MALVACEAE

Chapter 3

MALVACEAE

The Malvaceae are a moderately large family consisting of 75-82 genera and 1000-1500 species. The family is essentially cosmopolitan in distribution but particularly abundant in the tropics. The larger genera within the family are **Hibiscus** (200+), **Sida** (175+), **Pavonia** (150+), **Abutilon** (100+) and **Malvastrum** (75 +). In India the Malvaceae are represented by about 20 genera and 110 species.

The Malvaceae consist of herbs or seldom trees, generally the vesture being lepidote or stellate and producing mucilaginous sap. The leaves are alternate simple, entire or variously lobed and usually palmately veined and stipulate. Flowers basically in cymes, but often solitary in axils, bisexual (rarely unisexual and the plants then generally dioecious) and actinomorphic. The perianth is typically biseriate, but the calyx is frequently subtended by an involucre (epicâlyx) of distinct or connate bracts. Sepals five, distinct or basally connate and valvate with nectaries consisting of tufts of glandular hairs at the base. Petals five, distinct, often adnate to the base of the staminal tube, convolute, or less commonly imbricate. Androecium consisting of numerous stamens, initiated in centrifugal sequence, the outer sometimes staminodial, the filaments all connate into a tube for most of their length, apically distant, anthers 1-celled, bisporangiate, reniform, dehiscing longitudinally. Gynoecium of a single pistil, 2-many carpels, ovary superior, 2-many loculed, placentation axile with 1-many ovules in each chamber. Ovules are anatropous to campylotropous and bitegmic, style one or as many or twice as many styles as carpels, stigmas as many or twice as carpels, dry, usually papillate, distinct, capitate to discoid or introrsely decurrent. Fruit, typically, is a loculical capsule or schizocarpic with the mature carpels separating into mericarps from one another and from the axis, or a berry as in **Malvaviscus** or a samara. Seed often pubescent or comose (as in **Gossypium**); embryo straight or curved; endosperm mostly present, oily and proteinaceous.

Anatomical features

Stellate hairs form one of the most characteristic features of the Malvaceae. In addition, tufted multicellular hairs, small peltate hairs and glandular hairs (capitate or small) also occur in this family. Extrafloral nectaries consisting of groups of secretory trichomes situated on the surface or in concavities or depressions are also reported from some members. Mucilage-containing structures vary in structure and distribution. Some of the epidermal cells on the upper surface of the leaf get specialised for the secretion of mucilage, become large and penetrate to the mesophyll. Mucilage cells, cavities or canals are seen abundantly in the mesophyll, cortex or pith of young stems. Lysigenous secretory glands (cavities) with brown contents are seen in leaves of many plants. Cluster crystals are often seen in leaf and stem parenchyma and phloem. Nodes are trilacumar to multilacunar. Petiolar vascular supply complex, sometimes siphonostelic, more often with a ring of separate bundles,or seldom a single trough-shaped bundle. Stipules usually present. Vessel-segments with simple perforations; imperforate tracheary elements with simple or seldom bordered pits. Wood-rays very variable in type, ranging from a) highly multiseriate rays composed of narrow upright cells, together with numerous uniseriate rays to b) large homogeneous rays with few uniseriates or c) short, heterogeneous storied rays. Tile cells are often present. Wood parenchyma rather scanty to abundant, predominantly paratracheal in the Malveae and Ureneae and apotracheal in most of the Hibisceae. The phloem, in most cases, is especially characteristic, consisting of triangular strands as seen in transverse sections with bases towards the xylem and stratified tangentially into alternate fibrous and non-fibrous bands. The primary medullary rays, where passing through the phloem,also are triangular but with the apices towards the xylem (Metcalfe and Chalk,1950).

Palynological characters

The pollen grains of the Malvaceae are distinctive, usually large, spiny and spheroidal showing an evolutionary trend from a medium-sized ancestral zono-colporate pollen type with small spines to a large pantoporate polytreme type with long sometimes distinctly dimorphic spines. The most simple of the intermediate types have the apertures spaced over the pollen surface creating a pattern very much like the seam on a tennis ball (Christensen, 1986).

Cytology

Opinions vary on the basic chromosome number of the Malvaceae. Davie (1933) visualised divergent lines of origin of different genera and species from a common ancestral type with a basic number of 7. Skovsted (1935) recognised five series of chromosome numbers (7, 5, 6, 11 & 13) believed to be originated from different prototypes. According to Hazra and Sharma (1971) the number 7, which is deep-seated in the family, is derived from a basic set of 6 (**Thespesia populnea**). Bates and Blanchard (1970) considered the basic number to be 7, 6 & 5 which might have originated from a basic set of 8 through aneuploidy reduction. Dasgupta (1976) also considers 7 as the deep-seated number in the family.

Embryology

Pollen grains are binucleate at anthesis. Embryosac formation is crassinucellar, the micropyle is zig-zag, and the endosperm formation is nuclear.

Chemistry

The family Malvaceae is known for its mucilage, gossypol and cyclic fatty acids. The mucilages obtained from stem, leaves, flowers or roots are put to a variety of uses. **Althea** mucilage which is medicinally used as a bulk laxative (also exhibiting anti-ulcer activity-Baranlov et al 1985) consists of a group of polysaccharides, the principal component being a partially acylated acidic polysaccharide of a molecular weight of about 1,800,000 consisting of monomers such as L-rhamnose, D-galactose and D-glucuronic acid (Tomoda **et al.**, 1985). One of the **Hibiscus** mucilages (isolated from the roots of **Hibiscus moschatus**) consists of a partially acetylated acidic polysaccharide of M.W. 1,900,000 composed of L-rhamnose and D-glacturonic acid (Tomoda **et al.**,1986). Another mucilage obtained from flower buds of **Hibiscus syriacus** L. also is similar in having partially acetylated acidic polysaccharide of M.W.1,050,000-contains L-rhamnose,D-galactose and D-galacturonic acid (Tomoda, 1987).

Gossypol (Gossypium-phenol), the yellow colouring matter in cotton seed, used to be a toxic contaminant of the cotton seed oil. This compound, a polyphenol of molecular formula $C_{30} H_{30} O_8$, is found to be toxic to the livestock resulting from the feeding of the oil meal. The most common of the toxic effects of gossypol is cardiac irregularity and latter death due to circulatory failure (Adams and Geissman,1960). Of late, the male sterilant properties of this compound are attracting the attention of many and extensive clinical trials are carried out in India and elsewhere on the effectiveness of this compound in family planning programmes. Gossypol is also obtained from the flowers of **Thespesia populnea** (Dutta **et al.**,1971).

Cyclopropenoic fatty acids, sterculic and malvalic acids, are highly characteristic to the seed oils of the Malvaceae. They form the minor component fatty acids of seeds and are obtained from many plants belonging to this family.

The flower flavonoids of the Malvaceae are extensively investigated. Gossypetin (8-hydroxy quercetin), its isomer quercetagetin (6-hydroxy quercetin) and herbacetin (6-hydroxy kaempferol) were obtained first from **Gossypium** flowers. These compounds are also reported from flowers of **Hibiscus sabdariffa, H. cannabinus, Gossypium arboreum** and **Thespesia populnea** (Gibbs, 1974). The leaf flavonoids isolated include kaempferol and quercetin from **Abutilon indicum** and **Hibiscus sabdariffa.** (Subramanian and Nair, 1964). Triterpenoids are reported from the flowers of **Hibiscus rosa-sinensis** (Agarwal and Rastogi,1971). Alkaloids are rare in the family reported only from **Sida** (l-ephedrine and D-pseudoephedrine) and **Gossypium** (serotonin and histamine : Raffauf,1970).

Economic importance of the family

The Malvaceae are known for their fibres,the most prominent among them being cotton. The other fibres, mostly of pericyclic and phloem origin, obtained from the family are rozelle (from the stalks of **H. sabdariffa**) Deccan hemp (**H.cannabinus**), Queensland hemp (**Sida rhombifolia**), Indian hemp (**Abutilon avicennae**), Aramina fibre (**Urena lobata**) etc.The sources of medicinal mucilages are **Althea** (**A.officinalis,A. rosea**), **Hibiscus** (**H. surathensis, H.moschatus, H. syriacus**) and **Sida** (various species). A number of plants in this family are acclaimed medicinal herbs. They are various species of **Hibiscus** (**H. trionum**-flowers-diuretic, for skin diseases; **H. rosa- sinensis** - flowers and leaves, demulcent, antiperiodic; **H.micranthus**- febrifuge; **H.manihot**-bark, emmenagogue;**H.cannabinus**- seeds aphrodisiac),**Malva** (**M. parviflora** - seeds,demulcent, expectorant; **M. rotundifolia** - seeds, demulcent) **Malvastrum** (**M. coromandelianum**- leaves used for cooling drinks) **Malachra** (**M.capitata** - emollient) **Urena** (**U.lobata** - roots antirheumatic),**Pavonia (P.odorata**- astringent,antirheumatic; **P. zeylanica** - vermifuge & purgative), **Sida** (various species - the well-known 'bala' of Ayurveda) **Abutilon (A. asiatica** - leaves antigonorrhaeal; **A.indicum** seeds laxative) and **Thespesia (T. populnea** - fruit, leaves and roots for skin diseases). The vegetable-yielding plants of the family are **Hibiscus esculentus** (fruits) and **H. sabdariffa** (fruits, leaves, epicalyx). In addition, the family includes a number of ornamentals belonging to the genera **Hibiscus, Althea, Thespesia** and **Kydia.**

Taxonomy

Masters (1865), following Bentham and Hooker (1865), divided the family Malvaceae (inclusive of the Bombacaceae) into two groups. The first group having tubular antroecium (tube entire or but slightly divided at the apex), is the Malvaceae **sensu stricto.** The second group corresponding to the present day Bombacaceae possesses antroecium either tubular at the base only and divided above into pentadelphous filaments (rarely tubular higher up) or divided throughout into filaments. The first group is further divided into three tribes:

1) **Malveae** - Herbs or shrubs. Ripe carpels separating from the axis. Styles as many as carpels.
2) **Ureneae** - Styles or stigmatic branches twice as many as the carpels.
3) **Hibisceae** - Herbs or shrubs. Fruits capsular, sepals leafy. Staminal tube truncate or 5-toothed at the apex.

The second group (Bombacaceae) contained only one tribe Bombaceae.

Schumann (1895) separated the Bombacaceae from the Malvaceae and divided the later family into two groups. The group A contained plants having carpels in vertical rows and consisted of one tribe Malopeae. The group B had carpels in one plane and was subdivided into three tribes Malveae (Schizocarp, styles as many as carpels), Ureneae (Schizocarp, styles twice as many as carpels) and Hibisceae (capsule) as was done by Masters (1865). The tribe Malveae was further divided into three subtribes Abutilinae, Malvinae and Sidinae.

1872

Since the demarkating lines between the Malvaceae and Bombacaceae are rather vague, some genera have been shifted back and forth. The most radical proposal is that of Edlin (1935) transferring all the capsular genera (tribe Hibisceae - containing **Hibiscus, Senra, Gossypium, Thespesia** etc.) to the Bombacaceae and restrict the Malvaceae to the genera with schizocarpic fruits. Modern opinion emphasises the sculpture of the pollen grains as the most nearly constant distinction between the two families **i.e.** spinulose in the Malvaceae and smooth or nearly so in the Bombacaceae. This would mean that the Malvaceae would contain herbs and shrubs and Bombacaceae all the trees.

Though the boundaries of the tribes are more or less unchanged, the generic limits always remained a matter of controversy, resulting in shunting of many species between various genera. All the major genera can be said to have flexible boundaries and many a times new genera are constituted from a section of a large genus. The genus **Hibiscus** of Linnaeus (1737) has been an assemblage of **Ketmia** Tourn; **Malvaviscus** Dill.; **Trionum** L. and **Hibiscus** L. Miller (1754) split **Hibiscus** L. into **Ketmia** and **Hibiscus** restricting the latter genus to a single species, **H.malvaviscus.** This species turned out to be **Malvaviscus arboreus** Cav. Fabricius (1759) united **Ketmia, Hibiscus** and Malvaviscus and named this genus **Malvaviscus** reducing **Ketmia**,and **Hibiscus** to synonymy. It was Cavanilles (1787) who treated **Malvaviscus** as a distinct genus based on **Hibiscus malvaviscus** L. Since then the two genera **Hibiscus** and **Malvaviscus** are accepted as distinct. The species of **Hibiscus,** having a spathaceous, deciduous calyx splitting on one side, were separated into a new genus **Abelmoschus** by Medikius (1787). This concept had been accepted by Hochreutiner (1924) as in this genus the calyx, corolla and stamens are fused together at the base and fall as one piece at anthesis. The generic status of **Abelmoschus** is accepted by many workers (Schumann, 1890; Hu, 1955; Santapau,1955; Waalkes et al.,1966; Rakshit and Kundu,1970), while some others (Masters, 1872; Prain, 1903; Duthie,1903; Gamble 1957; Cooke 1958) considered **Abelmoschus** as a section of **Hibiscus.**

Azanza lampas Alef.is variously treated under **Hibiscus** (Schumann, 1890; Hochreutiner,1900; Santapau,1962) or **Thespesia** (Waalkes et al.,1966; Dalzelle and Gibson,1896). It is similar to **Hibiscus** in having distinctly lobed styles, noncaducous involvucre,clearly 5-lobed calyx and many seeded dehiscent capsule while the proposed affinities to **Thespesia** are considered due to its compound stigma and cupular or minutely 5-toothed calyx. Based on pollen characters, Rakshit and Kundu (1970) suggested **Azanza** to be intermediate between **Hibiscus** and **Thespesia.** Such a contention is arrived at, on the basis of cytological observations by Dasgupta (1976). **Senra incana** was once included in **Gossypium** and **Hibiscus schizopetalous** was treated a variety of **H.rosa-sinensis.**

In the present work 42 members belonging to 15 genera of the Malvaceae are subjected to a chemotaxonomic analysis using leaf phytochemicals as the markers. Based on the distribution of the chemical characters, the classification of the family, it's affinities and the various controversies existing at all levels of taxonomic hierarchy are evaluated.

Materials and Methods

Most of the plants are procured from Baroda and environs. Plants are also collected from Mahabaleshwar, Coimbatore, Ootakamand and Bangalore. The voucher specimens of all the plants are deposited in the herbarium, Dept. of Botany, M.S.University, Baroda. The date and place of collection of plants and the voucher numbers of the Herbaria are given in Appendix 1. Standard procedures described in chapter 2 are followed for the isolation and characterisation of the various compounds. The UV spectral data, including the **max** and the various bathochromic and hypsochromic shifts induced, are given in Table 2. The identity of all the flavonoids and phenolic acids are confirmed by co-chromatography with the authentic samples.

Results

The distribution of flavonoids,phenolic acids, alkaloids, saponins and tannins in 42 members of the Malvaceae is presented in Table 3.

Flavonoids were located in 31 plants only. The various flavonoids identified were flavonols, flavones, glycoflavones and proanthocyanidins. Flavonols formed the dominant phenolic pigments of the Malvaceae. Quercetin, Kaempferol and their methoxylated derivatives were the flavonols encountered. Kaempferol was more frequent,

Table 2: The colors and spectral properties of the flavonoids identified from the members of the Malvaceae

	Flavonoid	Colors: visible light	Colors: UV	Absorption maxima (max, nm): MeOH	NaOMe	$AlCl_3$	$AlCl_3/HCl$	Na OAC	$NaOAc/H_3BO_3$
1.	Apigenin	-	Br	267,296,336	___,392 (Incr.)	___,385	___,385	275,___	267,300',336
2.	7-OMe Apigenin	-	Br	269,296,334	___,390	___,384	___,384	268,___	268,300',336
3.	4'-OMe Apigenin	-	Br	267,290',329	___,364 (dec)	___,382	___,382	276,___	269,331
4.	7,4'-DiOMe Apigenin	-	Br	269,327	___,362 (dec)	___,381	___,381	267,___	267,331
5.	6-OMe Apigenin	Y	Br	281,300,336	___,392 (Inc)	___,386	___,386	281,___	284,336
6.	6,4'-DiOMe Apigenin	Y	Br	280,300',330	___,364 (dec)	___,390	___,386	281,___	280,330
7.	Luteolin	LY	Br	255,267',350	___,398 (Inc.)	274,426	___,387	270,___	259,370
8	4'-OMe Luteolin	LY	Br	252,267',345	___,364 (dec)	___,410	___,388	270,___	259,350
9	4'-OMe Vitexin	-	Br	268,329,	___,364 (dec)	___,382	___,380	274,___	269,330
10	Kaempferol	Y	Y	267,294',320',367	___,410 (dec)	___,425	___,425	276,___	268,372
11	7-OMe Kaempferol	Y	Y	269,293',320',365	___,410 (dec)	___,425	___,423	268,___	268,370
12	4'-OMe Kaempferol	Y	Y	267, 363	___,410	___,423	___,424	275,___	267,371

	Flavonoid	Colors		Absorption maxima (max, nm)					
		visib-le light	UV	MeOH	NaOMe	$AlCl_3$	$AlCl_3$/HCl	NaOAc	NaOAc/H_3BO_3
13.	Quercetin	Y	Y	255,267¦300¦371	___,320 (dec)	____,458	___,425	275,___	260,390
14.	3'-OMe Quercetin	Y	Y	253,267¦300¦367	___,430 (dec)	____,438	___,428	274,___	255,377
15.	3',4'-DiOMe Quercetin	Y	Y	253,267¦300¦365	___,410	____,430	___,429	274,___	255,377
16.	Myricetin	Y	Y	255,270¦310¦374	___,400 (dec)	____,459	___,428	270,___	258,390

' denotes shoulder, Y = Yellow, Br = Brown, MeOH = Methanol, NaOMe = with Sodium methoxide, $AlCl_3$ = with aluminium chloride, $AlCl_3$/HCl = with aluminium chloride and HCl, NaOAc = with sodium acetate NaOAc/H_3BO_3 = with sodium methoxide and boric acid (see Mabry _et al_ 1970).

Table - 3: The distribution of phytochemicals in leaves of 42 members of the Malvaceae

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
I. Tribe Malveae																									
(a) Subtribe Abutilinae																									
1. **Abutilon bidentatum** A.Rich	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	.	.
2. **A.indicum** (L) Sweet	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	+	.
3. **A.hybridum** Roxb.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.
4. **A. polyandrum** Schl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5. **A.ramosum** Guill.& Perr.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	+	+	+	+	.	.	.
6. **A.pannosum** Schl.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.
7. **Kydia calycina** Roxb.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(b) Subtribe Malvinae																									
8. **Althea rosea** L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
9. **Malvastrum coromendelianum** Gareke	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.	+	+	+	+	.	.	.	.	.	.
(c) Subtribe Sidinae																									
10. **Sida acuta** Burm.	+	.	+	.	.	.	.	.	.	.	.	.	+	.	.	+	+	+	+	+	+	+	+	.	.
11. **S. cordata** Bross	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	+	+	.	+	+
12. **S. alba** L.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	+	+	.	+	+	.	+	+
13. **S.rhomboidea** Roxb.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	+	.	.
14. **S.schimperiana** Hochst.	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.
15. **S.spinosa** L.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	.	.	.

Table - 3 (contd.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
II. Tribe Ureneae																									
16. **Malachra capitata** L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	+	.
17. **Malvaviscus arboreus** Cav.	.	.	+	.	+	.	.	.	.	.	+	.	.	.	.	.	+	+	+	+	+	+	.	.	.
18. **Pavonia arabica** Hocht.Steud.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	+
19. **P.odorata** Willd.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	+
20. **P.zeylanica** Cav.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	+	+	.	.	.
21. **Urena lobata** L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.	+	+	.
III. Tribe Hibisceae																									
22. **Abelmoschus pungens** Voigt	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	.	.	.
23. **A.moschatus** Medic.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	+	+	+	+	.	.	.
24. **A.ficulneus** W.&A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
25. **Hibiscus mutabilis** L.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+	.	+	.
26. **H.micranthus** L.f	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	+	+	+	+	.	+	.
27. **H.panduraeformis** Burm.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	+	+	+	.	.	.	+	+	.	.	.
28. **H.radiatus** Willd.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
29. **H.gossipifolius** Mill	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	+	+	.	.	.	.	.	.	+
30. **H.schizopetalus** H.f.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	+	+	.	.	.
31. **H.rosa-sinensis** L.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	+	+	+	+	+	.	.	.
32. **H.caesius** Garcke	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.
33. **H. syriacus** L.																									

Table - 3 (contd.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
34. **H.furcatus** Willd.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
35. **H.tiliaceus** L.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	.	.	.	+
36. **H.lobatus** O.Ktze	.	.	.	.	.	+	.	.	+	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.
37. **Gossypium arboreum** L.	.	.	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	+
38. **G.herbaceum** L.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	+	.	+	.	.	+	.	.	+
39. **G.hirsutum** L.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	+	+	+	.	.	+
40. **Senra incana** Cav.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.
41. **Thespesia populnea** Sol.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	+	+	.	+	.	.	+
42. **Azanza lampas** Alef.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	+	+

1) Acacetin, 2) 7-OMe Apigenin, 3) Kaempferol, 4) 4'-OMe Kaempferol, 5) 7,4'-DiOMe Kaempferol, 6) Quercetin, 7) 3-OMe Quercetin, 8) 4'-OMe Quercetin, 9) 3'4'-DiOMe Quercetin ,10) 7,3',4'-TriOMe Quercetin, 11) 4'-OMe Vitexin, 12) 7-OMe Vitexin, 13) 6-C-Glycosyl Kaempferol, 14) Proanthocyanidins 15) p-OH Benzoic acid, 16) Protocatechuic acid, 17) Vanillic acid, 18) Syringic acid, 19) Gentisic acid, 20) Melilotic acid, 21) p-Coumaric acid, 22) Ferulic acid, 23) Alkaloids, 24) Saponins and 25) Tannins.

from 17 plants. Unsubstituted Kaempferol was seen in 12 plants while methoxy Kaempferols were less frequent, present in 8 plants. The methoxylated derivatives replaced Kaempferol in four members while both methoxy Kaempferols and pure kaempferol occurred together in four plants. The methoxylated kaempferols identified were 4'-OMe kaempferol and 7,4'-diOMe kaempferol. Compared to kaempferol, quercetin and its derivatives were produced by fewer plants. Among the 13 plants which produced these compounds, quercetin was the sole flavonoid in six. Methoxylated quercetins were found in more plants i.e. eight. 3-OMe Quercetin,4'-OMe quercetin, 3',4'-diOMe quercetin and 7,3',4'- triOMe quercetin were the methoxylated quercetins identified from the Malvaceae. Flavonols occurred with flavones in 3 plants and with glycoflavones in six.

Flavonols formed the principal flavonoids in Malveae. Within this tribe the subtribe Sidinae is rich in flavonols while the subtribe Abutilinae contained fewer flavonols. The Ureneae contained only kaempferol and no quercetin, while the Hibisceae contain both the flavonols in almost equal proportions.

Flavones were found to occur in nine plants. They were acacetin and 7-OMe Apigenin. Flavones were the sole flavonoids in 2 plants and were absent from the tribe Ureneae and rare in Malveae and more frequent in Hibisceae. Flavones co-occurred with flavonols in six plants and with glycoflavones in three.

Glycoflavones were comparatively more frequent than flavones in their incidence having been located in 10 plants. They were 4'OMe vitexin, 7-OMe vitexin and 6-glycosyl kaempferol. These compounds were rare in Ureneae, comparatively rare in Malveae and more common in Hibisceae.

ln most of the plants they co-occurred with flavonols and in only three plants they occurred with flavones.

Proanthocyanidins were rare in this family obtained from five plants. Of these four are seen in Hibisceae. In most of the plants they occurred with flavonols.

Altogether eight phenolic acids have been isolated from the family. Of which, vanillic, syringic, gentisic, melilotic, p-coumaric and ferulic acids were more or less uniformly distributed. p-OH benzoic and protocatechuic acids are comparatively rare.

The family Malvaceae is very poor in alkaloids in that only five plants showed a positive test. All the alkaloid-containing species belong to the Malveae and Ureneae. Saponins though rare, present in 9 plants only, are distributed uniformly among the three tribes. Tannins were present in 11 plants. The subtribes Abutilinae and Malvinae are free of these compounds.

From among the three tribes of the family Malvaceae studied, the tribe Malveae contains seven (out of sixteen) plants which do not contain flavonoids. This tribe contained very few flavones, but more than 50% of plants contain flavonols. Of the three subtribes of Malveae, the subtribe Abutilinae contained very little flavonols and no glycoflavones. The subtribe Malvinae did not contain flavonols while the subtribe Sidinae exhibited comparatively larger incidence of flavonoids especially flavonols. The tribe Ureneae was devoid of flavones. More than half the number of plants did not contain flavonoids at all. The tribe Hibisceae contain more flavones and glycoflavones. Only three plants (out of 22) of this tribe are devoid of flavonoids.

Discussion

All the three tribes represented in the present study are similar to each other in containing the flavonols as the dominant phenolic pigments. They are also similar in possessing glycoflavones also, albeit, in varying amounts. The flavones are not very common in the family and therefore their absence from the Ureneae may not be assigned undue importance. All these features point to the homogeneity of the family Malvaceae as evidenced by their anatomy (Metcalfe and Chalk,1950).

Within the tribe Malveae, the three subtribes Abutilinae, Sidinae and Malvinae also are very similar to each other in their chemistry. Except for one plant, flavones are absent from this tribe. All the plants in this group are devoid of proanthocyanidins. Glycoflavones are not seen in any of the Abutilinae and this subtribe is very poor in flavonols as well as the flavonoid system. Both Abutilinae and Malvinae are devoid of tannins. Thus the Abutilinae chemically is the most advanced subtribe of the Malveae and within the subtribe **Kydia** is advanced over **Abutilon.** In elaborating more flavonols and tannins Sidineae deemed to be the most primitive subtribe.

The Ureneae with its four genera screened here (**Malachra, Malvaviscus, Pavonia and Urena**) appears to be very homogeneous in not containing any flavone and quercetin or their derivatives. Such homogeneity is also seen in having chromosome numbers which are simple multiples of 7 (Dasgupta, 1976). The preference of kaempferol over the more hydroxylated quercetin is definitely an advanced feature. Moreover, four out of seven plants, do not produce any flavonoid at all. Since the loss of flavonoid system is considered advanced, within the tribe, **Malachra** and **Urena** are the advanced genera and **Malvaviscus** primitive. **Pavonia** with flavonols in one species and tannins in two plants forms the intermediate taxon. This corroborates the evolutionary sequence **i.e. Pavonia, Urena** and **Malachra** proposed on the basis of Karyotype studies (Dasgupta **loc.cit.**)

In contrast to the tribes Malveae and Ureneae, the Hibisceae presents a picture of heterogeneity. The plants of this tribe produce all the four types of flavonoids **i.e.**flavones,flavonols, glycoflavones and proanthocyanidins. The genera within, also are different from each other in containing different assortments of flavonoids. The heterogeneous nature of the tribe is also evident in their cytology in that the members have varying chromosome numbers which are multiples of 6, 7, 8 or 13. **Abelmoschus**,which was once included in **Hibiscus**, is different from the latter genus in its inability to produce flavones, kaempferol, glycoflavones,proanthocyanidins and tannins, the compounds very common in **Hibiscus**. Such chemical identity validates the generic status assigned to **Abelmoschus**. Similarly **Azanza lampas** also is distinct in not synthesising the characteristic compounds of **Hibiscus**, **i.e.** flavonols, glycoflavones and proanthocyanidins. **Azanza** is different from **Thespesia** (another genus in which it is merged at times) in that the latter genus produces a flavonol while the former is devoid of these compounds and contains saponins. The presence of same flavone (acacetin) and tannins in both the plants indicates the closeness these two taxa enjoy. **Senra**, (once merged in **Gossypium**) does not possess the same flavonols of **Gossypium** but possesses another flavonol 7,4'-diOMe kaempferol which is not seen even in any other member of the tribe Hibisceae. The complexity exhibited by the genus **Hibiscus** also is intriguing. In this genus while some species produce only flavones (**H.syriacus**), others produce only flavonols (**H.furcatus**) or proanthocyanidins (**H.tiliaceous**) and some others a combination of all the flavonoids. Such heterogeneity is exhibited in possessing a wide range of chromosome number (2n = 24 to 2n = 120) representing multiple of 6, 7 & 8, also. **H.schizopelalus** and **H. rosa-sinensis**, the former was once considered a variety of latter, are similar in containing same flavone but are dissimilar in glycoflacones and this justify the independent status of the former.

The relationships of the Malvaceae with other families are evaluated in the chapters dealing with other families.