Welcome to the Programme, bachelor of science, first year. The subject is Botany, semester two and the course code is BOC 102. The course title is Biodiversity II (vascular plants). Title of the unit is classification and the module name is Bentham and Hooker up to series, Engler and Prantl up to series. I am Dr. Sheelpa Hindlekar, assistant professor at Government College of Arts, Science and commerce, Quepem.

Outline - We are going to study the classification of Bentham and Hooker up to series and the classification of Engler and Prantl up to series. Learning outcomes - At the end of this module, the student would be able to explain the classification of Bentham and Hooker and Engler and Prantl up to series. They would also be able to classify the plants up to series

## Classification by Bentham and Hooker.

It represents the most well developed natural system. Bentham published this classification in three volumes, that is *Genera Plantarum* from the year 1862 to 1883. He also published handbook on the *British flora, Flora Australiensis* and *Flora of British India*. Sir J.D.Hooker co-authored *Genera Plantarum* along with George Bentham. Sir J.D. Hooker was also the director of the Royal Botanical Gardens, Kew. The outline of the system of classification presented by Bentham and Hooker in *Genera Plantarum* wherein the Phanerogams are classified under three classes. Class one is dicotyledons, class two is gymnospermae and class 3 is monocotyledons. Class one dicotyledons, the flowers here are pentamerous or tetramerous. In class two gymnospermae, the ovules are naked and in class three monocotyledons, the flowers are trimerous. Under class one, dicotyledons, there are three subclasses, subclass one is polypetalae, subclass two is gamopetalae and subclass three is monochlamydeae. In polypetale, we have the sepals and the petals are distinct. The petals are free. Subclass 2 gamopetalae, the sepals and petals are distinct and the petals are united. Subclass 3, the flowers are apetalous.

Class one dicotyledonae as you know there are three subclasses, subclass one polypetalae, gamopetalae, and monochlamydeae. Under this subclass one polypetalae, we have three series thalamiflorae, disciflorae and calyciflorae. In Gamopetale, again

there are three series, inferae, heteromerae and bicarpellatae and in subclass three monochlamydeae there are eight series which include curvembryae, multiovulatae aquaticae, multiovulatae terrestres, microembryae, daphnales, achlamydosporae, unisexuales and ordines anomali.

Sub class one - polypetalae, thalimiflorae, the characters are the flowers are hypogynous, there are many stamens and the disc is absent so there is presence of a thalamus. Under this, there are six orders which are included which include the ranales, parietales, polygalineae, caryophyllineae, guttiferales and malvales. In series two, disciflorae, the flowers here are hypogynous. There is a presence of a disc below the ovary and that is why it is disciflorae. There are four orders which are included here geraniales, olacales, sapindales, celastrales. Series three, Calyciflorae. The flowers are perigynous or epigynous. The calyx is made up of united sepals. Here there are five orders included rosales, myrtales, passiflorales, ficoidales and umbellales. Subclass two Gamopetalae includes three series, inferae, heteromerae and bicarpellatae, Inferae, the sepals and petals are distinct. The petals are united and the ovary is inferior. There are three orders included under series inferae, rubiales, asterales and campanales. Series two heteromerae, stamens in one or two whorls, carpels are more than two and the ovary is superior. Again here there are three orders, ericales, primulales and ebenales. Series 3 - Bicarpellatae, the stamens in one whorl, carpels are two and ovary is superior. It includes four orders. gentianales, polemoniales, personales and lamiales. Subclass three- Monochlamydeae, which is also called as incomplete flowers. Here there are eight series, series one is curvembryeae, Series two is multiovulate aquaticae, Series three, multiovulate terrestres, micrembryae, daphnales, achlamydosporae, Series 7 is unisexuales and series 8 is ordines anomali. In curvembryeae the embryo is coiled and ovule is usually one. Multiovulate aquaticae these are aquatic plants wherein there are many ovules present. Multiovulatae terrestres, they are all terrestrial plants and the ovules are many. Micrembryae, the embryo is minute. Daphnales, the carpel is 1 and ovule is 1. Achlamydosporae, the ovary is inferior, unilocular and ovules are one to three in number. Unisexuales the flowers are unisexual and ordines anomali, the relation is uncertain. There is no classification they are not able to classify. Class 2 is gymnospermae, all gymnospermae the ovules are naked. It has three families, gnetales, coniferales and cycadales. Now, class 3 is monocotyledons wherein there are seven series. Series 1 - is microspermae, and series 2 - epigynae, series 3 - coronarieae, series 4 - calycinae, series 5 - nudiflorae, series 6- apocarpae, and Series 7 is glumaceae. Series one, the ovary is superior, tricarpellary the seeds are minute and many. In epigynae the ovary here which is inferior, seeds are large. In coronarieae the ovary is superior, carpels are united and the perianth is colored. Calycinae, the ovary superior and the carpels are united and the perianth is green. In nudiflorae, the ovary is superior and the perianth is absent . In apocarpae, ovary is superior and caperls are more than one and free. in glumaceae, the ovary is superior, hypogynous. Perianth is reduced and the flowers are enclosed in glumes.

Now this is an outline of Bentham and Hooker's system of classification,

where in the plant Kingdom is divided into cryptogams and phanerogams. So cryptograms are the non flowering plants which do not bear the flowers and the phanerogams are the seed plants which bear the seeds. Under this phanerogams, we have three classes dicotyledons, gymnospermae and monocotyledones. Dicotyledones have got two cotyledons which are present in the seed. In gymnosperms, the ovules are naked and monocotyledones there is only one cotyledon which is present. Now, this dicotyledons is further subdivided into 3 sub classes. polypetalae, gamopetalae, and monochlamydeae. In polypetalae there are three series included, thalamiflorae, disciflorae and calyciflorae. Gamopetalae again, there are three series inferae, heteromerae and bicarpellatae. In monochlamydeae, there are eight series curvembryae. multiovulatae aquaticae, multiovulatae terrestres. micrembryae, daphnales, achlamydosporeae, unisexuales and ordines anomali.

In monocotyledones there are seven series, which are included microspermae, epigynae, coronarieae, calycinae, nudiflorae, apocarpae, and glumaceae

Now the Genera plantarum of Bentham and Hooker classified seed plants describing 202 families to 7569 genera and estimated around 97,205 species. The descriptions were made on personal studies from specimens, and it was not a mere compilation of known facts. Many important herbaria of the world have specimens which are arranged

according to Bentham and Hooker's system of classification. Here there were no orders which are recognized within monochlamydeae and monocotyledons.

The merits - This classification is widely used for arrangement of specimens in the herbaria. Gymnosperms are not placed among dicots, but an independent group. Dicotyledons are placed before monocotyledons. the descriptions of families and genera are precise. The keys to the identification are very useful. Larger genera have been divided into smaller sub genera. Taxa arrangement is on overall natural affinities based on morphology. The grouping based on combination of characters rather than a single character.

The demerits - it does not incorporate phylogeny. The gymnosperms are placed between dicotyledons and monocotyledons. Creation of monochlamydeae resulted in separation of closely related families. Amaryllidaceae and Liliaceae in monocots are closely related but placed under different series that is epigynae and coronarieae. The affinities of families under ordines anomali were tentatively grouped together. Orchidaceae is an advanced family and it is placed at the beginning of monocotyledones.

Coming to the second classification, that is Engler and Prantl system of classification. These are the two German botanist, Adolf Engler and Carl Prantl. They published their classification in Die naturlichen pflanzenfamilien in 23 volumes. It has provided classification and description up to genus level with information on morphology, anatomy and geography. This was the beginning of the phylogenetic schemes and an arrangement of linear sequence starting with the simplest group to the complex ones. The classification has significant improvements over Bentham and Hooker. Gymnosperms were placed before angiosperms. Monochlamydeae is abolished and members of this are distributed with polypetalous relatives. Many unnatural families were split into smaller natural families. The monocots are placed before dicots and the plant Kingdom was divided into 13 divisions. This is the outline of Engler and Prantl system of classification. Division one to twelve includes bacteria, algae, fungi, bryophyte and pteridophytes, 13<sup>th</sup> division is the Embryophyta is also called as siphonogama or the seed plants. Now this, embryophyta or seed plants were further

divided into 3 classes, monocotyledonae, dicotyledonae and third one is gymnospermae. Under monocotyledonae, there are 11 orders and 45 families. Here, the 1st order is pandanales and the 11<sup>th</sup> order is microspermae. In dicotyledons there are 40 orders and 240 families. Now this dicotyledonae is further divided into subclass Archichlamydeae and metachlamydeae. Archichlmydeae is also called as polypetalae and metachlamydeae is called as sympetalae. The characters here are the corolla are polypetalous, perianth is single or double and there are 30 orders and 188 families included under this subclass. The 1st order is verticillatae and the 30th order is umbelliflorae. Subclass metachlamydeae, also called as sympetalae. The corolla is gamopetalous and the perianth in two whorls. Here there are 10 orders and 52 families. The 1st order is Ericales and the 10<sup>th</sup> order is campanulales. Under gymnosperm, there are seven orders which includes cycadofilicales, cycadales, benettitales, ginkgoales, coniferales ,cordaitales and gnetales. The merits - the first system to put the idea of organic evolution and phylogenetic system. It covers the entire plant kingdom, description and identification keys down to the level of family, genus, and species. There is valuable illustration and information on anatomy and geography are provided. Gymnosperms are treated separately. Many large unnatural families of Bentham and hooker have been split into smaller natural families. Urticaceae is divided into three families that is urticaceae, ulmaceae, and moraceae. Abolition of monochlamydeae has brought several related families together. The advanced families, compositae and orchidaceae are placed at the end. Gamopetalous condition is considered as advanced than the polypetalous one. The terms cohort and natural order have been replaced by order and family and the closely related families amaryllidaceae and liliaceae are placed in same order that is liliflorae. The demerits- the system is not phylogenetic one in the modern sense. Many ideas are outdated. Monocotyledonae are placed before dicotyledonae, now paleoherbs and sometimes magnolids are placed before monocotyledons. Amentiferae is considered primitive and now it is placed in advance group based on the studies on wood anatomy, palynology and floral anatomy. Dichlamydeous, that is distinct calyx and corolla forms were considered to have evolved from monochlamydeous forms that is single whorl of perianth forms. Angiosperms were

considered as polyphyletic groups. Recent advances point towards the monophyletic origin.

These are the references which I have used for the preparation of this e-content.

Thank you.