1. GENERAL INTRODUCTION

GENERAL INTRODUCTION

The Rubiaceae

The Rubiaceae are one of the larger families of the Asteridae with about 500 genera and 6000 species. Lawrence (1951) considers 400 genera and 4800 to 5800 species in this family, whereas Benson (1957) mentions 4500 species. Cronquist (1981) gives the number of species as 6500. In India this family is represented by only 550 species belonging to more than 50 genera, of which 364 species are endemic. The Rubiaceae are distributed in tropics and subtropics though a few plants extend into the temperate climate. Some species of *Galium* are found in Arctic region. In India the plants belonging to this family are mostly concentrated in South India and rain forests of Assam.

The family is distinguished by opposite leaves, interpetiolar stipules bearing colleters, a regular corolla with isomerous stamens attached to the tube, and an inferior ovary. The family comprises of trees, shrubs, herbs which are erect as well as prostrate and some are climbers also, unarmed or spiny or prickly. The leaves are mostly opposite, but whorled also exist in the family. They are simple, entire and stipulate but exstipulate in Galieae. Various stipules are present in the family. They are interpetiolar, but some are intra-petiolar; persistent or deciduous, free or united to the leaf or with adjacent stipules, entire, toothed or with bristles. Flowers are usually regular and bisexual, rarely unisexual. Inflorescence are of various types. Calyx tube attached to the ovary, sepals various. Corolla regular gamopetalous, limb 4-6, equal, valvate, imbricate or twisted, stamens as many as segments of corolla, attached to the tube; filaments short or long; anthers 2 celled. Disk epigynous. Ovary inferior, 2-10 celled, ovules 1 or more in each cell, style simple, bifid or multifid; stigmas various. Fruit varies from berry, capsule, drupe, or dehiscent or indehiscent cocci, 2-10 celled. Seeds various; albumen fleshy or horny; embryo straight or curved; cotyledons flat or semi-terete., radicle superior or inferior.

Anatomical features

The wood is typically with numerous vessels, rarely ring porous. Vessels are small in diameter except in some genera; vessel segments are with simple perforations. Intraxylery phloem absent. Sieve tubes with S-type plastids. Nodes are often unilacunar or less often trilacunar. The cork in stem arises superficially in some genera and more deep-seated in others. Sclerenchyma is a common feature in the pericycle. In a few genera anomalous secondary thickening with furrowed xylem development, or secondary strands of xylem and phloem has been recorded. Secretory elements are a common feature of the family in the form of secretory cavities or secretory cells, often with reddish brown resinous contents. Medullary rays are narrow and mostly up to 2-3 cells wide. Fibres are non-septate in about 75% of genera. The fibre type is used successfully in delimiting the Anthospermeae from the Paederieae in that former is characterised by fibre-tracheids and the latter contains libriform fibres (Koek-Noorman and Puff, 1983). Root is characterised with specialised tracheids having simple perforations formed after several adjacent pits have coalesced. The leaf is usually dorsiventral, but centric in <u>Asperula cynanchica</u> Linn. or homogeneous in a few species such as <u>Borreria verticillata</u> Meyr. The hairs are unicellular uniseriate, tufted and occasionally peltate. Unicellular hairs sometimes curved at the apex occur in species of <u>Galium</u>. The unicellular trichomes of <u>Guetarda</u> have crystals embedded in the thickened walls. The leaf surface is, in some instances, provided with a superficial vein-like net work containing spiral tracheids or fibres. The stomata, nearly always confined to the lower surface, are typically rubiaceous. The petiole, in transverse sections through the distal end, besides accessory strands towards the wings, exhibits a crescent-shaped or cylindrical median bundle, occasionally enclosing a few small medullary strands. Crystals are abundant in root, stem, and leaf. Crystals include, crystal sand as in <u>Adina</u>, raphides as in <u>Coffea</u>, <u>Galium</u>, clustured crystals as in Catesbaea, styloids and other acicular types as in Mussaenda (Metcalfe and Chalk, 1957). The type of crystal is of value in the identification of genera and species. Exceptionally large styloid crystals are reported in secondary xylem of Cosmocalyx spectabilis Standl. These crystals are unusal in terms of habit, structure, and distribution (Richter and Schmitt, 1987).

Cytological features

Nothing much is known about the cytology of the Rubiaceae. The basic chromosome numbers range from 6 to 17. Of the different basic numbers known for the Rubiaceae X = 11 is the most frequent one and less often X = 9 (Henriqueziaceae, Naucleaceae). Based on a karyomorphological study of the Rubiaceae, Selvaraj (1987) opines that the primary basic number may be 11.A process of ch Chromosomal reduction is observed in some species (Crepis) in operation so that the basic number 11 might have got reduced to n=10, n=9 and finally to n=6 by a series of unequal translocations involving concurrent loss of inert hetrochromatin parts of the chromosomes. The other higher haploid numbers above the level of n-11 are considered to have arisen by means of aneuploidy and euploidy. As revealed by karyotype analysis of 41 taxa of Rubiaceae, it is clear that there is a close correlation between the size and number of somatic chromosomes. Karyotypes in Rubiaceae also show differences in absolute chromosome size indicating changes in nuclear DNA in evolution. Due to the asymetrical karyotypes and common occurrence of subterminal kinetochores, this family is considered one of the most highly evolved families of Angiosperms.

Embryological features

Very little is known on the embryological features of the Rubiaceae. Ovules are normally anatropous to hemitropous often with a funicular obturator, with a massive single integument, tenuinucellar (or the nucellus obsolete as in Houstonia), without an integumentary tapetum (Cronquist, 1981); nucellus is short and the primordia of the integument of integuments arise near its apex. A suspensor haustorium is often produced in some members of the Rubiaceae (Psychotria) as also a ruminate endosperm. In a few plants there occur several sporogenous cells in the archesporial tissue, all of which may go through the meiotic division. The stage at which the starch makes its appearance in embryosac varies in different plants (Maheshwari, 1950). The nucellus in some members of the Rubiaceae is represented only by a single superficial cell situated above the archesporium and is virtually on its way to disappearance (Maheshwari, 1963).

The structure of anther, microsporogenesis and pollen development of the Rubiaceae are in general typical for the family (Andronova, 1984). Certain peculiar features of anther structure found in Rubiaceae are that the abaxial microsporangia longer than adaxial ones and are curved above stigma; reorganisation of secretary tapetum into false periplasmodium and amoeboid tapetum (some species of Galieae). In the Rubiaceae pollen tetrads are known only in Gardenia (Erdtman, 1952). A very exceptional phenomenon of pollen bud formation is reported to occur during the course of development of the male gametophyte in species of Ophiorrhiza (Mathew and Philip, 1975; Philip and Mathew, 1975).

Palynological features

From the extensive survey conducted by Mathew and Philip (1983) the Rubiaceae are found to be highly eurypalynous. Out of the 18 tribes studied, 11 are stenopalynous and the remaining are eurypalynous. The stenopalynous tribes are Naucleeae, Cinchoneae, Condaminieae, Rondeletieae, Hamelieae, Catesbeeae, Guettardeae, Knoxieae, Ixoreae, Morindeae and Galieae and the Eurypalynous tribes are Hedyotideae, Mussandeae, Gardenieae, Vanguerieae, Psychotrieae, Anthospermeae, and Spermacoceae. The family shows a wide range of aperture morphoforms also. Seven apertural types have been identified which are classified into five major types such as the colpate, colporate, porate, pororate and inaperturate. The various apertural morphoforms and their distribution in the tribes listed by the above workers are :-

Colpate - Anthospermeae, Hedyotideae, Psychotrieae, Galieae, Spermacoceae.

Colporate - Anthospermeae, Catesbaeeae, Cinchoneae, Condaminieae, Gardenieae, Hamelieae, Hedyotideae, Ixoreae, Knoxieae, Morindeae, Naucleeae, Psychotrieae, Rondeletieae, Spermacoceae, Vanguerieae.

Porate - Gardenieae, Guettardeae, Mussaendeae, Vanguerieae, Mussaendeae.

Pororate - Mussaendeae
and
Inaperturate - Psychotrieae

It is evident that the relatively advanced colporate morphoform is the dominant type in the Rubiaceae. Tricolpate condition, the most primitive form of the aperture type in the family, occurs in the Anthospermeae, Hedyotideae, and Psychotrieae. The pororate morphoform which is the highly advanced aperture type is seen in Mussaendeae.

The aperture number in the pollen grains varies from 3-14. The 3-aperturate morphoforms are the most frequently occuring type in this family.

Regarding ornamentation of pollen grains, majority of the taxa have sculptured grains. In sculptured grains the depression type and the excrescence type are the two broad categories of ornamentation of which the depression type is the predominent one.

Pollen size shows a wide range of variation from 10 μ to 89 μ. They exhibit different shapes like oblate, suboblate, and prolate. Pollen tetrads are known only in one genus, <u>Gardenia</u>.

Pollen dimorphism is another phenomemon reported in a few genera. Dimorphism occurs in pollen size, ora size, aperture number, exine thickness, exine ornamentation, pollen shape, and chemical dimorphism (Mathew and Philip, 1976). Even trimorphism with respect to size also has been found. A detailed discussion on playnological characters in the Rubiaceae is available elsewhere (Mathew and Philip, 1983).

<u>Chemical features</u>

This large family received relatively little attention from the phytochemist though some genera of great economic interest have been fully investigated while many others are entirely unknown with regard to their chemical constitution. The family is known to accumulate aluminium. Sugar alcohols such as D-mannitol are reported from some genera such as <u>Coffea</u>, <u>Randia</u>

Pavetta etc. Raphides are very common in the subfamily Rubioideae, but absent from Cinchonoideae and Guettardoideae. A wide variety of alkaloids exists within the Rubiaceae. They include indoles, quinolines, isoquinolines and purines. Indoles are comparatively rare. Indole alkaloids such as yohimbine is obtained from the bark of *Pausinystalia yohimbe*. Alkaloids of emetine group, having both isoquinoline and quinolizidine nuclei are abundant in the Rubiaceae, especially in Cinchonoideae and Rubioideae. Quinoline alkaloids such as quinine have a restricted occurrence, obtained from genera such as *Cinchona*, *Remijia* etc., Purine alkaloids also seem to have a restricted appearance. For example caffeine and adenine are obtained from *Coffea*, While the former is also obtained from *Oldenlandia corymbosa* and *Genipa americana* (Gibbs, 1974).

The Rubiaceae are well known for their anthraquinones. More than 3/4 of the known anthraquinones are reported from the members of this family (Mathis, 1966). These compounds are particularly abundant within the subfamily Coffeoideae. The majority of quinones are isolated from the roots. Usually all the hydroxyl groups are substituted on only one of the benzene rings. Although quinones clearly characterise the Rubiaceae, their distribution does not correlate well with the taxonomic categories. The root of *Rubia* contains several anthraquinone glycosides, the principal one ruberythric acid yeilding alizarin and primeverose on hydrolysis. Some of the medicinally important anthraquinones are ruberythric acid, rubiadin primeveroside, rubiadin glucoside and alizarin from Rubia and morindin from Morinda etc., (Trease and Evans, 1972).

Iridoids form another group of compounds common in the Rubiaceae. Asperuloside was first isolated from Madder root (Rubia). This compound was later obtained from Asperula, Galium, Gardenia, Morinda etc., Genipin is another iridoid closely similar to asperuloside in structure occuring in this family.

Flavonols such as quercetin and kaempferol are reported from some members of the Rubiaceae. Flavones (Gardenin A-E) are obtained from Gardenia gum. (Rama Rao and Venkataraman, 1968, 1970). Proanthocyanidins also occur in some members of this family (Gibs, 1974). Scopoletin a hydroxycoumarin is obtained from Luculia, Phylis, and Randia. Tannins and saponins are the other groups of compounds seen in some members of this family.

Economic importance

The most familiar economic product obtained from Rubiaceae is coffee, which is the roasted and pulverised seed of various species of Coffea mainly Coffea arabica Linn. Coffee contains the alkaloid caffeine. The most important medicinal plant of the family is Cinchona, from the bark of various species of which the antimalarial drug quinine is chiefly obtained. The commercially exploited species are C. calisaya, C. ledgeriana, C. officinalis and C. succirubra. Cinchona bark contains quinoline alkaloids, the most important are quinine, quinidine, cinchonidine and cinchonine. Galenicals of Cinchona are used as bitter tonics and stomachics; and a decoction is used as gargles. Quinine is used for malaria. Quinidine is employed for the prophylaxis of cardiac arrhythmias and for the treatment of atrial fibrillation. Ipecacuanha is another important drug which is the root of Cephaelis ipecacuanha. This contains the alkaloids emetine, cephaeline, psychotrine, psychotrine methyl ether and emetamine. Ipecacuanha is used as an expectorant and emetic and in the treatment of amoebic dysentry. Yohimbe bark is obtained from Pausinystallia yohimbe. It contains the indole alkaloids yohimbine, which is structurally related to reserpine. Mitragyna leaves, used as a herbal medicine, contains the alkaloids rotundifoline, rhynchophylline, isorhynchopylline and isorotundifoline. Some of the alkaloids of Mitragyna exhibit analgesic properties.

Rubia tinctorum (madder) is grown for the dye it contains. The colouring principles are several anthraquinone glycosides. The madders obtained from R. cordifolia and R. sikkimensis are known as the Indian madders. Madder is used in India and elsewhere for colouring various shades of red, scarlet, coffee brown and mauve, to cotton and woollen fabrics, but has now been replaced mostly by synthetic dyes.

Pale catechu or gambir, another dye, is the dried, aqueous extract prepared from the leaves and young twigs of a climbing shrub, *Uncaria gambier*. Gambir contains catechins, catechutannic acid, catechu red, quercetin and gambir-fluorescin. Gambir is used in medicine as an astringent (Trease and Evans, 1972).

The Rubiaceae do not provide very valuable timbers, but some of the woods are at times used as timbers. *Sarcocephalus* and *Mitragyna* are useful timbers that have wide uses. The wood of *Adina cordifolia* is one of the best turney woods in India and that selected pieces are attractively figured. Among the lesser known commercial timbers of Rubiaceae, *Anthocephalus*, *Canthium*, *Gardenia*, *Hymenodictyon*, *Morinda*, *Nauclea*, *Randia* and *Stephegyne* are counted (Metcalfe and Chalk, 1957).

Some members of the Rubiaceae such as *Mussaenda*, *Ixora*, *Gardenia*, *Pentas*, *Hamelia* are ornamental plants and are cultivated in gardens for their beautiful and colourful flowers.

Following is a list of lesser known medicinal plants of the Rubiaceae with its uses and parts used (Kirtikar and Basu,1918).

Name of plant	Part used	Uses
Adina cordifolia(Roxb.) B&H.	buds	headache
	roots	to kill worms in sores.

Anthocephalus cadamba Miq.	bark	febrifuge, tonic,
	leaves	gargle in aphthae and stomatitis.
Canthium didymum Roxb.	bark	fever
Canthium parviflorum Lamk.	leaves, root	anthelmintic
Diplospora sphaerocarpa Dalz.	seed	flavour of coffee.
Gardenia companulata Roxb.	fruit	cathartic, anthelmintic.
G. gummifera Linn.	gum	dyspepsia, flatulence, diarrhoea, carminative antiseptic, anthelmintic.
G. lucida Roxb.	gum	skin diseases
G. turgida Roxb.	root	indigestion
Hymenodictyon excelsum Wall.	bark	febrifuge.
Ixora coccinea Linn.	flowers	dysentery
I. parviflora Vahl.	root, fruit	coloured urine
Morinda citrifolia Linn.	leaves	diarrhoea
	fruit	gums
M. tinctoria Roxb.	root	astringent
M. umbellata Linn.	leaves	diarrhoea, dysentery
Mussaenda frondosa Linn.	root	white leprosy, jaundice
Nauclea ovalifolia Roxb.	bark	fevers and bowel complaints

Oldenlandia corymbosa Linn.	whole plant	remittent fevers
O. umbellata Linn.	leaves	expectorant
Ophiorrhiza mungos Linn.	root	tonic, snake poison.
Pavetta indica Linn.	root	dropsy, visceral obstructions,
	leaves	haemorrhoid.
Paederia foetida Linn.	leaves	diarrhoea
	root	emetic
	whole plant	rheumatism.
Randia dumetorium Lamk.	fruit	emetic, dysentery
	bark	astringent
R. uliginosa Dc.	fruit	diarrhoea, dysentery
Rubia cordifolia Linn.	root	colouring agent, astringent
Spermacoce hispida Linn.	root	tonic, alterative
	seed	substitute for coffee
Vangueria spinosa Roxb.	fruit	strengthening, cooling, expellent of phlegm and bile.

Inter-relationships of the Rubiaceae

The Rubiaceae have been placed variously in different classificatory schemes. This family is customarily placed in the Rubiales. The Rubiales of Bentham and Hooker (1873) contained along with this family, the Caprifoliaceae and Adoxaceae. Bessey's (1915) order Rubiales contained only Rubiaceae and Caprifoliaceae. Engler and Diels (1936) included three more families in the order namely Adoxaceae, Dipsacaceae, and Valerianaceae which were placed in Asterales by Bentham and Hooker. Bremekamp (1966) and Hutchinson (1973) were in favour of Bessey's bifamilial order Rubiales. Hutchinson has transferred the Adoxaceae to the Saxifragales and Valerianaceae and Dispsacaceae to the Valerianales.

In a number of recent taxonomic treatments, where chemical data are given due importance, the Rubiaceae are kept in the Gentianales. Wagenitz (1964) was the first to do so. He placed the Rubiaceae with the Loganiaceae, Apocynaceae, Asclepiadaceae, Gentianaceae and Menyanthaceae arguing that the Rubiaceae have more important similarities with some families of the order Contorte than with other families of Bessey's Rubiales, and resemblance between Rubiaceae and Caprifoliaceae is the result of convergence and not a close relationship. The Caprifoliaceae, Adoxaceae, Valerianaceae and Dipsacaceae have been kept under a different order, the Dipsacales by Wagenitz. The classification schemes of Gibbs (1974), Dahlgren (1975), Thorne (1976) and Takhtajan (1969) are somewhat similar to the treatment of Wagenitz. On the basis of serological evidences, Lee and Fairbrothers (1978) supported the placement of the Rubiaceae in the Gentianales. Cronquist (1981) shifts Caprifoliaceae to the Dipsacales and groups the Theligonaceae with the Rubiaceae in Rubiales.

The monotypic order Rubiales by Bremekamp also needs consideration. Rubiaceae and the other families of the Gentianales <u>sensu</u> Wagenitz have colleters and nuclear endosperm in common but in the absence of intraxylary phloem and in having inferior ovary the Rubiaceae have resemblances to the families of the Dipsacales. According to Bremekamp because of the absence of intraxylary phloem in the Rubiaceae it cannot be included in Gentianales and therefore to be kept in a monotypic order Rubiales which would be closer to families of order Gentianales rather than the Dipsacales. Cronquist (1981) also is in favour of treating the Rubiaceae as an order by themselves (of course with a satellite family Theligonaceae) and defends that the Rubiaceae form a connecting link between the Gentianales and Dipsacales. Based on the cytological and palynological evidences the Rubiaceae do not appear to fit well in the order Gentianales <u>sensu</u> Wagenitz (Mathew and Philip, 1983).

Intra-familial classification

In some of the earlier classifications deCandolle (1830) recognised 13 tribes under two main groups in the family and Lindley (1846) divided it into 11 tribes. Hooker (1873) classified the family into 25 tribes under three series. The tribes of series A is characterised by plurilocular ovary, series B with collateral ovules and uniovular ovary in series C. He had subdivided series A and C further into two subseries, based on nature of fruit in the former and based on the position of the embryo in the latter. The circumscription of the tribes agrees more or less with that of Schumann. Schumann (1891) in Engler and prantl's "Die Naturlichen Pflanzen Familien" had divided the family Rubiaceae into two sub-families the Cinchonoideae, and Coffeoideae. The Cinchonoideae is characterised by indefinite number of ovules in each loculus and Coffeoideae is characterised by a single ovule in each loculus. The Cinchonoideae is further divided into two groups Cinchoniae (with dry fruit) and Gardeninae (with fleshy fruit). Similarly Coffeoideae also is further divided into two groups Guettardinae (characterised by pendulous ovule; micropyle facing upwards) and Psychotrinae (characterised by ascending ovule; micropyle facing downwards). The tribes belonging to the Cinchonoideae are Condamineae, Oldenlandieae, Rondeletieae, Cinchoneae, Henriquezieae, Naucleae, Mussaendeae and Gardenieae and that of

Coffeoideae are Alberteae, Knoxieae, Vanguerieae, Guettardeae, Chiococceae, Ixoreae, Psychotrieae, Paederieae, Anthospermeae, Coussareae, Morindeae, Spermacoceae, and Galieae.

Bremekamp (1954) has taken into account a spectrum of characters from morphology, anatomy and embryology and has given a detailed systematic classification to the family. He has recognised eight subfamilies namely the Cinchonoideae having seven tribes, Urophylloideae with four tribes, Pomazotoideae, Gleasonioideae, Guettardoideae, Ilillioideae each with only one tribe, Ixoroideae with seven tribes and Rubioideae with 19 tribes. Verdcourt (1958) divided the family into, three subfamilies. Rubioideae with 17 tribes, Cinchonoideae with 11 tribes and Guettardoideae with only one tribe, the Guettardeae. Wagenitz (1964) distinguished 21 tribes in the family under two subfamilies (Cinchonoideae with pluri-ovular locule and Rubioideae with uniovular locule). His classification is more or less similar to the older classifications by Lindley (1846) and de Candole (1830). The classifications by Verdcourt and Bremekamp are different in systematic setting of tribes and subfamilies, whereas they are similar in fixing the genera.

Among the various classifications listed above, Hooker's (1873) is the most concise one. Bremekamp's classification is highly detailed among the recent classifications. But there are agreements and disagreements between these two systems regarding division of subfamilies and setting of certain tribes.

According to Bremekamp the most primitive tribes of the family are Naucleeae and Cinchoneae. He had shifted the genera Anthocephalus, Stephegyne and Uncaria into Cinchoneae from Bentham and Hooker's Naucleeae based on capituliform inflorescence. But Verdcourt (1958) has given a more advanced position to these two tribes by placing it in his intermediate subfamily Cinchonoideae. Hutchinson (1969) has placed the tribe Naucleeae in an advanced position. The four tribes Argostemmatideae, Hedyotideae, Cruckshanksieae, and Ophiorrhizeae which were placed in a single tribe Hedyotideae by Bentham and Hooker also are considered primitive.

Pollen bud formation is a unique feature specific to the genus Ophiorrhiza (Philip, 1978). This is not seen in pollens of any other genus of the family. On the basis of this it is suggested that Bremekamp's Ophiorrhizeae may be further divided and Ophiorrhiza should be kept under a monotypic tribe Ophiorrhizeae and the rest of the genera in a different tribe. Bremekamp considered knoxieae, Spermacoceae and Galieae as advanced tribes, but Verdcourt treats them as primitive groups.

The Caprifoliaceae

The Caprifoliaceae are considered the closest ally of the Rubiaceae. The bifamilial order Rubiales of Hutchinson (1973) contained only these families. The Caprifoliaceae are distinguished from most of the associated families (except Rubiaceae) by the inferior multicarpellate ovary and opposite leaves. The absence of interpetiolar stipules and colleters, and cellular pattern of endosperm development keep this family distinct from Rubiaceae.

The members of this family are shrubs or more or less woody wines or sometimes small trees and seldom herbs with different kinds of trichomes. Leaves are opposite, simple (pinnately compound in Sambucus). Stipules mostly absent or vestigial, when present usually small and adnate to the petiole. Colleters are absent. Winter buds commonly with well developed bud scales (in contrast to the Rubiaceae) but sometimes naked flowers in various sorts mostly cymose to mixed inflorescences, commonly bracteolate, perfect, epigynous mostly (4)-5-merous as to the calyx, corolla and androecium. Calyx usually small, lobes imbricate or open in bud, accrescent in fruit. Corolla sympetalous, with imbricate or open in bud, accrescent in fruit or some times valvate, lobes, regular or slightly irregular, rarely bilabiate; stamens attached to corolla tube alternate with lobes or sometimes only 4(Linnaea) or 2 (Carlemannia, Silvanthus); anthers dorsifixed and versatile, tetrasporangiate and dithecal, opening by longtudinal slits. Pollen grains trinucleate, commonly tricolporate, or triporate; gynoecium of 2-5(-8) carpels united to form a compound inferior or seldom half inferior ovary with typically as many ovules as carpels and with axile placentation or the partition sometimes failing to meet in the upper part of the ovary. Sometimes only one locule is fertile, the other locules with abortive ovules or empty and more or less strongly reduced in species of Viburnum. Nectary at times present atop the ovary; style terminal, with a wet capitate or lobed stigma or stigma(s) subsessile; ovules one to many in each locule, pendulous, anatropous, with a massive single integument, tenuinucellar (crassinucellar in Viburnum); endosperm development cellular or sometimes nuclear. Fruit a capsule, a berry or a drupe with as many seed like stones as fertile locules or dry and indehiscent; seeds commonly with a small, basal to linear and axile, straight dicotyledonous oily embryo, with fleshy endosperm. X=8-12+most often 8 or 9 (Carlemanniaceae, Sambucaceae).

Secretory cells are common in the family. The nodes are trilacunar, some times unilacunar or pentalacunar. Petiole anatomy is diverse. Leaf is usually dorsiventral, stomata are anomocytic, rarely paracytic. The wood is ring-porous or semi-ring-porous. The vessel segments are with simple or scalariform perforations, and tracheary elements are with bordered or seldom with simple pits, wood rays are heterocellular, mixed, uniseriate and pluriseriate. Wood parenchyma commonly diffuse sometimes scanty paratracheal (Metcalfe & Chalk, 1957).

The presence of valerianic acid in the family is noteworthy.

The family often accumulates one or another sort of phenolic heteroside (especially glycoside). Iridoid compounds are common in the family. Most of the members are tanniferous and or saponiferous and frequently with proanthocyanidins. Some members produce ellagic acid. A few members of the family also produce alkaloids. Crystals of calcium oxalate of varied forms are common.

The family consists of about 15 genera and 400 species mostly of north temperate and of tropical mountains. 75% Of the species belong to two large genera Lonicera and Viburnum with about 150 species each. Abelia, Linnaea, Sambucus, Symphoricarpos and Weigelia are some other familiar genera. Sambucus and Viburnum stand somewhat apart from the rest of the Caprifoliaceae and from each other and have been the subject of much comments and phylogenetic speculations. Sambucus is the more distinctive of the two but there is no other family in the vicinity to place this genus comfortably.

Hillebrand (1966), and Hillebrand and Fairbrothers (1970) suggest a close relationship of Caprifoliaceae to the Cornaceae and much less close relationship to the Rubiaceae based on serological studies. A more recent study by Lee and Fairbrothers (1978) indicates mutual interrelationships among Caprifoliaceae, Rubiaceae and some families of Gentianales and Cornales. In this study the serological study do not argue against a reasonably close relationship of the Caprifoliaceae to the Rubiaceae (Cronquist, 1981).

From an economic point of view the Caprifoliaceae do not offer much. The flowers of Sambucus nigra have long been used in domestic and veterinary medicine, particularly in the form of ointment. They contain p-coumaric acid, rutin and kaempferol. The root bark of Viburnum prunifolium (Black haw bark) was formerly official in most pharmacopoeias, but its use for dysmenorrhoea, threatened abortion and for asthma has gradually decreased. It contains about 0.2 percent of salicin, volatile oil and isovaleric acid, tannin and resin (Trease and Evans, 1972). Various species of Lonicera and Viburnum are cultivated for ornamental purposes.

Present work

The present work deals with three aspects of the family Rubiaceae: 1. Chemotaxonomical studies, 2. Cladistics and 3. Pharmacognostic studies of some medicinal plants; presented in three chapters.

The second chapter embodies the chemical screening of 64 plants belonging to 32 genera representing 15 tribes for their leaf constituents and their relevance in the taxonomy of the group. The chemical characters selected are flavonoids, phenolics, alkaloids, quinones, iridoids, saponins, steroids, tannins, coumarins, organic acids and sugar alcohols. In addition, eight members of the Caprifoliaceae also have been subjected to a chemical analysis for the above mentioned constituents.

The third chapter contains cladistic studies on 32 genera screened. 20 phylogenetically significant characters selected from morphology, palynology, cytology, and phytochemistry are taken into consideration. Wagner's tree is constructed and superimposed on a Wagner's bull eye chart. The different groupings resulted are assessed critically.

Pharmacognostic studies on medicinally important parts of 20 lesser-known medicinal plants form the fourth chapter. The distinguishing histological features are identified and illustrated. The anatomical characters specific to the family are discussed.

The principal aims and objectives of this research project are listed below.

1. To screen a number of members of the Rubiaceae to find out the distribution of various chemical characters within various taxa included in the family.

2. To assess the validity of the subfamilies and the tribes, and evolutionary levels of tribes.

3. To circumscribe various contraversial genera and species.

4. To evaluate the status and position of Ophiorrhiza.

5. To assess the separate identity of Hymenodictyon away from Cinchona and the validity Cinchoneae as a monotypic tribe.

6. To understand various evolutionary lines operating within the Rubiaceae and to evaluate the evolutionary status of the family.

7. To find out the affinities of the Rubiaceae with the related or supposedly related families.

8. To find out new sources of bioflavonoids, alkaloids, saponins, tannins, coumarins, quinones, and iridoids.

9. To assess the relationship of the Caprifoliaceae with the Rubiaceae.

10. To subject the plants to a cladistic treatment to arrive at a viable and non-controversial scheme of classification.

11. To prepare an inventory of the medicinal plants.

12. To study the pharmacognosy of drugs which are not yet worked out in detail so that genuine drug can be identified and any adulterant, spurious, or substitutes in the commercial drug can be differentiated.