GENERAL INTRODUCTION

Chapter 1

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The order Malvales, in which the family Malvaceae is customarily placed, is considered one of the most natural taxa of the Magnoliopsida. This order was first conceived by Lindley (1833), who kept it as the first order of his Polypetalae-Syncarpeae, containing the Malvaceae, Sterculiaceae, Elaeocarpaceae,Tiliaceae and Dipterocarpaceae. Except Hutchinson (1969), who seggregated the Malvaceae into his unifamilial order Malvales away from the Tiliales (containing the rest of the families), all other taxonomists recognised the Malvaceae, Sterculiaceae and Tiliaceae to form the core group of the order. In fact, the Malvales of Bentham and Hooker (1862) contained only these three families. Elaeocarpaceae are a splinter-group of the Tiliaceae recognised separate by many. Similarly Bombacaceae are a seggregate of the Malvaceae. Scytopetalaceae, Sphaerosepalaceae,Sarcolaenaceae,

Chlaenaceae,Triplochitonaceae,Buettneriaceae,Gonystylaceae and Dipterocarpaceae are some other families grouped in this order. Of these, Buettneriaceae and Triplochitonaceae are often included in the Sterculiaceae. Thorne (1976) and Dahlgren (1976) included Huaceae, Plagiopteraceae,Bixaceae, Cochlospermaceae and Cistaceae also in this order.

Cronquist (1981) recognises the Malvales as the third order of the Dilleniidae having stellate or lepidote hairs and usually with mucilage cells, sacs, or cavities, young stems usually with stratified phloem and very wide wedge-shaped phloem-rays,hypogynous flowers with valvate sepals (seldom imbricate),sepaline nectaries, mostly separate petals often convolute in bud,usually numerous and centrifugal stamens with filaments very often monadelphous (but sometimes distinct) or merely connate into groups and seeds commonly containing cyclopropenyl fatty acids. His Malvales contain five families, Elaeocarpaceae,Tiliaceae,Malvaceae,Bombacaceae and Sterculiaceae enclosing about 3000-3500 species,cosmopolitan in distribution,but best represented in the tropics. The Malvaceae with 1000-1500 spp. and the Sterculiaceae with about a thousand species, are the largest families. The Tiliaceae contain about 450 spp.,the Elaeocarpaceae about 400 and the Bombacaceae about 200.

The stellate hairs are the star-like multicellular hairs with a few to many arms. The mucilage containing secretory organs are either (1) epidermal cells which have a mucilaginous inner membrane and frequently give rise to transparent dots on the leaf or (2) cells with mucilaginous walls in the ground tissue of the axis or leaf, or (3) mucilage cavities of lysigeneous origin which sometimes are differentiated as canals. The phloem consists of triangular

strands in T.S.with bases towards the xylem (narrow portions outwardly directed) which are stratified tangentially into alternating fibrous and non-fibrous strands. The primary medullary rays, where passing through the phloem, are also triangular but with apices towards the xylem. The characteristic nectary glands of this order are multicellular glandular hairs which are usually packed closely together to form cushion-like growths. In the Tiliaceae these glands are distributed in sepals, petals and androgynophore while in other families they are more localised in the sepals. Sterculic and malvalic acids are the two cyclopropenyl fatty acids present in the seed-fats of this order.

Almost all the authors agree that the families included in this order by Cronquist are closely allied and such a closeness results in controversies on the circumcription of the individual families and often genera have been shifted from one family to another by various authors.For example, the whole tribe Hibisceae of the Malvaceae is sometimes referred to the Bombacaceae when fruit character is considered critical.Elaeocarpaceae stand somewhat isolated from the rest of the group though their close relationship with the Tiliaceae is unambiquous.

The various other families which are grouped in the Malvales at one time or other are the following.

The Sphaerosepalaceae (Rhopalocarpaceae) and Sarcolaenaceae (Chlaenaceae) are two families often grouped in the Malvales.Both these families differ from the Malvales **sensu stricto** in having an imbricate calyx and a different type of pollen, but are similar to them in possessing mucilage cells and phloem stratified to alternate strands of fibrous and non-fibrous tissues.

Cronquist (1981) considers these families as transitional between the Theales and Malvales and keeps them in the former order because their inclusion will make the relatively homogeneous Malvales a heterogenous taxon.

Scytopetalaceae and Dipterocarpaceae are the other two families included in Theales but having affinities to the Malvalean families. The former family is considered related to the Elaeocarpaceae and Tiliaceae due to the resemblences in embryological characters but differs from them in having bitegmic tenuinucellar ovules, cristarque cells in the cortex,unicellular hairs and in the absence of sepaline nectaries, mucilage and wedge-shaped phloem rays. The Dipterocarpaceae also are similar to the Tiliaceae in having a tillioid exine structure and stratified phloem but differ from the Malvales in having resins (in place of mucilage), imbricate sepals and in the absence of stellate hairs, sepaline nectaries and cyclopropenoid fatty acids.

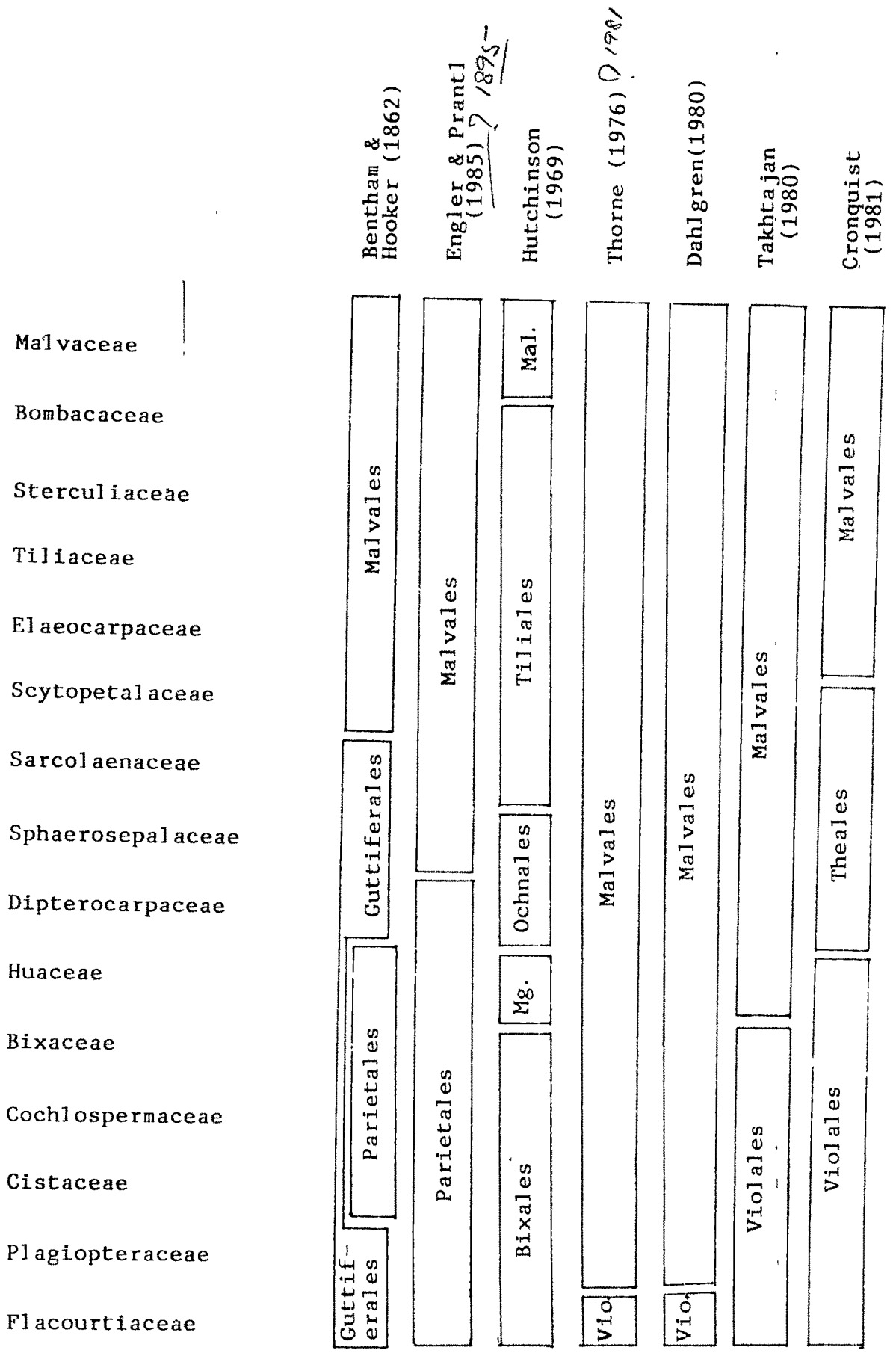
Huaceae, Bixaceae,Cochlospermaceae, Cistaceae and Plagiopteraceae are some other families grouped in Violales or Malvales by various authors. Huaceae are a bigeneric family differing from the Malvales in having unilocular ovary, non-stratified phloem and absence of mucilage cells and cyclopropenoid fatty acids. Both Bixaceae and Cochlospermaceae,sometimes grouped together in the former family, exhibit stratified phloem, wedgeshaped phloem rays and mucilage system of the Malvales but do not have valvate calyx, stellate hairs (except **Bixa**) septate ovary and cyclic fatty acids. The Cistaceae are very similar to the Bixaceae but for the stellate hairs. Plagiopteraceae are often included in the Flacourtiaceae.

According to Cronquist (1981), the Dilleniales, Theales, Malvales and Violales form a plexus with recognisable clusters of families, the clusters being delimited arbitrarily and the similarities exhibited by the members of these groups are due to the pervasive parallelism (1981).

Within the Malvales **sensu stricto**, it is generally agreed that the Elaeocarpaceae and Tiliaceae, with their numerous stamens,are the more primitive families. But the large number of stamens or carpels in these families is sometimes interpreted as resulted due to a secondary increase from a primitive flower with five stamens or carpels. The monothecal stamens of the Malvaceae and the Bombacaceae are widely admitted to represent longitudinal halves of ancestrally dithecal stamens. Polyandrous types commonly have one or more sets of five stamen traces (trunk bundles) with each trace repeatedly forked so that eventually there is one vascular bundle for each stamen. Polycarpellate types sometimes show a similar branching of five basic carpel traces. These patterns are cited to indicate that the group arose from an originally pentamerous flower.This suggestion will also keep the Sterculiaceae with a limited number of stamens to be primitive to the other four families.

The authors who disagree with the above concept derive the Malvales from the less modified Theales containing an indefinite number of stamens and carpels.The vegetative features common in the Malvales are often traced back to the Theales. Takhtajan (1980) derives his Malvales from the Violales and Hutchinson (1969) from Bixales.

In the present project,95 plants have been analysed for their chemotaxonomically significant leaf constituents



Vio = Violales, Mal = Malvales, Mg = Malpighiales.

Table 1. The fluid boundaries existing among the families included in the Malvales and related taxa.

such as the flavonoids, simple phenols,phenolic acids,alkaloids, saponins and tannins. These plants belong to Malvaceae (42),Bombacaceae (3),Sterculiaceae (22),Tiliaceae (20),Elaeocarpaceae (4),Bixaceae (1),Cochlospermaceae (1),Flacourtiaceae (1) and Dipterocarpaceae (1). Based on the data on the distribution of these chemical characters, the classification and phylogeny of the various taxa at different levels of hierarchy are evaluated. Some of the issues which were taken up in this investigation are :

1. The chemical inter-relationships of the five families **i.e.** the Malvaceae, Bombacaceae, Sterculiaceae Tiliaceae and Elaeocarpaceae which are consistantly grouped in the Malvales by most of the authors.

2. The taxonomic validity of the various subfamilies,tribes and subtribes proposed by different authors in the above said families.

3. The affinities of the tribe Hibisceae. The tribe Hibisceae,having mostly capsular fruits, is sometimes taken away from the rest of the Malvaceae,which characteristically produce schizocarpic fruits, and merged with the Bombacaceae. But the pollen morphological characters do not agree with this concept.

4. The status of the tribe Sterculieae. Some authors,(notably Edlin,1935) would restrict the family Sterculiaceae to the traditional tribe Sterculieae and refer the remaining genera to a separate family Buttneriaceae.

5. The evolutionary status of the Sterculieae. This tribe is considered advanced due to its unisexual, apetalous and polygamous flowers. But some authors supposed that the Sterculieae must be primitive within the family due to its apocarpy.

6. The taxonomic validity of the subfamily Buttnerioideae of the family Buttneriaceae.

7. The subfamily status of the Brownlowioideae. The Brownlowioideae are a subfamily recognised recently by Thorne (?) and Takhtajan (?) incorporating the tribe Brownlowieae, while the rest of the tribes are grouped in the subfamily Tilioideae.

8. The evaluation of the family status of Cochlospermaceae which are often merged with the Bixaceae.

9. Assessing the chemical affinities of the Bixaceae, Cochlospermaceae and Dipterocarpaceae which are, at one time or other, grouped in the Malvales.

10. An assessment of the evolutionary levels achieved by the various families in the Malvales. There is a continuing controversy about whether the large number of stamens and/or carpels found in Tiliaceae or Malvaceae reflects a primitive survival feature or a secondary increase. The resolution of this controversy will lead to the recognition of the most primitive group in this order and subsequent derivation of the Malvales from the proposed ancestors.

11. The ancestral group of the Malvales. Cronquist (1981) derives the Malvales from the less modified members of the Theales while Hutchinson (...) considers the Violales as the ancestral group of this order.

12. The position of **Muntingia**. This genus is kept in Tiliaceae (Thorne,1981), Elaeocarpaceae (Takhtajan,1981) or Flacourtiaceae (Cronquist,1981). **Muntingia** has valvate calyx and plurilocular ovary like the Elaeocarpaceae. Many anatomical features link this genus through **Echinocarpus** to the Tiliaceae while the short broad longitudinally dehiscent anthers of **Muntingia** suggest a flacourtiaceous relationship.

13. The generic status of **Azanza** and **Abelmoschus**,**Azanza** and **Abelmoschus** were sections under **Hibiscus** which are treated as independent genera by recent authors.

14. Identity of **Senra** from **Gossypium**. **Senra** is sometimes merged in **Gossypium** due to its morphological similarities.

15. The distinct identity of **Azanza** from **Thespesia**.**Azanza lampas** is sometimes treated under **Thespesia** due to its compound stigma and cupular or minutely 5-toothed calyx, while it has many characters in common with **Hibiscus**.

16. The distinct status of **Hibiscus schizopetalus** from **H. rosa sinensis**. The former species was treated as a variety of latter and have been elevated to a distinct species only recently.

17. New sources of bioflavonoids,alkaloids,saponins and tannins. Identifying new sources of economically important natural products such as bioflavonoids, alkaloids, saponins and tannis from these families is another important objective of the present study.