Water Yam (*Dioscorea alata*) has opposite leaves and stems that climb to the right (counterclockwise), while Pi`a or Five leaf Yam (*D. pentaphylla*) has compound leaves with 3 to 5 leaflets.

Special Characteristics

- **Canoe Plant** – Ancient Polynesians carried this plant to Hawaii in their canoes. They called it Hoi or Pi'oi and its poisonous if not properly prepared bulbils were eaten only in times of famine.
- **Edible** – The bulbils are poisonous, but they can become edible if well-rinsed in running water, boiled, and properly prepared by someone experienced with them. There are also more edible cultivated varieties. The other two yam species found here in Hawaii are not poisonous and are much better choices for eating.
- **Fragrant** – The male flowers are fragrant.
- **Poisonous** – The very bitter underground tubers and the improperly prepared bulbils are poisonous.

Classification

- **Kingdom:** Plantae – Plants
- **Subkingdom:** Tracheobionta – Vascular plants
- **Super Division:** Spermatophyta – Seed plants
- **Division:** Magnoliophyta – Flowering plants
- **Class:** Liliopsida – Monocotyledons
- **Subclass:** Liliidae
- **Order:** Liliales
- **Family:** Dioscoreaceae – Yam family
- **Genus:** *Dioscorea* L. – yam
- **Species:** *Dioscorea bulbifera* L. – air yam

More About This Plant

Dioscoreaceae is a family of mainly climbers whose best known members are the yams. The family Dioscoreaceae comes under the series Calycina of class Monocotyledons according to Bentham and Hookers (1862 -1883) system of classification. Members of the family have leaves with reticulate veins and occasional evidence of a second cotyledon in their embryo, (Lawton and Lawton, 1969) which are exceptional features for typical Monocotyledon family.

The family is distributed mainly in the tropical and temperate regions of the world. The family consists of six genera namely Trichopus, Stenomeris, Avetra, Dioscorea, Rajania and Tamus. Of these, Tamus is commonly found in temperate regions. All the remaining genera are mainly represented in the tropical regions of the world.

Trichopus is represented by a single species, Stenomeris by two species, Avetra by one species, Dioscorea by more than six hundred species, Rajania by twenty five species and Tamus by five species. All the genera except Trichopus, which is a dwarf shrub, are climbers.

Taxonomically the genus Dioscorea is divided into sections within which the species fall. The genus is divided into seven sections based on the nature of leaves, stamens, sepals, fruits and seeds, etc, in The Flora of British India (Hooker, 1892). It is directly divided 16 into species in The Flora of Presidency of Madras (Gamble, 1928). The direction of twining of the stem on support formed the basis of grouping of species. Engler and Prantl (1925) divided the genus into eight sections as follows; *Stenophora, Stenocorea, Combilium, Shannicorea, Opsophyton, Botryosicyos, Lasiophyton* and *Enantiophyllum.*.

The family Dioscoreaceae is represented mainly by the genera Dioscorea and Trichopus in Kerala state. The later genus has a single species Trichopus zeylanicus – an under shrub which gained much popularity recently for its acclaimed rejuvenating properties. The genus Dioscorea is represented by a number of species – both cultivated and wild. However, the identification and classification of the genus Dioscorea is rendered difficult because of the difficulty in species identification due to a high level of polymorphism with respect to morphological characters (Miege, 1952., 1954., Baquar, 1980., Zoundjihekpon et al, 1990).

Some species of Dioscorea produce bulbils from the leaf axils. The production of bulbils commence after a period of vegetative growth. Once started, the productions of bulbils continue till the end of vegetative growth. Bulbils vary much in their size, color, shape, 18 and weight. Under ideal humid conditions, these structures develop roots while attached to the parent plant. When mature, these get detached and develop into new plants. In many species of Dioscorea, bulbils form the main method of propagation.

Check Your Progress

10. Describe *Dioscoreaceae* plants.
11. What is the colour of *Dioscoreaceae* plant?
12. What is the height of *Dioscoreaceae* plant?
13. Is bulbils edible?

7.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. Monocotyledons or monocots are a major group of flowering plants (angiosperms) whose members typically have one cotyledon, or embryonic leaf, in their seeds, and whose flowers generally have parts in threes or multiplies of threes.
2. Flowering plants that are not monocotyledons are designated as dicotyledons, a traditional (but paraphyletic) flowering plant group whose seed typically contains two cotyledons, and whose flower parts are generally in fours or fives.
3. The roots of a monocot lack a vascular cambium (the area of secondary xylem and phloem, or secondary vascular tissue, development) and therefore have no means of secondary thickening.
4. The root system of monocots is wholly adventitious, i.e., the roots originate laterally from the stem or from the hypocotyl (the region of transition between the root and the stem in the embryo).
5. Monocot flowers most often have the parts in sets of three, occasionally four, but almost never five.
6. *Hydrocharitaceae,* the frog's-bit family of monocotyledonous flowering plants, with some 18 cosmopolitan genera of submerged and emergent freshwater and saltwater aquatic herbs.
7. Members of *Hydrocharitaceae* are generally dioecious (individuals are either male or female) and produce radially symmetrical flowers.
8. The female flowers have an inferior ovary (i.e., positioned below the attachment point of the sepals and petals), and the inflorescences are usually subtended by two bracts (modified leaves).
9. The leaves are produced in whorls or clusters at numerous points along the stems, which may be erect or floating.
10. Plants in the Yam Family (*Dioscoreaceae*) are herbaceous vines with twining stems, usually tuberous roots, simple or palmately compound leaves, unisexual flowers, and fruit in the form of longitudinally opening, 3-lobed or 3-angled seed capsules.
11. Flower color of *Dioscoreaceae* plant are pale green (female), white aging to purple (male).
12. A *Dioscoreaceae* plant can climb up to 100 feet (30 m) tall.
13. The bulbils are poisonous, but they can become edible if well-rinsed in running water, boiled, and properly prepared by someone experienced with them. There are also more edible cultivated varieties. The other

two yam species found here in Hawaii are not poisonous and are much better choices for eating.

7.6 SUMMARY

NOTES

- Monocotyledons or monocots are a major group of flowering plants (angiosperms) whose members typically have one cotyledon, or embryonic leaf, in their seeds, and whose flowers generally have parts in threes or multiplies of threes.
- Flowering plants that are not monocotyledons are designated as dicotyledons, a traditional (but paraphyletic) flowering plant group whose seed typically contains two cotyledons, and whose flower parts are generally in fours or fives.
- As a member of the angiosperms or flowering plants, monocots (and dicots) bear their reproductive organs in a structure called a flower and cover their seeds by including them in a true fruit.
- Angiosperms are a major group of land plants, with 250,000 species, and are one of two groups in the seed plants. The other seed plant group is gymnosperms, in which the ovule is not enclosed at pollination and the seeds are not in a true fruit.
- Monocots dominate great parts of the earth and comprise the majority of agricultural plants in terms of biomass produced. There are between 50,000 and 60,000 species within this group.
- Not only are monocots important ecologically, commercially, and as a food staple, but they also offer aesthetic values.
- The largest family in this group (and in the flowering plants) are the orchids (usually taken to be the family Orchidaceae, but sometimes treated at the rank of order), with about twenty thousand species.
- The economically most important family in this group (and in the flowering plants) are the grasses, family Poaceae (Gramineae). These include all the true grains (rice, wheat, maize, etc.), the pasture grasses, and the bamboos. This family of the true grasses has evolved in another direction, becoming highly specialized for wind pollination.
- Monocotyledon, byname monocot, one of the two great groups of flowering plants, or angiosperms, the other being the eudicotyledons (eudicots).
- Monocot plants are marked by seeds with a single cotyledon, parallel-veined leaves, scattered vascular bundles in the stem, the absence of a typical cambium, and an adventitious root system.

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- The roots of a monocot lack a vascular cambium (the area of secondary xylem and phloem, or secondary vascular tissue, development) and therefore have no means of secondary thickening.
- The taproot or primary roots in such a system have a vascular cambium and are thickened by secondary growth. This kind of root system is not available to monocots.
- Flowers of monocots differ from those of eudicots mainly in the number of parts of each kind. Monocot flowers most often have the parts in sets of three, occasionally four, but almost never five.
- The monocots are considered to form a monophyletic group arising early in the history of the flowering plants. The earliest fossilspresumed to be monocot remains date from the early Cretaceous period. Hahn (1997) notes that a singular origin is generally accepted for the monocots.
- Taxonomists have considerable latitude in naming this group, as the monocots are a group above the rank of family. Article 16 of the I*nternational Code of Botanical Nomenclature (ICBN)* allows either a descriptive name or a name formed from the name of an included family.
- *Hydrocharitaceae,* the frog's-bit family of monocotyledonous flowering plants, with some 18 cosmopolitan genera of submerged and emergent freshwater and saltwater aquatic herbs. The largest genera are *Najas* (37–40 species), *Ottelia* (some 21 species), *Lagarosiphon* (9 or 10 species), *Blyxa* (9 or 10 species), *Halophila* (some 10 species), *Vallisneria* (6–10 species), and *Elodea* (5 or 6 species).
- Plants in the Yam Family (*Dioscoreaceae*) are herbaceous vines with twining stems, usually tuberous roots, simple or palmately compound leaves, unisexual flowers, and fruit in the form of longitudinally opening, 3-lobed or 3-angled seed capsules.
- The plants are dioecious with male and female flowers on separate plants, however these plants rarely bloom. When present, the tiny flowers are in slender, pendent spikes or panicles at the leaf axils. The female flowers are followed by seed capsules that are only winged on the basal side.
- *Dioscoreaceae* is a family of mainly climbers whose best known members are the yams. The family Dioscoreaceae comes under the series Calycina of class Monocotyledons according to Bentham and Hookers (1862 -1883) system of classification.
- Members of the family have leaves with reticulate veins and occasional evidence of a second cotyledon in their embryo, (Lawton and Lawton, 1969) which are exceptional features for typical Monocotyledon family.

NOTES

7.7 KEY WORDS

- **Monocotyledons:** Monocotyledons commonly referred to as monocots are flowering plants (angiosperms) whose seeds typically contain only one embryonic leaf, or cotyledon.
- ***Dioscoreaceae:*** *Dioscoreaceae* is a family of monocotyledonous flowering plants, with about 715 known species in nine genera.
- **Eudicots:** The eudicots are a hugely diverse and abundant group of angiosperm plants.
- **Endosperm:** The endosperm is a tissue produced inside the seeds of most of the flowering plants following fertilization. It surrounds the embryo and provides nutrition in the form of starch, though it can also contain oils and protein.
- **Germination:** Germination is the process by which an organism grows from a seed or similar structure, for example sprouting of a seedling from a seed of an angiosperm or gymnosperm.
- **Ovary:** The ovary is a ductless reproductive gland in which the female reproductive cells are produced.
- **Pollen:** Pollen is a fine to coarse powdery substance comprising pollen grains which are male micro-gametophytes of seed plants, which produce male gametes (sperm cells).

7.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a short note on monocots.
2. Give physical characteristics of monocotyledons.
3. Write about history and taxonomy of monocots.
4. Write a short note on *Hydrocharitaceae.*
5. Brief about *Dioscoreaceae.*
6. Write about the classification of *Dioscoreaceae.*

Long Answer Questions

1. Give a detailed overview of monocotyledons mentioning its history, taxonomy as well.
2. Discuss about the physical characteristics of monocots in detail.
3. Expalin about *Hydrocharitaceae* in detail.

4. Discuss about *Dioscoreaceae* in detail.
5. Give the plant characteristics of *Dioscoreaceae.*
6. Explain about special characteristics and classification of *Dioscoreaceae.*

NOTES

7.9 FURTHER READINGS

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UNIT 8 MONOCOTELEDONS: ARECACEAE AND CYPERACEAE

Structure

8.0 INTRODUCTION

Monocotyledons or monocots are a major group of flowering plants - angiosperms whose members typically have one cotyledon, or embryonic leaf, in their seeds, and whose flowers generally have parts in threes or multiplies of threes. Flowering plants that are not monocotyledons are designated as dicotyledons, a traditional flowering plant group whose seed typically contains two cotyledons, and whose flower parts are generally in fours or fives.

As a member of the angiosperms or flowering plants, monocots and dicots bear their reproductive organs in a structure called a flower and cover their seeds by including them in a true fruit.

In this unit, you will study about monocotyledons and its types like *Arecaceae* and *Cyperaceae* in detail.

8.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about monocotyledons
- Discuss about *Arecaceae* and its characteristics
- Explain about *Cyperaceae* and its characteristics

8.2 MONOCOTELEDONS: *ARECACEAE*

NOTES

Characteristics of *Arecaceae*

Mainly trees with stout unbranched stem ending in crown of leaves; leaves large, compound, alternate, young leaves are plicate, exstipulate with long petioles; inflorescence enclosed in a persistent spathe; flowers unisexual; perianth 6 in two whorls of 3 each; in male flower 6 stamens in two whorls, anthers versatile; in female flowers carpels three; apocarpous or syncarpous, superior, trilocular or rarely unilocular; fruit berry or drupe; seed endospermic.

A. Vegetative Characters

Habit: Large unbranched trees (Phoenix, Areca catechu), shrubs or garden palms, trailing (Calamus), herbs (Reinhardtia).

Root: Adventitious roots arising from the base of bulbous stem. Thick aerial roots are also found in some species of Manicaria.

Stem: Aerial, woody, erect, unbranched, very rarely branched, (Hyphaene), in some short rhizome (Nipa), cylindrical, hairy, old stem protected by woody leaf bases, climbing (Calamus).

Leaves: Alternate crowded at the apex of stem giving palmlike appearance to the plant; petiolate, leaf-base sheathing, broad and persistent; exstipulate, compound pinnately (Phoenix, Areca), palmately (Borassus), acute, thick, leathery, parallel venation. In some palms (Copernica) the petiole is prolonged into a ligule like structure called histula.

B. Floral Characters

Inflorescence: It is simple or compound, spike or branched panicle, usually a spadix with a woody spathe which opens by two valves; spadix may have sessile or pedicellate flowers, simple racemose (Borassus), or compound racemose (Cocos) or even profusely branched panicle (Daemonorops).

Flower: Sessile or shortly pedicellate, bracteate, mostly unisexual (Phoenix) or hermaphrodite (Livingstonia), actinomorphic, incomplete or complete, hypogynous trimerous, flowers are of small size and produced in large numbers. Plant may be monoecious or dioecious.

In monoecious flower the position of male and female flowers is variable i.e. male flowers at the base or at the apex and the female flowers at the upper part (Ruffia, Rap his) or male and female flowers are inter-mingled or female flowers in the centre, made on the either side as the Cocos, Caryota.

Perianth: Tepals 6, in two whorls of 3 each, polyphyllous or slightly connate at the base; perianth lobes tough, persistent, coriaceous, leathery or fleshy, valvate or imbricate aestivation, white or petaloid.

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Androecium: In male or hermaphrodite flowers, stamens are 6 in number, two whorls of 3 each, polyandrous, staminodes may be present in the female flowers; anthers versatile, dithecous, basifixed or dorsifixed, introrse, filament short and distinct.

Gynoecium: In female or hermaphrodite flower-carpels 3 in number, apocarpous or syncarpous, ovary superior, trilocular, axile placentation, single ovule in each loculus; style short, stigma small or broad or 3 lobed.

Fruit: Usually a berry, fleshy or fibrous waxy coating on the fruit; the mature fruit contains a single seed (Phoenix); drupe (Cocos nucifera).

Seed: Endospermic.

Pollination: Anemophilous or entomophilous.

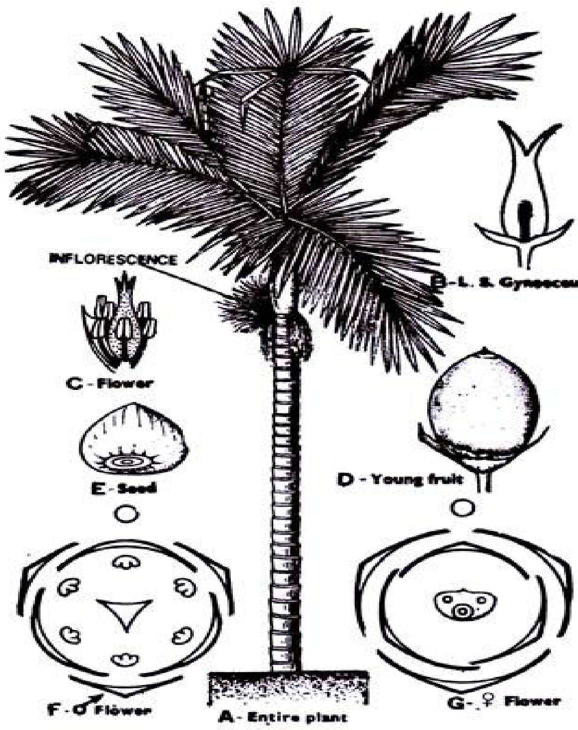

Fig. 8.1 *Areca Catechu*

Distribution of Arecaceae

The family is commonly known as 'Palm family'. It includes 217 genera and 2500 species. The members are confined to tropics in both the hemispheres and extending in the warmer regions of the world. In India it is represented by 225 species belonging to 25 genera.

Economic Importance of Arecaceae

- **Food:** Pith of Metroxylon rumphii and M. leave (Sago palm) yield sago of commerce. The sap of Borassus yields a sugar, which on fermentation

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gives alcoholic drink 'Toddy'. Fruits of Phoenix dactylifera are very delicious and eaten throughout the Arab world. The nuts of Areca catechu serve as a asteringent and used with betel leaves.

- **Medicinal:** Tender leaves of Calamus travancoricus are given in bilousness, worms and dyspepsia.
- **Fibres:** Mesocarps of the drupes of Coconut are extensively used for stuffing pillows and sofa sets. The cane of commerce is obtained from Calamus tenuis and C. rotang and are used for making mats, baskets and other furniture. Borassus flabellifer – yields palmyra fibres which are used to prepare brushes and brooms. The leaves are used in the manufacture of hand fans, umbrellas, baskets and mats.
- **Wax and oil:** Wax is obtained from the leaves of Copernicia cerifera and Ceroxylon andicola. The wax is used in making gramophone records, candles and models. Coconut oil is obtained from the Cocos nucifera and is used as hair oil, in soap industry and also for cooking.
- **Ornamentals:** Roystonea regia (Royal palm), Corypha elata (Talipot palm).

Primitive characters:

- Mostly plants are trees.
- Leaves are spirally arranged.
- Flowers are actinomorphic, hypogynous and hermaphrodite.
- Gynoecium is apocarpous (Phoenix, Rhapis).
- Ovary superior.

Advanced characters:

- Small herbaceous forms are also present.
- Leaves are compound and exstipulate.
- Inflorescence is a spadix.
- Perianth is present.
- Flowers are usually unisexual (Phoenix, Cocos).
- Flowers trimerous.
- Stamens epiphyllous.
- Gynoecium tricarpellary, syncarpous rarely unilocular.
- Style very short or absent.
- Axile placentation.

According to Eames (1961) 'The palms give evidence of great age; they are primitive taxon that has become greatly diversified and advanced in many characters, each character giving evidence of long specialization'.

Common plants of the family:

- Areca catechu (H. Supari; Betelnut palm): Graceful single stemmed palm.
- Caryota urens (Fish-tail palm): Toddy is tapped from its stem.
- Corypha umbraculifera (Talipot palm): Planted in gardens.
- Cocos nucifera (H. Nariyal): a tall palm, widespread along sea shore in tropics and sub-tropics.
- Calamus tenuis and C. rotang (H. Bent): climbing palm.
- Metroxylon: Fruits take 3 years to mature and pith yields 'sago'.
- Nipa fruitcans (Water coconut): palm with delicate round leaves used as cigarette paper; stemless palm of Sunderbans.
- Phoenix dactylifera (Date palm): tall palm with rough trunk due to persistent leaf bases; fruits are delicious.

NOTES

Division of the Family and Chief Genera

The family Arecaceae is divided into seven tribes as follows:

Tribe 1. Areceae

Leaves pinnatisect; flowers hermaphrodite; fruit a berry or fibrous drupe, for example Areca.

Tribe 2. Borassieae

Leaves pinnatisect; flowers unisexual, for example Borassus.

Tribe 3. Cococeae

Leaves pinnatisect; flowers hermaphrodite, fruit fibrous drupe not covered with scales, for example Cocos.

Tribe 4. Phoeniceae

Leaves pinnatisect; flowers unisexual; fruit one seeded berry, for example Phoenix.

Tribe 5. Phytelephanteae

Leaves pinnatisect; male and female inflorescences separate, for example Nipa.

Tribe 6. Lepidocaryeae

Leaves palmatisect or pinnatisect; spadices terminal or interfoliar, for example Calamus.

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Tribe 7. Sabaleae

Leaves palmatisect; flowers unisexual or bisexual, for example Corypha.

Important Type of Arecaceae

Phoenix sylvestris (Date palm) (Refer Figure 8.2)

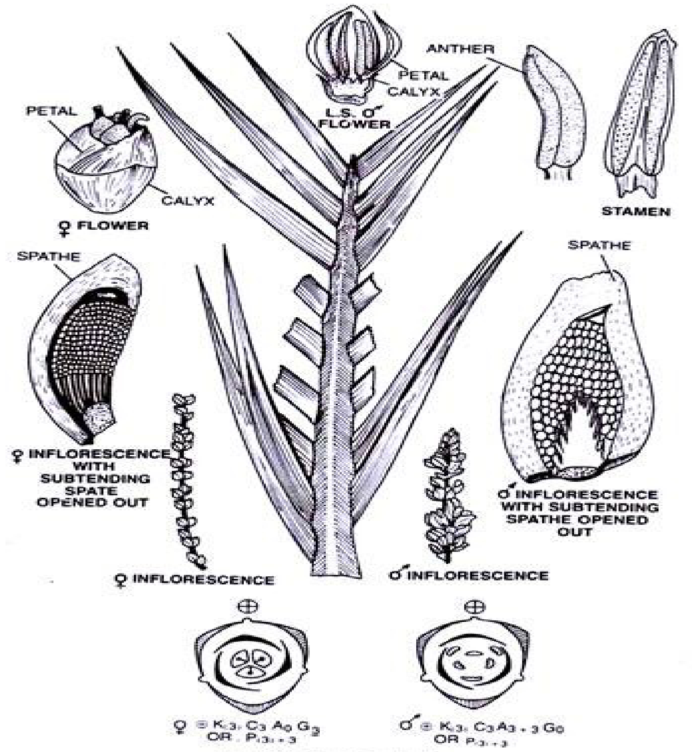

Fig. 8.2 Phoenix Sylvestris

Habit: A tree.

Root: Adventitious.

Stem: Aerial, woody, erect, cylindrical, rough, covered with persistent leaf bases, unbranched, solid, brown.

Leaves: Forming a dense terminal crown, exstipulate, compound, unipinnate, petiolate, glabrous.

Leaflets: Sub-sessile, lanceolate, entire, acute, unicostate parallel venation.

Inflorescence: Spadix-branched, erect, long, enclosed by spathe.

Flower: Small, actinomorphic, hypogynous, unisexual, bracteate, incomplete.

Male Flower: Bracteate, sessile, incomplete, numerous, angular, actinomorphic, hypogynous, trimerous.

Perianth: Tepals 6, in two whorls of 3 each, white, angular, free and inferior.

Androecium: Stamens 6, in two whorls of 3 each, polyandrous, filament short; anthers dithecous, dorsifixed, introrse.

Gynoecium: Absent.

Female flower: Bracteate, sessile, incomplete, actinomorphic, hypogynous, trimerous.

Perianth: As in male flower.

Androecium: Absent.

Gynoecium: Tricarpellary, syncarpous, ovary superior, one ovule in each carpel; style absent; stigma hooked.

Fruit: One seeded berry, orange yellow.

Seed: Hard and endospermic.

Check Your Progress

1. What is the habitat of of Arecaceae?
2. What is the structure of stem of Arecaceae?
3. What is the type of flower of Arecaceae?
4. What type of gynoecium does Arecaceae have?

8.3 MONOCOTELEDONS: CYPERACEAE

Characters, Distribution and Types

Characters of Cyperaceae

Plants usually herbs with 3 angled stem, solid culm; leaves with entire sheathing base not split on one side; flowers in spikelets of cymes, subtended by a single glume, naked or with perianth of scales or hairs; stamens 1 to 3; carpels 2 or 3, ovary superior, unilocular with single basal ovule; fruit an achene or nut, seed endospermic.

A. Vegetative characters

Habit: Plants are commonly perennial herbs rarely annual; perennating by means of creeping rhizomes or tubers. The members are inhabitants of damp places.

Root: Adventitious, fibrous, branched or tuberous.

Stem: Underground rhizomes, tubers or stolons, aerial shoots terete (angled), solid glaucous or glabrous, without distinction into nodes and internodes; usually unbranched rarely branched near the tip.

NOTES

Leaves: Exstipulate, sessile, leaf base sheathing, sheath closed, eligulate, arranged in three rows, alternate, simple, lamina linear, narrow, pointed, sharply edged.

NOTES

B. Floral Characters

Inflorescence: Inconspicuous flowers arranged in spikelets, panicles or in spikes of cymose rarely solitary terminal (Oreobolus).

Flower: Sessile, bracteate, zygomorphic hermaphrodite or unisexual arising in the axil of a single glume, hypogynous, small.

Perianth: Usually absent but in some represented by hairs or scales (Oreobolus); flowers naked (Cyperus, Carex).

Androecium: In male or hermaphrodite flowers stamens usually 3, may be 1 to 6 or one (Hemicarpa), polyandrous; anthers dithecous, basifixed, oblong or linear; filaments long and thread-like.

Gynoecium: In female flowers or hermaphrodite flowers gynoecium is bicarpellary (Rhyncospora) or tricarpellary (Carex), syncarpous, superior, unilocular, single basal ovule; style single or divided into the equal number of carpels; stigma linear or feathery corresponding to the number of carpels. In Kobresia ovary is enclosed in a bract or utricle.

Fruit: A flattened 3-angled nut.

Seed: Endospermic.

Distribution of Cyperaceae

The family is commonly known as 'Sedge family'. It is distributed throughout the world but most abundant in temperate zones. It comprises 70 genera and 4000 species. In India it is represented by 441 species.

Economic Importance of Cyperaceae

The family is of little economic importance.

- **Food:** The tubers of Cyperus esculentus (H. Kaseru) are used as food due to their high oil content. The tubers yield 25 to 30% oil of pleasant taste. The tubers of Eleocharis tuberosa are also edible.
- **Fodder:** Many species of Cyperus are taken by cattle as fodder.
- **Medicinal:** The tubers and rhizomes of Cyperus articulatus, C. iria, C. longus are carminative, stimulant and tonic. The tubers of Cyperus stoloniferous are stimulant for heart. The tubers of Scirpus kysoor, S. grossus are used in diarrhoea and vomitting. Scirpus articulatus is purgative. Kyllingia triceps is used in diabetes.
- **Poisonous:** Carex cernua is cattle poison.

- **Other uses:** Carex arenaria and species of Cyperus are good sand binders. Scirpus lacustris is used for matting. Aromatic scented oil is obtained from Cyperus stoloniferous.
- **Ornamentals:** Cyperus alterifolius and Isolepis are cultivated in gardens.

Primitive Characters:

- Leaves are simple, alternate with sheathing base.
- Flowers are hypogynous, hermaphrodite and bracteate.
- Flowers are actinomorphic.
- Ovary superior.
- Seeds are endospermic.

Advanced Characters:

- Plants are herbs, mostly annuals.
- Leaves are exstipulate.
- Flowers are small and arranged in spikelets.
- Flowers are zygomorphic in Scirpus.
- Perianth lobes are absent or represented by hairs.
- Reduction in the number of stamens.

Common Plants of the Family

- Cyperus rotundus (ordinary sedge): A weed of cultivated lands.
- Carex: Leaves of many species have sharp and saw-like edges.
- Eriophorum cosmusum (Cotton sedge): A glabrous herb with long perianth hairs used for stuffing.
- Fimbristylis: A weed having glabrous stem.
- Kyllinga: A perennial glabrous herb common in Western Himalayas.
- Scirpus (Club-rush or bull rush): A perennial herb found in bogs and marshes.

Division of the Family and Chief Genera:

Engler divided the family as follows:

Sub-family I. Scirpoideae:

Flowers hermaphrodite, without perianth, for example Scirpus, Cyperus.

Sub-family II. Caricoideae:

Flowers unisexual and naked in many flowered spikes, for example Carex.

NOTES

Sub-family III. Rhyncosporoideae:

Flowers hermaphrodite or unisexual, with or without perianth, for example Rhyncospora. Hutchinson divided the family into seven tribes.

Important Type of Cyperaceae:

Scirpus articulatus (Refer Figure 8.3):

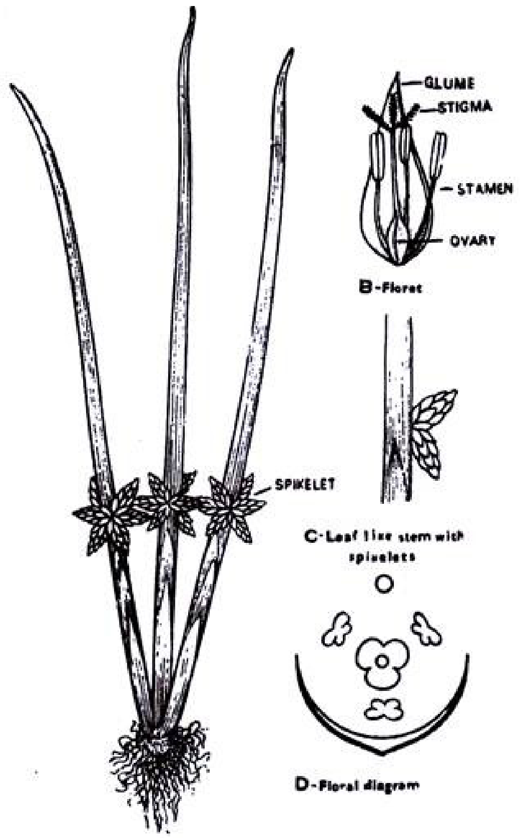

Fig. 8.3 *Scirpus Articulatus*

Habit: A glabrous perennial herb.

Root: Adventitious.

Stem: Herbaceous, 1 to 3 ft. long, densely tufted, fistular, green, terete, trigonous, striate, transversely separate.

Leaves: Absent or the sheaths with a membranous acute tip.

Inflorescence: Terminal or lateral spikelets with glumes.

Flower: Hermaphrodite, zygomorphic, complete, hypogynous, trimerous.

Perianth: Represented by hypogynous bristle or scale.

Androecium: Stamens 3, polyandrous, anthers linear, obtuse, yellow, introrse, dithecous, basifixed.

Gynoecium: Tricarpellary, syncarpous, ovary superior, unilocular, single basal ovule; style long; slender; stigma trifid, feathery.

Fruit: Trigonous nut.

Seed: Endospermic.

Check Your Progress

5. Give any two vegetative characters of Cyperaceae.
6. Give any two floral characters of Cyperaceae.
7. What are the economic characters of Cyperaceae.
8. What are the advanced characters of Cyperaceae.

8.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Habitat of Arecaceae is large unbranched trees (Phoenix, Areca catechu), shrubs or garden palms, trailing (Calamus), herbs (Reinhardtia).
2. Stem of Arecaceae is aerial, woody, erect, unbranched, very rarely branched, (Hyphaene), in some short rhizome (Nipa), cylindrical, hairy, old stem protected by woody leaf bases, climbing (Calamus).
3. Flower of Arecaceae is sessile or shortly pedicellate, bracteate, mostly unisexual (Phoenix) or hermaphrodite (Livingstonia), actinomorphic, incomplete or complete, hypogynous trimerous, flowers are of small size and produced in large numbers. Plant may be monoecious or dioecious.
4. Gynoecium is in female or hermaphrodite flower-carpels 3 in number, apocarpous or syncarpous, ovary superior, trilocular, axile placentation, single ovule in each loculus; style short, stigma small or broad or 3 lobed.
5. Two vegetative characters of Cyperaceae are:
    - Habit: Plants are commonly perennial herbs rarely annual; perennating by means of creeping rhizomes or tubers. The members are inhabitants of damp places.
    - Root: Adventitious, fibrous, branched or tuberous.
6. Two floral characters of Cyperaceae are:
    - Inflorescence: Inconspicuous flowers arranged in spikelets, panicles or in spikes of cymose rarely solitary terminal (Oreobolus).
    - Flower: Sessile, bracteate, zygomorphic hermaphrodite or unisexual arising in the axil of a single glume, hypogynous, small.

7. Two economic importance of Cyperaceae are:
   - Food: The tubers of Cyperus esculentus (H. Kaseru) are used as food due to their high oil content. The tubers yield 25 to 30% oil of pleasant taste. The tubers of Eleocharis tuberosa are also edible.
   - Fodder: Many species of Cyperus are taken by cattle as fodder.
8. Advanced Characters of Cyperaceae are:
   - Plants are herbs, mostly annuals.
   - Leaves are exstipulate.
   - Flowers are small and arranged in spikelets.
   - Flowers are zygomorphic in Scirpus.
   - Perianth lobes are absent or represented by hairs.
   - Reduction in the number of stamens.

8.5 SUMMARY

- Monocotyledons or monocots are a major group of flowering plants - angiosperms whose members typically have one cotyledon, or embryonic leaf, in their seeds, and whose flowers generally have parts in threes or multiplies of threes.
- Flowering plants that are not monocotyledons are designated as dicotyledons, a traditional flowering plant group whose seed typically contains two cotyledons, and whose flower parts are generally in fours or fives.
- Mainly trees with stout unbranched stem ending in crown of leaves; leaves large, compound, alternate, young leaves are plicate, exstipulate with long petioles; inflorescence enclosed in a persistent spathe; flowers unisexual; perianth 6 in two whorls of 3 each; in male flower 6 stamens in two whorls, anthers versatile; in female flowers carpels three; apocarpous or syncarpous, superior, trilocular or rarely unilocular; fruit berry or drupe; seed endospermic.
- Habit of Arecaceae is large unbranched trees (Phoenix, Areca catechu), shrubs or garden palms, trailing (Calamus), herbs (Reinhardtia).
- Root of Arecaceae is adventitious roots arising from the base of bulbous stem. Thick aerial roots are also found in some species of Manicaria.
- Stem of Arecaceae is aerial, woody, erect, unbranched, very rarely branched, (Hyphaene), in some short rhizome (Nipa), cylindrical, hairy, old stem protected by woody leaf bases, climbing (Calamus).
- Leaves of Arecaceae is alternate crowded at the apex of stem giving palmlike appearance to the plant; petiolate, leaf-base sheathing, broad

and persistent; exstipulate, compound pinnately (Phoenix, Areca), palmately (Borassus), acute, thick, leathery, parallel venation. In some palms (Copernica) the petiole is prolonged into a ligule like structure called histula.

NOTES

- In monoecious flower the position of male and female flowers is variable , i.e., male flowers at the base or at the apex and the female flowers at the upper part (Ruffia, Rap his) or male and female flowers are inter-mingled or female flowers in the centre, made on the either side as the Cocos, Caryota.
- In male or hermaphrodite flowers, stamens are 6 in number, two whorls of 3 each, polyandrous, staminodes may be present in the female flowers; anthers versatile, dithecous, basifixed or dorsifixed, introrse, filament short and distinct.
- The family of Arecaceae is commonly known as 'Palm family'. It includes 217 genera and 2500 species. The members are confined to tropics in both the hemispheres and extending in the warmer regions of the world. In India it is represented by 225 species belonging to 25 genera.
- Pith of Metroxylon rumphii and M. leave (Sago palm) yield sago of commerce. The sap of Borassus yields a sugar, which on fermentation gives alcoholic drink 'Toddy'. Fruits of Phoenix dactylifera are very delicious and eaten throughout the Arab world. The nuts of Areca catechu serve as a asteringent and used with betel leaves.
- Mesocarps of the drupes of Coconut are extensively used for stuffing pillows and sofa sets. The cane of commerce is obtained from Calamus tenuis and C. rotang and are used for making mats, baskets and other furniture. Borassus flabellifer – yields palmyra fibres which are used to prepare brushes and brooms. The leaves are used in the manufacture of hand fans, umbrellas, baskets and mats.
- Plants usually herbs with 3 angled stem, solid culm; leaves with entire sheathing base not split on one side; flowers in spikelets of cymes, subtended by a single glume, naked or with perianth of scales or hairs; stamens 1 to 3; carpels 2 or 3, ovary superior, unilocular with single basal ovule; fruit an achene or nut, seed endospermic.
- The family is commonly known as 'Sedge family'. It is distributed throughout the world but most abundant in temperate zones. It comprises 70 genera and 4000 species. In India it is represented by 441 species.

8.6 KEY WORDS

- **Arecaceae:** The Arecaceae are a botanical family of perennial plants. Their growth form can be climbers, shrubs, trees and stemless plants, all commonly known as palms
- **Cyperaceae:** The Cyperaceae are a family of monocotyledonous graminoid flowering plants known as sedges, which superficially resemble grasses and rushes.
- **Apocarpous:** Apocarpous have the carpels of the gynoecium separate.
- **Syncarpous:** Syncarpous having the carpels of the gynoecium united in a compound ovary.
- **Inflorescence:** An inflorescence is a group or cluster of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches.
- **Androecium:** Androecium is a collection of stamens that form the male reproductive organs of a flowering plant.
- **Gynoecium:** The gynoecium is the innermost whorl of a flower, it consists of (one or more) pistils and is typically surrounded by the pollen-producing reproductive organs, the stamens, collectively called the androecium.

8.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a brief note on Arecaceae.
2. Write adout vegetative characters of Arecaceae.
3. Write a short note on floral characters of Arecaceae.
4. What are the economic importance of Arecaceae?
5. What are the primitive characteristics of Arecaceae
6. Write a short note on characterstics of Cyperaceae.
7. Give a brief note on distribution of Cyperaceae.

Long Answer Question

1. Give a detailed note on Arecaceae
2. Explain about the vegetative and floral characters of Arecaceae.
3. Give a detailed overview of primitive and advanced characters of Arecaceae.

4. Discuss about division of the family and chief genera of Arecaceae.
5. Write in detail about vegetative and floral characters of Cyperaceae.
6. Explain the distribution and economic importance of Cyperaceae.
7. Discuss in detail about division of the family and chief genera of Cyperaceae.
8. Write a note on important type of Cyperaceae.

NOTES

8.8 FURTHER READINGS

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UNIT 9 MONOCHLAMYDEAE FAMILY : POLYGONACEAE AND AMARANTHACEAE

Structure

9.0 INTRODUCTION

Monochlamydae is an artificial taxonomic group used in the identification of plants. It was largely abandoned by taxonomists in the 19th century, but has been often used since. Bentham and Hooker's classification, published in 1880, used this grouping, but stated that it was neither natural nor well defined, and that De Candolle's system was superior. Under Engler and Prantl's revision of 1931, the group Monochlamydeae was completely abandoned

The group was one of three within the Dicotyledons, the others being Polypetalae and Gamopetalae.It included plants with flowers that had either a calyx or corolla, but not both.

In this unit, you will study about Monochlamydae family, *Polygonaceae* - its characteristics, distribution and types, *Amaranthaceae* - its distribution and types.

9.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about monochlamydeae family
- Expalin the various characteristics of *Polygonaceae*
- Discuss about *Amaranthaceae* - its distribution and types

9.2 POLYGONACEAE : CHARACTERSTICS, DISTRIBUTION AND TYPES

NOTES

Characteristics of *Polygonaceae*

Mostly herb, climbing, leaves stipulate ochrea intrapetiolar, sheathing, swollen nodes; racemose, flowers small, crowded, di-trimerous, hypogynous, hermaphrodite, polyphyllous in two whorls; stamens 6 (3 + 3) or more; carpels (3), 1-loculed, single basal ovule; fruit a nut, enclosed by persistent membranous perianth.

A. Vegetative Characteristics

- **Habit:** Mostly herbs for example Polygonum plebejum, annual or perennial rarely shrubs (Polygonum hydropiper) or small trees (Coccoloba uvifera); tendrills – climber (Antigonum spp.). Acidic properties due to presence of various oxalates.
- **Root:** Tap, branched.
- **Stem:** Generally herbaceous with swollen nodes surrounded by a stipular sheath; sometimes bent like a knee, i.e., geniculate; phylloclades in Muehlenbeckia.
- **Leaves:** Simple, alternate, sometimes sparse, entire, lobed leaves occur in Rumex acetosella; leaves usually sour in taste due to the presence of calcium oxalate crystals in the cells.

In Muehlenbeckia platyclados leaves very few or absent, the stem is modified into flat and green phylloclades; leaves radical in Rumex hastatus; stipulate, stipules form an intrapetiolar sheath, the ochrea (= ocrea) which surrounds the nodes, stipules sometimes fimbriate or hairy or rarely absent as in Koenigia islandica. The leaves may have a felt of hair as an adaptation to cold.

B. Floral Characteristics

- **Inflorescence:** Variable compound, the general plan usually is racemose but may also be a spike or a panicle; the individual bunches may be built on cymose pattern. Erigonum, which is non-ochreate, has its flowers in cymose umbels or heads.
- **Flower:** Small, open, crowded on the inflorescence; parts arranged in 4 or 5 whorls; trimerous, rarely dimerous as in Oxyria digyna; bisexual, rarely unisexual than monoecious or dioecious; cyclic or acyclic, actinomorphic, hypogynous; honey secreted in large amount.
- **Perianth:** Tepals 3 to 6 in two indistinguishable whorls (= homochlamydeous). According to Laubengayer (1937) the trimerous

whorled plan is fundamental, the apparent spiral plan is fundamentally whorled as can be seen anatomically; when 5 tepals are present, the fusion of one of the outer tepals with one inner has occurred; tepals usually pink, green or white and often persistent.

The inner tepals are sometimes enlarged as memberanous wings (Rumex) or rarely the outer ones enlarge (Triplaris) or these may get modified as hooks, spines or bristles and help in the distribution of the fruit.

- **Androecium:** Stamens 6 to 9, in two whorls, the six outer ones often introrse, the three inner extrorse (Polygonum fagopyrum), A4 in Polygonum diospyrifolium; A 4+2 in Oxyria; filaments free or slightly adnate with tepals at the base; anthers 2-celled, longitudinal dehiscence.
- **Gynoecium:** Generally tricarpellary, rarely bicarpellary (Oxyria and some species of Polygonum), syncarpous, unilocular, superior; ovule one, orthotropous, basal placentation, style 1, stigmas 2-4. The ovary is subtended by a nectariferous disc which may be lobed with as many as 8 lobes.
- **Fruit:** A dry nut with a single seed, it may be three-sided or biconvex, laterally winged, or an achene with wings. The wings may be furnished in bristles or hooks.
- **Seed:** With embryo excentric or lateral, curved or straight; the endosperm mealy and copious.
- **Pollination:** Flowers made conspicuous by crowding and nectar secrereted by the disc aid in cross pollination mostly by insects (Polygonum), anemophious in Rumex, when cross pollination fails self pollination may take place.
- **Distribution of Polygonaceae:** It is commonly called buck-wheat or knot-wheat or smartweed family. It contains about 40 genera and 1000 species mostly distributed in the north temperate regions, a few in tropical, arctic or Southern hemisphere. In India it is represented about 10 genera and 100 species.

Economic Importance of Polygonaceae

- **Food:** Coccoloba uvifera supplies edible fruits as well as gum kinos. The starchy seeds of Fagopyrum esculentum, called ‘buckwheat’, from an article of diet. The young shoots of Rumex conglomerate, R. crispus, R. obtusifolia and R. uesicarius are used as edible greens. The leaves of R. hastatus are used as condiment.
- **Medicinal:** Rheum emodi is of medicinal value. The root-stock of R. officinale (China) and R. palmatum (Turkey) is the source of ‘drug rhubarb’.

- **Dye:** Polygonum tinctorium and Rumex dentatus yield dye.
- **Ornamentals:** Antigonum leptopus, Coccoloba uvifera and Polygonum aubertii.

NOTES

Common Plants of the Family

- Polygonum plebejum- Diffused branched prostrate herb.
- Antigonon leptous- Railway creeper, a garden climber, bearing panicle of pink or white flowers.
- Calligonum polygonoides L. is a slow-growing nearly leafless shrub.
- Coccoloba uvifera L. and Muehlenbeckia platyclada Mesin are characterised by flattened leaf-like stems.
- Polygonum barbatum L., P. glabrum L., P. orientale L. and P. serrulatum Lagasc are weeds in ditches and damp places.
- Muehlenbeckia platyclados Meissn.; stem flattened, phylloclade like, cultivated as an ornamental.
- Rumex maritimus L. is a marsh weed whose perianth segments have white tubercled midrib.

Division of the Family and Chief Genera

The Polygonaceae is divided into three subfamilies, each with two tribes

Sub-family I. Coccoloboideae: Endosperm ruminate.

Tribe (i) Cocolobeae: Flowers bisexual. Examples are : Coccoloba, Muehlenbeckia, etc.

Tribe (ii) Triplarideae: Flower unisexual. Example are : Triplaris.

Sub-family II. Polygonoideae: Flowers somewhat cyclic. Endosperm non-ruminate.

Tribe (i) Atraphaxideae: Shrubs. Example: Calligonum.

Tribe (ii) Polygoneae: Herbs. Examples: Fagopyrum, Polygonum, etc.

Sub-family III. Rumicoideae: Flowers cyclic. Endosperm non-ruminate.

Tribe (i). Erigoneae: Ochreate stipules absent. Examples are: Antigonon, Erigonum, etc.

Tribe (ii). Rumiceae: Ochreate stipules present. Examples are : Rumex, Rheum, etc.

Affinities of Polygonaceae

In Bentham and Hooker's arrangement, the Polygonaceae is the last member of the Curvembryeae under the Monochlamydeae. Engler included the family in a distinct order (Polygonales), lying between the Aristolochiales and Centrospermae.

NOTES

Bessey accepted the family as an advanced taxon of the Caryophyllales. Hallier considered its position under the Caryophyllales, seeking its origin directly from early Ranales on a line parallel to the Papaveraceae.

Rendle expressed the view that the Polygonaceae occupies a somewhat isolated position. Hutchinson opined that the Polygonales is a degraded and reduced type of the Caryophylolales, descending from the Ranales.

The Polygonaceae is related to the Amaranthaceae, Chenopodiaceae and Nyctaginaceae in the plan of floral structure, but differs from them by the presence of orchreate stipules, triangular ovary, solitary erect ovule and S-shaped embryo. The family is also allied to the Urticaeae by having stipulate leaves and orthotropous ovules.

An unique feature of the family, as suggested by Rendle, is 'the multiplication of the stamens and the relation between the two-whorled trimerous and the cyclic perianth'.

Important Types of Polygonaceae

1. Polyonum glabrum (Refer Figure 9.1)

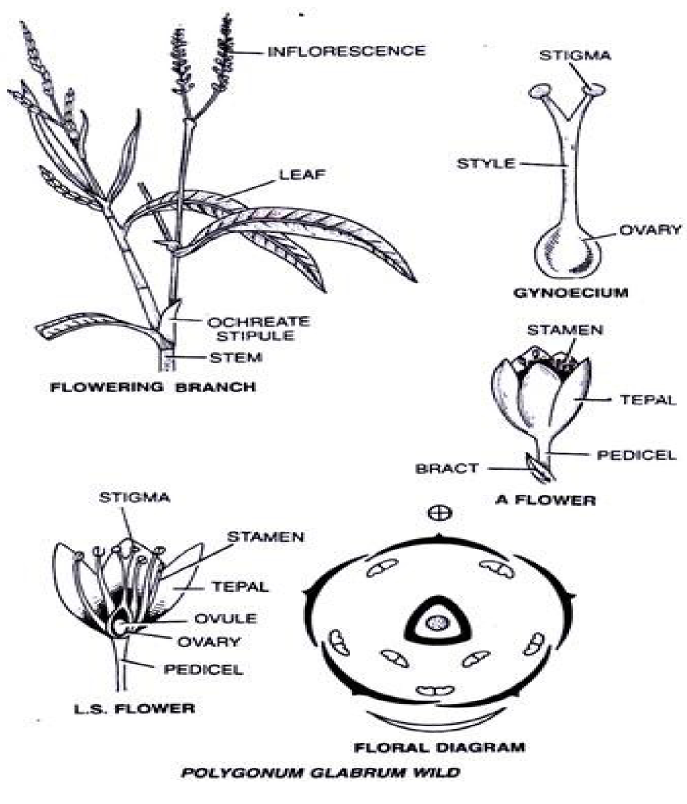

Fig. 9.1 *Polyonum Glabrum*

Habit: An annual or perennial herb.

Root: Tap root, Branched.

Stem: Herbaceous, weak, semi-erect, branched, cylindrical, differentiating into nodes and internodes, glabrous, green to greenish pink.

Leaf: Ramal and cauline, simple, alternate, stipulate, stipule ochreate, petiolate or sub-sessile, lanceolate, entire, acute or acuminate, unicostate reticulate, large, tapering at the base.

Inflorescence: Racemose, forming a terminal panicle.

Flower: Bracteate, ebracteolate, pedicellate, complete, hermaphrodite, actinomorphic, pentamerous, hypogynous, small, pink.

Perianth: Tepals 5, polyphyllous, ovate, quincuncial, pink.

Androecium: Stamens 5 to 8 or very rarely more, arranged in an outer whorl of 5 introrse stamens and inner whorl of 2 or more exstrose stamens, dithecous, basifixed, filaments long.

Gynoecium: Tricarpellary, syncarpous, superior, unilocular, ovule one, basal placentation, style long, stigma bifid, fringed.

Fruit: Nut.

Seed: Endospermic with curved embryo.

2. Corculum leptopus Stuntz (Syn. Antigonon leptopus) (Refer Figure 9.2)**:**

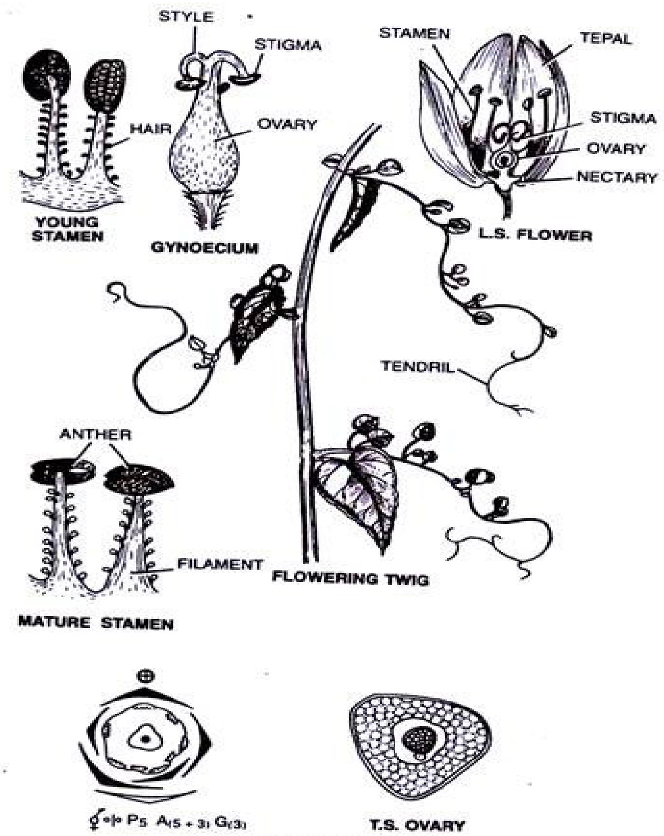

Fig. 9.2 Corculum leptopus Stuntz

NOTES

Habit: A perennial, tendril climbing herb.

Root: Tap root.

Stem: Climbing, climbs by tendrils which represent modified branches (stem tendrils), ribbed, hairy, solid, cylindrical, weak, herbaceous.

Leaves: Simple, cauline, petiolate, stipulate, stipules reduced to a rim like structure alternate, cordate, entire and acute or acuminate; unicostate reticulate venation.

Inflorescence: Short cymes of three flowers arranged on long axillary inflorescence axis which continues growth and terminates above in a branched tendrils (Axillary raceme ending into a tendril).

Flower: Bracteate, pedicellate, (pedicel hairy and pink), complete, bisexual, actinomorphic, hypogynous, pink.

Perianth: Tepals, 5, polyphyllous three outer ovate-cordate, two inner oblong, petaloid, pink, quincuncial aestivation.

Androecium: Stamens 8, arranged in one or two whorls, polyandrous, filaments coloured, hairy, broader at the base; anthers yellow, dithecous, dorsifixed, introrse.

Gynoecium: Tricarpellary, syncarpous, ovary superior, unilocular with a single ovule, basal placentation, a nectary is located below ovary; styles 3 curved down-wards each ending into a globose stigma, stigmas 3, capitate.

Fruit: Singled seeded nut.

Check Your Progress

1. What are the characteristic of *Polygonaceae?*
2. Give vegetative characteristic of *Polygonaceae* .
3. How is inflorescences of *Polygonaceae?*
4. Give a difference between androecium and gynoecium.
5. Give the economic characters tics of *Polygonaceae* .

9.3 AMARANTHACEAE: CHARACTERSTICS , DISTRIBUTION AND TYPES

Characteristics of Amaranthaceae

Plants mostly herbs, a few shrubs, leaves exstipulate and simple; opposite or alternate, hairy; flowers small, incospicuous and usually with bracts and bracteoles, actinomorphic, arranged in spikes or racemes; perianth 2 to 5, uniseriate, green or coloured, free or united; stamens 3 to 5 free, dithecous, antiphyllous (opposite the perianth segments); gynoecium bi or tri-carpellary, unilocular with a single basal ovule; fruit one seeded nutlet.

A. Vegetative Characteristics

NOTES

Habit: Mostly herbs, rarely shrubs or undershrubs (Deeringia), annual or perennial (Bosia, Ptilotus).

Root: A branched tap root.

Stem: Aerial, herbaceous or woody, erect or straggling, cylindrical, or angular, branched, solid, hairy, green or striped green.

Leaves: Simple, alternate or opposite, petiolate, exstipulate, reddish in colour, unicostate reticulate venation.

B. Floral Characteristics

Inflorescence: Axillary or terminal spikes (Achyranthes, Digera). Some times in cymose panicles.

Flower: Bracteate, sessile or sub-sessile, bracteolate, bracteoles two, actinomorphic, hermaphrodite or unisexual hypogynous, small inconspicuous, green or variously coloured.

Perianth: Usually five tepals, free or united, sometimes two or three (Amaranthus), dry membranous, valvate or twisted, sometime, hairy, green or coloured, persistent, inferior.

Androecium: Stamens 5 or 3 (Amaranthus), free or united, staminodes sometimes present, introrse, dithecous or monothecous (Alternanthera). In Achyranthes 5 fimbriated scales alternate with 5 fertile stamens.

Gynoecium: Bicarpellary, or tricarpellary; syncarpous, ovary superior, unilocular, usually one campylotropous ovule; basal placentation; style short or filiform; stigma 2 or 3.

Fruit: Dry one seeded achene or several seeded capsule or one to several seeded berry.

Seed: Endospermic with polished testa, kidney-shaped embryo curved.

Pollination: Mostly anemophilous and in some plants entomophilous.

Distribution of Amaranthaceae

The family Amaranthaceae is commonly called ‘Amaranth family’. It is a small family comprising 65 genera and 850 species which are chiefly represented in tropical and temperate regions. In India it is represented by 50 species.

Economic Importance of Amaranthaceae

The Amaranthaceae is of little economic importance.

NOTES

- **Food:** Seeds of Amaranthus caudatus are edible. Amaranthus cruentus and A. frumentacea are raised as cereals by primitive tribes in Tropical Asia. The leaves of Amaranthus viridis, A. spinosus and A. tricolor are also used as vegetables.
- **Medicinal:** Achyranthes aspera is diuretic and purgative. Decoction of Aerua tomentosa is used to remove swellings. The stem and leaves of Alternanthera are used in snake-bite. The flowers and seeds of Digera muricata (syn. D. arvensis) are given for urinary discharges.
- **Dye:** Leaves of Bosia amherstiana yield a black dye. The fruit juice of Deeringia is a substitute for red ink.
- **Weeds:** Some genera are weeds, for example Amaranthus, Celosia, Digera, Achyranthes, Gomphrena, etc.
- **Ornamentals:** Celosia cristata (Cockscomb), Gomphrena globosa (Globe amaranthus) are cultivated in gardens.

Primitive Characteristics

- Plants under-shrubs or shrubs (Bosia, Ptilotus).
- Leaves simple and alternate.
- Flowers actinomorphic, hypogynous and hermaphrodite.
- Anthers dithecous.
- Seeds endospermic.

Advanced Characteristics

- Plants mostly herbs.
- Leaves exstipulate, opposite (Gomphrena, Alternanthera).
- Flowers small, inconspicuous and unisexual (Aerua, Amaranthus).
- Perianth gamophyllous.
- Number of stamens reduced to 2 or 3.
- Gynoecium bicarpellary and syncarpous.
- Basal placentation.
- One ovule in a carpel.
- Ovule campylotropous.
- Anemophilous pollination.

Affinities of Amaranthaceae

Engler and Prantl regarded the Amaranthaceae as primitive but Hutchinson, Takhtajan and Cronquist regard it as one of the advanced families of dicots. Many taxonomists have felt that the family is not primitive and has been derived from caryophyllous ancestors.

The Amaranthaceae is related to the Chenopodiaceae by the possession of monochlamydous flowers, uniseriate stamens and single basal ovule. However the Amaranthaceae differs from the Chenopodiaceae in having scarious bracts, membranous perianth and congested inflorescence.

Common Plant of the Family

- Aerua javanica: A hoary tomentose under-shrub.
- Achyranthes aspera: Chaff flowered, common weed of waste places.
- Alternanthera sessilis: A prostrate herb of damp places.
- Bosia amherstiana: A glabrous shrub with edible berries.
- Celosia (Cockscomb): A cultivated herb in different colours.
- Digera muricata: A wild herb of winter.
- Gomphrena globosa: Button flower of Globe amaranth, cultivated for deep pink heads.
- Cyathula tomentosa: Densely woody herb.

Division of the Family and Chief Genera

Schinz divided the family into two sub-families and tribes as follows:

Sub-family I. Amaranthoideae: Stamens four loculed or anthers dithecous, ovary 1 to 2 ovuled.

Tribe 1. Celosieae: Ovules 2 to many per carpel, for example Celosia.

Tribe 2. Amarantheae: Ovary with one ovule, for example Amaranthus, Achyranthes.

Sub-family II. Gomphrenoideae: Stamens two loculed or anthers monothecous; ovary one ovuled.

Tribe 3. Brayulineae: Flowers in axillary fascicles or solitary, for example Brayulinea.

Tribe 4. Gomphreneae: Inflorescence spikelet or capitate, for example Gomphrena, Alternanthera.

Important Types of Amaranthaceae

Amaranthus viridis (H. Chaulai):

Habit: Wild or cultivated annual, herb.

Root: Branched tap root.

Stem: Aerial, erect, herbaceous, angular, branched, green or striped, hairy.

Leaves: Alternate, simple, petiolate, exstipulate, ovate, entire or repand, acute, hairy or glabrous, unicostate reticulate.

Inflorescence: Axillary or terminal spikes.

Flower: Bracteate, sessile, incomplete, unisexual, actinomorphic, hypogynous, small, green.

Male Flower:

Perianth: Tepals 3, distinct, ovate, acute keeled, green, valvate, inferior.

Androecium: Stamens 3, free, antiphyllous, anthers dithecous, basifixed, introrse. Gynoecium may be rudimentary.

Female Flower:

Perianth: Tepals 2, ovate, green, inferior, valvate.

Androecium: Absent.

Gynoecium: Bicarpellary, syncarpous, ovary superior, unilocular, basal placentation, ovule one; style three, persistent, stigma capitate, hairy.

Fruit: An indehiscent utricle.

Seed: Endospermic.

Check Your Progress

6. List the vegetative characteristics of *Amaranthaceae*
7. List the floral characteristics of *Amaranthaceae*
8. Give the distribution of *Amaranthaceae*
9. What are the primitive characteristics of Amaranthaceae?

9.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Characteristics of *Polygonaceae* includes mostly herb, climbing, leaves stipulate ochrea intrapetiolar, sheathing, swollen nodes; racemose, flowers small, crowded, di-trimerous, hypogynous, hermaphrodite, polyphyllous in two whorls; stamens 6 (3 + 3) or more; carpels (3), 1-loculed, single basal ovule; fruit a nut, enclosed by persistent membranous perianth.
2. Vegetative Characteristics of *Polygonaceae* are as follows:
   - Habit: Mostly herbs for example Polygonum plebejum, annual or perennial rarely shrubs (Polygonum hydropiper) or small trees (Coccoloba uvifera); tendrills – climber (Antigonum spp.). Acidic properties due to presence of various oxalates.
   - Root: Tap, branched.

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- Stem: Generally herbaceous with swollen nodes surrounded by a stipular sheath; sometimes bent like a knee, i.e., geniculate; phylloclades in Muehlenbeckia.
- Leaves: Simple, alternate, sometimes sparse, entire, lobed leaves occur in Rumex acetosella; leaves usually sour in taste due to the presence of calcium oxalate crystals in the cells.

3. Inflorescence of *Polygonaceae is va*riable compound, the general plan usually is racemose but may also be a spike or a panicle; the individual bunches may be built on cymose pattern. Erigonum, which is non-ochreate, has its flowers in cymose umbels or heads
4. Androecium: Stamens 6 to 9, in two whorls, the six outer ones often introrse, the three inner extrorse (Polygonum fagopyrum), A4 in Polygonum diospyrifolium; A 4+2 in Oxyria; filaments free or slightly adnate with tepals at the base; anthers 2-celled, longitudinal dehiscence.

   Gynoecium: Generally tricarpellary, rarely bicarpellary (Oxyria and some species of Polygonum), syncarpous, unilocular, superior; ovule one, orthotropous, basal placentation, style 1, stigmas 2-4. The ovary is subtended by a nectariferous disc which may be lobed with as many as 8 lobes.
5. Economic importance of *Polygonaceae* is as follows:

   Food: Coccoloba uvifera supplies edible fruits as well as gum kinos. The starchy seeds of Fagopyrum esculentum, called 'buckwheat', from an article of diet. The young shoots of Rumex conglomerate, R. crispus, R. obtusifolia and R. uesicarius are used as edible greens. The leaves of R. hastatus are used as condiment.

   Medicinal: Rheum emodi is of medicinal value. The root-stock of R. officinale (China) and R. palmatum (Turkey) is the source of 'drug rhubarb'.

   Dye: Polygonum tinctorium and Rumex dentatus yield dye.

   Ornamentals: Antigonum leptopus, Coccoloba uvifera and Polygonum aubertii.
6. Vegetative characteristics of Amaranthaceae are:

   Habit: Mostly herbs, rarely shrubs or undershrubs (Deeringia), annual or perennial (Bosia, Ptilotus).

   Root: A branched tap root.

   Stem: Aerial, herbaceous or woody, erect or straggling, cylindrical, or angular, branched, solid, hairy, green or striped green.

   Leaves: Simple, alternate or opposite, petiolate, exstipulate, reddish in colour, unicostate reticulate venation.

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7. Floral characteristics of Amaranthaceae are:

   Inflorescence: Axillary or terminal spikes (Achyranthes, Digera). Some times in cymose panicles.

   Flower: Bracteate, sessile or sub-sessile, bracteolate, bracteoles two, actinomorphic, hermaphrodite or unisexual hypogynous, small inconspicuous, green or variously coloured.

   Perianth: Usually five tepals, free or united, sometimes two or three (Amaranthus), dry membranous, valvate or twisted, sometime, hairy, green or coloured, persistent, inferior.

8. Distribution of Amaranthaceae is: The family Amaranthaceae is commonly called 'Amaranth family'. It is a small family comprising 65 genera and 850 species which are chiefly represented in tropical and temperate regions. In India it is represented by 50 species.
9. Primitive characteristics of Amaranthaceae are:
   - Plants under-shrubs or shrubs (Bosia, Ptilotus).
   - Leaves simple and alternate.
   - Flowers actinomorphic, hypogynous and hermaphrodite.
   - Anthers dithecous.
   - Seeds endospermic.

9.5 SUMMARY

- Mostly herb, climbing, leaves stipulate ochrea intrapetiolar, sheathing, swollen nodes; racemose, flowers small, crowded, di-trimerous, hypogynous, hermaphrodite, polyphyllous in two whorls; stamens 6 (3 + 3) or more; carpels (3), 1-loculed, single basal ovule; fruit a nut, enclosed by persistent membranous perianth.
- Mostly herbs for example Polygonum plebejum, annual or perennial rarely shrubs (Polygonum hydropiper) or small trees (Coccoloba uvifera); tendrills – climber (Antigonum spp.). Acidic properties due to presence of various oxalates.
- Stems are generally herbaceous with swollen nodes surrounded by a stipular sheath; sometimes bent like a knee , i.e., geniculate; phylloclades in Muehlenbeckia.
- Leaves are simple, alternate, sometimes sparse, entire, lobed leaves occur in Rumex acetosella; leaves usually sour in taste due to the presence of calcium oxalate crystals in the cells.
- In Muehlenbeckia platyclados leaves very few or absent, the stem is modified into flat and green phylloclades; leaves radical in Rumex

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hastatus; stipulate, stipules form an intrapetiolar sheath, the ochrea (= ocrea) which surrounds the nodes, stipules sometimes fimbriate or hairy or rarely absent as in Koenigia islandica. The leaves may have a felt of hair as an adaptation to cold.

- Inflorescence is vriable compound, the general plan usually is racemose but may also be a spike or a panicle; the individual bunches may be built on cymose pattern. Erigonum, which is non-ochreate, has its flowers in cymose umbels or heads.
- Flowers are small, open, crowded on the inflorescence; parts arranged in 4 or 5 whorls; trimerous, rarely dimerous as in Oxyria digyna; bisexual, rarely unisexual than monoecious or dioecious; cyclic or acyclic, actinomorphic, hypogynous; honey secreted in large amount.
- Tepals 3 to 6 in two indistinguishable whorls (= homochlamydeous). According to Laubengayer (1937) the trimerous whorled plan is fundamental, the apparent spiral plan is fundamentally whorled as can be seen anatomically; when 5 tepals are present, the fusion of one of the outer tepals with one inner has occurred; tepals usually pink, green or white and often persistent.
- Androecium includes stamens 6 to 9, in two whorls, the six outer ones often introrse, the three inner extrorse (Polygonum fagopyrum), A4 in Polygonum diospyrifolium; A 4+2 in Oxyria; filaments free or slightly adnate with tepals at the base; anthers 2-celled, longitudinal dehiscence.
- Gynoecium is generally tricarpellary, rarely bicarpellary (Oxyria and some species of Polygonum), syncarpous, unilocular, superior; ovule one, orthotropous, basal placentation, style 1, stigmas 2-4. The ovary is subtended by a nectariferous disc which may be lobed with as many as 8 lobes.
- Fruits are dry nut with a single seed, it may be three-sided or biconvex, laterally winged, or an achene with wings. The wings may be furnished in bristles or hooks.
- Polygonaceae is used as food in coccoloba uvifera supplies edible fruits as well as gum kinos. The starchy seeds of Fagopyrum esculentum, called ‘buckwheat’, from an article of diet. The young shoots of Rumex conglomerate, R. crispus, R. obtusifolia and R. uesicarius are used as edible greens. The leaves of R. hastatus are used as condiment.
- Polygonaceae is used as medicinal purpose Rheum emodi is of medicinal value. The root-stock of R. officinale (China) and R. palmatum (Turkey) is the source of ‘drug rhubarb’.
- Polygonaceae is used as dye Polygonum tinctorium and Rumex dentatus yield dye.

NOTES

- Polygonaceae is used as ornamentals as Antigonum leptopus, Coccoloba uvifera and Polygonum aubertii.
- In Bentham and Hooker's arrangement, the Polygonaceae is the last member of the Curvembryeae under the Monochlamydeae. Engler included the family in a distinct order (Polygonales), lying between the Aristolochiales and Centrospermae.
- Bessey accepted the family as an advanced taxon of the Caryophyllales. Hallier considered its position under the Caryophyllales, seeking its origin directly from early Ranales on a line parallel to the Papaveraceae.
- Rendle expressed the view that the Polygonaceae occupies a somewhat isolated position.
- Hutchinson opined that the Polygonales is a degraded and reduced type of the Caryophylolales, descending from the Ranales.
- The Polygonaceae is related to the *Amaranthaceae*, Chenopodiaceae and Nyctaginaceae in the plan of floral structure, but differs from them by the presence of orchreate stipules, triangular ovary, solitary erect ovule and S-shaped embryo. The family is also allied to the Urticaeae by having stipulate leaves and orthotropous ovules.
- An unique feature of the family, as suggested by Rendle, is 'the multiplication of the stamens and the relation between the two-whorled trimerous and the cyclic perianth'.
- Plants mostly herbs, a few shrubs, leaves exstipulate and simple; opposite or alternate, hairy; flowers small, incospicuous and usually with bracts and bracteoles, actinomorphic, arranged in spikes or racemes; perianth 2 to 5, uniseriate, green or coloured, free or united; stamens 3 to 5 free, dithecous, antiphyllous (opposite the perianth segments); gynoecium bi or tri-carpellary, unilocular with a single basal ovule; fruit one seeded nutlet.
- The family *Amaranthaceae* is commonly called 'Amaranth family'. It is a small family comprising 65 genera and 850 species which are chiefly represented in tropical and temperate regions. In India it is represented by 50 species.
- Engler and Prantl regarded the *Amaranthaceae* as primitive but Hutchinson, Takhtajan and Cronquist regard it as one of the advanced families of dicots. Many taxonomists have felt that the family is not primitive and has been derived from caryophyllous ancestors.
- The *Amaranthaceae* is related to the Chenopodiaceae by the possession of monochlamydous flowers, uniseriate stamens and single basal ovule. However the *Amaranthaceae* differs from the Chenopodiaceae in having scarious bracts, membranous perianth and congested inflorescence.

9.6 KEY WORDS

NOTES

- **Monochlamydae:** Monochlamydae is an artificial taxonomic group used in the identification of plants.
- ***Amaranthaceae*:** *Amaranthaceae* is a family of flowering plants commonly known as the amaranth family, in reference to its type genus.
- **Polygonaceae:** The Polygonaceae are a family of flowering plants known informally as the knotweed family or smartweed—buckwheat family in the United States.
- **Inflorescence:** An inflorescence is a group or cluster of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches.
- **Pollination:** Pollination is the act of transferring pollen grains from the male anther of a flower to the female stigma.
- **Gynoecium:** Gynoecium is most commonly used as a collective term for the parts of a flower that produce ovules and ultimately develop into the fruit and seeds.

9.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a short note on characteristics of *Polygonaceae.*
2. List the floral characteristics of *Polygonaceae.*
3. Write about economic importance of *Polygonaceae.*
4. List some of the common plants of the family *Polygonaceae.*
5. Write about vegetative characteristics of *Amaranthaceae.*
6. Write about floral characteristics of *Amaranthaceae.*
7. List the advanced characteristics of *Amaranthaceae.*

Long Answer Questions

1. Write a detailed note on characteristics of *Polygonaceae* including its vegetative and floral characteristics.
2. Give the economic importance of *Polygonaceae.*
3. List the common plants of the family *Polygonaceae* including division of the family and chief genera.
4. Write about the affinities of *Polygonaceae* and some important types of *Polygonaceae.*

5. Explain about the vegetative and floral characteristics of *Amaranthaceae.*
6. Discuss about primitive and advanced chracterstics of *Amaranthaceae.*
7. List some of the common plants and division of the family and chief genera of *Amaranthaceae* family.
8. Mention some important types of *Amaranthaceae.*

9.8 FURTHER READINGS

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NOTES

UNIT 10 MONOCHLAMYDEAE FAMILY: ARISTOLOCHIACEAE AND LORANTHACEAE

Structure

10.0 INTRODUCTION

Monochlamydae is an artificial taxonomic group used in the identification of plants. It was largely abandoned by taxonomists in the 19th century, but has been often used since. Bentham and Hooker's classification, published in 1880, used this grouping, but stated that it was neither natural nor well defined, and that De Candolle's system was superior. Under Engler and Prantl'srevision of 1931, the group Monochlamydeae was completely abandoned.

The group was one of three within the Dicotyledons, the others being Polypetalaeand Gamopetalae. It included plants with flowers that had either a calyx or corolla, but not both.

The *Aristolochiaceae* are a family, the Birthwort family, of flowering plants with seven genera and about 400 known species belonging to the order Piperales. The type genus is Aristolochia L.

Loranthaceae, commonly known as the showy mistletoes, is a family of flowering plants It consists of about 75 genera and 1,000 species of woody plants, many of them hemiparasites. The three terrestrial species are Nuytsia floribunda (the Western Australian Christmas tree), Atkinsonia ligustrina (from the Blue Mountains of Australia), and Gaiadendron punctatum (from Central \South America). *Loranthaceae* are primarily xylem parasites, but their haustoria may sometimes tap the phloem while Tristerix aphyllus is almost holoparasitic.

NOTES

In this unit, you will study about Monochlamydae family which includes - *Aristolochiaceae* and its characteristics, distribution and affinities, *Loranthaceae* and its characteristics, distribution and affinities in detail.

10.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about Monochlamydae family
- Discuss about *Aristolochiaceae* - its characteristics, distribution and affinities
- *Explain about Loranthaceae* - its characteristics, distribution and affinities

10.2 *ARISTOLOCHIACEAE* : CHARACTERSITICS, DISTRIBUTION AND AFFINITIES

Characteristics of *Aristolochiaceae*

Plants twinner, flower actinomorphic, trimerous, stamens 6-36 free or attached with the style forming gynostemium, generally 6-loculed inferior ovary.

A. Vegetative Characteristics

Habit: Mostly climbing herbs or shrubs with woody stems or low herbs.

Root: Tap and branched.

Stem: Softly woody or herbaceous, branched twinner.

Leaf: Simple, alternate, with oil glands, entire, petioled, exstipulate.

B. Floral Characteristics

Inflorescence: Either solitary or clustered or in racemes of spikes.,

Flower: Hermaphrodite, actinomorphic or zygomorphic, epigynous and with haplochlamydous trimerous perianth usually.

In Aristolochia flowers aire zygomorphic, the perianth members are united to form a pitcher like structure having constricted neck, the interior of which is lined with downwardly directed hairs.

Perianth: 3 petaloid, united, 3-lobed or unilateral often bizarrely coloured occasionally an inner whorl of 3 minute teeth (vestigial corolla) present.

Androecium: Stamens 6-36. free or adnate to style and producing a column or gynostemium, filaments short and thick or anthers sessile, bithecous dehiscing longitudinally.

Gynoecium: Carpels usually 6 rarely 4, connate in an inferior six chambered, rarely four chambered ovary. Ovules anatropous, many on axile palcentas.

Fruit: Septicidal capsule with basal dehiscence.

Seed: Endospermic and small.

Pollination: Entomophilous.

Floral formula:

$$\oplus \text{ or } \circ\!|\!\circ \quad ☿\ P_{(3)}\ A_{6-36 \text{ or } (6-36)}\ G_{\overline{(6)}}.$$

Distribution of *Aristolochiaceae*

The family Aristolochiaceae or Birthwort family contains 7 genera with 625 species (Rendle) having fairly wide range of distribution, the main centre of distribution being north temperate and tropical regions of the globe. Aristolochia is mainly tropical. According to Willis genera 5, species 300.

Economic Importance of *Aristolochiaceae*

- **Medicinal:** The roots of Aristolochia, serpentaria and Bragantia wallichii serve as a cure for snake-bites. The roots of Aristolochia indica are used by snake-charmers for catching snakes.
- **Ornamental:** Aistolochia grandiflora, A. clematis, A. microphylla, A. gigas are ornamental plants.

Affinities of *Aristolochiaceae*

Hutchinson placed the family as a terminal derivative from the Ranales via herbaceous members of Berberidaceae. It is presumed that the more or less woody climbing members of the family may have derived from the herbaceous ones.

According to Bentham and Hooker, it is most closely related to certain petaliferous families such as Menispermaceae.

Ranales → Berberidales (Menispermaceae) → Aristolochiales.

Common Plant of the Family

1. Aristolochia bracteolata – a decumbent, slender perennial.
2. A. tagala – twining perennial shrub.

Division of the family and chief genera:

The Aristolochiaceae is divided into three tribes, i.e.,

I. Aristolochieae

Perennial herbs or shrubs; flowers zygomorphic, solitary or in cymes or racemes. Petals absent. Stamens in one row, united with style.

Ovary inferior. Fruit a capsule, for example Aristolochia, Euglypha and Helostylis.

II. Bragantieae

Shrubs or semi shrubs, flowers actinomorphic in cymes or racemes. Petals absent. Stamens in two rows, free or united with the style. Ovary inferior, fruit a capsule,for example Apana, Thotte.

The families of flowering plants - L. Watson and M.J. Dallwitz

Aristolochiaceae Juss.

Habit and Leaf Form: Shrubs, or lianas, or herbs (mostly woody vines); bearing essential oils.

Plants Green and Photosynthesizing: Perennial; without conspicuous aggregations of leaves. Climbing, or self supporting (less often); mostly stem twiners. Mesophytic.

Leaves: alternate, spiral, flat, 'herbaceous', or 'herbaceous' and membranous, petiolate, sheathing to non-sheathing, gland-dotted (pellucid punctate), or not gland-dotted, aromatic simple. Lamina entire (usually), or dissected; when dissected, palmatifid (trilobed), palmately veined, or pinnately veined, cross-venulate, often cordate. Leaves exstipulate (but sometimes with the first 1–2 leaves of the suppressed axillary branches simulating stipules); leaf development not 'graminaceous'.

General Anatomy: Plants with silica bodies, or without silica bodies.

Leaf Anatomy: The leaf *lamina* dorsiventral (usually), or bifacial. Epidermis containing silica bodies, or without silica bodies. Stomata present; anomocytic. Hairs present; eglandular (mostly), or glandular (lacking typical glandular hairs, but hairs with basal secretory cells occur); multicellular. Multicellular hairs uniseriate; simple (but varied in form). The mesophyll with spherical etherial oil cells, or without etherial oil cells; containing crystals. The crystals raphides, druses, and solitary-prismatic. Minor leaf veins without phloem transfer cells (*Aristolochia*, *Asarum*).

Axial (Stem, Wood) Anatomy: Cork cambium present; initially superficial. Nodes tri-lacunar. Primary vascular tissues comprising a ring of bundles; collateral. Internal phloem absent. Cortical bundles absent. Medullary bundles absent. Secondary thickening developing from a conventional cambial ring (but sometimes the pith and primary medullary rays are unusually dilated, the original vascular bundles becoming fan-shaped and deforming the secondarily thickened structure). Primary medullary rays very wide.

The wood ring porous to diffuse porous. The vessels small to large (very large in some twiners). The vessel end-walls simple. The vessels with spiral thickening, or without spiral thickening. The axial xylem with fibre tracheids, or without fibre tracheids; with libriform fibres, or without libriform fibres, including septate fibres. The fibres with spiral thickening, or without spiral thickening. The parenchyma apotracheal, or paratracheal.

Reproductive Type

Pollination: Unisexual flowers absent. Plants hermaphrodite. Pollination entomophilous, via diptera, mechanism conspicuously specialized (via an elaborate system for trapping flies within the perianth tube, involving articulated hairs which subsequently wither to release them).

Inflorescence, Floral, Fruit and Seed Morphology: Flowers solitary, or aggregated in 'inflorescences', when aggregated, in cymes, or in racemes, or in spikes. The ultimate inflorescence units cymose, or racemose. Inflorescences terminal, or axillary; terminal or lateral racemes or cymes. Flowers small to large; often malodorous (smelling of carrion), or odourless, regular to very irregular, cyclic, tricyclic to pentacyclic.

***Perianth* with Distinct Calyx and Corolla, or Petaline:** 3, or 6, joined,1 whorled, or 2 whorled (the corolla whorl conspicuous and well developed only in *Saruma*), when two-whorled, isomerous. Calyx 3, 1 whorled; gamosepalous, entire, or blunt-lobed; campanulate, or tubular (the tube often S-shaped), unequal but not bilabiate, or bilabiate, or regular; persistent, or not persistent; valvate (or valvate-induplicate). Corolla when present, 3 (usually reduced or absent), 1 whorled.

Androecium 6–36. Androecial members free of the perianth; united with the gynoecium (forming a gynostemium by fusion to the style of the filaments, or of both the filaments and the anthers), or free of the gynoecium; free of one another, or coherent (via the gynostemium); when joined, 1 adelphous; 1 whorled, or 2 whorled. Androecium exclusively of fertile stamens. Stamens 4, or 6 (commonly), or 12(–36), isomerous with the perianth to polystemonous, filantherous, or with sessile anthers.

Anthers: Cohering, or separate from one another, basifixed, or adnate, non-versatile; dehiscing via longitudinal slits; extrorse, or extrorse and introrse (*Heterotropa*), tetrasporangiate; appendaged (apically, with the expanded connective assuming stigmatic functions in association with the gynostemium), or unappendaged. Endothecium developing fibrous thickenings. Anther epidermis persistent. Microsporogenesis successive, or simultaneous. The initial microspore tetrads tetrahedral, or isobilateral, or decussate, or T-shaped (rarely). Anther wall initially with more than one middle layer; of the 'dicot' type. Tapetum glandular. Pollen shed as single grains. Pollen grains aperturate, or nonaperturate; 1–7 aperturate; sulcate, or sulculate (monosulcate to multisulcoidate or sulculate); 2-celled.

***Gynoecium* 4–6 Carpelled:** Carpels isomerous with the perianth to increased in number relative to the perianth. The pistil 1 celled, or 4–6 celled. Gynoecium syncarpous; synovarious (*Hexastylis*), or synstylovarious, or eu-syncarpous; partly inferior (sometimes), or inferior (usually). Ovary 4–6 locular, or 1 locular (the septa sometimes incompletely intruded). Epigynous disk present, or absent. Gynoecium stylate. Styles 1, or 4–6; free, or partially joined; apical. Stigmas dry type (mostly), or wet type, papillate; Group II type, or Group III type , Placentation when unilocular, parietal; when plurilocular, axile. Ovules in the single cavity when unilocular, 50–100 ('many'); when plurilocular, 20–50 per locule ('many'); funicled; pendulous, or horizontal; anatropous (or circinotropous); bitegmic; crassinucellate. Outer integument not contributing to the micropyle. Embryo-sac development *Polygonum*-type. Polar nuclei fusing prior to fertilization. Antipodal cells formed; 3; not proliferating; ephemeral, or persistent. Synergids pear-shaped. Hypostase present. Endosperm formation cellular. Embryogeny probably solanad.

Fruit non-fleshy (usually), or fleshy (sometimes with a fleshy endocarp); dehiscent (usually), or indehiscent (rarely), or a schizocarp (*Saruma*). Mericarps in *Saruma*, 4–6 ; in *Saruma*, comprising follicles. Fruit a capsule (usually), or a berry, or a nut. Capsules when dehiscent, septicidal and valvular (usually basally, rarely at the top), or splitting irregularly. Seeds endospermic. Endosperm ruminate, or not ruminate, oily.

Embryo rudimentary at the time of seed release to weakly differentiated: Embryo achlorophyllous (2/3).

Seedling: Germination phanerocotylar, or cryptocotylar.

Physiology, phytochemistry. Inulin recorded (*Aristolochia*, Gibbs 1974): Not cyanogenic. Alkaloids present (usually), or absent. Arbutin absent. Iridoids not detected. Proanthocyanidins absent. Flavonols present; quercetin, or kaempferol and quercetin. Ellagic acid absent (2 genera, 5 species). Aluminium accumulation not found. Sieve-tube plastids P-type; type I (a), or type II (a).

Geography, cytology: Temperate (warm), sub-tropical to tropical. Widespread, except Australasia. $X = 4–7, 12, 13$. Supposed basic chromosome number of family: 7.

Taxonomy: Subclass Dicotyledonae; Crassinucelli. Dahlgren's Superorder Magnoliiflorae; Aristolochiales. Cronquist's Subclass Magnoliidae; Aristolochiales. APG III core angiosperms; Superorder Magnolianae. APG IV Order Piperales.

Species 400. Genera 7; *Apama*, *Aristolochia*, *Asarum*, *Euglypha*, *Holostylis*, *Saruma*, *Thottea*.

Economic use: A few *Aristolochia* and *Asarum* spp. cultivated as ornamentals.

Check Your Progress

1. State the vegetative characteristics of *Aristolochiaceae.*
2. What type of flowers does *Aristolochiaceae* have?
3. List the *e*conomic importance of *Aristolochiaceae.*
4. What are Aristolochieae?

10.3 *LORANTHACEAE* : CHARACTERSITICS, DISTRIBUTION AND AFFINITIES

Characters of *Loranthaceae*

Aerial parasite usually, cup-shaped receptacle; inferior ovary and the absence of distinct ovules.

A. Vegetative Characteristics

Habit: Herbs, perennial, aerial parasitic or semi-parasitic on trees.

Root: Modified adventitious roots in the form of haustoria, Nuystia (W. Australia) rooted in earth.

Stem: Herbaceous, soft, branched, branching dichotomous, swollen nodes.

Leaf: Simple, opposite, entire, exstipulate, thick and leathery, ever-green, often reduced to mere scales.

B. Floral Characteristics

Inflorescence: Flowers are solitary or in racemes and cymes.

Flower: Hermaphrodite or unisexual,for example Viscum (when so, plants dioecious), actinomorphic or slightly irregular, often brightly coloured, dimerous or trimerous, apetalous, epigynous with cup-shaped or disc-like receptacle.

Perianth: Biseriate, the two whorls similar and 2-3 merous, both green and sepal-like (Viscum) or both large, brilliantly coloured and petaloid, for example Loranthus (no apparent differentiation into calyx and corolla), an irregular rim, called calyculus, is sometimes present below the perianth and is interpreted as calyx.

Androecium: Stamen 4-6, opposite to the perianth members, and borne on them (epiphyllous) or at their base; anthers 2-celled, dehisencing by longitudinal or by transverse slits or by pores (in staminate flowers a rudimentary pistil may be present).

Gynoecium: Carpels 1-3 or 5, syncarpous, inferior, unilocoular, ovules not differentiated from placenta, basal placentation, style simple or absent, stigma 1 and often sessile.

Fruit: Berry or drupe, often viscid.

Seed: Fleshy endospermic.

Pollination: Entomophilous.

Floral Formulae:

$$Br\ Brl \oplus \text{☿}\ \overparen{P_{4-6}\ A_{4-6}}\ G_{\bar{1}}$$
$$Br\ Brl \oplus \text{♂}\ \overparen{P_{4-6}\ A_{4-6}}\ G_{0}$$
$$Br\ Brl \oplus \text{♀}\ P_{4-6}\ A_{0}\ G_{\bar{1}}$$

Distribution of *Loranthaceae*

Mistletoe family consists of 36 genera and 1300 species, mostly distributed in tropical and temperate regions. About 10 genera and 52 species have been reported from India.

Affinities of *Loranthaceae*

The family is closely related to Santalaceae but can be distinguished by its aerial parasitic habit; cup-shaped receptacle; inferior ovary, lacking a clearly defined locule and the absence of distinct ovules.

The *Loranthoideae* and Viscoideae show great variations in the floral structure. Moreover, the mode of development of the embryosac, endosperm and embryo and location of the viscous part of the fruit are different in the two sub-families.

The *Loranthoideae* contains bisexual or unisexual flowers generally associated with calyculus. The ovary is characterised by a collenchyma pad and contains a mamelon which may or may not be lobed.

The viscid zone of the fruit is located outside the vascular bundles of the corolla. Other features peculiar to the *Loranthoideae* include the Polygonum type of embryosac, protrusion of tip of the embryosac into the style, formation of composite endosperm and vertical division of the zygote.

The Viscoideae contains only unisexual flowers where the calyculus in invariably absent. The viscous layer of the fruit is situated within the vascular bundles of the perigone. The bisporic embryosac with a slow but steady curvature, endosperm developing from a single embryosac and embryo without a suspensor are unique to the Viscoideae.

In view of the above differences, Johri and his associates suggested that the Loranthoideae is distinct from the Viscoideae. These differences, according to them, warrant the elevation of the status of the sub-families to that of families – Loranthaceae and Viscaceae.

Common Plants of the Family

NOTES

- Arceuthobium minutissimum Hook, f., parasitic on the twigs of Pinus wallichiana, is the smallest known dicotyledonous plant, known in the world, is endemic in India.
- Dendropthoe falcata – Parasite on mango and other trees.
- Viscus album – True Misletoe- was used as ceremonial plant by the Druids and other early Europeans.
- Loranthus cordifolius – Abundant on Oak (Quercus dilatata) in Giri valley, Central India.

Division of the Family and Chief Genera

The Loranthaceae is divided into two sub-families:

Sub-family I. Loranthoideae

Flowers bisexual or unisexual. Calyculus present. Examples: Loranthus, Struthanthus, etc.

Sub-family II. Viscoideae

Flower unisexual. Calyculus absent. Examples: Arceuthobium, Viscum, etc.

Check Your Progress

5. List the vegetative characteristics of *Loranthaceae* .
6. Write about androecium and gynoecium of *Loranthaceae* flower.
7. List some of the common plants of the family *Loranthaceae.*

10.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Vegetative characteristics of *Aristolochiaceae* are:
   - Habit: Mostly climbing herbs or shrubs with woody stems or low herbs.
   - Root: Tap and branched.
   - Stem: Softly woody or herbaceous, branched twinner.
   - Leaf: Simple, alternate, with oil glands, entire, petioled, exstipulate.
2. Flowers of *Aristolochiaceae* are Hermaphrodite, actinomorphic or zygomorphic, epigynous and with haplochlamydous trimerous

perianth usually. In Aristolochia flowers aire zygomorphic, the perianth members are united to form a pitcher like structure having constricted neck, the interior of which is lined with downwardly directed hairs.

3. Economic Importance of *Aristolochiaceae* are:
    - Medicinal: The roots of Aristolochia, serpentaria and Bragantia wallichii serve as a cure for snake-bites. The roots of Aristolochia indica are used by snake-charmers for catching snakes.
    - Ornamental: Aistolochia grandiflora, A. clematis, A. microphylla, A. gigas are ornamental plants.
4. Aristolochieae are perennial herbs or shrubs; flowers zygomorphic, solitary or in cymes or racemes. Petals absent. Stamens in one row, united with style. Ovary inferior. Fruit a capsule, for example Aristolochia, Euglypha and Helostylis.
5. Vegetative characteristics of *Loranthaceae are:*
    - Habit: Herbs, perennial, aerial parasitic or semi-parasitic on trees.
    - Root: Modified adventitious roots in the form of haustoria, Nuystia (W. Australia) rooted in earth.
    - Stem: Herbaceous, soft, branched, branching dichotomous, swollen nodes.
    - Leaf: Simple, opposite, entire, exstipulate, thick and leathery, ever-green, often reduced to mere scales.
6. Androecium: Stamen 4-6, opposite to the perianth members, and borne on them (epiphyllous) or at their base; anthers 2-celled, dehisencing by longitudinal or by transverse slits or by pores (in staminate flowers a rudimentary pistil may be present).
    - Gynoecium: Carpels 1-3 or 5, syncarpous, inferior, unilocoular, ovules not differentiated from placenta, basal placentation, style simple or absent, stigma 1 and often sessile.
7. Some of the common plants of the family *Loranthaceae* are:
    - Arceuthobium minutissimum Hook, f., parasitic on the twigs of Pinus wallichiana, is the smallest known dicotyledonous plant, known in the world, is endemic in India.
    - Dendropthoe falcata – Parasite on mango and other trees.
    - Viscus album – True Misletoe- was used as ceremonial plant by the Druids and other early Europeans.
    - Loranthus cordifolius – Abundant on Oak (Quercus dilatata) in Giri valley, Central India.

10.5 SUMMARY

NOTES

- The *Aristolochiaceae* are a family, the Birthwort family, of flowering plants with seven genera and about 400 known species belonging to the order Piperales. The type genus is Aristolochia L.
- The family Aristolochiaceae or Birthwort family contains 7 genera with 625 species (Rendle) having fairly wide range of distribution, the main centre of distribution being north temperate and tropical regions of the globe. Aristolochia is mainly tropical. According to Willis genera 5, species 300.
- Hutchinson placed the family as a terminal derivative from the Ranales via herbaceous members of Berberidaceae. It is presumed that the more or less woody climbing members of the family may have derived from the herbaceous ones.
- According to Bentham and Hooker, it is most closely related to certain petaliferous families such as Menispermaceae.
- Aristolochieae are perennial herbs or shrubs; flowers zygomorphic, solitary or in cymes or racemes. Petals absent. Stamens in one row, united with style. Ovary inferior. Fruit a capsule, for example Aristolochia, Euglypha and Helostylis.
- Bragantieae are shrubs or semi shrubs, flowers actinomorphic in cymes or racemes. Petals absent. Stamens in two rows, free or united with the style. Ovary inferior, fruit a capsule,for example Apana, Thotte.
- The leaf *lamina* dorsiventral (usually), or bifacial. Epidermis containing silica bodies, or without silica bodies.
- Stomata present; anomocytic. Hairs present; eglandular (mostly), or glandular (lacking typical glandular hairs, but hairs with basal secretory cells occur); multicellular. Multicellular hairs uniseriate; simple (but varied in form). The mesophyll with spherical etherial oil cells, or without etherial oil cells; containing crystals.
- The crystals raphides, druses, and solitary-prismatic. Minor leaf veins without phloem transfer cells (*Aristolochia*, *Asarum*).
- Unisexual flowers absent. Plants hermaphrodite Pollination entomophilous, via diptera, mechanism conspicuously specialized (via an elaborate system for trapping flies within the perianth tube, involving articulated hairs which subsequently wither to release them).
- Mistletoe family consists of 36 genera and 1300 species, mostly distributed in tropical and temperate regions. About 10 genera and 52 species have been reported from India.

NOTES

- The family is closely related to Santalaceae but can be distinguished by its aerial parasitic habit; cup-shaped receptacle; inferior ovary, lacking a clearly defined locule and the absence of distinct ovules.
- The *Loranthoideae* and Viscoideae show great variations in the floral structure. Moreover, the mode of development of the embryosac, endosperm and embryo and location of the viscous part of the fruit are different in the two sub-families.
- The *Loranthoideae* contains bisexual or unisexual flowers generally associated with calyculus. The ovary is characterised by a collenchyma pad and contains a mamelon which may or may not be lobed.
- The viscid zone of the fruit is located outside the vascular bundles of the corolla. Other features peculiar to the *Loranthoideae* include the Polygonum type of embryosac, protrusion of tip of the embryosac into the style, formation of composite endosperm and vertical division of the zygote.
- The Viscoideae contains only unisexual flowers where the calyculus in invariably absent. The viscous layer of the fruit is situated within the vascular bundles of the perigone. The bisporic embryosac with a slow but steady curvature, endosperm developing from a single embryosac and embryo without a suspensor are unique to the Viscoideae.
- *Loranthaceae*, commonly known as the showy mistletoes, is a family of flowering plants It consists of about 75 genera and 1,000 species of woody plants, many of them hemiparasites.
- The three terrestrial species are Nuytsia floribunda (the Western Australian Christmas tree), Atkinsonia ligustrina (from the Blue Mountains of Australia), and Gaiadendron punctatum (from Central \South America). *Loranthaceae* are primarily xylem parasites, but their haustoria may sometimes tap the phloem while Tristerix aphyllus is almost holoparasitic.

10.6 KEY WORDS

- **Loranthaceae:** Loranthaceae, commonly known as the showy mistletoes, is a family of flowering plants.
- **Aristolochiaceae:** The Aristolochiaceae are a family, the birthwort family, of flowering plants with seven genera and about 400 known species belonging to the order Piperales.
- **Hemiparasite:** A plant which obtains or may obtain part of its food by parasitism,for example mistletoe, which also photosynthesizes.
- **Menispermaceae:** Menispermaceae is a family of flowering plants.

10.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

NOTES

Short Answer Questions

1. Write about the vegetative characteristics of *Aristolochiaceae.*
2. What are the floral characteristics of *Aristolochiaceae?*
3. Write a short note on affinities of *Aristolochiaceae*.
4. Write a short note on reproductive system of *Aristolochiaceae* family plants.
5. Write about the floral characteristics of *Loranthaceae.*
6. List some of the common plants of the family *Loranthaceae.*

Long Answer Questions

1. Write a detailed note on *Aristolochiaceae* family.
2. Write about the vegetative and floral characteristics of *Aristolochiaceae.*
3. Give a detailed note on families of flowering plants.
4. Write in detail about vegetative and floral characteristics of *Loranthaceae.*
5. Write a detailed note on Affinities of *Loranthaceae.*

10.8 FURTHER READINGS

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BLOCK - IV

SALIENT FEATURES OF PLANT FAMILIES

UNIT 11 GAMOPETALAE FAMILIES: SAPOTACEAE, RUBIACEAE, ASTERACEAE AND APOCYNACEAE

Structure

11.0 INTRODUCTION

Gamopetalae is an artificial group used in the identification of plants based on Bentham and Hooker's classification system. George Bentham and Joseph Dalton Hooker published an excellent classification in three volumes between 1862 and 1883. As a natural system of classification, it does not show evolutionary relationship between plants but still is a useful and popular system of classification based on a dichotomous key especially for the flowering plant groups (angiosperms). It is the most popular system of classification based on key characteristics enabling taxonomic students to quickly identify plant groups based only on physical characteristics. However, it is not a scientific group and is used for identification purposes only based on similar plant characteristics. Under the system Gamopetalae is a Sub Class and comprises of flowers with distinct calyx and corolla. The petals are joined together in the corolla.

In this unit, you will study about Gamopetalae family, *Sapotaceae, Rubiaceae, Asteraceae* and *Apocynaceae* and their characteristics, distribution and economic importance.

11.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about Gamopetalae family
- Discuss about *Sapotaceae* and its characteristics, distribution and economic importance
- Explain *Rubiaceae* and its characteristics, distribution and economic importance
- Describe about *Asteraceae* and its characteristics, distribution and economic importance
- Learn about *Apocynaceae* and its characteristics, distribution and economic importance

11.2 *SAPOTACEAE*: CHARACTERSTICS, DISTRIBUTION AND ECONOMIC IMPORTANCE

Characteristics of *Sapotaceae*

Trees and shrubs with laticiferous vessels; Leaves, flowers and fruits often clothed with hairs; flower hermaphrodite, hypogynous, actinomorphic; sepals 2-8 in two isomerous whorls or 5 in one whorl, pelals 4-8 gamopetalous in one whorl, rarely double the sepals in two whorls; stamens epipetalous in 2-3 whorls, the outer antisepalous whorl reduced to staminodes or absent; carpels many, syncarpous; ovary superior, completely separated, many chambered, axile placentation.

A.Vegetative Characteristics

Habit: Trees or shrubs with laticiferous milky sap.

Root: Tap, branched.

Stem: Erect, woody, branched.

Leaf: Simple, alternate or opposite usually entire, coriaccous, sometimes stipulate, hairy leathery.

B. Floral Characteristics

Inflorescence: Solitary or in cymose clustes in the leaf axils or on old stems.

Flower: Actinomorphic, hermaphrodite, hypogynous, hairy bracteolate.

Calyx: Sepals 4-8, in two isomerous whorls or 5 in one whorl, free or slightly united at the base, imbricate persistent.

Corolla: Petals 4-8, more or less united, in one whorl or more rarely double the number of sepals in two whorls, united in semi-funnel shaped rotate or lenceolate corolla, corolla lobes imbricate or contorted in bud, rarely petals with dorsal appendages which resemble corolla lobes.

Androecium: Stamens 4-5, sometimes more, in 2 or 3 whorls of 4-5 each but usually only the inner whorl fertile, epipetalous, the outer whorl of steames reduced to staminodes; another bithecous, introrse dehiscing longitudinally.

Gynoecium: Carpels number is double that of stamens, syncarpous, superior ovary; with as many chambers as carpels, axile placentation, style simple; stigma inconspicuous and sticky ovule anatropous, integument one.

Fruit: Berry inner pulp lacticiferous.

Seed: Seeds few or one testa hard, shiny, endosperm oily.

Pollination: Entomophilous.

Floral formula:

$$\oplus, ⚥, K_{4-8 \text{ or } 5}, \overset{\frown}{C_{4-8}\, A_{\alpha}}\, G_{(\underline{\alpha})}.$$

Distribution of Sapotaceae

Sapotaceae includes 40 genera and 60 species of primarily tropical trees common in old world.

Economic Importance of Sapotaceae

- **Food:** Several species of Achras sapota (H. Chiku), Manilkara kauki (H. Khirini), Manilkara hexandra, Mimusops elengi (V. Maulsari), Bassia longifolia yield juicy edible fruits. (Note: the nomenclature of these species is unsettled and authorities on the family are not in accord to identify or names to be used).
- **Oil:** The seeds of Madhuca butyracca produce the vegetable butter called 'phulwa' used as cold cream, lip salve leminant and as substitute for ghee and for soap-making. The latex of Manilkara achras yeilds 'chickle' used for making chewing gum. An aromatic oil is obtained from the flowers of Mimusops elengi and is used in manufacture of perfumes.
- **Gutta percha:** It is obtained from latex of Mimusops, Palaquium gutta and Payena species.
- **Medicinal:** The bark of Bassia longifolia and Mimusops elengi is used in decoction as astringent and emollient and also as a cure for itches.
- **Timber:** The wood of Sideroxylon, Chrysophyllum and Bassia afford hard and useful timber.

NOTES

Check Your Progress

1. Give the characteristics of *Sapotaceae.*
2. What type of corolla does *Sapotaceae* have?
3. What types of root does *Sapotaceae* have?
4. How are the stems of *Sapotaceae ?*

11.3 *RUBIACEAE*: CHARACTERSTICS, DISTRIBUTION AND TYPES

Characters of *Rubiaceae*

Trees or herbs; leaves alternate or opposite; stipules interpetiolar or intrapetiolar, inflorescence cymose; flowers tetra or pentamerous, hermaphrodite, actinomorphic, epigynous, corolla, gamopetalous; stamens 4-5; epipetalous, introrse, dithecous; ovary inferior, bilocular with one or many ovules in each loculus; fruit capsule or berry.

A. Vegetative Characteristics

Habit: Mostly shrubs (Gardenia, Ixora, Mussaenda, Hamelia); trees (Morinda, Adina) and a few herbs (Galium, Rubia).

Root: Much branched tap root system.

Stem: Erect, herbaceous or woody or twinning (Manettia), climbing by hooks (Uncaria), branched, cylindrical or angular, hairy or smooth.

Leaves: Cauline, ramal, opposite or verticillate, simple, entire or toothed, stipulate, stipules bristle like (Pentas) and leafy (Galium, Rubia), stipules mostly interpetiolar or sometimes intrapetiolar; unicostate reticulate venation.

B. Floral Characteristics

Inflorescence: Solitary (Gardenia) usually cymose or globose head (Adina), or panicled cyme; may be axillary (Coffea arabica) or terminal cyme (Mussaenda glabra).

Flower: Actinomorphic, rarely zygomorphic (somewhat bilabiate as in Henriquezia), mostly hermaphrodite, rarely unisexual, epigynous, pedicellate or sessile (Greenia, Randia), bracteate or ebracteate, complete, tetra or pentamerous, cyclic, variously coloured.

Calyx: Sepals 4 or 5, gamosepalous, superior, sometimes one sepal modified into coloured bract like structure (Mussaenda), valvate.

Corolla: Petals 4 or 5, gamopetalous, lobed, generally funnel shaped (Asperula), tubular (Ixora), valvate to twisted or imbricate, superior.

Androecium: Stamens 4 or 5, rarely many (Gardenia), epipetalous, alternipetalous, inserted near the mouth of corolla tube, stamens dithecous, introrse, dehiscing longitudinally, superior.

Gynoecium: Bicarpellary, rarely polycarpellary, syncarpous, inferior rarely half inferior (Synaptanthera) or superior (Paganea), sometimes unilocular (Gardenia) with one to many anatropous ovules in each loculus, axile placentation (parietal placentation in Gardenia), style one sometimes bifid or multifid, stigma simple or bilobed.

Fruit: Capsular (Anotis), berry (Mussaenda, Hamelia, Ixora).

Seed: Endospermic, sometimes winged.

Pollination: Entomophilous; ant pollination is well known.

Distribution of *Rubiaceae*

It is commonly known as Madder or Coffee family. It includes 6000 species and 500 genera. In India it is represented by 551 species. The members of this family are distributed in tropics, sub-tropics and temperate regions.

Economic Importance of *Rubiaceae*

Medicinal plants: Bark of Cinchona officinalis yields an alkaloid called Quinine which is the best remedy for malarial fever. The roots of Rubia cordifolia are also used as medicine.

Beverage plants: The seeds of Coffea arabica, C. liberica and C. robusta are roasted and ground to give coffee powder.

Ornamental plants: Rubia, Hamelia, Gardenia, Ixora, Mussaenda are cultivated in gardens for their beautiful flowers.

Primitive Characteristics

- Plants mostly trees and shrubs.
- Leaves simple and stipulate.
- Flowers mostly hermaphrodite and actinomorphic.
- Stamens polyandrous.
- Ovules anatropous and many in some genera.
- Seeds endospermic.

Advanced Characteristics

- A few plants are herbs (Rubia, Galium).
- Leaves opposite or whorled.
- Flowers epigynous and rarely unisexual, zygomorphic.
- Calyx and corolla fused.
- Stamens epipetalous.

- Carpel number reduced to two.
- Fruit simple.

Common Plant of the Family

- Coffea arabica (Coffee): An evergreen shrub, cultivated for seeds.
- Cinchona officinalis (Quinine): Tree cultivated for medicinal importance.
- Hamelia: A large evergreen shrub with reduced flowers.
- Rubia: A common climbing herb.
- Gardenia: A resinous shrub or tree.
- Ixora: Evergreen shrub with showy flowers. Many species are cultivated in gardens as ornamentals.
- Mussaenda: A shrub, very conspicuous during flowering.

Ramal and cauline, simple, opposite decussate, sub-sessile, interpetiolar stipules are present, lanceolate, entire, acute, unicostate reticulate.

3. Mussaenda (Refer Figure 11.1)

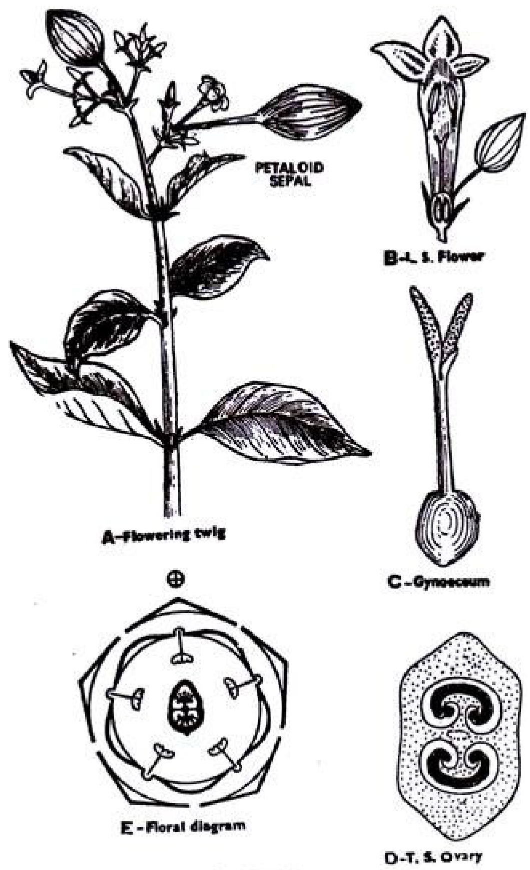

Fig. 11.1 *Mussaenda*

Habit: An ornamental, perennial, evergreen, shrub.

Root: Branched, tap root.

Stem: Herbaceous but woody in the lower portions, erect, cylindrical, branched, differentiating into nodes and internodes; internodes are swollen, hairy and green.

Leaf: Ramal and cauline, simple, opposite decussate, sub-sessile, interpetiolar stipules are present, lanceolate, entire, acute, unicostate reticulate.

Inflorescence: Dichasial cyme.

Flower: Bracteate, pedicellate, complete, hermaphrodite, actinomorphic but mature and older flowers are zygomorphic, pentamerous, epigynous, whitish yellow.

Calyx: Sepals 5, polysepalous or sometimes gamosepalous; 4 sepals are smaller and 5th one is modified into a yellow leafy bract in zygomorphic flowers; all sepals are of same shape, size and colour in actinomorphic flowers; persistent, valvate, green.

Corolla: Petals 5, gamopetalous, corolla tube is elongated and funnel shaped, valvate or rarely imbricate, yellow; coronary structures are present in the form of silky hairs.

Androecium: Stamens 5, alternipetalous, polyandrous, epipetalous, dithecous, basifixed or dorsifixed introrse.

Gynoecium: Bicarpellary, syncarpous, inferior, bilocular, many ovules, axile placentation; style long with two stigmatic lobes.

Fruit: A berry.

Seed: Many, small, endospermic.

Floral formula – (a) Young Flower – Br, $\oplus$ ⚥, K_5, $\widehat{C_{(5)}\,A_2}$, $G_{\overline{(2)}}$.

(b) Older flower – Br, $\oplus$, ⚥ K_5, $C_{(5)}$ $\widehat{A_5,\,G_{(2)}}$.

Common Plants of the Family

- Dichopsis pentaphylla: lndian butter tree.
- Madhuca butyracea: Mohwa tree.
- Palaquiu gutta: Common tree in Malaya and South India.
- Mimusops elengi: Bulbet-wood tree or the Indian medlar tree. Molsari.
- Bassia: Large handsome tree.

NOTES

Check Your Progress

5. Give characters of *Rubiaceae.*
6. What are the habits of *Rubiaceae?*
7. How are the stems of *Rubiaceae?*

11.4 *ASTERACEAE*: CHARACTERSTICS, DISTRIBUTION AND TYPES

Characteristics of *Asteraceae*

Mostly herbs or shrubs or rarely trees; leaves alternate rarely opposite, exstipulate rarely stipulate; inflorescence capitulum or head surrounded by involucre of bracts; ray and disc florets, flower tubular or ligulate, flowers bi- or unisexual or outer male or female, pentamerous, actinomorphic or zygomorphic, caryxpappus, corolla gamopetalous, petal lobes 5, stamens 5, epipetalous, usually dithecous, filament free and anthers united, i.e. syngenesious, introrse, ovary unilocular, inferior, with basal placentation, style slender stigma bifid; fruit cypsela.

A. Vegetative Characteristics

Habit: Herbs (Ageratum, Lactuca, Dahlia, Sonchus), shrubs (Inula, Senecio) rarely trees (Vernonia arborea and Leucomeris). Many of the plants are xerophytes (Proustia), hydrophytes (Cotula) some are semiaquatic (Caesulia axilaris).

Root: Tap root, sometimes modified into tubers (Dahlia).

Stem: Erect, or prostrate, herbaceous or woody (Artemisia), hairy, sometimes with latex. Stem tubers are also present (Helianthus); tubers are edible (H. tuberosus); cylindrical; glabrous, solid or fistular, stem may be leaf-like (Baccharis).

Leaf: Alternate rarely opposite (Zinnia, Dahlia) or whorled; leaves may be radical, petiolate or sessile, exstipulate, mostly simple sometimes scale-like (Senecio), unicostate or multicostate reticulate venation.

B. Floral Characteristics

Inflorescence: A head or capitulum, consisting of a few or large number of flowers or florets closely arranged on an axis surrounded by involucral bracts. The whole head or capitulum is apparently similar to a single flower because the involucral bracts perform the function of protection.

In Helianthus the outer or peripheral, ligulate and zygomorphic florets are called ray-florets; whereas inner or central, tubular and actinomorphic ones are called disc-florets.

In capitulum or head the form of flowers and distribution of sex also varies.

On the basis of form of flowers the heads are of three types

- **Heterogamous or radiate heads:** The outer or ray-florets are ligulate and zygomorphic and inner or disc-florets tubular and actinomorphic, for example Helianthus.
- **Homogamous-rayed or ligulate heads:** All the flowers in the head are ligulate, zygomorphic and alike, for example Sonchus.
- **Homogamous-non-rayed or discoid heads:** All the flowers are tubular, actinomorphic and alike, for example Ageratum.

Flower: Bracteate, sessile, (Sonchus, Ageratum), complete or incomplete, hermaphrodite or unisexual, pentamerous, tubular (actinomorphic) or ligulate (zygomorphic), epigynous and inconspicious.

Ray-florets: Zygomorphic, ligulate, pistillate, or neuter or sometimes also bisexual, epigynous.

Calyx: Modified into pappus or absent or scale-like.

Corolla: Petals 5, gamopetalous, highly coloured, ligulate, strap-shaped, valvate.

Androecium: Absent.

Gynoecium: Either absent or if present then bicarpellary, syncarpous, inferior, unilocular with basal placentation, one anatropous ovule; style one; stigma bifid.

Fruit: Absent; if present cypsela.

Seed: Non-endospermic.

Disc florets

Flower: Bracteate, sessile, complete, hermaphrodite, actinomorphic, pentamerous, epigynous and tubular.

Calyx: Modified into pappus or scale, persistent.

Corolla: Petals 5, gamopetalous, tubular, coloured.

Androecium: Stamens 5, epipetalous, syngenesious, dithecous, introrse, dehiscing longitudinally.

Gynoecium: Bicarpellary, syncarpous, inferior, unilocular with single anatropous ovule, basal placentation; style simple, long, stigma bifid.

Fruit: Cypsela.

Seed: Non-endospermic.

Pollination: Entomophilous.

Economic Importance of *Asteraceae*

- **Food:** Leaves of Lactuca sativa are used as salad. The roots of Helianthus tuberosus are edible.
- **Oil:** The seeds of Helianthus and Artemisia yield oil.
- **Medicinal:** Solidago used in dropsy. Artemisia yields santonin which is used as vermifuge. The roots of Taraxacum used in bowel disorders. The juice of Emillia sonchifolia leaves has cooling effect and is used in eye inflammation and also for night blindness. Eclipta alba used as tonic in spleen enlargement. Centipeda orbicularis is used in cold and toothache.
- **Rubber:** It is obtained from Solidago laevenworthii and Taraxacum.
- **Insecticide:** The capitula of Chrysanthemum roseum and C. cinerriefolium are dried, powdered and used as insecticide.
- **Ornamental:** Zinnia, Dahila, Cosmos, Chrysanthemum, Calendula, Helichrysium, Aster Helianthus etc. are well known garden plants.
- **Weeds:** Xanthium, Blumea, Sonchus, Vernonia are the common weeds.

Primitive Characteristics

- Some plants are woody and perennial.
- Leaves alternate and simple.
- Capitulum of only actinomorphic, hermaphrodite flower in some genera viz. Vernonia, Ageratum, Mikania.
- Ovules anatropous.
- Pollination by insects.

Advanced Characteristics

The family Asteraceae (Compositae) is regarded as the most advanced and highly evolved and is considered to occupy the highest position in the plant kingdom.

- It includes maximum number of genera (950) and species (20000).
- The members of this family are worldwide in distribution.
- Plants mostly herbaceous annuals, biennials or perennials.
- Leaves exstipulate, opposite or whorled.
- Floral buds are well protected by involucral bracts.

- Flowers sessile, small, inconspicuous.
- Flowers arranged to form capitulum inflorescence.
- Flowers epigynous and in many species zygomorphic.
- Calyx reduced to pappus or scales.
- Corolla gamopetalous and tubular.
- Reduction in the number of stamens.
- Stamens epipetalous and syngenesious.
- Gynoecium bicarpellary, syncarpous, inferior, unilocular.
- Single ovule.
- Basal placentation.
- Fruit simple, in some mechanism of wind dispersal (parachute).
- Some plants are wind pollinated.
- Seed non-endospermic.
- Due to small flowers much of the material is saved.

Launea asplenifolia (Refer Figure 11.2)

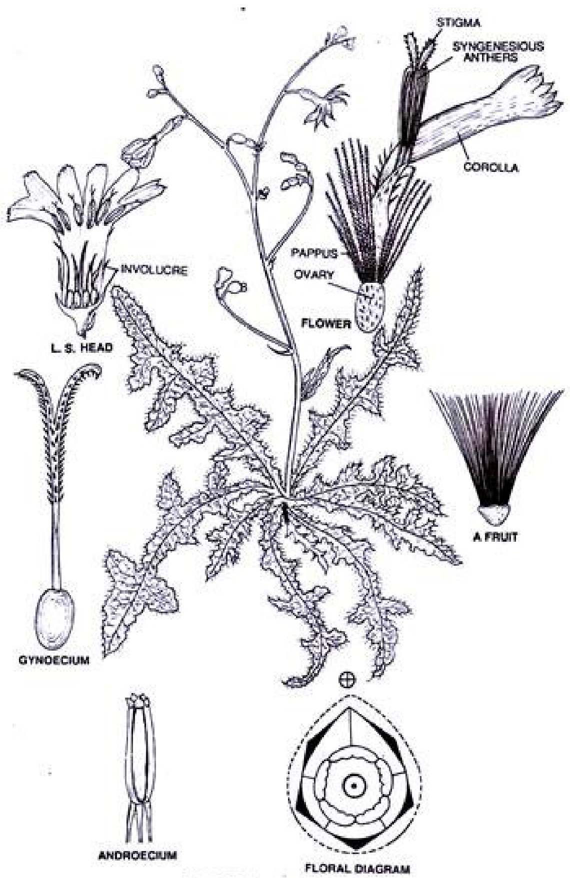

Fig. 11.2 *Launea asplenifolia*

Habit: A perennial herb, grows in rosettes.

Root: Tap, branched.

Stem: Herbaceous, reduced but trailing, cylindrical, solid, glabrous.

Leaves: Radical, alternate, sessile, simple, exstipulate, margin spinulose toothed, unicostate reticulate venation.

Inflorescence: Head of homogamous ligulate flowers.

Flower: Bracteate, sessile, complete, hermaphrodite, zygomorphic, pentamerous, epigynous, all ligulate, yellow.

Calyx: Represented by pappus, i.e., tuft of hairs, superior.

Corolla: Petals 5, gamopetalous, ligulate, valvate, superior, yellow.

Androecium: Stamens 5, epipetalous, syngenesious, basifixed, dithecous, introrse, superior.

Gynoecium: Bicarpellary, syncarpous, inferior, unilocular, basal placentation, single basal ovule; style simple, stigma bifid.

Fruit: Capsela.

Floral formula:

$$Br \ \text{o|o} \ ⚥ \ K_{pappus} \ \overset{\frown}{C_{(5)} \ A_{(5)}} \ G_{\overline{(2)}}$$

Check Your Progress

8. What type of inflorescence does *Asteraceae* have?
9. Give some economic importance of *Asteraceae.*
10. Give some primitive characteristics of *Asteraceae*
11. Give some advanced characteristics of *Asteraceae.*

11.5 *APOCYNACEAE*: CHARACTERSTICS, DISTRIBUTION AND TYPES

Explanation on Family *Apocynaceae*

There are about 300 genera and 1300 species in this family.

Distribution: The members of this family are found throughout the world, but they are more commonly met with in the tropical regions.

Habit: There is a great variation in the habit of the plants of this family. They may be herbs, erect or twining shrubs or trees. Vinca rosea (Verna-Sadabahar) is a perennial herb; Vallaris solanacea (Verna-Ramsar) is a large twining shrub; Nerium indicum (N. odorum) is a large shrub with beautiful red or white flowers; The vetia peruviana or The vetia nerifolia (Verna-Pili kaner) is a large shrub or a small tree; Plumeria acutifolia is a small sized tree and Alstonia scholaris is a medium sized tree. In some genera, the stem becomes tuber like, for example Adenium. The species of Landolphia and Clitandra are climbing shrubs.

The latex is present in most of the genera.

Root: Tap and branched.

Stem: Usually erect, branched, solid, glabrous rarely tuber-like and thick.

Leaves: The leaves are simple, petiolate, usually opposite decussate. In rare cases the leaves are alternate or even whorled (for example, in Nerium odorum, Alstonia, etc.) Usually the leaves are exstipulate and very rarely they may be stipulate.

Inflorescence: Usually the inflorescence is of cymose type. It is very rarely solitary as in Vinca. In Carissa, the flowers are found to be arranged in corymbose cymes. In Plumeria, the flowers are arranged in terminal cymes. In Alstonia, the flowers are found to be arranged in umbellate branched panicled cymes. In Rauvolfia, the flowers are arranged in umbellate or corymbose cymes.

Flowers: The flowers are pedicellate, bracteate, bracteolate, hermaphrodite, actinomorphic, regular, sometimes slightly, zygomorphic, complete, hypogynous and pentamerous. In rare cases the flowers are tetramerous with reduction to two in the pistil.

Calyx: Usually it consists of five sepals, gamosepalous. The calyx is generally divided almost to the base. The aestivation is quincuncial.

Corolla: Usually the corolla consists of five petals, gamopetalous. It is generally salver or funnel shaped. The corolla tube usually possesses hairy appendage or scales. The aestivation is contorted.

Androecium: It consists of five stamens alternating with the petals. The stamens are situated on the tube or the throat of the corolla (i.e., epipetalous). The filaments are short; anthers introrse, polyandrous or connate and often adhere to the stigma. The antherlobes are sometimes empty at their base and prolonged into spines.

Gynoecium: It consists of two carpels. The carpels may be free (apocarpous) or connate (syncarpous); superior, sometimes partly inferior as in Plumeria. The style is simple and the stigma is thick and often bilobed. Rarely the number of carpels exceeds, i.e., 3 to 5. Usually a nectar secreting disc is situated beneath the gynoecium.

In syncarpous gynoecium, the ovary may be unilocular with parietal placentation or it may be bilocular with axile placentation. In the case of separate ovaries the placentation is marginal. The ovary is superior or half-inferior. Numerous ovules are found to be situated on parietal placentas or in two chambered ovaries on marginal walls.

Fruit: In the case of free ovaries, the fruit is a pair of follicles. Sometimes the fruits of separate ovaries are fleshy and indehiscent, or may be one seeded, for example Cameraria. In the case of syncarpous ovary, usually the fruit is indehiscent, fleshy and berry-like, for example in Landolphia. In Cerbera, it may be a drupe.

This fruit is coconut like and distributed by means of water currents. In certain genera, possessing syncarpous ovaries a two-valved capsule is found, e.g., in Aspidosperma and Allamanda.

Seed: In dry fruits the seeds are generally winged, for example in Plumeria. Sometimes the seed bears a tuft of hairs at the base, for example in Kickxia, and sometimes at both ends, for example in Strophanthus the embryo is straight, with or without endosperm.

Pollination: Generally it takes place through the agency of insects.

Vinca rosea; Verna.-Sadabahar

Habit: A perennial herb.

Stem: Erect, cylindrical, branched, solid, reddish green, glabrous.

Leaf: Cauline, simple, opposite, decussate, petiolate, exstipulate, obovate, entire, glabrous, mucronate apex, unicostate reticulate venation.

Inflorescence: Cymose, flowers arranged in axillary pairs.

Flower: Pedicellate, bracteate, hermaphrodite, actinomorphic, complete, pink, hypogynous.

Calyx: 5, polysepalous, glandular, green, inferior, quincuncial aestivation.

Corolla: 5, gamopetalous forming corolla tube, throat of corolla tube hairy forming a corona, contorted aestivation.

Androecium: 5, free, epipetalous, alternate to petals, almost sessile, anthers dorsifixed, connivent round the stigma, yellowish.

NOTES

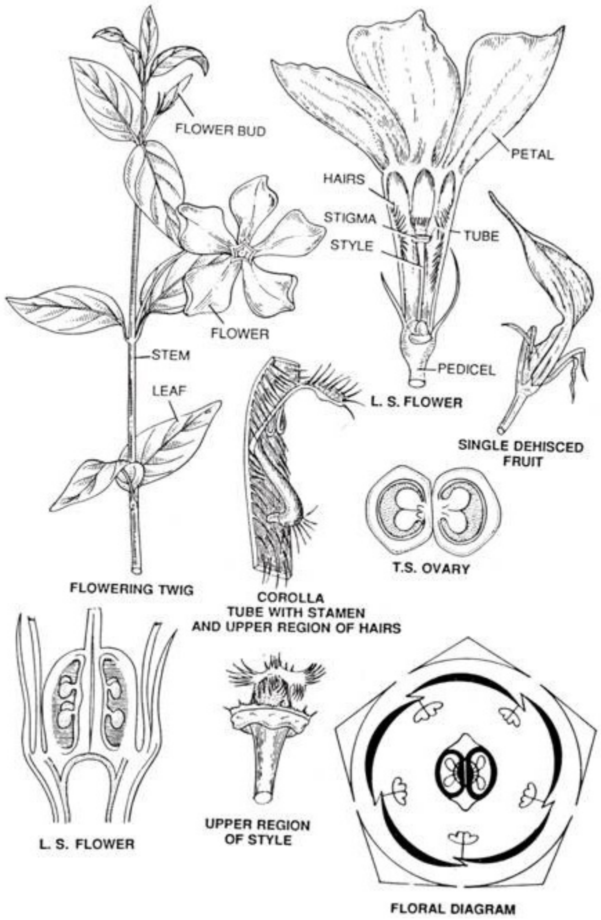

Fig. 11. 3 *Apocynaceae. Lochnera rosea*

Gynoecium: 2 carpels (bicarpellary), syncarpous, carpels united above in the region of style and stigma, ovaries free (apocarpous below), with single style and stigma, ovaries superior nectar secreting disc present beneath ovaries, unilocular, marginal placentation, glands present alternating with the carpels, style filiform, stigma thickened, dumb-bell shaped.

Fruit: A pair of elongated follicles.

2. Plumeria acutifolia; Verna.-Goburchampa (Refer Figure 11.4):

Habit: A large shrub or small tree.

Stem: Erect, solid, branched, woody, latex present, glabrous, green, and cylindrical.

Leaf: Simple, whorled, petiolate, margin smooth, apex acute, unicostate reticulate venation large.

Inflorescence: Cymose.

Flowers: Pedicellate, bracteate, hermaphrodite, actinomorphic, complete, hypogynous.

NOTES

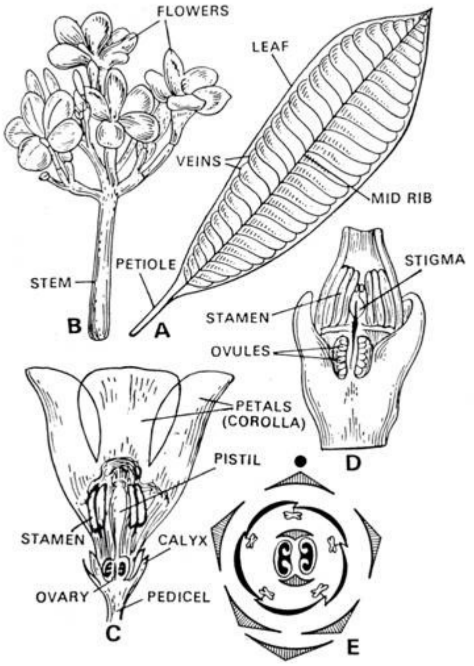

Fig. 11.4 Apocyanceae, Plumeria sp.

Calyx: 5, polysepalous, imbricate aestivation.

Corolla: 5, gamopetalous forming a corolla tube, twisted aestivation.

Androecium: 5, free, epipetalous, included in the corolla tube, introrse, two-celled, basifixed.

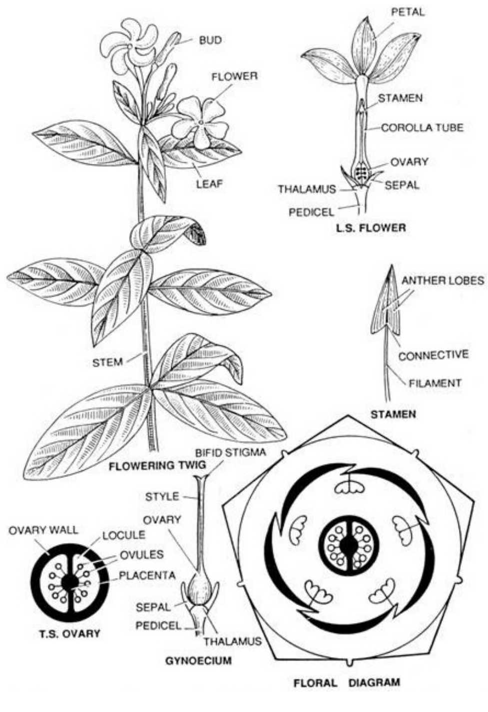

Fig. 11.5 Apocynacee, Tabernaemontana divaricate

Economic value: Grown as an ornamental. The red pulp around seed is used as a dye. Wood is refrigerant. Milky juice is used for diseases of eye. Root is acrid, bitter, used as local anodyne and chewed for relief of toothache. (Refer Figure 11.5)

Gynoecium: 2 (bicarpellary), syncarpous, ovary superior or partly inferior, bilocular, axile placentation, style one, stigma simple.

Floral Formula: $\oplus$ ⚥ $K_5, \overparen{C_{(5)}, A_5}, G_{(\underline{2})}$.

Economic value: A beautiful shrub; grown as a hedge plant. Plant is poisonous. Root is powerful resolvent and attenuant; used externally. Oil prepared from root bark is used in skin diseases and leprosy.

Economic Importance of *Apocynaceae*

The family is of little economic value. Some plants are grown as ornamentals, while some possess medicinal properties.

A list of some important plants is given here:

- Alstonia scholaris; Eng.-Dita bark; Verna.-Satwin. This is a small tree grown as an ornamental. Its wood is quite light and used for carvings. In Myanmar, the black boards are prepared from its wood. The bark possesses medicinal properties, which is used for diarrhoea and dysentery. Its latex is applied to ulcers.
- Beaumontia grandiflom; Eng.-Nepal trumpet flower-It is a climbing shrub, usually grown as an ornamental for its large, white fragrant flowers. It is native of the Eastern Himalayas.
- Beaumontia jerdoniana -This is also grown as an ornamental.
- Anodendron paniculatum - Its leaves and roots possess medicinal properties.
- Carissa carandas; Eng.-Karanda; Verna.-Karaunda-This is a spiny shrub grown throughout India for its sour edible fruits. The fruits are used as vegetable and pickle is prepared from them. The plant makes a good hedge.
- Carissa grandiflora; Syn. Arduina grandiflora; Eng.-Natal plum.-This is a large spiny shrub usually grown in Maharashtra and Baroda for its edible fruits.
- Carissa spinarum. This is a shrub or a small tree cultivated throughout India for fragrant flowers and hedge plants.
- Carrisa arduina; Syn. C. bispinosa- Eng.-Natal plum.-This is a thorny shrub grown for its edible fruits.
- Ichnocarpus frutescens; Eng. -blackcreeper; Verna.-Dudhilata, Siamalata. This is a twining ornamental shrub. It is found in Uttar

Pradesh, Madhya Pradesh, Bihar, Assam and the Sundarbans. The stems are used for making ropes, baskets and fishing traps. The leaves possess medicinal properties.

- Landolphia kirkii.-The rubber is prepared from its latex. They have leaves with hook tendrils.
- Nerium indicum; Syn. N. odorum; N. oleander, Eng.-Oleander; Verna.-Kaner.-It is a shrub. They are grown as hedge plants. The plants possess medicinal properties.
- Rauvolfia serpentine; Syn. Ophioxylon serpentinum; Verna.-Chhotachand.-This is a small shrub found in Assam, Dehradun, Bihar, the Western Ghats and Bengal; the roots possess medicinal properties and are used in the treatment of hypertension, mental disorders and related ailments.
- Plumeria rubra forma acutifolia; Syn. P. acutifolia; Verna.-Goburchampa-It is grown as an ornamental. It possesses several medicinal properties.
- Plumeria alba.-A small tree, grown as an ornamental. The latex is applied to ulcers.
- The vetia peruviana; Syn. The vetia nerifolia; Eng.-Yellow oleander; Verna. - Pilikaner. - It is a shrub. The plants are grown as ornamental. They are also grown as hedge plants. The latex is highly poisonous.
- Wrightia tinctoria; Syn. W. rothii; Nerium tinctorum; Verna.-Dudhi.-A tree, found in Rajasthan, Madhya Pradesh and Tamil Nadu. A blue dye is obtained from its flowers and fruits. The fruits are edible. The bark and seeds possess medicinal properties.
- Wrightia tomentosa; Syn. W. mollissima; Nerium tomentosum; Verna.-Dharauli-The seeds and roots yield a yellow dye. The leaves and fruits are edible. Its soft wood is used for carvings. The bark and roots are used as an antidote for snake bite.
- Aganosma dichotoma; Syn. Echites dichotoma; Verna.-Malati.-This is a climbing shrub, grown as an ornamental in the gardens.
- Allamanda cathartica; Eng.-Allamanda-This is a beautiful climbing shrub, grown as an ornamental in the gardens. It is native of Central America and Brazil.

11.6 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Characteristics of *Sapotaceae* include trees and shrubs with laticiferous vessels; Leaves, flowers and fruits often clothed with hairs; flower

hermaphrodite, hypogynous, actinomorphic; sepals 2-8 in two isomerous whorls or 5 in one whorl, pelals 4-8 gamopetalous in one whorl, rarely double the sepals in two whorls; stamens epipetalous in 2-3 whorls, the outer antisepalous whorl reduced to staminodes or absent; carpels many, syncarpous; ovary superior, completely separated, many chambered, axile placentation.

2. Corolla of *Sapotaceae* have Petals 4-8, more or less united, in one whorl or more rarely double the number of sepals in two whorls, united in semi-funnel shaped rotate or lenceolate corolla, corolla lobes imbricate or contorted in bud, rarely petals with dorsal appendages which resemble corolla lobes.
3. Roots of *Sapotaceae* are tap, branched.
4. Stem of *Sapotaceae* are erect, woody, branched.
5. Characters of *Rubiaceae* includes trees or herbs; leaves alternate or opposite; stipules interpetiolar or intrapetiolar, inflorescence cymose; flowers tetra or pentamerous, hermaphrodite, actinomorphic, epigynous, corolla, gamopetalous; stamens 4-5; epipetalous, introrse, dithecous; ovary inferior, bilocular with one or many ovules in each loculus; fruit capsule or berry.
6. Habit of *Rubiaceae* is mostly shrubs (Gardenia, Ixora, Mussaenda, Hamelia); trees (Morinda, Adina) and a few herbs (Galium, Rubia).
7. Stems of *Rubiaceae are* erect, herbaceous or woody or twinning (Manettia), climbing by hooks (Uncaria), branched, cylindrical or angular, hairy or smooth.
8. Inflorescence of *Asteraceae* have a head or capitulum, consisting of a few or large number of flowers or florets closely arranged on an axis surrounded by involucral bracts. The whole head or capitulum is apparently similar to a single flower because the involucral bracts perform the function of protection.
9. Economic Importance of *Asteraceae*
    - Food: Leaves of Lactuca sativa are used as salad. The roots of Helianthus tuberosus are edible.
    - Oil: The seeds of Helianthus and Artemisia yield oil.
    - Medicinal: Solidago used in dropsy. Artemisia yields santonin which is used as vermifuge. The roots of Taraxacum used in bowel disorders. The juice of Emillia sonchifolia leaves has cooling effect and is used in eye
10. Primitive characteristics of *Asteraceae*
    - Some plants are woody and perennial.
    - Leaves alternate and simple.

- Capitulum of only actinomorphic, hermaphrodite flower in some genera viz. Vernonia, Ageratum, Mikania.
- Ovules anatropous.
- Pollination by insects.

NOTES

11. Some of the advanced characteristics of *Asteraceae includes:*
    - It includes maximum number of genera (950) and species (20000).
    - The members of this family are worldwide in distribution.
    - Plants mostly herbaceous annuals, biennials or perennials.
    - Leaves exstipulate, opposite or whorled.

11.7 SUMMARY

- Trees and shrubs of *Sapotaceae* are with laticiferous vessels; Leaves, flowers and fruits often clothed with hairs; flower hermaphrodite, hypogynous, actinomorphic; sepals 2-8 in two isomerous whorls or 5 in one whorl, pelals 4-8 gamopetalous in one whorl, rarely double the sepals in two whorls; stamens epipetalous in 2-3 whorls, the outer antisepalous whorl reduced to staminodes or absent; carpels many, syncarpous; ovary superior, completely separated, many chambered, axile placentation.
- *Rubiaceae* are trees or herbs; leaves alternate or opposite; stipules interpetiolar or intrapetiolar, inflorescence cymose; flowers tetra or pentamerous, hermaphrodite, actinomorphic, epigynous, corolla, gamopetalous; stamens 4-5; epipetalous, introrse, dithecous; ovary inferior, bilocular with one or many ovules in each loculus; fruit capsule or berry.
- *Rubiaceae* is commonly known as Madder or Coffee family. It includes 6000 species and 500 genera. In India it is represented by 551 species. The members of this family are distributed in tropics, sub-tropics and temperate regions.
- *Asteraceae are* mostly herbs or shrubs or rarely trees; leaves alternate rarely opposite, exstipulate rarely stipulate; inflorescence capitulum or head surrounded by involucre of bracts; ray and disc florets, flower tubular or ligulate, flowers bi- or unisexual or outer male or female, pentamerous, actinomorphic or zygomorphic, caryxpappus, corolla gamopetalous, petal lobes 5, stamens 5, epipetalous, usually dithecous, filament free and anthers united , i.e., syngenesious, introrse, ovary unilocular, inferior, with basal placentation, style slender stigma bifid; fruit cypsela.

- Habit of *Asteraceae are as* Herbs (Ageratum, Lactuca, Dahlia, Sonchus), shrubs (Inula, Senecio) rarely trees (Vernonia arborea and Leucomeris). Many of the plants are xerophytes (Proustia), hydrophytes (Cotula) some are semiaquatic (Caesulia axilaris).
- Floral characteristics of *Asteraceae* inflorescence is head or capitulum, consisting of a few or large number of flowers or florets closely arranged on an axis surrounded by involucral bracts. The whole head or capitulum is apparently similar to a single flower because the involucral bracts perform the function of protection.
- In Helianthus the outer or peripheral, ligulate and zygomorphic florets are called ray-florets; whereas inner or central, tubular and actinomorphic ones are called disc-florets.
- Androecium of *Asteraceae* have stamens 4 or 5, rarely many (Gardenia), epipetalous, alternipetalous, inserted near the mouth of corolla tube, stamens dithecous, introrse, dehiscing longitudinally, superior.
- Gynoecium of *Asteraceae* is Bicarpellary, rarely polycarpellary, syncarpous, inferior rarely half inferior (Synaptanthera) or superior (Paganea), sometimes unilocular (Gardenia) with one to many anatropous ovules in each loculus, axile placentation (parietal placentation in Gardenia), style one sometimes bifid or multifid, stigma simple or bilobed.
- *Rubiaceae* is used as medicinal plants as the bark of Cinchona officinalis yields an alkaloid called Quinine which is the best remedy for malarial fever. The roots of Rubia cordifolia are also used as medicine.
- *Rubiaceae* is used as in beverage plants the seeds of Coffea arabica, C. liberica and C. robusta are roasted and ground to give coffee powder.
- *Apocynaceae* have the habitat of great variation in the habit of the plants of this family. They may be herbs, erect or twining shrubs or trees. Vinca rosea (Verna-Sadabahar) is a perennial herb; Vallaris solanacea (Verna-Ramsar) is a large twining shrub; Nerium indicum (N. odorum) is a large shrub with beautiful red or white flowers; The vetia peruviana or The vetia nerifolia (Verna-Pili kaner) is a large shrub or a small tree; Plumeria acutifolia is a small sized tree and Alstonia scholaris is a medium sized tree. In some genera, the stem becomes tuber like, for example Adenium. The species of Landolphia and Clitandra are climbing shrubs.
- Leaves of *Apocynaceae* are simple, petiolate, usually opposite decussate. In rare cases the leaves are alternate or even whorled (for example, in Nerium odorum, Alstonia, etc.) Usually the leaves are exstipulate and very rarely they may be stipulate.

- Inflorescence of *Apocynaceae* is usually the inflorescence is of cymose type. It is very rarely solitary as in Vinca. In Carissa, the flowers are found to be arranged in corymbose cymes. In Plumeria, the flowers are arranged in terminal cymes. In Alstonia, the flowers are found to be arranged in umbellate branched panicled cymes. In Rauvolfia, the flowers are arranged in umbellate or corymbose cymes.
- Flowers of *Apocynaceae* are pedicellate, bracteate, bracteolate, hermaphrodite, actinomorphic, regular, sometimes slightly, zygomorphic, complete, hypogynous and pentamerous. In rare cases the flowers are tetramerous with reduction to two in the pistil.
- Calyx of *Apocynaceae* usually consists of five sepals, gamosepalous. The calyx is generally divided almost to the base. The aestivation is quincuncial.
- Corolla of *Apocynaceae* consists of five petals, gamopetalous. It is generally salver or funnel shaped. The corolla tube usually possesses hairy appendage or scales. The aestivation is contorted.
- Androecium of *Apocynaceae* is of five stamens alternating with the petals. The stamens are situated on the tube or the throat of the corolla (i.e., epipetalous). The filaments are short, anthers introrse, polyandrous or connate and often adhere to the stigma. The antherlobes are sometimes empty at their base and prolonged into spines.

11.8 KEY WORDS

- **Apocynaceae:** Apocynaceae is a family of flowering plants that includes trees, shrubs, herbs, stem succulents, and vines, commonly known as the dogbane family.
- **Gamopetalous:** gamopetalous Describing a flower in which the petals are fused to form a corolla tube.
- **Aestivation:** Aestivation is a state of animal dormancy, similar to hibernation, characterized by inactivity and a lowered metabolic rate, that is entered in response to high temperatures and arid conditions.
- **Quincuncial:** Arranged in a quincunx. (botany) Having the leaves of a pentamerous calyx or corolla so imbricated that two are exterior, two are interior, and the other has one edge exterior and one interior.
- **Rubiaceae:** The Rubiaceae are a family of flowering plants, commonly known as the coffee, madder, or bedstraw family.
- **Gamopetalae:** Gamopetalae is an artificial group used in the identification of plants based on Bentham and Hooker's classification system.

- **Sapotaceae:** The Sapotaceae are a family of flowering plants belonging to order Ericales.
- **Asteraceae:** Asteraceae or Compositae is a very large and widespread family of flowering plants.

11.9 SELF ASSESSMENT QUESTIONS ANDN EXERCISES

Short Answer Questions

1. Write a short note on general characteristics of *Sapotaceae.*
2. Mention some of the vegetative characters of *Sapotaceae.*
3. Write some of the floral characters of *Sapotaceae.*
4. Write about primitive and advanced characters of *Rubiaceae.*
5. Name some of the common plants of *Rubiaceae* family.
6. Give some floral characteristics of *Asteraceae.*
7. What is the habitat of *Apocynaceae.*

Long Answer Questions

1. Give a detailed note on *Sapotaceae* family including its floral, vegetative and economic importance.
2. Write in detail about *Rubiaceae* family giving its vegetative and floral characters.
3. Give a detailed note on *Rubiaceae* family mentioning about its distribution, economic importance, primitive and advanced characters.
4. Write about the character of Mussaenda plant.
5. Explain in detail about the vegetative , floral, primitive and advanced characters of *Asteraceae*.
6. Write in detail about *Apocynaceae* family.
7. Discuss about the economic importance of *Apocynaceae.*

11.10 FURTHER READINGS

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UNIT 12 GAMOPETALAE FAMILY: CONVOLVULACEAE, BIGNONIACEEAE, SCROPHULARIACEEAE AND VERBENACEAE

Structure

12.0 INTRODUCTION

Gamopetalae is an artificial group used in the identification of plants based on Bentham and Hooker's classification system. George Bentham and Joseph Dalton Hooker published an excellent classification in three volumes between 1862 and 1883. As a natural system of classification, it does not show evolutionary relationship between plants but still is a useful and popular system of classification based on a dichotomous key especially for the flowering plant groups (angiosperms). It is the most popular system of classification based on key characteristics enabling taxonomic students to quickly identify plant groups based only on physical characteristics. However, it is not a scientific group and is used for identification purposes only based on similar plant characteristics. Under the system Gamopetalae is a Sub Class and comprises of flowers with distinct calyx and corolla. The petals are joined together in the corolla.

In this unit, you will study about Gamopetalae family, *Convolvulaceae, Bignoiaceae, Scrophulariaceae* and *Verbenaceae* in detail.

12.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about Gamopetalae family
- Discuss about *Convolvulaceae* and its characteristics, distribution and economic importance
- Explain *Bignoiaceae* and its characteristics, distribution and economic importance
- Describe about *Scrophulariaceae* and its characteristics, distribution and economic importance
- Learn about *Verbenaceae* and its characteristics, distribution and economic importance

12.2 *CONVOLVULACEAE*

Convolvulaceae, the morning glory family of flowering plants, which includes some 57 genera and about 1,600 species, widely cultivated for their colourful funnel-shaped flowers. The family is classified as a member of the order Solanales. Most are twining and erect herbs, with a few woody vines, trees, and shrubs. The family is widespread in both tropical and temperate areas. The sweet potato (*Ipomoea batatas*) is an economic plant of the family, but the ornamental vines are used in horticulture; several species of bindweeds are agricultural pests. The seeds of two species, Turbina corymbosa and Ipomoea violacea, are sources of hallucinogenic drugs of historical interest and contemporary concern.

The leaves of plants belonging to the family are alternate and simple or compound, and the flower petals are united in the characteristic funnel-shaped corolla. The stems often contain latex and are rarely tuberous. The roots are usually fibrous but sometimes form rootstalks or tubers.

Characters of *Convolvulaceae*

Herbs or shrubs, climbing; leaves alternate, simple, exstipulate, rarely stipulate; inflorescence cymose; flowers actinomorphic, hermaphrodite, hypogynous; calyx 5, polysepalous; colrolla gamopetalous, campanulate; stamens 5, epipetalous, alternipetalous, disc present; ovary bicarpellary, syncarpous, superior, axile placentation, generally two ovules per loculus; fruit capsule or nut.

A. Vegetative Characteristics

Habit: Herbs (Convolvulus, Evolvulus), shrubs and climbing {Ipomoea, Argyeria), the plants may be xerophytic, hydrophytic (Ipomoea aquatica) or parasitic (Cuscuta).

Root: Tap, branched, fleshy (Ipomoea batatus; H. Sakarkand). Cuscuta without ordinary roots but adventitious haustoria are present.

Stem: Erect, or prostrate, herbaceous, twiner (Ipomoea and Cuscuta), cylindrical, branched, solid or fistular, tuberous rhozomatous (Convolvulus).

Leaves: Alternate, simple, exstipulate, petiolate, entire or palmately lobed, or pinnately divided (Quamoclit pinnata), unicostate or multicostate reticulate venation.

B. Floral Characteristics

Inflorescence: Solitary axillary (Convolvulus, Evolvulus) or cymes.

Flower: Bracteate, bracteolate, pedicellate, complete hermaphrodite, actinomorphic, pentamerous, (in Hildebrandita the flowers are tetramerous, unisexual) and hypogynous.

Calyx: Sepals 5, polysepalous rarely gamosepalous, persistent, imbricate, inferior.

Corolla: Petals 5, gamopetalous, campanulate, or infundibuliform, imbricate, or valvate (induplicate valvate in Ipomoea), inferior.

Androecium: Stamens 5, polyandrous, epipetalous, length of the filaments variable in the same flower; dorsifixed or basifixed, inserted deep in the corolla tube, dithecous and introrse.

Gynoecium: Bicarpellary, syncarpous, superior, situated on a disc, sometimes tetralocular, axile placentation, two or rarely one ovule per loculus; style simple, or two (Cuscuta), filiform, stigma capitate or bifid (Convolvulus, Ipomoea palmata).

Fruit: Capsule (Convolvulus, Evolvulus, Cuscuta) or berry.

Seed: Endospermic.

Pollination: Entomophilous.

Floral Formula:

$$Br \oplus ⚥ K_5 \overset{\frown}{C_{(5)} A_5} \underline{G_{(2)}}.$$

Distribution of *Convolvulaceae*

It is commonly known as Sweet-potato family. It includes 55 genera and 1650 species which are found in tropical region of the world. In India the family is represented by 177 species belonging to 20 genera.

Economic Importance of *Convolvulaceae*

- **Food:** Tuberous roots of *Ipomoea batatus* (Sweet potato) are rich in starch and edible. Root stock of *Calystegia sepium* are cooked and eaten. The leaves of *Ipomoea aquatica* are used as vegetable.
- **Medicinal:** Due to the purgative property of latex, several species are used as medicine *(Exogynum purga)*. *Ipomoea hederacea* yields Kaladana. Leaves of *Ipomoea pescarpae* are boiled and applied externally in case of colic while decoction in used as a blood purifier and in bilious disorders. *Ipomoea paniculata* is considered good for rejuvenation, *Merremia tridentata* is used in rheumatism, piles and urinary disorders.
- **Weed:** *Convolvulus arvensis, Evolvulus alsinoides*, are the common weeds. Cuscuta is a parasite and ruins many types of plants.
- **Ornamental:** *Ipomoea biloba, Convolvulus, Porana, Calystegia apd Quamoclit* are cultivated as ornamentals.

Primitive Characteristic

- Presence of shrubs and woody climbers.
- Leaves simple and alternate.
- Solitary axillary inflorescence.
- Flowers actinomorphic, hermaphrodite and hypogynous.
- Calyx mostly free.
- Stamens polyandrous and dithecous.
- Seeds endospermic.

Advanced Characteristics

- Plants mostly herbs annual or perennial.
- Leaves reduced and scale-like in Cuscuta.
- Parasitic habit.
- Leaves exstipulate.
- Corolla gamopetalous.
- Number of stamens five; epipetalous.
- Gynoecium with two fused carpels.
- Fruit simple.

Affinities of *Convolvulaceae*

Convolvulaceae is closely related to the Boraginaceae but can be distinguished by the terminal bilobed stigma, disc below the ovary and curved embryo.

Rendle and Wettestein segregated the family in a separate order Covolvulales, Wettestein considered them to be allied to the Malvales and Geraniales.

Common Plants of the Family

- **Ipomoea:** Largest genus of the family; twining or erect herb, or shrub.
- **Cuscuta (H. Akash bel):** Parasitic, leafless twiner.
- **Convolvulus:** Common weed in the fallow fields.
- **Argyeria roxburghi:** Robust, beautiful climber with red, funnel-shaped flowers.
- **Argyeria nervosa (Elephant climber):** Garden climber with cordate leaves.
- **Evolvulus:** Sleeping, perennial herb, common on sandy soil.
- **Merremia:** Climbing or creeping shrub with cord-like stem rooting at the nodes.
- **Ipomoea biloba (Goats foot):** A sand binder.

Division of the Family and Chief Genera

The family is divided into 2 sub-families as follows:

Sub-family 1. *Convolvuloideae*

The plants are autotrophic and bear leaves; cotyledons plicate. It includes 8 tribes, viz., Dichondreae, Dicranostyleae, Hidenbrandtieae, Convolvuleae, Poraneae, Ipomoeae, Argyerieae and Erycibrae.

Sub-family 2. *Cuscutoideae*

Parasitic members with reduced scale leaves; cotyledons are either absent or reduced; Cuscuta.

Important Types of *Convolvulaceae*

1. **Ipomoea palmata** (Refer Figure 12.1)

NOTES

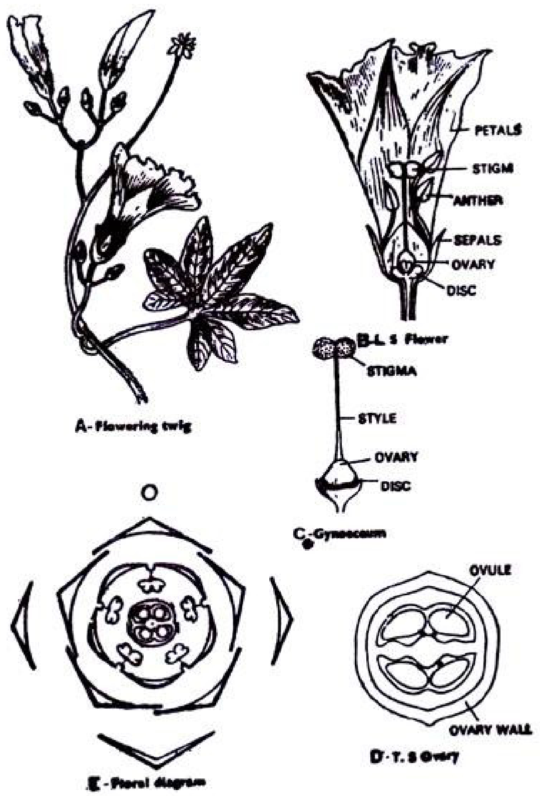

Fig. 12.1 *Ipomoea palmata*

Root: Tap, branched.

Stem: Thin, cylindrical, greenish, climbing, perennial with distinct nodes and internodes solid, herbaceous.

Leaf: Alternate, exstipulate, palmately compound divided into 5-7 leaflets, petiolate, leaves ovato-elliptical, entire, acute, unicostate reticulate.

Inflorescence: A dichasial cyme.

Flower: Bracteate, pedicellate, complete, hermaphrodite, pentamerous, hypogynous, violet coloured.

Calyx: Sepals 5, polysepalous, green, quincuncial, inferior.

Corolla: Petals 5, gamopetalous, infundibuliform, induplicate valvate.

Androecium: Stamens 5, polyandrous, epipetalous, filaments of unequal length, slender, basifixed, dithecous, introrse.

Gynoecium: Bicarpellary, syncarpous, superior, bilocular, axile placentation, with 2 ovules per locule, style slender long, stigma bilobed.

Fruit: Capsule.

Floral formula:

$$Br \oplus ⚥ K_{(5)} \overbrace{C_{(5)} A_5} G_{\underline{(2)}}.$$

2. **Cuscuta reflexa (Refer Figure 12.2):**

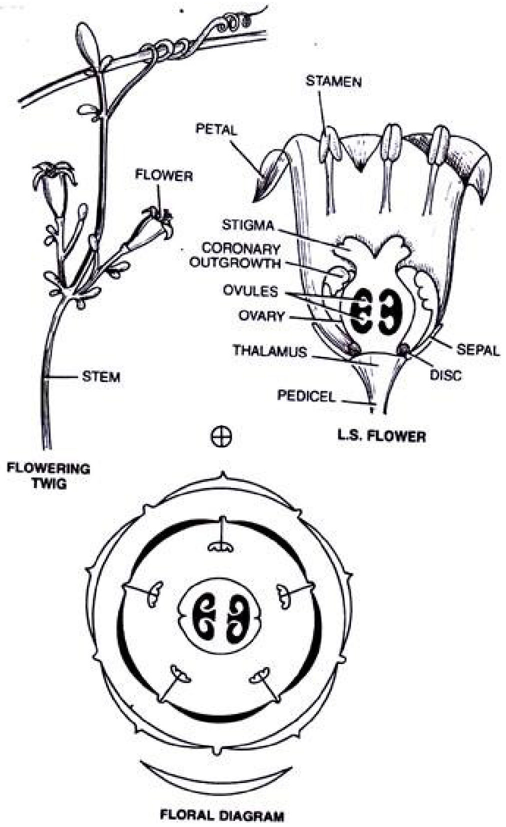

Fig. 12.2 *Cuscuta reflexa*

Habit: A perennial herb, leafless, total parasite.

Root: Absent, haustoria present.

Stem: Weak, herbaceous, twining, branched, cylindrical, solid, smooth, yellowish green.

Leaves: Absent.

Inflorescence: Racemose or fasciculate.

Flower: Bracteate, pedicellate, complete, hermaphrodite, actinomorphic, pentamerous, hypogynous, white.

Calyx: Sepals 5, polysepalous; or slightly fused at the base, green, quincuncial, greenish white; inferior.

Corolla: Petals 5, gamopetalous, campanulate, corolla teeth or lobes acute, reflexed, imbricate; corona like scales present at the base of corolla tube, inferior.

Androecium: Stamens 5, polyandrous, epipetalous, filaments short, anthers dorsifixed, dithecous, introrse, inferior.

Gynoecium: Bicarpellary, syncarpous, superior, bilocular, axile placentation, 2 ovules per loculus; style reduced; stigma bifid.

Fruit: Capsule.

Floral Formula:

$$\oplus \; ⚥ \; K_5 \; \overbrace{C_{(5)} \; A_5} \; \underline{G_{(2)}}.$$

Check Your Progress

1. What are the characteristics of *Convolvulaceae?*
2. what type of habitat does *Convolvulaceae* have?
3. How are the roots of *Convolvulaceae ?*
4. Give the distribution of *Convolvulaceae.*

12.3 *BIGNONIACEAE*

Characters of *Bignoniaceae*

Plant predominently lianous, compound leaves, zygomorphic flowers, anthers connivent in pairs; numberous ovule, silique-like woody capsule, large winged seed and non-endospermic.

A. Vegetative Characteristics

Habit: Mostly trees or shrubs; often climbing or twining vine, rarely herbs.

Root: Tap, deep, branched.

Stem: Hard, woody and branched; weak in climbers and twiners, rootlet or tendril climbers.

Leaf: Usually pinnately compound, opposite, decussate, rarely simple or alternate, exstipulate, terminal leaflet modified into tendril, adhesive disc or hook.

B. Floral Characteristics

Inflorescence: Usually dichasial cyme with bracts and bracteoles.

Flower: Bracteate, bracteolate, hermaphrodite, hypogynous, zygomophic, complete.

Calyx: Sepals 5, gamopetalous, lobed or bilabiate, valvate.

Corolla: Petals 5, obliquely campanulate or infundibuliform, imbricate, gamopetalous, lobes or teeth 5, sometimes bilabiate.

Androecium: Stamens 4, didynamous, epipetalous, posterior staminode, sometimes 2 (Catalpa); anther two-lobed, lobes divaricate, disc present.

Gynoecium: Carpels 2, syncarpous; ovary superior, bilocular with axile placentation, each loculus many – ovuled; sometime unilocular (Eccremocarpus) with two bifid parietal placentae; style terminal and single; stigma bifid.

Fruit: Capsule – two valved septicidal or loculicidal or berry.

Seed: Non-endospermic, flattened, winged.

Pollination: Entomophilous.

Distribution of *Bignoniaceae*

Bignoniaceae or Bignonia family is primarily tropical or subtropical family comprising 120 genera and 800 species of trees or shrubs, often climbing or twining vines and rarely herbs.

Economic Importance of *Bignoniaceae*

- **Timber:** Catalpa bignonioides, Millingtonia, Spathodea companulata, Tabebuia pentaphylla, Oroxylum are prized for timber.
- **Dye:** The leaves of Cybistax antisyphilitica are used as source of blue dye.
- **Ornamental:** The garden ornamental plants are represented by Pyrostegia venusa (Syn. Bignonia uenusta), Spathodea campanulata, Tecoma stans.

Common Plants of the Family

- Crescentia cujete – Calabash-fruit large, ground-like.
- Jacaranda acutifolius – Jack tree a road-side avenue tree with wonderful masses of purplish flowers.
- Catalpa speciosa – tree grown for valuable wood.
- Bignonia vensusta – Climber, ornamental plant.
- Millingtonia hortensis – Indian cork – tree.
- Tecoma stans – garden shrub.
- Tabebuia – West Indian Box tree.

Division of the Family and Chief Genera:

According to Schumann the Bignoniaceae is separated into four tribes:

Tribe I. Bignonieae: Ovary completely bilocular, compressed, parallel to the septum or ovary may be cylindrical. Capsule septifragal. Seeds winged. Mostly climbing shrubs by means of leaf tendrils or sometimes trees. Genera: Glaziovia, Bignonia, Oroxylum, Millingtonia, etc.

Tribe II. Tecomeae: Ovary bilocular compressed, at right angles to the septum, or ovary may be cylindrical. Capsule loculicidal with winged seeds. Erect shrubs or trees, rarely climbers by tendrils. Genera: Tecoma, Catalpha, Spathodea, Heterophragma, Pajanelia, etc.

Tribe III. Eccremocarpeae: Ovary unilocular. Capsule dehiscing from base upwards. Seeds winged. Climbing shrubs by tendrils. Only genus Eccremocarpus (Peru, S. America).

Tribe IV. Crescentieae: Ovary uni- or bilocular. Fruit berry or dry indehiscent. Seeds not winged. Erect trees or shrubs. Genera: Kigelia, Crescentia etc.

Check Your Progress

5. What are the characteristics of *Convolvulaceae?*
6. What type of habitat does *Convolvulaceae* have?
7. How are the roots of *Convolvulaceae ?*
8. Give the distribution of *Convolvulaceae.*

12.4 *SCOPHULARIACEAE*

Characteristics of *Scrophulariaceae*

Plants mostly herbs; leaves alternate or opposite, exstipulate; flowers zygomorphic and hypogynous, hermaphrodite; calyx gamosepalous; corolla gamopetalous; stamens four or two, if four didynamous; epipetalous; gynoecium bicarpellary, syncarpous, bilocular, axile placentation with many ovules; fruit capsule or berry; seeds endospermic.

A. Vegetative Characteristics

Habit: Mostly herbs (Antirrhinum) or shrubs rarely trees (Paulownia), climbers (Maurandia), root parasites (Pedicularis).

Root: Branched tap root system.

Stem: Herbaceous, or woody (Paulownia) aerial, erect.

Leaves: Alternate, or opposite, rarely whorled (Veronica), simple; in Limnophila leaves are dimorphic, exstipulate, margin entire, unicostate reticulate, in parasitic species leaves are reduced.

B. Floral Characteristics

Inflorescence: Cymose or racemose, it may be spike, rarely solitary axillary (Scoparia, Striga densiflora).

Flower: Bracteate, pedicellate, or sessile (Lindenbergia), hermaphrodite, pentamerous, hypogynous, complete, zygomorphic, rarely actinomorphic, (Verbascum, Veronica).

Calyx: Sepals 5, rarely 4 (Veronica, Scoparia), gamosepalous, imbricate or valvate aestivation, persistent; calyx teeth may be 2/5, campanulate or shortly tubular; inferior.

Corolla: Petals 5, gamopetalous, zygomorphic petals, sometimes two petals fused (Veronica), campanulate (Digitalis), spurred (Linaria); saccate (Antirrhinum), imbricate aestivation, inferior, variously coloured.
Androecium:

Stamens 4 in Digitals, 5 in Verbascum or 2 in Veronica; when didynamous and one staminode present (Digitalis); epipetalous, polyandrous; anthers basifixed or dorsifixed, dithecous, filament short, introrse.
Gynoecium: Bicarpellary, syncarpous, superior, bilocular, axile placentation, ovules many in each loculus; style short, simple; stigma bifid; usually nectariferous disc present below the ovary.

Fruit: A capsule or berry.

Seed: Endospermic.

Pollination: Entomophilous rarely self pollination in Veronica.

Floral Formula:

$$\text{Br } \circ\!|\!\circ \text{ rarely } \oplus ⚥ \; K_{(5) \text{ or } (4)} \; \overset{\frown}{C_{(5) \text{ or } 4} \, A_{5 \text{ or } 4}} \; G_{(\underline{2})}$$

Distribution of *Scrophulariaceae*

It is commonly called 'Snapdragon family'. It includes 220 genera and 3000 species which are distributed all over the world but most abundant in temperate regions. In India it is represented by 273 species.

Economic Importance of *Scrophulariaceae*

- **Medicinal:** Digitalis is used in heart diseases. The leaves of Verbascum thapsus are used in asthma and pulmonary complaints. The juice of leaves of Torenia asiatica is considered a cure for gonorrhoea. The juice of Lindenbergia indica is given in bronchitis. Anticharis is used in diabetes.
- **Ornamentals:** Antirrhinum, Veronica, Linaria, Mimulus, Cymbalaria, Russelia, Torenia and Digitalis are cultivated for ornamental purposes.

Primitive Characteristics

- A few shrubs and trees.
- Leaves simple and alternate (Linaria, Antirrhinum).

- Flowers hermaphrodite, hypogynous and rarely actinomorphic (Verbascum thapsus).
- Stamens dithecous.
- Seeds endospermic.

Advanced Characteristics

- Plants mostly herbs.
- Leaves exstipulate.
- Flowers zygomorphic.
- Calyx gamosepalous.
- Corolla gamopetalous.
- Stamens epipetalous.
- Reduction in the number of stamens
- Gynoecium bicarpellary, syncarpous.

Affinities of *Scrophulariaceae*:

Hallier regarded *Scrophulariaceae* as a primitive component of the Tubiflorae and related to Globulariaceae and Lentibulariaceae. Bessey treated this family as one of the advanced members of his order *Scrophulariales* and probably derived from Bignoniaceae.

Rendle placed the family in Tubiflorae but kept apart Convolvulaceae which has been kept in the monotypic order Convolvulales. This family Scrophulariaceae is undoubtedly very much allied to Solanaceae but is separated by zygomorphic corolla, reduction in number of stamens and medianly placed carpels.

It is also related to Lamiaceae and Acanthaceae but differs from them due to alternate phyllotaxy, form of corolla, nature of ovary and characters of fruits.

Common Plants of the Family

- **Antirrhinum majus (Snapdragon or dog flower):** Ornamental herb cultivated in winter.
- **Mimulus gracilis (Donkey flower):** An ornamental herb.
- **Digitalis purpurea (Foxglove):** A common ornamental herb with medicinal value.
- **Linaria vulgaris (Toad flax):** A beautiful herb.
- **Veronica:** Cultivated herb with 4 sepals, 4 petals and 2 stamens.
- **Bonnaya:** An annual glabrous herb of winter.
- **Striga:** A root parasite of Pennisetum.
- **Lindenbergia:** A common perennial herb on old walls and soil.

Division of the Family and Chief Genera

Wettstein divided the family into 3 sub-families and 12 tribes:

A. Two posterior corolla teeth or upper lip cover lateral teeth in bud.

Sub-family 1. *Verbascoideae* (Pseudosolaneae): All leaves usually alternate; 5 stamens often present. This includes 2 tribes e.g. Verbascum, Aptosimum.

Sub-family 2. *Scrophularioideae* (Antirrhinoideae): Lower leaves at least opposite; the 5th stamen wanting or staminode. This includes 7 tribes.

B. Two posterior teeth or upper lip of corolla covered in bud by one or both of the lateral teeth.

Sub-family 3. *Rhinanthoideae*: Corolla teeth all flat and divergent, or the upper erect. This includes 3 tribes.

Important Type of *Scrophulariaceae*

Lindenbergia indica (Refer Figure 12.3):

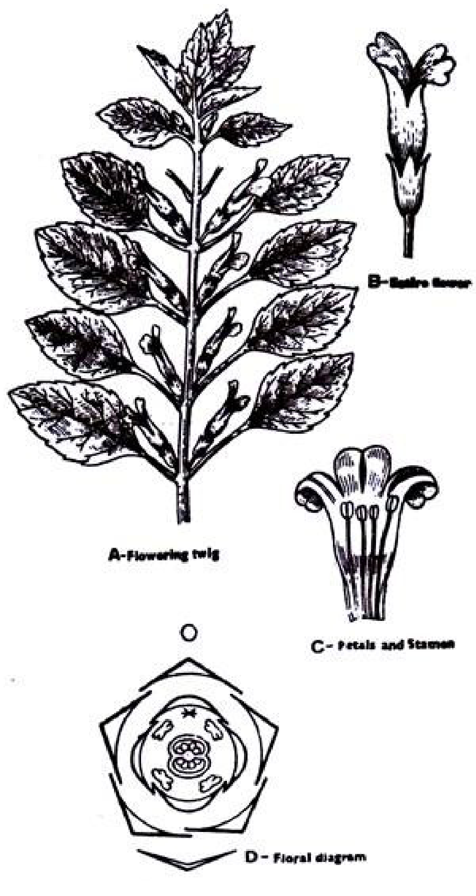

Fig. 12.3 *Lindenbergia indica*

NOTES

Habit: An annual herb.

Root: Tap, branched.

Leaf: Opposite, simple, petiolate, exstipulate, ovate, dentate, hairy, unicostate reticulate.

Inflorescence: Solitary axillary.

Flower: Bracteate, pedicellate, complete, hermaphrodite, zygomorphic, pentamerous, hypogynous.

Calyx: Sepals 5, gamosepalous, campanulate, valvate, inferior.

Corolla: Petals 5, bilipped, 2/3, upper with 2 lobes, lower of 3 -lobes, red throat, hairy, imbricate, inferior.

Androecium: Stamens 4, didynamous, fifth posterior stamen reduced, polyandrous, epipetalous, anthers dithecous, dorsifixed, filaments filiform, introrse.

Gynoecium: Bicarpellary, syncarpous, superior, bilocular, axile placentation, many ovules in each loculus, style simple, stigma bifid.

Floral formula:

$$\text{Br} \ \text{o|o} \ ⚥ \ K_{(5)} \ \overset{\frown}{C_{(2/3)} A_{2+2}} \ G_{\underline{(2)}}.$$

Check Your Progress

9. List primitive characteristics of *Scrophulariaceae.*
10. List advanced characteristics of *Scrophulariaceae.*
11. What is the distribution of *Scrophulariaceae?*

12.5 VERBENACEAE

Characters of *Verbenaceae*

Plants herbs, shrubs or trees, leaves simple, exstipulate, opposite or whorled; inflorescence cymose, racemose or spike, flowers hermaphrodite, zygomorphic, hypogynous, calyx gamosepalous, persistent; corolla 5 lobed, gamopetalous sometimes 2 lipped, stamens four, didynamous, unequally paired, epipetalous; carpels two, syncarpous, superior, axile placentation, fruit drupe.

A. Vegetative Characteristics

Habit: Mostly annual or perennial herbs, may be shrubs or trees (Tectona) or rarely woody climbers or halophyte (Avicennia) in tropical shores.

Root: Tap, branched, pneumatophore in Avicennia.

Stem: Erect, herbaceous or woody, young branches quadrangular, in some branches spiny.

Leaves: Simple or palmately or pinnately (Peronema) compound, opposite or whorled, exstipulate, entire or divided.

B. Floral Characteristics

Inflorescence: Cyme or racemose spikes often with an involucre of coloured bracts; cymose is usually dichasial (Clerodendron).

Flower: Zygomorphic, hermaphrodite, rarely unisexual by abortion (Aegiphila), hypogynous, pentamerous or tetramerous (Physopsis), rarely actinomorphic (Physopsis) complete.

Calyx: Sepals 5 lobed, gamosepalous, persistent, bell shaped or tubular, rarely 4 to 8 valvate, inferior.

Corolla: Petals 5 or 4 lobed, gamopetalous petals unequal, tubular or cylindrical, bi-lippod, imbricate, inferior.

Androecium: Stamens 4, didynamous, fifth stamen may be staminode or absent rarely 5 present (Tectona), epipetalous, bithecous, filaments free, dorsifixed, introrse, dehiscence longitudinal.

Gynoecium: Bicarpellary, syncarpous, rarely carpels 4 (Duranta) or 5 (Geunsia) superior in early stage bilocular but soon divided into 4 or many loculed by false septa, axile placentation or free central in Avicennia; style terminal, stigma entire or bilobed.

Fruit: Drupe rarely schizocarpic capsule enclosed by persistent calyx.

Seed: Non-endospermic with a straight embryo.

Pollination: Entomophilous.

Floral Formula:

$$\%\ ⚥\ K_{(5)}\ \overset{\frown}{C_{(5)}\ A_{2+2 or 5}}\ G_{(\underline{2})}.$$

Distribution of *Verbenaceae*

The family is commonly called Verbena family. It includes 77 genera and 3,020 species, out of which 21 genera and 125 species occur in India. The members of family are inhabitants of tropical and subtropical regions, they also extend into temperate lands.

Economic Importance of *Verbenaceae*

The family is of fairly great economic importance.

- **Timber:** The wood of *Tectona grandis* (Teak, H. Sagwan) is extremely hard and lasting. The wood is largely used in manufacturing of ships and good quality furniture. Teak is grown in forests of Burma, Madhya Pradesh and Assam. The wood of *Gmelina arborea* is used in making drums, sitars and other musical instruments.

- **Medicinal:** The roots of Clerodendron are used in asthma and cough. The decoction of leaves of Lantana camara is given in tetanus and rheumatism. The leave's juice of Gmelina arborea is used in gonorrhoea, cough and ulcers.
- **Oils:** Lippia alba produces a valuable oil.
- **Tanning:** The bark of Avicennia is used in tanning.
- **Febrifuge:** The leaves of Vitex negundo serve as febrifuge. The branches of this plant are kept over stored grains to keep off insects.
- **Ornamental:** Lantana, Verbena officinalis, Duranta, Congea tomentosa, Callicarpa, Clerodendron, Petrea are cultivated in gardens.

Affinities of *Verbenaceae*

The family shows close relationship with Lamiaceae (Labiatae) in the bilabiate corolla, persistent calyx. It also bears some affinity with Boraginaceae in the nature of inflorescence, calyx and fruit. It bears relationship with Acanthaceae.

Bentham and Hooker included the family Verbenaceae in the Lamiales. Hallier retained Verbenaceae within Tubiflorae and sought its origin from the Scrophulariaceae. Hutchinson at first (1926) accepted it as belonging to his Lamiales, but later (1948, 1959) segregated it as the Verbenales and derived it from rubiaceous stocks.

Hutchinson (1969) in "Families of Flowering plants" treated Stibaceae, Chloranthaceae and Phrymataceae as separate families, which were tribes of Verbenaeae in Bentham and Hooker's Genera plantarum. Thus the family is reduced to include five tribes only.

Common Plants of the Family

- **Avicennia alba (White mangrove):** A tree of Sunderban with long pneumatophore and viviparous seeds.
- **Callicarpa arborea (H. Ghiwala):** A tree with hard, light coloured wood.
- **Clerodendron (H. Bharangi) (Clerodendrum L.):** Clerodendron increme – sea shore plant.
- **Duranta repens:** An erect shrubby hedge plant.
- **Lantana indica:** Lantana indica Weed.
- **Tectona grandis (H. Sagwan):** A deciduous tree yields timber teak for furniture.
- **Verbana officinalis:** Stem quadrangular, common on waste places.
- **Vitex negundo:** Vitex negundo (H. Indrani).

Division of the Family and Chief Genera

Briquet divided the family into following:

Group-A: Inflorescence spike or raceme or head like spike, sometimes uniparous cyme, ovule basal, erect and anatropous.

Tribe 1. Stilbeae: Seed endospermous, flower regular or slightly irregular, seldom fully zygomorphic, for example Stilbe, etc.

Tribe 2. Verbeneae: Seed exendospermous. Other characters like above, for example Verbena, Phyla, Lantana.

Group-B: Inflorescence cymose or cymose panicle or cymose umbel, rarely flowers are axillary solitary

Tribe 3: Chloantheae: Ovule marginal. Fruit 4-10 celled drupe. Seed with endosperm, for example Chloanthes, etc.

Tribe 4. Viliceae: As above but seed without endosperm, for example Tectona.

Tribe 5. Caryopterieae: Fruit capsular 4-valved, valve separating from placental axis or not, for example Caryopteris, etc.

Tribe 6. Symphoremeae: Ovule pendulous orthotropous, ovary completely 2 celled. Fruit dry 1 seeded, for example Symphorema, etc.

Tribe 7. Avicennieae: Ovary incompletely 4-celled, with central placental column. Fruit capsular, bivalved 1 seeded, for example Avicennia.

Important Type of Verbenaceae

Duranta plumeri (Refer Figure 12.4):

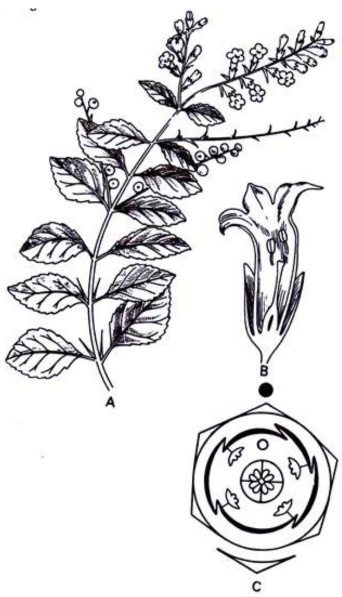

Fig. 12.4 *Duranta plumeri*

Habit: Small shrub.

Root: Tap, deep, branched.

Stem: Herbaceous, woody below, erect, solid, branched, green when young.

Leaf: Ramal and cauline, simple, opposite, petiolate, exstipulate, ovate, serrate, acute, unicostate reticulate venation.

Inflorescence: Raceme.

Flower: Pedicellate, bracteate, complete, hermaphrodite, zygomorphic, hypogynous, pentamerous, bluish-white.

Calyx: Sepals 5, gamosepalous, tubular, valvate, persistent.

Corolla: Petals 5, gamopetalous, tubular, lobes, unequal, three anterior lobes are larger, two posterior ones smaller, corolla slightly curved near apex, quincuncial aestivation.

Androecium: Stamens 4, polyandrous, epipetalous, didynamous, posterior stamen absent, bithecous, introrse, basifixed.

Gynoecium: Tetracarpellary, syncarpous, ovary superior, tetralocular, axile placentation, two ovules in each loculus; style simple, stigma simple or bifid.

Fruit: Drupe.

Floral Formula:

$$\text{Br op} ☿ \, K_{(5)} \, \overset{\frown}{C_{(5)} \; A_4} \, G^{\underline{(4)}}.$$

12.6 ANSWERS TO CHECK YOUR PROGRESS

1. Characters of *Convolvulaceae* includes herbs or shrubs, climbing; leaves alternate, simple, exstipulate, rarely stipulate; inflorescence cymose; flowers actinomorphic, hermaphrodite, hypogynous; calyx 5, polysepalous; colrolla gamopetalous, campanulate; stamens 5, epipetalous, alternipetalous, disc present; ovary bicarpellary, syncarpous, superior, axile placentation, generally two ovules per loculus; fruit capsule or nut.
2. Habit of *Convolvulaceae* is herbs (Convolvulus, Evolvulus), shrubs and climbing (Ipomoea, Argyeria), the plants may be xerophytic, hydrophytic (Ipomoea aquatica) or parasitic (Cuscuta).
3. Root of *Convolvulaceae* are tap, branched, fleshy (Ipomoea batatus; H. Sakarkand). Cuscuta without ordinary roots but adventitious haustoria are present.
4. *Convolvulaceae* is commonly known as Sweet-potato family. It includes 55 genera and 1650 species which are found in tropical region of the

world. In India the family is represented by 177 species belonging to 20 genera.

5. *Bignoniaceae* flower are bracteate, bracteolate, hermaphrodite, hypogynous, zygomophic, complete.
6. Calyx of *Bignoniaceae* are sepals 5, gamopetalous, lobed or bilabiate, valvate.
7. Corolla of *Bignoniaceae* have petals 5, obliquely campanulate or infundibuliform, imbricate, gamopetalous, lobes or teeth 5, sometimes bilabiate.
8. Gynoecium is carpels 2, syncarpous; ovary superior, bilocular with axile placentation, each loculus many – ovuled; sometime unilocular (Eccremocarpus) with two bifid parietal placentae; style terminal and single; stigma bifid.
9. Primitive characteristics of *Scrophulariaceae* includes:
   - A few shrubs and trees.
   - Leaves simple and alternate {Linaria, Antirrhinum).
   - Flowers hermaphrodite, hypogynous and rarely actinomorphic (Verbascum thapsus).
   - Stamens dithecous.
   - Seeds endospermic.
10. Advanced characteristics of *Scrophulariaceae* includes:
    - Plants mostly herbs.
    - Leaves exstipulate.
    - Flowers zygomorphic.
    - Calyx gamosepalous.
    - Corolla gamopetalous.
    - Stamens epipetalous.
11. *Scrophulariaceae* is commonly called ‘Snapdragon family’. It includes 220 genera and 3000 species which are distributed all over the world but most abundant in temperate regions. In India it is represented by 273 species.

12.7 SUMMARY

- *Convolvulaceae*, the morning glory family of flowering plants, which includes some 57 genera and about 1,600 species, widely cultivated for their colourful funnel-shaped flowers. The family is classified as a member of the order Solanales.

- Most are twining and erect herbs, with a few woody vines, trees, and shrubs. The family is widespread in both tropical and temperate areas. The sweet potato (*Ipomoea batatas*) is an economic plant of the family, but the ornamental vines are used in horticulture; several species of bindweeds are agricultural pests.
- The seeds of two species, Turbina corymbosa and Ipomoea violacea, are sources of hallucinogenic drugs of historical interest and contemporary concern.
- The leaves of plants belonging to the family are alternate and simple or compound, and the flower petals are united in the characteristic funnel-shaped corolla. The stems often contain latex and are rarely tuberous.
- The roots are usually fibrous but sometimes form rootstalks or tubers.
- Herbs or shrubs, climbing; leaves alternate, simple, exstipulate, rarely stipulate; inflorescence cymose; flowers actinomorphic, hermaphrodite, hypogynous; calyx 5, polysepalous; colrolla gamopetalous, campanulate; stamens 5, epipetalous, alternipetalous, disc present; ovary bicarpellary, syncarpous, superior, axile placentation, generally two ovules per loculus; fruit capsule or nut.
- Characters of *Bignoniaceae* includes plant predominently lianous, compound leaves, zygomorphic flowers, anthers connivent in pairs; numberous ovule, silique-like woody capsule, large winged seed and non-endospermic.
- Habit of *Bignoniaceae* mostly trees or shrubs; often climbing or twining vine, rarely herbs.
- Root of *Bignoniaceae* are tap, deep, branched.
- Stem of *Bignoniaceae* are hard, woody and branched; weak in climbers and twiners, rootlet or tendril climbers.
- Leaf of *Bignoniaceae* are usually pinnately compound, opposite, decussate, rarely simple or alternate, exstipulate, terminal leaflet modified into tendril, adhesive disc or hook.
- Characteristics of *Scrophulariacea* includes the plants mostly herbs; leaves alternate or opposite, exstipulate; flowers zygomorphic and hypogynous, hermaphrodite; calyx gamosepalous; corolla gamopetalous; stamens four or two, if four didynamous; epipetalous; gynoecium bicarpellary, syncarpous, bilocular, axile placentation with many ovules; fruit capsule or berry; seeds endospermic.
- Distribution of *Scrophulariaceae* is commonly called 'Snapdragon family'. It includes 220 genera and 3000 species which are distributed all over the world but most abundant in temperate regions. In India it is represented by 273 species.

- *Scrophulariaceae* is used as medicinal purpose as digitalis is used in heart diseases. The leaves of Verbascum thapsus are used in asthma and pulmonary complaints. The juice of leaves of Torenia asiatica is considered a cure for gonorrhoea. The juice of Lindenbergia indica is given in bronchitis. Anticharis is used in diabetes.
- *Scrophulariaceae* is used as ornamentals Antirrhinum, Veronica, Linaria, Mimulus, Cymbalaria, Russelia, Torenia and Digitalis are cultivated for ornamental purposes.
- Affinities of *Scrophulariaceae* are hallier regarded *Scrophulariaceae* as a primitive component of the Tubiflorae and related to Globulariaceae and Lentibulariaceae. Bessey treated this family as one of the advanced members of his order *Scrophulariales* and probably derived from Bignoniaceae.
- Rendle placed the family in Tubiflorae but kept apart Convolvulaceae which has been kept in the monotypic order Convolvulales. This family Scrophulariaceae is undoubtedly very much allied to Solanaceae but is separated by zygomorphic corolla, reduction in number of stamens and medianly placed carpels.
- Characters of *Verbenaceae* are plants herbs, shrubs or trees, leaves simple, exstipulate, opposite or whorled; inflorescence cymose, racemose or spike, flowers hermaphrodite, zygomorphic, hypogynous, calyx gamosepalous, persistent; corolla 5 lobed, gamopetalous sometimes 2 lipped, stamens four, didynamous, unequally paired, epipetalous; carpels two, syncarpous, superior, axile placentation, fruit drupe.
- Distribution of *Verbenaceae* is commonly called Verbena family. It includes 77 genera and 3,020 species, out of which 21 genera and 125 species occur in India. The members of family are inhabitants of tropical and subtropical regions, they also extend into temperate lands.
- Affinities of *Verbenaceae* is the family shows close relationship with Lamiaceae (Labiatae) in the bilabiate corolla, persistent calyx. It also bears some affinity with Boraginaceae in the nature of inflorescence, calyx and fruit. It bears relationship with Acanthaceae.
- Bentham and Hooker included the family Verbenaceae in the Lamiales. Hallier retained Verbenaceae within Tubiflorae and sought its origin from the Scrophulariaceae. Hutchinson at first (1926) accepted it as belonging to his Lamiales, but later (1948, 1959) segregated it as the Verbenales and derived it from rubiaceous stocks.
- Hutchinson (1969) in 'Families of Flowering plants' treated Stibaceae, Chloranthaceae and Phrymataceae as separate families, which were tribes of Verbenaeae in Bentham and Hooker's Genera plantarum. Thus the family is reduced to include five tribes only.

NOTES

12.8 KEY WORDS

- ***Verbenaceae***: The Verbenaceae are a family, commonly known as the verbena family or vervain family, of mainly tropical flowering plants. It contains trees, shrubs, and herbs ...
- **Loculus**: Loculus definition is - a small chamber or cavity especially in a plant or animal body. How to useloculus in a sentence.
- **Unicostate:** Unicostate having only one costa, rib, or ridge. Botany . (of a leaf) having only one primary or prominent rib, the midrib.
- **Stamen:** The stamen is the pollen-producing reproductive organ of a flower. Collectively the stamens form the androecium.
- **Dichasium:** Dichasium. a cymose inflorescence in which each branch bearing a flower gives rise to two other flowering branches, as in the stitchwort. Compare monochasium.
- ***Convolvulaceae:*** *Convolvulaceae* known commonly as the bindweed or morning glory family, is a family of about 60 genera and more than 1,650 species of mostly herbaceous vines, but also trees, shrubs and herbs, and also including the sweet potato and a few other food tubers.
- ***Bignoniaceae:*** *Bignoniaceae* is a family of flowering plants in the order Lamiales commonly known as the bignonias. It is not known to which of the other families in the order it is most closely related.
- ***Scrophulariaceae*****:** The *Scrophulariaceae* is a family of flowering plants, commonly known as the figwort family. The plants are annual and perennial herbs, as well as one genus of shrubs.

12.9 SELF ASSESSMENT QUESTIONS AND ANSWERS

Short Answer Questions

1. Write a short note on general characteristics of *Convolvulaceae.*
2. Mention some of the vegetative characters of *Convolvulaceae.*
3. Write some of the floral characters of *Convolvulaceae.*
4. Write about primitive and advanced characters of *Bignoniaceae.*
5. Name some of the common plants of *Bignoniaceae*family.
6. Give some floral characteristics of *Scrophulariaceae.*
7. What is the habitat of *Verbenaceae.*

Long Answer Questions

1. Give a detailed note on *Convolvulaceae* family including its floral, vegetative and economic importance.
2. Write in detail about *Bignoniaceae* family giving its vegetative and floral characters.
3. Give a detailed note on *Bignoniaceae* family mentioning about its distribution, economic importance, primitive and advanced characters.
4. Write about the character of Lindenbergia indica plant.
5. Explain in detail about the vegetative , floral, primitive and advanced characters of *Scrophulariaceae*.
6. Write in detail about *Verbenaceae* family.
7. Discuss about the economic importance of *Verbenaceae.*

12.10 FURTHER READINGS

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UNIT 13 POLYPETALAE FAMILIY: MAGNOLIACEAE, MENISPERMACEAE, PAPAVERACEAE AND TILIACEAE

Structure

13.0 INTRODUCTION

Polypetalae was a taxonomic grouping used in the identification of plants, but it is now considered to be artificial group, one that does not reflect evolutionary history. The grouping was based on similar morphological plant characteristics. Polypetalae was defined as including plants with the petals free from the base or only slightly connected.

Polypetalae contribute 259 species to the flora of the study area (34.44% of total species and 47.18%) of dicot species). Fabaceae are the largest family with 62 species, followed by Malvaceae with 22 species, Caesalpiniaceae 18 species, Mimosaceae 14 species, and Cucurbitaceae 11 species. These five families, together, account for 23% of total dicot species and 49%) of polypetalous species. One family is represented by 9 species, 2 families by 8 species, 3 families by 7 species, 1 family by 6 species, I family by 5 species, 3 families by 4 species, 8 families by 3 species, 11 families by 2 species and 17 families by 1 species each.

In this unit, you will study about Polypetalae family, *Magnoliaceae, Menispermaceae, Papaveraceae* and *Tiliaceae* in detail.

13.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about Polypetalae family
- Discuss about *Magnoliaceae*and its characteristics, distribution and economic importance
- Explain *Menispermaceae*and its characteristics, distribution and economic importance
- Describe about *Papaveraceae* and its characteristics, distribution and economic importance
- Learn about *Tiliaceae* and its characteristics, distribution and economic importance

13.2 *MAGNOLIACEAE*

Characteristics of Magnoliaceae

Trees and shrubs; two ranked stipulate leaves, stipules enclose young buds; flowers hermaphrodite, actinomorphic, large; perianth usually trimerous, whorled or spiral; stamens and carpels numerous; apocarpous, spirally arranged on elongated axis, fruit an etario of follicles or berries, sometimes samara.

A. Vegetative Characteristics

Habit: Trees or shrubs sometimes climbing. Oil sacks present in stem and leaves.

Root: Tap branched.

Stem: Erect, aerial, woody, branched.

Leaves: Alternate, simple, entire, commonly ever-green, coriaceous, stipules large (Magnolia) covering young leaves.

B. Floral Characters

Inflorescence: Solitary terminal or axillary.

Flower: Largest and sometimes, 25 cm in diameter (Magnolia, Fraseri), complete, regular, actinomorphic, unisexual (Drimys), usually bisexual, hypogynous, aromatic. Floral axis (torus) long to long convex.

Perianth: Nine to many, free, all alike and petaloid or the three outer ones green (Liriodendron), arranged in whorls of three, imbricate and cyclic (Magnolia and Michelia) or acyclic (spiral) arranged on an elongated or semi-elongated convex torus, free, inferior.

Androecium: Stamens many, free, often spirally arranged in a beautiful series, filaments short or absent, anther lobes linear, with a prolonged connective.

Gynoecium: Carpels numerous, free, superior, arranged spirally on a cone-shaped elongated thalamus (gynophore), rarely carpels are fused, for example Zygogynum, placentation marginal.

Fruit: An aggregate of berries or follicles, sometimes, a samara as in Liriodendron.

Seed: Large, with abundant oily endosperm, and bright or orange testa which makes them highly decorative.

Pollination: Entomophilous due to large and scented flowers.

Distribution of Magnoliaceae

Magnoliaceae or the Magnolia family embraces 10 genera and about 100 species. The members of this family belong to the temperate regions of northern hemisphere, with centres of distribution in eastern Asia, Malaysia, eastern North America, West Indies, Brazil and North-east and south east India.

Economic Importance of Magnoliaceae:

- **Medicinal:** The root bark and dried roots of Michelia champaca are used as purgative, while the flowers and fruits are used as carminative and in certain renal troubles and venerial diseases like gonorrhoea. The bark of Drimys winteri and Illicium uerum is useful in medicine.
- **Timber:** The wood of Michelia excelsa is an excellent commercial timber known as white wood. M. acuminata, Manglietia hookeri, Michelia baillonii, M. dottsopa and Pachylarnax pleiocarpa produce valuable timber used for mill work, furniture, musical instruments, toys, etc.
- **Ornamentals:** The species of Magnolia and Michelia are of surprising beauty because of their conspicuous white and yellow-tinted, fragrant flowers. Flowers of Michelia champaca are used by womens to ornament their hair and also offered in temples.

Michelia champaca yields ‘champaca oil’ from the flowers, camphor from the wood and scented water from the leaves.

Affinities of Magnoliaceae

Magnoliaceae is akin to Annonaceae, Engler, Rendle and other botanists put the Magnoliaceae under the Ranales. But Hutchinson placed the family within the Magnoliales and considered it as the most primitive among the dicotyledons.

The primitiveness of this family is shown by the spiral arrangement of stamens and carpels and apocarpous pistil – characters also shared with the Ranunculaceae. Smith, however, cast some doubt on the assumption of the primitive nature of the Magnoliaceae and thought that the family is relatively specialised from vegetative and reproductive aspects.

From the stand-point of construction and organisations of flowers, the Magnoliaceae is allied to the Annonaceae.

Common Plants of the Family

- Liriodendron tulipifera L., A large tree with handsome flowers, wood as a timber.
- Michelia champaca L. 'Champa', A garden plant cultivated for its flowers which are sweet scented; used in perfumery.
- Michelia grandiflora L. 'Bari Champa' or 'Him Champa" A small tree with fragrant flowers.
- Magnolia acuminata – Cucumber tree. Largest tree of Magnolias. Its green fruits resemble a cucumber; wood light, soft and durable.

Division of the Family and Chief Genera

On the basis of the habit, presence or absence of stipules and degree of development of thalamus, the Magnoliaceae is separated into three subfamilies :

Subfamily I: Magnolioideae. Leaves with sheathing stipules. Flowers bisexual. Thalamus long. Example**:** Magnolia.

Subfamily II: Illiciodeae. Leaves with ho stipules. Flowers bisexual or unisexual. Thalamus short. Example**:** Illicium.

Subfamily III: Schisandroideae. Climbing shrub. Leaves with no stipules. Flowers unisexual. Example**:** Schisandra.

Check Your Progress

1. What are the characteristics of *Magnoliaceae?*
2. What type of inflorescence does *Magnoliaceae* have?
3. What type of flowers does *Magnoliaceae* have?
4. How is the perianth of *Magnoliaceae?*

13.3 *MINISPERMACEAE*

Characteristics of Menispermaceae

Mostly woody vines – lianas, dioecious; flowers trimerous, unisexual; double whorls of sepals and petals; curved seed.

A. Vegetative Characteristics

Habit: Mostly twining, woody vines (lianas), rarely erect shrubs or small trees.

Root: Tap and branched.

Stem: Mostly woody and twining rarely erect.

Leaf: Simple (rarely trifoliate in a few tropical spp.) petiolate, exstipulate, mostly entire or occasionally palmately-lobed, mostly palmately-veined.

B. Floral Characteristics

Inflorescence: Racemose, dioecious (monoecious in Albertisia).

Flower: Small, unisexual, greenish, generally actinomorphic, hypogynous, cyclic, trimerous or dimerous.

Calyx: Sepals 6, in two whorls of 3 each.

Corolla: Petals 6, in two whorls of 3 each, usually smaller than sepals.

Androecium: Staminate flowers with usually 6 stamens opposite to petals, when of same number, free; variously connate or monadelphous forming a central column (Cissampelos), anthers 4-celled, dehiscing longitudinally.

Gynoecium: Carpels 3 or more, in pistillate flowers, apocarpous; ovary superior, 1-loculed, ovules 2 aborting to 1, parietal placentation; style very short or absent; stigma terminal, capitate or discoid, entire or lobed.

Fruit: Drupe or achene.

Seed: Endospermic or non-endospermic, usually curved, endosperm fleshy in Menispermum, Cocculus, Calycocarpum.

Pollination: Entomophilous.

Distribution of Menispermaceae

It is commonly known as Moonseed family, includes 70 genera and 400 species, distributed largely throughout paleotropic regions and a few genera extend into the eastern Mediterranean region and eastern Asia

Economic Importance of Menispermaceae

Ornamentals: A few species of Menispermum, Cocculus and Cissampelos are grown as ornamentals.

Common Plants of the Family

- Menispermum. Menispermum canadense, a twinning vine.
- Cocculus. Cocculus carolinus, a garden ornamental.
- Cissampeols. Cissampeols pareira, a garden ornamental.
- Calycocarpum. Calycocarpum lyoni. Common in Florida.

- Stephania. Stephania elegans and S. rotunda. Climbing herbs with yellow purple flowers, grow wild in valleys below Simla; July-Sept, ascending to 200 metres.

Check Your Progress

5. What are the characteristics of *Menispermaceae ?*

6. What type of inflorescence does *Menispermaceae* have?

7. What type of flowers does *Menispermaceae* have?

8. How is the calyx of *Menispermaceae?*

13.4 *PAPAVERACEAE*

Characters of Papaveraceae

Leaves alternate, simple, lobed, latex present, flower solitary, actinomorphic, hypogynous. Sepals two or three, caducous, petals 2 or 3, stamens numerous, free, sometimes reduced to four or two, anthers extrorse, carpels two or many, parietal placentation, fruit capsule.

A. Vegetative Characteristics

Habit: The members of this family are mostly annual or perennial herbs, shrubs (Dendromedon), rarely trees (Bocconia). The plants have latex which may be white or yellowish in colour.

Root: Tap root and branched.

Stem: Erect, herbaceous, branched, cylindrical and woody in Bocconia.

Leaves: Radical simple, alternate, exstipulate, dissected (Fumaria, Chelidonium).

B. Floral Characteristics

Inflorescence: Solitary terminal (Papaver), axillary raceme and panicles (Bocconia).

Flower: Ebracteate, pedicellate, actinomorphic, complete, di- or trimerous, hypogynous rarely perigynous (Eschscholtzia).

Calyx: Sepals 2 or 3, polysepalous, caducous and inferior.

Corolla: Petals 2 + 2 or 3 + 3 or more, rolled or crumpled in bud, polypetalous, brightly coloured.

Androecium: Stamens four or indefinite (Papaver, Argemone), polyandrous, filament slender; anthers dithecous and extrorse.

Gynoecium: Carpels two or more syncarpous; ovary superior (slightly perigynous in Eschscholtzia), unilocular, parietal placentation; ovules numerous, stigma sessile, persistent forming a crown in the fruit.

Fruit: Capsule, dehiscence by valves or pores, rarely nut.

Pollination: Entomophilous.

Economic Importance of Papaveraceae

- **Food:** Seeds of Papaver somniferum are used as condiment and food of people.
- **Medicinal:** Opium is obtained from the latex of the unripe fruits of Papaver somniferum. Opium is supposed to contain some 25 alkaloids; the better known are morphine, codeine, narcotine, etc. Opium is a powerful narcotic and is used for addiction.

  Medicinally the alkaloid are quite valuable. Morphine is widely used to relieve pain as it acts on the sensory cells of the brain and the patient is lulled into an artificial sleep. Codeine is used in cough syrups as a mild sedative.

  The roots of Sanguinaria canadensis produce bloodroot and are used in rheumatism and dyspepsia. The seeds of Argemone produce an oil which is used for adulterating mustard oil. This oil is of course harmful to man.
- **Ornamental:** Papaver rhoeas, Eschscholtzia, Sanguinaria are cultivated as ornamental garden plants.

Some authors have treated Fumariaceae as a sub-family of Papaveraceae while Hutchinson recognised it as a separate family.

Primitive Characteristics

- Presence of shrub and tree (Bocconia).
- Leaves simple and alternate.
- Flowers hermaphrodite, hypogynous and actinomorphic.
- Calyx and corolla free.
- Stamens numerous, free and produce abundant pollen.
- Carpels many and loosely united (Platystemon).
- Ovules anatropous and many on each placentum.

Advanced Characteristic

- Plants are mainly herbs.
- Leaves are deeply incised (Argemone).
- Flower perigynous (Eschscholtzia).

- Calyx gamosepalous (Echscholtzia).
- Gynoecium syncarpous.

Common Plants of the Family

- **Argemone Mexicana:** A prickly herb that grows wild on roadside with yellow flowers.
- **Papaver somniferum:** A source of opium.
- **Bocconia:** A tree with apetalous flowers and arillate seeds.
- **Sanguinaria:** It has a thick rhizome, giving off annually one leaf and one flowered scape.
- **Meconopsis aculeate:** A prickly shrub with blue purple flowers.

Division of the Family and Chief Genera

The family Papaveraceae has been divided into three sub-families:

- **Papaveroideae:** Latex present; flower regular; petals neither spurred nor saccate; stamens indefinite, free; carpels 2 to many. Papaver, Argemone.
- **Hypecoideae:** Latex absent; flower regular; petals trilobed; stamens four, carpels two; fruit a long pod. Hypecoum, Pteridophyllum.
- **Fumarioideae:** Oil sacs present; flower irregular; petals saccate or spurred; stamens two, tripartite, carpels two.

The sub-family Fumarioideae has been considered as a separate family Fumariaceae by Bentham and Hooker and Lawrence.

Argemone mexicana. Linn.(Prickly Poppy)

Habit: Erect, annual herb.

Root: Tap, branched.

Stem: Herbaceous, erect, cylindrical, solid, spiny, sparingly branched with yellow latex.

Leaves: Radical, cauline, simple, exstipulate, sessile, spiny, green, alternate and unicostate reticulate venation.

Flower: Ebracteate, pedicellate, complete, hermaphrodite, actinomorphic, trimerous, hypogynous.

Calyx: Sepals 3, polysepalous, caducous, prickly, twisted aestivation.

Corolla: Petals 6, in two whorls of 3 each, polypetalous, yellow.

Androecium: Stamens indefinite, polyandrous, arranged in several whorls, filament long, anthers basifixed, dithecous, extrorse.

NOTES

Gynoecium: Pentacarpellary, syncarpous, ovary superior, unilocular, parietal placentation, many ovules on each placentum, stigma as many as carpels, red, style absent.

Fruit: Capsule.

Floral formula:

⊕ ⚥ K3 C3+3 A α G $\underline{(5)}$

Check Your Progress

9. What are the characteristics of *Papaveraceae ?*
10. What type of inflorescence does *Papaveraceae* have?
11. What type of flowers does *Papaveraceae* have?
12. Write some advanced characteristic of *Papaveraceae*

13.5 POLYGALACEAE

Plants of the Milkwort Family

Flowers of the Milkwort family look superficially like those of the Pea family, but there are some significant differences. Milkwort flowers are irregular and bisexual. There are 5 sepals-but usually 3 green outer sepals and 2 petal-like inner sepals. There are 3 (sometimes 5) united petals, usually fused with the stamens, and the lower petal is often fringed. There are 8 (sometimes fewer) stamens, fused to the petals. The ovary is positioned superior. It consists of 2 (rarely 5) united carpels with the partition walls present, forming an equal number of chambers. It matures as a capsule, nut, or drupe (a fleshy fruit with a stony seed.)

Worldwide, there are about 17 genera and 850 species in the Milkwort family. The genera below are found in North America. Milkworts are found in patchy distribution mostly across the southern states.

13.6 *TILIACEAE*

Characteristics of Tiliaceae

Leaves simple, stipulate; flower hermaphrodite, hypogynous, actinomorphic, stamens indefinite sometimes 5 to 10; carpels 2 to indefinite, syncarpous, axile placentation; fruit capsule or drupe.

A. Vegetative characteristics

Habit: Shrubs or trees rarely herbs (Corchorus) with mucilagenous juice.

Root: Tap and branched.

Stem: Erect, cylindrical or angular, woody, solid and branched.

Leaves: Alternate rarely opposite, simple, margin entire, dentate or lobed-, stipulate, stipule caducous (Tilia).

B. Floral characteristics

Inflorescence: Cymose and often very complex (Tilia, Triumfetta).

Flower: Pedicellate, actinomorphic, hypogynous, hermaphrodite, rarely unisexual (Carpodiptera), tetra or pentamerous, sometimes with epicalyx.

Calyx: Sepals 5 or 4 rarely 3, polysepalous or basally connate, valvate aestivation, inferior.

Corolla: Petals 5 or 4 rarely absent (Prockia), polypetalous, often glandular, imbricate aestivation, usually coloured but sometimes sepaloid, inferior.

Androecium: Stamens 10 to indefinite, free or united in groups (Grewia), inserted at the base of petals or on androphore (Grewia), anthers dithecous, extrorse, dehiscence by apical pores or longitudinal slits.

Gynoecium: Carpels 2 to 10 or many (Apeiba), syncarpous; ovary superior, 2 to many locular with 1 to many anatropous ovules in each loculus; axile placentation; style simple; stigma capitate or lobed.

Fruit: Capsule or schizocarpic or drupaceous.

Seed: Endospermic, embryo curved with leafy cotyledon.

Pollination: Entomophilous.

Distribution of Tiliaceae

It is commonly called Jute family. It comprises 50 genera and 450 species. The members are mostly tropical and some inhabitants of temperate climate. It is abundant in South East Asia and Brazil.

Economic Importance of Tiliaceae

- **Fibre:** Corchorus capsularis and C. olitorius are cultivated for their tenacious blast fibres, which yield jute of commerce. It is used in making gunny bags.
- **Medicinal:** The fruits of Grewia asiatica are astringent, cooling and digestive. The root bark is used in rheumatism.
- The flowers, leaves and fruits of Triumfetta bartramia are used in gonorrhoea. Bark and fresh leaves of this plant are used in diarrhoea and dysentery.

- **Wood:** The species of Tilia yield useful timber. Tilia americana is one of the best timber plant of America.
- **Ornamental:** Some of the plants viz. Sparmannia, Microcos are grown in gardens.

Primitive Characteristics

- Plant are generally shrubs or trees.
- Leaves alternate, simple, stipulate.
- Flowers hermaphrodite, hypogynous and actinomorphic.
- Corolla polypetalous.
- Gynoecium polycarpellary (Apeiba).
- Seeds endospermic.

Advanced Characteristics

- Inflorescence cymose or complex (Tilia).
- Flowers unisexual (Carpodipetera).
- Corolla rarely absent (Prockia).
- Gynoecium syncarpous with axile placentation.
- Presence of curved embryo in the seeds.

Common Plants of the Family

- Corchorus – The well known Jute fibre, is obtained from this plant.
- Grewia asiatica – The fruits are acidic and syrups are made from it.
- Telia – A big tree.
- Triumfetta bartramia – A weed of waste places.

Division of Family and Chief Genera:

The family Tiliaceae has been divided into four tribes:

Tribe (i) Tiliae: Sepals connate at the base, stamens without appendages; carpels 2 to 5. Tilia.

(ii) Greweae: Petals with basal glands; androphore present. Grewia, Duboscia.

(iii) Brownloweae: Sepals connate at the base and free at the apex; anther-lobes confluent at apex. Brownlowia, Berrya.

(iv) Apeibeae: Sepals free, anther-lobes free, stamens with apical appendages, androphore absent; carpels six to indefinite. Apeiba, Ancistrocarpus.

Check Your Progress

13. What are the characteristics of *Tiliaceae?*
14. What type of inflorescence does *Tiliaceae* have?
15. What type of flowers does *Tiliaceae* have?
16. How is the calyx of *Tiliaceae?*

13.7 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Characteristics of *Magnoliaceae* are trees and shrubs; two ranked stipulate leaves, stipules enclose young buds; flowers hermaphrodite, actinomorphic, large; perianth usually trimerous, whorled or spiral; stamens and carpels numerous; apocarpous, spirally arranged on elongated axis, fruit an etario of follicles or berries, sometimes samara.
2. Inflorescence of *Magnoliaceae* is solitary terminal or axillary.
3. Flowers of *Magnoliaceae* are largest and sometimes, 25 cm in diameter (Magnolia, Fraseri), complete, regular, actinomorphic, unisexual (Drimys), usually bisexual, hypogynous, aromatic. Floral axis (torus) long to long convex.
4. Perianth of *Magnoliaceae* are nine to many, free, all alike and petaloid or the three outer ones green (Liriodendron), arranged in whorls of three, imbricate and cyclic (Magnolia and Michelia) or acyclic (spiral) arranged on an elongated or semi-elongated convex torus, free, inferior.
5. Characteristics of *Menispermaceae* are mostly woody vines – lianas, dioecious; flowers trimerous, unisexual; double whorls of sepals and petals; curved seed.
6. Inflorescence of *Menispermaceae* is racemose, dioecious (monoecious in Albertisia).
7. Flower of *Menispermaceae* are small, unisexual, greenish, generally actinomorphic, hypogynous, cyclic, trimerous or dimerous.
8. Calyx of *Menispermaceae* have sepals 6, in two whorls of 3 each.
9. Characters of *Papaveraceae* includes leaves alternate, simple, lobed, latex present, flower solitary, actinomorphic, hypogynous. Sepals two or three, caducous, petals 2 or 3, stamens numerous, free, sometimes reduced to four or two, anthers extrorse, carpels two or many, parietal placentation, fruit capsule.
10. Inflorescenceof *Papaveraceae* is solitary terminal (Papaver), axillary raceme and panicles (Bocconia).

11. Flowers of *Papaveraceae are* ebracteate, pedicellate, actinomorphic, complete, di- or trimerous, hypogynous rarely perigynous (Eschscholtzia).
12. Advanced characteristic of *Papaveraceae* are:
    - Plants are mainly herbs.
    - Leaves are deeply incised (Argemone).
    - Flower perigynous (Eschscholtzia).
    - Calyx gamosepalous (Echscholtzia).
13. *Tiliaceae* have leaves simple, stipulate; flower hermaphrodite, hypogynous, actinomorphic, stamens indefinite sometimes 5 to 10; carpels 2 to indefinite, syncarpous, axile placentation; fruit capsule or drupe.
14. Inflorescence of *Tiliaceae* is Cymose and often very complex (Tilia, Triumfetta).
15. Flowers of *Tiliaceae* are pedicellate, actinomorphic, hypogynous, hermaphrodite, rarely unisexual (Carpodiptera), tetra or pentamerous, sometimes with epicalyx.
16. Calyx of *Tiliaceae have s*epals 5 or 4 rarely 3, polysepalous or basally connate, valvate aestivation, inferior.

13.8 SUMMARY

- Characteristics of *Magnoliacea* includes trees and shrubs; two ranked stipulate leaves, stipules enclose young buds; flowers hermaphrodite, actinomorphic, large; perianth usually trimerous, whorled or spiral; stamens and carpels numerous; apocarpous, spirally arranged on elongated axis, fruit an etario of follicles or berries, sometimes samara.
- Habit of *Magnoliacea* have trees or shrubs sometimes climbing. Oil sacks present in stem and leaves.
- Leaves of *Magnoliacea* alternate, simple, entire, commonly ever-green, coriaceous, stipules large (Magnolia) covering young leaves.
- Inflorescence of *Magnoliacea* solitary terminal or axillary.
- Flower of of *Magnoliacea* are largest and sometimes, 25 cm in diameter (Magnolia, Fraseri), complete, regular, actinomorphic, unisexual (Drimys), usually bisexual, hypogynous, aromatic. Floral axis (torus) long to long convex.
- Perianth of *Magnoliacea* have nine to many, free, all alike and petaloid or the three outer ones green (Liriodendron), arranged in whorls of three, imbricate and cyclic (Magnolia and Michelia) or acyclic (spiral) arranged on an elongated or semi-elongated convex torus, free, inferior.

- Androecium:of *Magnoliacea* have stamens many, free, often spirally arranged in a beautiful series, filaments short or absent, anther lobes linear, with a prolonged connective.
- Gynoecium of *Magnoliacea* have carpels numerous, free, superior, arranged spirally on a cone-shaped elongated thalamus (gynophore), rarely carpels are fused.
- Fruit of *Magnoliacea* are aggregate of berries or follicles, sometimes, a samara as in Liriodendron.
- Seed of *Magnoliacea* are large, with abundant oily endosperm, and bright or orange testa which makes them highly decorative.
- Pollination of *Magnoliacea is e*ntomophilous due to large and scented flowers.
- Magnoliaceae or the Magnolia family embraces 10 genera and about 100 species. The members of this family belong to the temperate regions of northern hemisphere, with centres of distribution in eastern Asia, Malaysia, eastern North America, West Indies, Brazil and North-east and south east India.
- Magnoliaceae is used as medicinal purpose also as the root bark and dried roots of Michelia champaca are used as purgative, while the flowers and fruits are used as carminative and in certain renal troubles and venerial diseases like gonorrhoea. The bark of Drimys winteri and Illicium uerum is useful in medicine.
- Magnoliaceae is used as timber also as the wood of Michelia excelsa is an excellent commercial timber known as "white wood". M. acuminata, Manglietia hookeri, Michelia baillonii, M. dottsopa and Pachylarnax pleiocarpa produce valuable timber used for mill work, furniture, musical instruments, toys, etc.
- Magnoliaceae is used as ornamentals purpose also as species of Magnolia and Michelia are of surprising beauty because of their conspicuous white and yellow-tinted, fragrant flowers. Flowers of
- Magnoliaceae is akin to Annonaceae, Engler, Rendle and other botanists put the Magnoliaceae under the Ranales. But Hutchinson placed the family within the Magnoliales and considered it as the most primitive among the dicotyledons.
- The primitiveness of this family is shown by the spiral arrangement of stamens and carpels and apocarpous pistil – characters also shared with the Ranunculaceae. Smith, however, cast some doubt on the assumption of the primitive nature of the Magnoliaceae and thought that the family is relatively specialised from vegetative and reproductive aspects.
- From the stand-point of construction and organisations of flowers, the Magnoliaceae is allied to the Annonaceae.

- Characteristics of Menispermacea includes mostly woody vines – lianas, dioecious; flowers trimerous, unisexual; double whorls of sepals and petals; curved seed.
- Menispermacea is commonly known as Moonseed family, includes 70 genera and 400 species, distributed largely throughout paleotropic regions and a few genera extend into the eastern Mediterranean region and eastern Asia
- Characters of Papaveraceae involves the leaves alternate, simple, lobed, latex present, flower solitary, actinomorphic, hypogynous. Sepals two or three, caducous, petals 2 or 3, stamens numerous, free, sometimes reduced to four or two, anthers extrorse, carpels two or many, parietal placentation, fruit capsule.
- Flowers of the Milkwort family look superficially like those of the Pea family, but there are some significant differences. Milkwort flowers are irregular and bisexual. There are 5 sepals-but usually 3 green outer sepals and 2 petal-like inner sepals. There are 3 (sometimes 5) united petals, usually fused with the stamens, and the lower petal is often fringed.
- There are 8 (sometimes fewer) stamens, fused to the petals. The ovary is positioned superior. It consists of 2 (rarely 5) united carpels with the partition walls present, forming an equal number of chambers. It matures as a capsule, nut, or drupe (a fleshy fruit with a stony seed.)
- Worldwide, there are about 17 genera and 850 species in the Milkwort family. The genera below are found in North America. Milkworts are found in patchy distribution mostly across the southern states.
- Tiliaceae is commonly called Jute family. It comprises 50 genera and 450 species. The members are mostly tropical and some inhabitants of temperate climate. It is abundant in South East Asia and Brazil.

13.9 KEY WORDS

- **Polygalaceae:** The Polygalaceae or the milkwort family are made up of flowering plants in the order Fabales.
- **Magnoliaceae:** The Magnoliaceae are a flowering plant family, the magnolia family, in the order Magnoliales.
- **Menispermaceae:** Menispermaceae is a family of flowering plants. The alkaloid Tubocurarine, a neuromuscular blocker and the active ingredient in the 'tube curare' form of the dart poison curare, is derived from the South American liana Chondrodendron tomentosum.
- **Papaveraceae:** The Papaveraceae are an economically important family of about 42 genera and approximately 775 known species of

flowering plants in the order Ranunculales, informally known as the poppy family.

- **Tiliaceae:** Tiliaceae is a botanical name for a family of flowering plants. It is not a part of the APG, APG II and APG III classifications, being sunk in Malvaceae but has an extensive historical record of use
- **Gonorrhoea:** Gonorrhoea is a sexually transmitted infection (STI) caused by bacteria called Neisseria gonorrhoeae or gonococcus.
- **Annonaceae:** The Annonaceae are a family of flowering plants consisting of trees, shrubs, or rarely lianas commonly known as the custard apple family or soursop family.

13.10 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a short note on general characteristics of *Magnoliaceae.*
2. Mention some of the vegetative characters of *Magnoliaceae.*
3. Write some of the floral characters of *Magnoliaceae.*
4. Write about primitive and advanced characters of *Menispermaceae.*
5. Name some of the common plants of *Papaveraceae* .
6. Give some floral characteristics of *Papaveraceae* .
7. What is the habitat of *Tiliaceae.*

Long Answer Questions

1. Give a detailed note on *Magnoliaceae* family including its floral, vegetative and economic importance.
2. Write in detail about *Menispermaceae* family giving its vegetative and floral characters.
3. Give a detailed note on *Menispermaceae* family mentioning about its distribution, economic importance, primitive and advanced characters.
4. Explain in detail about the vegetative , floral, primitive and advanced characters of *Papaveraceae* .
5. Write in detail about *Tiliaceae*family.
7. Discuss about the economic importance of *Tiliaceae.*

13.11 FURTHER READINGS

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UNIT 14 POLYPETALAE FAMILIY: GERAMIACEAE, MIMOSACEAE, MYRTACEAE, MELIACEAE AND SAPINDACEAE

Structure

14.0 INTRODUCTION

Polypetalae was a taxonomic grouping used in the identification of plants, but it is now considered to be artificial group, one that does not reflect evolutionary history. The grouping was based on similar morphological plant characteristics. Polypetalae was defined as including plants with the petals free from the base or only slightly connected.

Polypetalae contribute 259 species to the flora of the study area (34.44% of total species and 47.18%) of dicot species). Fabaceae are the largest family with 62 species, followed by Malvaceae with 22 species, Caesalpiniaceae 18 species, *Mimosaceae* 14 species, and Cucurbitaceae 11 species. These five families, together, account for 23% of total dicot species and 49%) of polypetalous species. One family is represented by 9 species, 2 families by 8 species, 3 families by 7 species, 1 family by 6 species, I family by 5 species, 3 families by 4 species, 8 families by 3 species, 11 families by 2 species and 17 families by 1 species each.

In this unit, you will study about Polypetalae family, *Germaiaceae, Mimosaceae, Myrtaceae, Meliaceae* and *Sapindaceae* in detail.

14.1 OBJECTIVES

NOTES

After going through this unit, you will be able to:

- Understand about Polypetalae family
- Discuss about *Germaiaceae* its characteristics, distribution and economic importance
- Explain *Mimosaceae* and its characteristics, distribution and economic importance
- Describe about *Myrtaceae* and its characteristics, distribution and economic importance
- Discuss about *Sapindaceae* and its characteristics, distribution and economic importance

14.2 *GERAMIACEAE*

Characteristics of *Geraniaceae*

Flowers hermaphrodite, actinomorphic rarely zygomorglic, hypogynous, pentamerous, Stamens 10, obdiplostemonous; carpels 3-5, ovary terminating into beaked structure at the apex; beaked or lobed fruit distinctive by its usually elastic dehiscence.

A. Vegetative Characteristics

Habit: Annual herbs or under shrubs very rarely shrubs.

Root: Tap and branched.

Stem: Often fleshy, thick below and woody, in many genera rhizome or tuber like covered with simple or glandular hairs.

Leaf: Alternate or opposite rarely, leaves incised or palmilobed or incised upto the base or compound, rarely entire, stipulate.

B. Floral Characteristics

Inflorescence: Cymose or solitary or biclustered.

Flower: Hermaphrodite, actinomorphic, rarely zygomorphic, hypogynous, bracteate, pentamerous, complete.

Calyx: Sepals 5, rarely 4 or 8, polysepalous, rarely connate, partially imbricate, rarely twisted, the posterior sometimes spurred.

Corolla: Petals 5, rarely 4 or 8, imbtricate nectiferous glands usually alternating with the petals, polypetalous.

NOTES

Androecium: Stamens 10 in two whorls of 5 each, obdiplostemonous, outer stamens, shorter than inner rarely stamens 15 in 3 whorls, sometimes stamens reduced to antherless or scale-like staminodes, sometimes basally connate; anthers, basifixed, bithecous, pendulous with special connectives.

Gynoecium: Carpels 3-5 rarely 2-3, syncarpous. Superior, 3-5-carpellary, axile placentation, ovules 1-2 in each locule, pendulous, anatropous; style 3-5, slender (beak-like) ovary terminating into beaked structure at the apex, stigma ligulate, (rarely capitate).

Fruit: Capsule, dehiscing septicidally into 3-5 rarely more, one or more seeded beaked parts or mericarps, the style usually adhering to the ovarian beak and the basal portion recurving elastically and sometimes spirally.

Seed: Plicate cotyledons, incumbent, embryo mostly curved, without endosperm or endosperm scanty.

Pollination: Entomophilous.

Distribution of *Geraniaceae*

Geraniaceae of 11 genera and 650 species widely distributed over temperate and subtropical regions of northern and southern hemispheres.

Economic Importance of *Geraniaceae*

- **Oil:** Aromatic oil-French rose oil or otto is obtained from Pelargonium odoratissimum Ait.
- **Ornamental:** Different species and hybrids of Geranium and Pelargonium are cultivated in gardens for their showy and aromatic flowers.

Affinities of *Geraniaceae*

Geraniaceae closely resembles Oxalidaceae in both floral and anatomical structures, hence Oxalidaceae was included in Geraniceae by Hooker.

Common Plants of the Family

- Geranium ocellatum Jacq. found in hills, a straggling herb with rose-coloured flowers.
- Erodium cicutarium- esteemed as a range-forage plant.
- Pelargonium odoratissimum – yield on distillation, ‘geranium oil’.

Division of the Family

The family *Geraniaceae* is divided into two tribes as follows:

Tribe I: Geranieae: Mature fruits with elastic rolled bristles.

Tribe II: Biebersteineae: Mature fruits without elastic rolled bristies.

14.2 *MIMOSACEE*

Characteristics of *Mimosaceae*

Trees or shrubs; leaves bipinnate and stipulate, stipule may be modified into spines; inflorescence cymose head or head; flowers actinomorphic, hermaphrodite, small, tetra or pentamerous; calyx and corolla valvate; petals connate below, stamens number varies from 4 (Mimosa) to many (Acacia, Albizzia); carpel one; fruit legume.

A. Vegetative characteristics

Habit: Herbs (Mimosa), climbers (Entada) and trees (Acacia, Albizzia) and hydrophytic (Neptunia oleracea). Many members are xerophytic (Acacia, Prosopis).

Root: Tap, much branched and deep.

Stem: Erect or climbing woody, branched angular or cylindrical, solid, covered with bark, some species yield gum, sometimes spiny.

Leaf: Cauline, ramal, alternate, pinnate or bipinnate compound, stipulate, stipules may be modified into spines, petiolate; in some species of Acacia the petiole becomes flattened into a phyllode and leaflets fall down; leaflets show movements (Mimosa, Neptunia).

B. Floral Characteristics

Inflorescence: Cymose head (Acacia), spike or racemose (Dichrostachys and Prosopis).

Flower: Pedicellate or sub-sessile (Acacia) or sessile (Prosopis), bracteate, actinomorphic, hermaphrodite, hypogynous, complete, tetra or pentamerous, small.

Calyx: Sepals 5, gamosepalous, valvate or imbricate (Parkia), green or petaloid (Acacia nilotica), inferior.

Corolla: Petals 5, polypetalous or gamopetalous (Acacia, Albizzia) valvate, inferior.

Androecium: 4 free in Mimosa, 10 free in Prosopis, indefinite and monadelphous in Albizzia, filaments long, anthers dithecous, pollen grains often in packets; often gland dotted to attract the insects.

Gynoecium: Monocarpellary, ovary superior, unilocular, marginal placentation, one or many ovules in a carpel; style long and filiform; stigma minute and simple.

Fruit: A legume or lomentum.

Seed: Non-endospermic.

Floral formula:

$$Br \oplus ☿ K (4) \text{ or } (5) C_{4 \text{ or } 5}, A10 \text{ or } \alpha G_{\underline{1}}.$$

Distribution of Mimosaceae

It is commonly called Acacia family. It includes 40 genera and 2000 species. The members are mostly distributed in tropical and sub-tropical regions. In India it is represented by 12 genera and 90 species.

Economic Importance of Mimosaceae

The sub-family is not of much economic importance. A few members are however useful.

- Acacia catechu serves as a host for the lac insects. From this plant Katha is also obtained. Gum arabic is obtained from the barks of A. nilotica (syn. A. arabica) and A. Senegal. Saresh- a type of gum – is obtained from Albizzia lebbek. The flowers of A. decurrens var. dealbata yield a perfume. The bark of Acacia yields tannin which is used in leather tanning.
- The wood of Adenanthera pavonina is powdered and yields a red dye.
- Prosopis spicigera is grown as a hedge plant and also as a wind breaker in Rajasthan to check spreading desert, acts as water indicator.
- Durable timber is obtained from Acacia melanoxylon, Lysistoma sabicu, Xylia dolabriformis (Iron wood).

Primitive Characteristics

- Plants are mostly trees shrubs.
- Leaves are stipulate and spirally arranged.
- Flowers actinomorphic, hermaphrodite and hypogynous.
- Petals are mostly free.
- Stamens are numerous and free.

Advanced Characteristics

- Leaves are compound and in many stipules are modified into spines.
- Leaves modified into phyllode in Australian Acacias.
- Flowers are small and inconspicuous.
- Calyx is gamosepalous.
- Reduction in number of petals and stamens (Mimosa).
- Gynoecium is monocarpellary and unilocular.
- Fruit is simple-pod.
- Seeds are non-endospermic.

Common Plants of the Subfamily

- **Acacia:** Tree or shrub, with yellow flowers in rounded head.
- **Albizzia lebbek (Siris):** Silk flower, flowers in round heads, flower fragrant.
- **Mimosa – H. Chuimui:** Leaves are highly sensitive, showing sleep movements.
- **Neptunia oleracea:** An aquatic, common water weed.
- **Parkia roxburghii:** A handsome avenue tree.
- **Prosopis:** Prickly tree or shrub. Prosopis spicigera- tree of arid regions; it is water indicator.
- **Entada:** A woody climber.
- **Xylia:** Iron wood tree.

Important Types of Mimosaceae

Acacia nilotica (Linn.) Dd. (Syn. A. arabica Wild)

Habit: Tree.

Root: Tap, branched, deep.

Stem: Erect, cylindrical, solid, woody, branched.

Leaf: Compound, bipinnate, alternate, petiolate, stipulate, modified into spines, leaflet oblong with entire margin, obtuse, or retuse, opposite, unicostate reticulate venation.

Inflorescence: Cymose head.

Flower: Small, sessile, bracteate (bracts caducous), brocteolate, actinomorphic, complete, hermaphrodite, pentamerous, hypogynous.

Calyx: Sepals 5, gamosepalous, campanulate, valvate aestivation, inferior.

Corolla: Petals 5, yellow, gamopetalous, tubular, valvate aestivation, inferior.

Androecium: Stamens numerous, polyandrous, filament long, anthers small, versatile, introrse.

Gynoecium: Monocarpellary, ovary superior, unilocular, marginal placentation, style long filiform and stigma minute.

Check Your Progress

1. What are the characteristics of *Germaiaceae?*
2. What type of corolla does *Germaiaceae*have?
3. What type of androecium does *Germaiaceae* have?
4. How is the gynoecium of *Germaiaceae?*

14.3 *MIMOSOIDEAE*

This sub-family is divided into 6 tribes on the basis of calyx and stamens:

NOTES

A. Calyx valvate:

(a) Stamens more than 10:

1. **Ingeae:** Stamens united into a tube. Inga, Albizzia.
2. **Acacieae:** Stamens free or only slightly joined at base, Acacia.

(b) Stamens as many or twice as many as petals:

3. **Mimoseae:** Anthers glandless. Mimosa.
4. **Adenanthereae:** Anther in bud crowned by a gland, seed endospermic. Prosopis, Neptunia.
5. **Piptadenieae:** Anther usually glandular, rarely without a gland; seeds without endosperm. Piptadenia, Entada.

B. Calyx imbricate:

6. **Parkieae:** Parkia – flowers in heads.

Check Your Progress

5. What type of roots does *Mimosaceae* have?
6. What type of stem does *Mimosaceae* have?
7. How are the leaves of *Mimosaceae?*
8. What are the adavance characters of *Mimosaceae?*

14.4 *MYRTACEAE*

Characteristics of Myrtaceae

Leaves aromatic, gland dotted, exstipulate, entire margin; flower hermaphrodite, actinomorphic, epigynous; calyx 4-5, gamosepalous, sometimes thrown off as a lid; corolla 4-5, free or united; stamens indefinite; carpels 2-5 syncarpous, ovary inferior, placentation axile; style and stigma simple; fruit a berry or drupe.

A. Vegetative Characteristics

Habit: The members of this family are mostly trees (Eucalyptus, Syzygium, Psidium) or shrub (Carreya) very rarely herbs. Some of the species of Eucalyptus may attain a height of 300 ft.

Root: Tap root and branched.

Stem: Erect woody, branched, bark very shining, smooth and goes off in old trees (Eucalyptus); vascular bundle bicollateral.

Leaves: Simple, opposite, alternate (Eucalyptus), or whorled, shortly petiolate, exstipulate or with minute stipule, gland dotted, coriaceous, evergreen. Leaves of Eucalyptus show adaptation to dry climatic and intense sunlight conditions and may become needle like and take up vertical position.

B. Floral Characteristics

Inflorescence: Usually of cyme type, sometimes panicle cyme or corymbose cyme, proliferous drooping spike in Callistemon; axillary in Psidium; solitary axillary (Myrtus communis); trichotomous cyme (Syzygium); paniculate cyme (Eucalyptus).

Flower: Pedicellate (Eucalyptus) or sessile (Callistemon), bracteate usually with two bracteoles (Callistemon), ebracteate (Eucalyptus) actinomorphic, hermaphrodite, epigynous sometimes perigynous; complete.

Calyx: Sepals 4-5, polysepalous or united, rarely reduced or thrown off like a lid as the flower opens (Eucalyptus) or entirely absent in some of Eucalyptus spp; quincuncial aestivation.

Corolla: Petals 4-5 more or less circular in form, polypetalous sometimes gamopetalous and forming cap (Eucalyptus), quincuncial aestivation.

Androecium: Stamens indefnite, arranged in several whorls at the edge of the receptacle, polyandrous rarely mondadelphous (Callistemon); 5 and antipetalous in Melaleuca. In Melaleuca leucadendron the stamens are numerous but in five bundles opposite to petals, anthers dorsifixed or versatile, dithecous, small, introrse, connectives of anthers are usually gland dotted. In the bud condition the stamens are bent.

Gynoecium: Carpels 2 to indefinite, syncarpous; perigynous to fully epigynous; inferior, two to many locular, axile placentation rarely parietal (Rhodamnia), 2 to indefinite anatropous or campylotropous ovules per loculus; style simple, long, stigma capitate.

Fruit: A berry (Psidium), capsule (Eucalyptus, Callistemon)-, drupe (Eugenia).

Seed: Non-endospermic.

Pollination: Entomophilous. Insects are attracted by coloured stamens and floral parts.

Distribution of Myrtaceae

The family contains 100 genera and 300 species out of which India contributes 116 species. The chief centres of distribution are Australia and America.

Economic Importance of Myrtaceae

- **Fruits:** Some members of the family produce edible fruits e.g. Syzygium cumini (syn. Eugenia jambolana) (H. Jamun), Psidium guajava (Amrood) with edible fruits.
- **Oil:** The essential oils are obtained by the steam distillation of leaves and branches of Eucalyptus species.
- **Spice:** Syzygium caryophyllata (syn. Eugenia caryophyllata) yields the cloves of commerce. Clove oil (H. Laung ka tel) is extracted out of them.
- **Medicine:** Eucalyptus oil is used in influenza. It is mixed with clove oil and used in rheumatism. The roots of Eucalyptus are purgative. Clove oil is antipyretic and largely used in gum troubles. The leaves of S. cumini are used in indigenous medicine for dysentery.
- The fruits of Myrtus communis are carminative and given in dysentery, diarrhoea, and rheumatism.
- **Wood:** The wood of Eucalyptus and Psidium is used in engraving and making handles. In Australia the wood of Eucalyptus is used for railway sleepers, bridges and plywood industries.
- **Ornamental:** Many plants viz., Callistemon, Myrtus, Melaleuca leucadendron, Tristania, Eucalyptus are cultivated for their showy nature in the gardens.

2. Eucalyptus

Habit: A cultivated tall tree.

Root: Tap, branched.

Stem: Erect, woody, solid, cylindrical, branched, glabrous, shining.

Leaf: Alternate, petiolate, simple, exstipulate, lanceolate, gland-dotted, entire margin, apex acute, smooth, unicostate reticulate venation.

Inflorescence: Umbellate trichotomous cyme.

Flower: Ebracteate, pedicellate, complete, hermaphrodite, actinomorphic, pentamerous, epigynous.

Calyx: Sepals 5, gamosepalous, forming a lid or cap which is thrown off as flower opens.

Corolla: Petals 5, gamopetalous, corolla cap covered by calyx cap forming calyptra which falls off on the opening of flower, superior.

Androecium: Stamens indefinite, polyandrous, stamens attached to the rim of the calyx tube, anthers dorsifixed, dithecous, introrse.

Gynoecium: Tricarpellary, syncarpous, ovary inferior, trilocular, axile placentation, 3-6 ovules per loculus, stigma small.

Formal formula:

Ebr. ⊕ ⚥ K (5) C (5) Aα G $\overline{(3)}$.

NOTES

Check Your Progress

9. What are the characteristics of *Myrtaceae?*
10. What type of roots does *Myrtaceae* have?
11. What type of stem does *Myrtaceae* have?
12. How are the leaves of *Myrtaceae?*

14.5 *MELIACEAE*

Characteristics of Meliaceae

Plants woody trees, leaves pinnately compound exstipulate; leaflets asymmetrical, margin serrate, inflorescence cymose panicles, flowers actinomorphic, hermaphrodite, calyx and corolla sometimes united, stamens 8 to 10, monadelphous, obdiplostemonous: annular necticiferous disc between petals and stamens, gynoecium pentacarpellary, syncarpous, superior, fewer or multilocular with 1-2 rarely more ovules in each locule; single style; fruits various – capsular or drupaceous.

A. Vegetative Characteristics

Habit: Mostly woody trees rarely shrubs, often with a characteristic smell.

Roots: Much branched tap root.

Stem: Woody much branched, erect, solid.

Leaves: Alternate, exstipulate, pinnately compound rarely simple, without transparent dots or glandular dots, serrate margin.

B. Floral Characteristics

Inflorescence: Cymose panicles often axillary.

Flower: Pedicellate, bracteate, complete, hermaphrodite or polygamous, actinomorphic, hypogynous, pentamerous, with a necticiferous disc.

Calyx: Sepals 4-5, small poly- or gamoseplaous (connate at the base), imbricate rarely valvate aestivation, inferior.

Corolla: Petals 4-5 rarely 3 to 8, polypetalous rarely connate at the base or adnate to the staminal tube, imbricate or twisted aestivation, inferior.

Androecium: Stamens 8-10, inserted outside the base of hypogynous disc, filaments united to form a columnar tube (monadelphous; Cedrela), anthers bithecous, erect, introrse, longitudinal dehiscence, necticiferous disc present or absent.

Gynoecium: Carpels 2-5, syncarpous, superior, 2-5 locular, axile placentation, with 1-2 ovules in each loculus, single style, stigma capitate, discoid or lobed.

Fruit: Berry, capsule or drupe.

Seed: Winged, albuminous or exalbuminous.

Pollination: Entomophilous, due to the presence of nectaries.

Distribution of Meliaceae

This family is also called Mahogany family. It includes 50 genera and 1400 species according to Willis. In India it is represented by 20 genera and 70 species. It is widely distributed in tropics of both the hemispheres.

Economic Importance of Meliaceae

The family is not of great economic importance.

- **Oil:** The seeds of Melia azadirachta (H. Neem) yield the 'margossa' oil of commerce. The oil is used in soap industry and medicinally in rheumatism and skin diseases. The oil of Carapa guianensis is used as an illuminant. The oil of Cedrela, i.e., cedar oil is used in microscopy.
- **Medicines:** Almost every part of Melia azadirachta possesses some medicinal properties. The bark is a bitter tonic, astringent and antiperiodic. The bark, root bark and young fruits are used as a tonic antiperiodic and alterative. Leaves are used as poultice and applied to boils, the twigs as tooth brushes.
- Decoction of leaves is antiseptic and used to wash ulcers and eczema. The oil is used in rheumatism and skin diseases. Dry flowers are used as a tonic and stomachic. It is blood purifier.The bark of Cedrela tonna is used as astringent, tonic and antiperiodic in chronic dysentery.
- **Timber:** The wood of Cedrela toona (H. Tun), is used for furniture, carving and also for cigar boxes. The Swietenia mahoganii, Khaya senegalensis produce cabinet wood.
- **Ornamentals:** Some of the plants, e.g., Melia, Amoora, Swietenia are grown in gardens.

Primitive Characteristics

- Plants are mostly trees or shrubs.
- Leaves alternate.
- Presence of secretary cells.

- Wood rays heterogenous.
- Flowers hermaphrodite and hypogynous.
- Flowers actinomorphic.
- Calyx and corolla free.
- Stamens free.
- Pollination by insects.

Advance Characteristics

- Leaves mostly compound.
- Leaves exstipulate.
- Unisexual flowers in Amoora, Lansium.
- Flowers are small in size.
- Inflorescence cymose or racemose.
- Reduction in number of sepals and petals e.g. Amoora (3 sepals and 3 petals).
- Androecium is monadelphouB.
- Reduction in number of stamens (Melia 10-12, in Heynea 8-10, Cedrela 4-6, Amoora 3).
- Gynoecium syncarpous.
- Placentation axile.
- Fruit simple.
- Seed non-endospermic in many genera.

Check Your Progress

13. How are the roots of *Meliaceae ?*
14. What type of leaves does *Myrtaceae* have?
15. What type of androecium does *Myrtaceae* have?

14.6 SAPINDACEAE

Characteristics of Sapindaceae

Trees, shrubs or climbers usually pinnate leaves, the spring like circinately, coiled tendrils of lianous genera. Flowers polygamous or polygamodioecious; the scale or gland-appendaged petals; unilateral extrastaminal disc, tricarpellate ovary, trilocular, superior and usually arillate seed.

NOTES

A. Vegetative Characteristics

Habit: Trees, shrubs or climbers with watch-spring like tendrils.

Root: Tap, deep in tree species, branched.

Stem: Erect, or weak, climbing by tendrils which are axillary and represent the modified inflorescence axis. They are forked at the apex and the branches are often flat and rolled like a watch-spring.

Leaf: Alternate compound, pinnate, stipulate (climbing species), stipules small and soon falling off, sometimes imparipinnate, the end leaflet of a paripinnate leaf is bent round to serve as a terminal leaflet. Latex or resin present in special sacs or cells in the lamina.

B. Floral Characteristics

Inflorescence: Cymose, unilateral, cymes arranged in racemes or panicles.

Flower: Obliquely pentamerous, zygomorphic, or actinormophic, bisexual or unisexual, hypogynous, polygamous or polygamodioecious, extra staminal disc is unilateral or glandular.

Both bisexual and unisexual flowers are found in the same individual (polygamous) or bisexual and staminate or bisexual and pistillate flowers (polygamo-dioecious) occur in separate individual plants.

Calyx: Sepal 5, polysepalous, imbricate, in actinomorphic flowers sepals become 4 by the union of 3rd and 5th.

Corolla: Petals 5 in actinomorphic flower becomes to 4 as a result of suppression of one of the five petals, polypelatous, with hairy or scaly appendages, Petals are absent in Schleichera, Dodonaea etc. Between petals and stamens the floral axis is developed to form a disc, which is generally ring-like and bears glandular swellings opposite the petal insertions.

Androecium: Stamens 8 or 10, in two whorls, polyandrous, inserted inside the dise; dithecous, basifixed, introrse.

Gynoecium: Tricarpellary, syncarpotfs; ovary superior, trilocular, with one or two ovules in each loculus, axile placentation; style terminal; stigma trifid.

Fruit: Capsule, nut, berry, drupe.

Seed: Arillate, non-endospermic.

Pollination: Entomophilous.

Floral Formula:

$$\oplus \text{ or } \%, ⚥, ♂ \text{ or } ♀ \; K_{5-4}\, C_{5-4}\, A_{8-10}\, G_{\underline{(3)}}.$$

Economic Importance of Sapindaceae

- **Food:** Species of Pappeae, Melicocca, Euphoria, Nephelium and Litchi yield edible fruits with sweet, fleshy aril. Acer saccharinum a native of North America is the source of maple sugar. The maple sugar is obtained from the juice of stem. Paullinia cupania yields quarana', a stimulant used as a beverage.
- **Medicinal:** The roots of Cardiospermum halicacabum are diaphoretic and diuretic and given in decoction as aperient. The leaves are administered in pulmonic complaints and mixed with castor oil are externally applied in rheumatism and lumbago. The leaves mixed with jaggery and boiled in oil, are specific for eye sore. Dodonaea uiscosa and species of Allophylus are also medicinals.
- **Soapy lather:** Sapindus saponaria or soap berry – Ritha yield fruits, which contain saponin and yield lather with water that is used for washing woolen and silken clothes.
- **Timber:** Schliechera oleosa yield Ceylon oak – a good timber.
- **Ornamental:** Koelreuteria paniculata (varnish-tree) and Xanthoceras sarbifolia are cultivated as hardy ornamentals.

Common Plants of the Family

- Litchi Chinensis – Litchi – fruit having sweet fleshy edible aril.
- Euphoria syn. Nephelium, N. longana (Longon) – yield sweet fleshy edible aril.
- Sapindus – Latin Sapo and indicus; Indian Soap berry Ritha.
- Cardiospermum – From the Greek cardia – a heart and sperm, a seed, referring Dodonaea – evergreen shrub, flowers without corolla.

Division of the Family and Chief Genera

Based on the characters of the ovule, the Sapindaceae is divided into two subfamilies:

Subfamily I. Dyssapindoieae: Ovules 2 or more in each loculus, erect or pendulous with upwardly micropyle. Examples: Dodonaea, Turpinia, etc.

Subfamily II. Eusapindoieae: Ovules in each loculus, erect, with downwardly microphyle. Examples: Nephelium, Sapindus, etc.

14.7 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Characteristics of *Geraniaceae* includes lowers hermaphrodite, actinomorphic rarely zygomorglic, hypogynous, pentamerous, Stamens

10, obdiplostemonous; carpels 3-5, ovary terminating into beaked structure at the apex; beaked or lobed fruit distinctive by its usually elastic dehiscence.

2. Corolla of *Geraniaceae have p*etals 5, rarely 4 or 8, imbtricate nectiferous glands usually alternating with the petals, polypetalous.
3. Androecium of *Geraniaceae have s*tamens 10 in two whorls of 5 each, obdiplostemonous, outer stamens, shorter than inner rarely stamens 15 in 3 whorls, sometimes stamens reduced to antherless or scale-like staminodes, sometimes basally connate; anthers, basifixed, bithecous, pendulous with special connectives.
4. Gynoecium of *Geraniaceae have c*arpels 3-5 rarely 2-3, syncarpous. Superior, 3-5-carpellary, axile placentation, ovules 1-2 in each locule, pendulous, anatropous; style 3-5, slender (beak-like) ovary terminating into beaked structure at the apex, stigma ligulate, (rarely capitate).
5. Root of *Mimosaceae* are tap, much branched and deep.
6. Stem of *Mimosaceae* are erect or climbing woody, branched angular or cylindrical, solid, covered with bark, some species yield gum, sometimes spiny.
7. Leaves of *Mimosaceae* are cauline, ramal, alternate, pinnate or bipinnate compound, stipulate,
8. Advanced characteristics of *Mimosaceae* are:
   - Leaves are compound and in many stipules are modified into spines.
   - Leaves modified into phyllode in Australian Acacias.
   - Flowers are small and inconspicuous.
   - Calyx is gamosepalous.
   - Reduction in number of petals and stamens (Mimosa).
9. Characteristics of *Myrtacea* includes leaves aromatic, gland dotted, exstipulate, entire margin; flower hermaphrodite, actinomorphic, epigynous; calyx 4-5, gamosepalous, sometimes thrown off as a lid; corolla 4-5, free or united; stamens indefinite; carpels 2-5 syncarpous, ovary inferior, placentation axile; style and stigma simple; fruit a berry or drupe.
10. Root of *Myrtacea* are tap root and branched.
11. Stem of *Myrtacea* are erect woody, branched, bark very shining, smooth and goes off in old trees (Eucalyptus); vascular bundle bicollateral.
12. Leaves of *Myrtacea are* simple, opposite, alternate (Eucalyptus), or whorled, shortly petiolate, exstipulate or with minute stipule, gland dotted, coriaceous, evergreen. Leaves of Eucalyptus show adaptation

to dry climatic and intense sunlight conditions and may become needle like and take up vertical position.

13. Roots of *Meliaceae* are much branched tap root.
14. Leaves of *Meliaceae* are lternate, exstipulate, pinnately compound rarely simple, without transparent dots or glandular dots, serrate margin.
15. Androecium of *Meliaceae h*ave stamens 8-10, inserted outside the base of hypogynous disc, filaments united to form a columnar tube (monadelphous; Cedrela), anthers bithecous, erect, introrse, longitudinal dehiscence, necticiferous disc present or absent.

14.8 SUMMARY

- Flowers hermaphrodite, actinomorphic rarely zygomorglic, hypogynous, pentamerous, Stamens 10, obdiplostemonous; carpels 3-5, ovary terminating into beaked structure at the apex; beaked or lobed fruit distinctive by its usually elastic dehiscence.
- Stamens 10 in two whorls of 5 each, obdiplostemonous, outer stamens, shorter than inner rarely stamens 15 in 3 whorls, sometimes stamens reduced to antherless or scale-like staminodes, sometimes basally connate; anthers, basifixed, bithecous, pendulous with special connectives.
- Capsule, dehiscing septicidally into 3-5 rarely more, one or more seeded beaked parts or mericarps, the style usually adhering to the ovarian beak and the basal portion recurving elastically and sometimes spirally.
- Geraniaceae of 11 genera and 650 species widely distributed over temperate and subtropical regions of northern and southern hemispheres.
- Geraniaceae closely resembles Oxalidaceae in both floral and anatomical structures, hence Oxalidaceae was included in Geraniceae by Hooker.
- Trees or shrubs; leaves bipinnate and stipulate, stipule may be modified into spines; inflorescence cymose head or head; flowers actinomorphic, hermaphrodite, small, tetra or pentamerous; calyx and corolla valvate; petals connate below, stamens number varies from 4 (Mimosa) to many (Acacia, Albizzia); carpel one; fruit legume.
- Erect or climbing woody, branched angular or cylindrical, solid, covered with bark, some species yield gum, sometimes spiny.
- It is commonly called Acacia family. It includes 40 genera and 2000 species. The members are mostly distributed in tropical and sub-tropical regions. In India it is represented by 12 genera and 90 species.

- Leaves aromatic, gland dotted, exstipulate, entire margin; flower hermaphrodite, actinomorphic, epigynous; calyx 4-5, gamosepalous, sometimes thrown off as a lid; corolla 4-5, free or united; stamens indefinite; carpels 2-5 syncarpous, ovary inferior, placentation axile; style and stigma simple; fruit a berry or drupe.
- Simple, opposite, alternate (Eucalyptus), or whorled, shortly petiolate, exstipulate or with minute stipule, gland dotted, coriaceous, evergreen. Leaves of Eucalyptus show adaptation to dry climatic and intense sunlight conditions and may become needle like and take up vertical position.
- Some members of the family produce edible fruits e.g. Syzygium cumini (syn. Eugenia jambolana) (H. Jamun), Psidium guajava (Amrood) with edible fruits.
- Plants woody trees, leaves pinnately compound exstipulate; leaflets asymmetrical, margin serrate, inflorescence cymose panicles, flowers actinomorphic, hermaphrodite, calyx and corolla sometimes united, stamens 8 to 10, monadelphous, obdiplostemonous: annular necticiferous disc between petals and stamens, gynoecium pentacarpellary, syncarpous, superior, fewer or multilocular with 1-2 rarely more ovules in each locule; single style; fruits various – capsular or drupaceous.
- Almost every part of Melia azadirachta possesses some medicinal properties. The bark is a bitter tonic, astringent and antiperiodic. The bark, root bark and young fruits are used as a tonic antiperiodic and alterative. Leaves are used as poultice and applied to boils, the twigs as tooth brushes.
- Trees, shrubs or climbers usually pinnate leaves, the spring like circinately, coiled tendrils of lianous genera. Flowers polygamous or polygamodioecious; the scale or gland-appendaged petals; unilateral extrastaminal disc, tricarpellate ovary, trilocular, superior and usually arillate seed.
- Species of Pappeae, Melicocca, Euphoria, Nephelium and Litchi yield edible fruits with sweet, fleshy aril. Acer saccharinum a native of North America is the source of maple sugar. The maple sugar is obtained from the juice of stem. Paullinia cupania yields quarana', a stimulant used as a beverage.

14.9 KEY WORDS

- ***Geraniaceae:*** *Geraniaceae* is a family of flowering plants placed in the order Geraniales.

- ***Mimosaceae:*** The *Mimosaceae* are mostly tropical and subtropical trees and shrubs comprising about 40 genera and 2,000 species.
- ***Myrtaceae:*** *Myrtaceae* or the myrtle family is a family of dicotyledonous plants placed within the order Myrtales.
- ***Meliaceae:*** *Meliaceae*, or the mahogany family, is a flowering plant family of mostly trees and shrubs in the order Sapindales.
- ***Sapindaceae:*** The *Sapindaceae* is a family of flowering plants in the order Sapindales known as the soapberry family.
- **Inflorescence:** An inflorescence is a group or cluster of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches

14.10 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Write a short note on general characteristics of *Germaiaceae.*
2. Mention some of the vegetative characters of *Germaiaceae.*
3. Write some of the floral characters of *Mimosaceae.*
4. Write about primitive and advanced characters of *Myrtaceae.*
5. Name some of the common plants of *Meliaceae* .
6. Give some floral characteristics of *Meliaceae* .
7. What is the habitat of *Sapindaceae* .

Long Answer Questions

1. Give a detailed note on *Germaiaceae* family including its floral, vegetative and economic importance.
2. Write in detail about *Mimosaceae* family giving its vegetative and floral characters.
3. Give a detailed note on *Myrtaceae* family mentioning about its distribution, economic importance, primitive and advanced characters.
4. Explain in detail about the vegetative , floral, primitive and advanced characters of *Meliaceae* .
5. Write in detail about *Sapindaceae* family.
7. Discuss about the economic importance of *Sapindaceae* .

14.11 FURTHER READINGS

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