# TILIACEAE

Chapter 6

# TILIACEAE

The family Tiliaceae is a comparatively large family with about 50 genera and 450 species. It is widespread in tropical and subtropical regions with a few extensions into the temperate regions. **Grewia** (170),**Triumfetta** (70),**Tilia** (50) and **Corchorus** (40) are the larger genera of this family.

The Tiliaceae consist of mostly woody trees and shrubs and rarely herbs. The stem and leaves are clothed by stellate hairs, or peltate scales,less often with simple hairs. Leaves alternate or rarely opposite, simple but often toothed or lobed, palmately or pinnipalmately veined, often asymmetric. Stipules often present, deciduous. Flowers borne on various types of cymose inflorescences or rarely paired or solitary,perfect or sometimes unisexual, regular, hypogynous, sometimes with an epicalyx. Sepals mostly five, rarely four or five;valvate, distinct or rarely connate at the base. Petals 3-5, distinct, imbricate or convolute or valvate. Nectaries consist of variously located tufts of glandular

hairs. Androecium consists of 10-many stamens on a short androgynophore or internal to a nectariferous disc. Filaments distinct or sometimes basally connate into 5 or 10 groups. Staminodes rare. Anthers tetrasporangiate and dithecal. Pollensacs contiguous or separate at the tips of the branches of the shortly bifurcate filament, opening by longitudinal slits or sometimes by apical pores. Gynoecium of 2-many carpels, syncarpous with a single style and a capitate or lobed dry stigma. Ovary multilocular or rarely unilocular (**Mollia**). Ovules 1-several in each locule in axile placentation, ascending or pendulous, more or less anatropous and bitegmic. Endosperm development nuclear. Fruit fleshy or dry (dehiscent or indehiscent) of various types. Seed with straight embryo, cotyledons sometimes folded. Endosperm, scanty or copious, oily.

**Anatomical features**

Hairs are varied: unicellular, uniseriate, stellate, tufted, peltate and glandular. Mucilage cells are seen in leaf,cortex and pith. The vascular structure of the petiole is very variable ranging from a single arc-shaped strand to cylindrical types enclosing one or more medullary bundles. Mucilage cavities are present in cortex, phloem and or pith. Tanniniferous cells are found scattered among the parenchyma. Crystals of calcium oxalate occur solitary or clustered. Phloem in T.S. appear as triangular strands with the apices outwardly directed and stratified into fibrous and non-fibrous portions. Vessels are small to medium-sized. Wood semi-ring-porous, perforations large, intervascular pittings minute or moderately large. Parenchyma predominantly apotracheal,in numerous short irregular uniseriate bands, but in a few genera predominantly paratracheal, vasicentric to aliform and intermediate between paratracheal and apotracheal in others, often storeyed. Rays in Brownlowieae,

2-3 cells wide, storied, while in others of two sizes,(1) numerous uniseriates that tend to be storied or,(2) unstoried 4-15 cells wide. Sheath cells and tile cells present in many genera. Fibres simple-pitted, frequently storied.

**Palynological characters**

The pollen grains of the Tiliaceae are similar to those of other Malvalean families. Exine is smooth, but variable in structure, tricclporate or sometimes triporate. Pollen binucleate at anthesis.

**Embryological characters**

Tiliaceae resemble Sterculiaceae and Malvaceae in their embryological characters. Pollen is binucleate at the time of disposal. Ovules are more or less anatropous. Embryosac formation is crassinucellar and ovule has a zig-zag micropyle. Endosperm development is nuclear. Endosperm is scanty or abundant,oily.

**Chemistry**

Very little is known on the chemistry of this family. Cardiac glycosides such as corchorin, corchorigenin, corchosularin and strophanthidin are reported from the seeds of **Corchorus acutangulus** (Rao and Rao,1969) **C. aestuans** (Singh,1972), **C.capsularis** and **C. olitorius** (Senetal,1957). Alkaloids are found to be present in **C.fascicularis** (Chakravarti **et al.**,1950). Ellagic acid and proanthocyanidins are found to be rare in this family (Gibbs, 1974).

**Economic importance of the family**

The Tiliaceae are known for the valuable fibres obtained

from the phloem of several members of the family, the best known being jute, derived from **Corchorus capsularis, C.olitorius** and related species of **Corchorus**. Less familiar fibres are derived from **Grewia, Hockenya** and **Triumfetta. Tilia, Berrya** and **Pentace** yield valuable timbers. Medicinal properties are attributed to **Corchorus aestuans** (seeds-stomachic and in pneumonia), **C.capsularis** (leaves-demulcent, stomachic, carminative, antidysenteric, antiperiodic, roots and fruits-antidiarrhoeal) **C. depressus** (leaves-emollient, antiperiodic; seeds-tonic; mucilage-anti-gonorrhoeal). **Grewia asiatica** (fruit-astringent; bark-demulcent, antirheumatic) and **G. tiliaefolia** (bark-antidysenteric; woodemetic, antidcte for opium poisoning). Species of **Grewia, Corchorus, Corchoropsis** and **Entelea** are grown as ornamentals.

**Taxonomy**

In flora of British India, Masters (1895) 1872 divided the Tiliaceae into two series which are subdivided to tribes.

**Series A Holopetalae:** Petals glabrous or rarely downy, coloured,thin, unguiculate, entire or nearly so, imbricate or twisted in bud. Anthers globose, cells ultimately fonfluent at the tcp.

Tribe 1. Brownlowieae Sepals ccmbined below into a cup. Anthers globose, Cells ultimately confluent at the top.

Tribe 2. Grewieae Sepals distinct, petals glandular at the base, stamens springing from the apex of a raised torus.

Tribe 3. Tilieae. Sepals distinct, petals not glandular, stamens springing from a contracted torus.

**Series B. Heteropetalae.** Petals sepaloid. incised or 0, induplicate or imbricate, not twisted. Anthers linear, opening by a terminal pore. (**Echinocarpus, Elaeocarpus**).

Engler and Prantl (1895) treated the plants belonging to the series Heteropetalae as a separate family,Elaeocarpaceae. Schumann (1895) classified the family directly into four tribes Brownlowieae, Apiebeae, Tilieae and Grewieae and his tribes correspond to those of Masters. Most of the recent authors follow the same pattern. But thorne (1981) and Takhtajan (1980) separate the plants of the tribe Brownlowieae into a sub-family Brownlowioideae and group the the other three tribes in subfamily Tilioideae. The latter author adds two more unigeneric subfamilies Tetralicoideae and Neotessmannioideae to the existing subfamilies.

In the present work, 20 members belonging to six genera have been analysed for their flavonoids, phenolic acids, alkaloids,saponins and tannins. An attempt is done to correlate the distribution of these chemical characters to the taxonomic concepts of this family.

## Materials and Methods

Most of the plants have been collected from Baroda and environs. Some species of **Grewia** are obtained from Coimbatore. The place and data of collection and herbarium numbers of voucher specimens are given in the Appendix 1. Standard procedures described in chapter 2 are followed for the isolation and identification of the compounds.

## Results

The distribution of various flavonoids and phenolic acids in 20 members of the Tiliaceae screened is presented in Table 6.

Flavonoids are found to be present in the leaves of all

Table 6: Distribution of various flavonoids and phenolic acids in members of the Tiliaceae

| | 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 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tribe Brownlowieae** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. **Berrya ammonilla** Roxb. | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | + | + | . | . | . |
| **Tribe Tilieae** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. **Corchorus aestuans** L. | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | + | . | . | + | + | + | . | + | + | + | . |
| 3. **C. capsularis** L. | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | + | + | . | . | . | + | . | . |
| 4. **C.depressus** Stocks. | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | . | + | + | . | . | + | . | + | . |
| 5. **C.fascicularis** Lam. | . | . | . | . | . | . | . | . | . | + | . | . | + | + | . | . | . | . | . | + | + | + | . | . | + | . | . |
| 6. **C.olitorius** L. | . | . | . | . | . | . | . | . | . | + | . | . | + | . | . | . | . | . | + | + | + | . | + | . | + | + | . |
| 7. **C.trilocularis** L. | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | | + | + | + | . | . | + | + | + | . |
| 8. **Luhea endopogon** L. | . | + | . | . | . | . | . | . | . | + | . | . | + | . | . | . | . | . | . | + | + | + | . | . | | | |
| **Tribe Grewieae** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9. **Grewia abutilifolia** Juss. | . | . | . | . | . | . | . | . | . | + | + | . | + | . | + | . | . | . | . | + | + | . | . | + | . | . | . |
| 10. **G.asiatica** L. | . | . | + | . | . | . | . | . | . | . | . | . | + | . | . | . | . | + | . | + | + | . | . | . | . | . | + |
| 11. **G.flavescens** Juss. | + | . | . | . | . | . | . | . | . | . | . | . | . | + | + | + | . | . | + | + | + | . | . | . | . | + | . |
| 12. **G. damine** Gaertin | . | . | . | . | + | . | . | . | . | .. | . | + | . | . | . | . | + | . | + | + | . | + | . | . | . | . | + |

Table - 6 (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 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13. **Grewia hirsuta** Vahl | + | + | + | . | . | . | + | + | . | . | . | . | . | . | + | + | . | . | + | . | + | + | . | + | . | . | + | + |
| 14. **G. tenax Fiori** | + | + | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | + | . | + | . | . | . | . | . |
| 15. **G. tiliaefolia** Vahl | . | . | + | . | . | . | . | . | . | . | . | + | . | . | . | . | . | + | . | + | + | . | . | . | . | + | + |
| 16. **Erinocarpus nimmoanus** Lam. | . | . | . | . | . | + | . | . | + | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | . | . |
| 17. **Triumfetta pilosa** Roth. | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | . | . | . | . | . | . |
| 18. **T. rhomboidea** Jacq. | . | + | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | . | . |
| 19. **T. rotundifolia** Lam. | . | . | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | + | . | . |
| 20. **T.pentandra** A.Rich | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | . | . | . |

1) Apigenin, 2) 7-OMe Apigenin, 3) 4'-OMe Apigenin, 4) Scutellarein, 5) 4'-OMe Scutellarein, 6)Luteolin 7) 4'-OMe Luteolin, 8) 3'-OMe Luteolin, 9) 3',4'-DiOMe Luteolin, 10) Kaempferol, 11) 3-OMe Kaempferol, 12) 7-OMe Kaempferol, 13) Quercetin, 14) 3'-OMe Quercetin, 15) 3',4'-DiOMe Quercetin. 16) 3,3',4'-TriOMe Quercetin, 17) Gossypetin, 18) Proanthocyanidins, 19) p-Hydroxy benzoic acid, 20) Vanillic acid, 21) Syringic acid, 22) Gentisic acid, 23) Melilotic acid, 24) Ferulic acid 25) Alkaloids, 26) Saponins 27) Tannins.

the plants except **Berrya**. The different groups of flavonoids seen in the family are flavones, flavonols, and proanthocyanidins. Flavones and flavonols exhibit a more or less equal frequency of incidence being located in 12 and 13 plants respectively. In **Luhea** and **Grewia** both these groups of compounds occur together. The various flavones observed in the family are apigenin, scutellarein and luteolin along with their variously methoxylated derivatives. Apigenin and its derivatives are seen in **Luhea, Grewia**, and **Triumfetta.** Apigenin is comparatively rare, located in three species of **Grewia** only,while 7-OMe apigenin and 4'-OMe apigenin are present in eight plants belonging to **Grewia, Luhea** and **Triumfetta.** These compounds are poorly represented in tribe Tilieae while they are concentrated in Grewieae. Luteolin and its derivatives are identified from **Grewia** and **Erinocarpus** only. 6-Oxygenated flavones **i.e.**,scutellarein and 4'-OMescutellarein are present in species of **Triumfetta** only. Of the four species of this genus screened, only **T.pilosa** are found to be devoid of them. Altogether flavones are more or less confined to the tribe Grewieae.

In contrast to the flavones, flavonols are more or less equally distributed in both the Tilieae and Grewieae. In Tilieae flavonols are seen in sever plants while in Grewieae they are present in six species. Kaempferol, quercetin, gossypetin and their methoxy derivatives are the flavonols present in the family. Kaempferol is seen in two species of **Corchorus** and **Luhea** while 3-OMe kaempferol and 7-OMe kaempferol are seen in **Grewia abutilifolia** and **G.tiliaefolia** respectively. Quercetin was present in all the species of **Corchorus** screened and two species of **Grewia i.e.G.asiatica** and **G.damine.** The monomethoxy quercetins are present in both **Corchorus** and **Grewia** while the di,and trimethoxy quercetins are seen in the latter genus only. Only **Corchorus aestuans**

contained the 8-hydroxy flavonol, the gossypetin,in the leaves. Proanthocyanidins are rare in the family located in four plants of the tribe Grewieae.

Among the six phenolic acids found in the family,vanillic and syringic acids are almost ubiquitous. Melilotic acid has higher frequency of occurrence in Grewieae and ferulic acid in Tilieae.

Alkaloids are located in six plants, five of which belong to the genus **Corchorus**, in Tilieae. Saponins are seen in seven plants which also, incidentally,belong to **Corchorus** (4) and **Grewia** (3). Tannins are present in only four plants all belonging to the gerus **Grewia.**

## Discussion

All the three tribes represented in the present study appear to be distinct from each other in their flavonoid chemistry. The tribe Brownlowieae, in which only one member **Berrya ammonilla** was available for analysis, is devoid of flavonoids. Though this data cannot be relied heavily due to the poor representation of the tribe, the fact remains that **Berrya** is incapable of synthesising flavonoids. More members of this tribe are to be screened to assess whether this trite is indeed free of flavonoids. If the trend seen in **Berrya** is concurred by other taxa of this tribe, the Brownlowieae are clearly distinct from the rest of the family which synthesises a broad spectrum of flavonoids. In anatomical characters also this tribe is distinct in possessing 2-3 cells wide rays with few uniseriates and storied while the remaining tribes have rays of two different sizes,(1) with numerous uniseriates that tend to be storied and,(2) high unstoried rays 4-15 cells wide (Metcalfe and Chalk,1950).The

elimination of flavonoids keep the Brownlowieae as the highly evolved tribe in Tiliaceae and such a view corroborates well with Kukachka and Rees (1943) who considered the Brownlowieae as the most highly specialised group on the basis of fibre-vessel length ratio.

The tribe Tilieae is characterised by the uniform presence of flavonols, abundance of alkaloids and saponins and absence of proanthocyanidins. Flavones also are rare in this tribe. **Luhea** is distinct from **Corchorus** in containing flavones. The presence of gossypetin in **Corchorus aestuans** and the predominance of flavonols and alkaloids keep this tribe a primitive one.

The tribe Grewieae elaborate all types of flavonoids notably the flavones. The uniform presence of flavones forms a tribal character. The genus **Grewia** is peculiar in having a curious association of both advanced (flavones) and primitive (flavonols and proanthocyanidins) chemical characters. The retention of primitive characters may be attributed to the woody nature of this genus. But the most distinctive of all the plants screened is **Triumfetta** which possesses the 6-oxygenated flavones, the scutellarein and its 4'-methyl ether. Evidently this genus is the most advanced taxon in this tribe coming close to the evolutionary level achieved by the Brownlowieae. The tribe Grewieae comes in between the Tilieae and Brownlowieae in the evolutionary hierarchy.

The relationships of Tiliaceae with other families are assessed in General discussion (Chapter 8).