

Pollen Morphology of Tiliaceae Juss. and Sterculiaceae Vent. and Their Relations to Malvaceae Juss. in Egypt

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ABSTRACT

Pollen morphology of 11 species (6 genera) representing the Tiliaceae and Sterculiaceae in the flora of Egypt was studied using Light Microscope (LM) and Scanning Electron Microscope (SEM). Pollen grains are spheroidal to prolate or oblate-spheroidal to spheroidal, tricolporate or trizonoporate. Sculpturing is reticulate-perforate or spiny-perforate. Three pollen types were recorded: *Grewia*, *Hermannia* and *Melhania* types. Pollen morphology in relation to taxonomy of the investigated taxa and their relations to Malvaceae is briefly discussed.

Key Words: Pollen morphology; Tiliaceae; Sterculiaceae; Malvaceae

INTRODUCTION

Tiliaceae and Sterculiaceae are large families of trees, shrubs or rarely annual herbs, mainly tropical and subtropical, but Tiliaceae is represented in the northern hemisphere by the single genus *Tilia* (Hutchinson, 1967).

Erdtman (1952) described pollen morphology of 70 species and 90 species of Tiliaceae and Sterculiaceae, respectively. Erdtman *et al.* (1961) described pollen morphology of three *Tilia* species. Rao and Ong (1974) gave an account of pollen morphology of two species of Tiliaceae and one species of Sterculiaceae. Bayer *et al.* (1999) mentioned that: the traditional delimitation of Sterculiaceae, Tiliaceae, Bombacaceae and Malvaceae (order Malvales) is un-tenable and showed that the previous families emerge with Malvaceae. They subdivided Malvaceae *s.l.* (which comprises all four families) into nine subfamilies on the basis of molecular, morphological, palynological and biogeographical data.

According to Hutchinson (1967) the Sterculiaceae and Tiliaceae share a number of common characters (axil placentation, syncarpy, palminerved leaves & stellate hairs), which distinguish them from other families in the Malvales. The two families are easily separable from each other since the Tiliaceae usually have numerous free stamens (sometimes shortly connate at base, rarely 10 or less), whereas the Sterculiaceae have 10 - 30 stamens forming a staminal column (rarely few & alternate with petals).

The present study aims to assess the taxonomic significance of pollen morphology in the Tiliaceae and Sterculiaceae and their relations to family Malvaceae Juss in the light of palynological findings by Saad (1960), Hosni and Araffa (1999).

MATERIALS AND METHODS

Pollen grains of 11 species (6 genera) native to the flora of Egypt are the subject of the present study.

Collecting localities for the examined specimens are given in Table I.

Pollen samples were obtained from anthers of herbarium specimens kept in Cairo University Herbarium (CAI) and the Herbarium of Agricultural Research Center (CAIM). Materials for light microscopy were boiled for 25 - 30 seconds in an aqueous 5% NaOH, washed several times in distilled water, spread on a clean slide in a drop of lactic acid and gently heated until the boiling point. Materials, where prepared for SEM by mounting acetolyzed pollen grains on clean stubs using double sided cello tape, coated with gold and examined by a JEOL JSM 5400 LV Scanning Electron Microscope operated at accelerated Voltage of 15 KV, at Electron Microscope Unit, Assiut University. The terminology used here for pollen description followed Wodehouse (1935), Erdtman (1952) and Erdtman *et al.* (1961).

Nomenclature of the genera and species was up-dated according to Boulos (2000). Voucher specimens and pollen slides were kept in Cairo University Herbarium (CAI).

RESULTS

Light and scanning electron microscopic investigations of pollen grains of 11 species belonging to Tiliaceae and Sterculiaceae, show that they have three pollen types. Table II summarizes the available information of the pollen morphology among the studied species.

1- *Grewia* type. Pollen grains isopolar, radially symmetrical, tricolporate, 25 - 30 (-35) × 20 - 25 (-28) μm (*Corchorus*), 35 - 40 (-45) × 25 - 30 μm (*Triumfetta*) and 25 - 30 (-37) × 15 - 25 (-30) μm (*Grewia*), spheroidal to prolate (Fig. 1a - d), elliptical in equatorial view, sculpturing is reticulate - perforate, muri sharply ridged, tetragonal to pentagonal, with thin, regular ridges (*Corchorus depressus*, *C. oltorius*, *C. trilocularis* & *Grewia tenax*) or irregular ridges (*Grewia villosa*, *G. tembensis* & *Triumfetta*

Table I. Collection data of specimens of 11 species representing 6 genera of Tiliaceae and Sterculiaceae used as sources of pollen grains

Taxa	Localities
Tiliaceae Juss.	
<i>Corchorus depressus</i> (L.) Stocks	Gebel El-Faraied, Red Sea, near the well, 12.2.1961; V. Täckholm <i>et al.</i> B 15 (CAI) – Expedition to Gebel Elba, January 1962; V. Täckholm 1607 (CAI).
<i>C. olitorius</i> L.	Ghara Sultan, Faiyum, 6.10.1967; V. Täckholm <i>et al.</i> s.n. (CAI) - Banha, Ballana, Nubia, 2.1.1964; Boulos s.n. (CAI).
<i>C. trilocularis</i> L.	Beheira Province, Rosetta, 18.8.1987; A. Amer 12691 (CAI) - Dakhla, Bed Khlou, 16.8.1967; El-Hadidi s.n. (CAI).
<i>Triumfetta flavescens</i> Hochst. Ex A. Rich.	Wady at the foot of Gebel Elba, 20.1.1962; V. Täckholm <i>et al.</i> s.n. (CAI) - Wady Kansisrob, Gebel Elba, 3.2.1962; V. Täckholm <i>et al.</i> s.n. (CAI).
<i>Grewia tenax</i> (Forssk.) Fresen.	Wady Haikwal, Gebel Elba, 23.10.1956; Boulos s.n. (CAI).
<i>G. villosa</i> Willd.	Wady Akaw, Gebel Elba, 14.9.1936; Drar 61/898 (CAIM).
<i>G. tembensis</i> Fresen.	Gebel Elba, January 1933; Hassib s.n. (CAI) - Wady Kansisrob, Gebel Elba, 23.1.1933; Shabetai z 2770 (CAIM).
Sterculiaceae Vent.	
<i>Hermannia modesta</i> (Ehrenb.) Planch, ex Mast.	Wady Haikwal, Gebel Elba, 26.1.1933; Drar 196/33 (CAIM) - Gebel Karam Elba, Gebel Elba, 72.1962; V. Täckholm <i>et al.</i> 1757 (CAI).
<i>Melhanianthus phillipsiae</i> Baker f.	Gebel Elba, Wady Aideib, 5.2.1933; Shabetai z 2763 (CAIM) - Northwest and west slopes of Gebel Asotriba, 28.1.1962; V. Täckholm <i>et al.</i> 943 (CAI).
<i>M. denhamii</i> R.Br.	Near Wady Kansisrob, Gebel Elba, 26.1.1933; Shabetai z 2761 (CAIM) - sandy soil, down Karam Elba, 2.3.1933; Shabetai 5531 (CAIM).
<i>Waltheria indica</i> L.	Gebel Elba, 14.3.1932; Drar 362/32 (CAIM) - Gebel Ekwat, Gebel Elba, 26.1.1933; Shabetai z 2764 (CAIM).

Table II. Comparative recording of 7 pollen morphological characters of 11 species (6 genera) of Tiliaceae and Sterculiaceae

Taxa	Polar axis (p) μm	Equatorial diameter (E) μm	P/E	Shape	Aperture character	Ora μm	Sculpture
Tiliaceae Juss.							
<i>Corchorus depressus</i> (L.) Stocks	30 – 32 (– 34)	20 – 22 (– 24)	1.4	prolate	tricolporate	3 × 10	reticulate-perforate
<i>C. olitorius</i> L.	30 – 35	20 – 25	1.4	prolate	tricolporate	2 × 8	reticulate-perforate
<i>C. trilocularis</i> L.	25 – 30 (– 32)	20 – 25 (28)	1.2	subprolate	tricolporate		reticulate-perforate
<i>Triumfetta flavescens</i> Hochst. ex A. Rich.	35 – 40 (– 45)	25 – 30	1.2 – 1.4	subprolate to prolate	tricolporate	2 × 5	reticulate-perforate
<i>Grewia tenax</i> (Forssk.) Fresen.	25 – 30	15 – 25	1 – 1.6	spheroidal to prolate	tricolporate	2 × 6	reticulate-perforate
<i>G. villosa</i> Willd.	28 – 34 (– 37)	26 – 28 (– 30)	1 – 1.3	spheroidal to prolate	tricolporate	2 × 7	reticulate-perforate
<i>G. tembensis</i> Fresen.	25 – 35	25 – 30	1 – 1.4	spheroidal to prolate	tricolporate	3 × 7	reticulate-perforate
Sterculiaceae Vent.							
<i>Hermannia modesta</i> (Ehrenb.) Planch, ex Mast.	25 – 28 (– 30)	22 – 28 (– 30)	1 – 1.1	spheroidal to prolate-	tricolporate	2 × 6	reticulate
<i>Melhanianthus phillipsiae</i> Baker f.	45 – 60 (– 75)	60 – 68 (– 75)	0.75 (–0.9) – 1	oblate- spheroidal	to trizonoporate	6 – 8	spiny and perforate
<i>M. denhamii</i> R.Br.	34 – 38 (– 40)	36 – 38 (– 40)	0.9 – 1	oblate-spheroidal	to trizonoporate	3 – 5	spiny and perforate
<i>Waltheria indica</i> L.	35 – 40 (– 45)	30 – 35 (– 40)	1 – 1.1	spheroidal to prolate-	tricolporate	3 × 8	reticulate

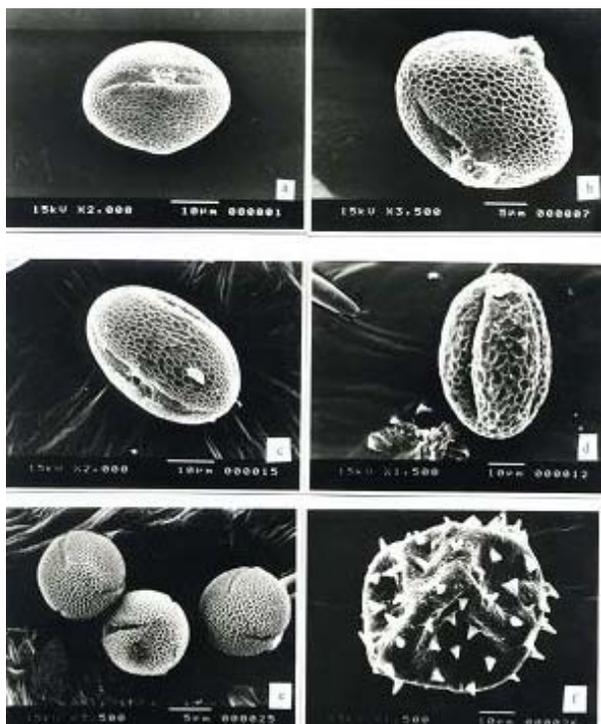
flavescens). Lumina have minute perforations. Colpi 20 - 26 (–28) μm long × 2 - 3 μm broad, apocolpy with acute ends, margins un-even; colpus membrane with granules or irregular – shaped particles; ora rectangular, lalongate, 2 - 3 μm × 8 - 10 μm (*Corchorus*), 2 - 3 μm × 5 - 8 μm (*Triumfetta* & *Grewia*).

This type characterizes the Tiliaceae species (*Corchorus depressus* L.) stocks, *C. olitorius* L., *C. trilocularis* L., *Triumfetta flavescens* Hochst ex A. Rich.,

Grewia tenax (Forssk.) Fiori, *G. villosa* Willd and *G. tembensis* Fresen (Fig. 2a - d).

2- Hermannia type. Pollen grains isopolar, radially symmetrical, tricolporate, 25 - 28 (–30) μm × 22 - 28 (–30) μm (*Hermannia*), 35 - 40 (–45) μm × 30 - 35 (40) μm (*Waltheria*), spheroidal to prolate – spheroidal (Fig. 1e), sculpturing is reticulate - perforate, muri irregular and undulate, lumina have minute perforations, colpi 7 - 9 μm long × 2 - 3 μm broad (*Hermannia*), 14 - 16 μm long × 3

Fig. 1. SEM micrographs of pollen grains of: a. *Corchorus olitorius*, b. *C. trilocularis*, c. *Grewia tenax*, d. *G. tembensis*, e. *Waltheria indica*, f. *Melhanhia phillipsiae*.



μm broad (*Waltheria*), apocolpy with acute ends, margins uneven; colpus membrane granulate; ora rectangular, lalongate, $2 - 3 \mu\text{m} \times 6 - 8 \mu\text{m}$.

This type characterizes *Hermannia modesta* (Ehrenb.) Planch. ex Mast. and *Waltheria indica* L (Fig. 2e).

3- *Melhanhia* type. Pollen grains isopolar, radially symmetrical, trizonoporate, $34 - 40 \mu\text{m} \times 36 - 40 \mu\text{m}$ (*Melhanhia denhamii*), $45 - 60 (-75) \mu\text{m} \times 60 - 68 (-75) \mu\text{m}$ (*M. phillipsiae*), oblate-spheroidal to spheroidal (Fig. 1f), sculpturing is spiny - perforate, spines $2 - 4 (-7) \mu\text{m}$, pores $3 - 6 (-8) \mu\text{m}$ in diameter.

This type characterizes two species. *Melhanhia phillipsiae* Baker f. and *M. denhamii* R. Br. (Fig. 2f).

DISCUSSION

The results of the present study showed that the pollen morphology of the indigenous taxa of Tiliaceae and Sterculiaceae in Egypt are represented by three pollen types.

Tiliaceae is represented by three genera and seven species (Table I), which have one pollen type (*Grewia* type). Pollen grains are spheroidal to prolate, tricolporate, exine sculpture is reticulate perforate.

The differences between the studied species are in the pollen size, in the shape of the muri ridges, which are sharply ridged, tetragonal to pentagonal in (*Corchorus depressus*, *C. olitorius*, *C. trilocularis* & *Grewia tenax*) or

muri are irregular ridged (*Grewia villosa*, *G. tembensis* & *Triumfetta flavescens*).

In Sterculiaceae, there are two pollen types. The first is *Hermannia* type, which is closely related to the *Grewia* type, the pollen grains are spheroidal to prolate - spheroidal, tricolporate, exine sculpture is reticulate - undulate and perforate.

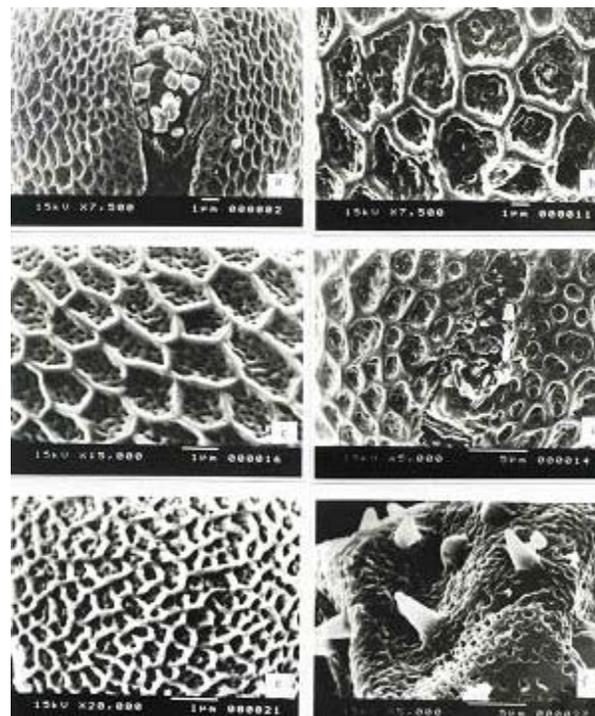
This type is present in *Hermannia modesta* and *Waltheria indica*. The second type is *Melhanhia* type in which the pollen grains are oblate-spheroidal to spheroidal, trizonoporate, exine sculpture is spiny and perforate. It is present in *Melhanhia phillipsiae* and *M. denhamii*.

Erdtman (1952) mentioned that Sterculiaceae is a eurypalynous, somewhat heterogenous family. Hosni and Araffa (1999) showed that the pollen morphology of Malvaceae is apparently uniform. One pollen type was recognized: pollen grains are spheroidal, with numerous pores (polyantoporate), exine sculpture is spiny. Thus, Sterculiaceae contains both of Tiliaceae-like type and Malvaceae-like type.

In Tiliaceae, Sterculiaceae and Malvaceae, there is a clear consistency between the results of the present study and the results of the previous studies of pollen morphology.

Nair (1965), proposed that the porate form might have evolved from the colpate form by reduction. Furthermore, Saad (1972) mentioned that tricolporate aperture (primitive in Tiliaceae) gives triporate aperture (relatively advanced in

Fig. 2. SEM micrographs showing exine sculpture of pollen grains of: a. *Corchorus olitorius*, b. *C. trilocularis*, c. *Grewia tenax*, d. *G. tembensis*, e. *Waltheria indica*, f. *Melhanhia phillipsiae*.



Sterculiaceae). He added that the surface ornamentation of the exine is a significant morphological character the reticulate exine sculpture (primitive in Tiliaceae), the spiny exine sculpture (relatively advanced in Sterculiaceae) and the echinate exine sculpture (advanced in Malvaceae).

Concerning order Malvales, Engler and Melchior (1964) treated the Tiliaceae, Malvaceae, Bombacaceae and Sterculiaceae as separate families.

Palynological results of the present study on Tiliaceae and Sterculiaceae, in conjunction with those reported by Saad (1960), Hosni and Araffa (1999) for the Malvaceae, provide sound basis for considering them as three separate families within order Malvales. Additional support for this notion is provided by an impressive array of correlated characters from floral structure (presence or absence of epicalyx, number & cohesion of the stamens & the number of pollen chambers in the anther) and the habit of the plants.

REFERENCES

- Bayer, C., M.F. Fay, A.Y. De Bruijn, V. Salvolainen, C.M. Morton, K. Kubitzki, W.S. Alverson and M.W. Chase, 1999. Support for an expanded family concept of Malvaceae within a circumscribed order Malvales: a combined analysis of plastid *atpB* and *rbcL* DNA sequences. *Bot. J. Linn. Soc.*, 129: 267–303
- Boules, L., 2000. *Flora of Egypt*. V.2. Al Hadara publishing, Cairo, Egypt
- Engler, A. and H. Melchior, 1964. *Syllabus der Pflanzenfamilien* (12th ed. Vol. 2) Berlin – Nikolasssee
- Erdtman, G., 1952. *Pollen Morphology and Plant Taxonom – Angiosperms (An introduction to Palynology 1)*. Almqvist and Wiksell, Stockholm
- Erdtman, G., B. Berglund and J. Praglowski, 1961. An introduction to a Scandinavian pollen flora. *Grana Palynol.*, 2: 1–92
- Hosni, H.A. and S. Araffa, 1999. Malvaceae in the flora of Egypt. 2. pollen morphology and its taxonomic significance. *Taekholmia*, 19: 147–56
- Hutchinson, J., 1967. *The Genera of Flowering Plants (Angiospermae)*, V.2 (*Dicotyledons*). Royal Botanic Gardens, Kew, England
- Hutchinson, J., 1969. *Evolution and Phylogeny of Flowering Plants*. Academic press, London and New York
- Nair, P.K.K., 1965. Pollen morphology of some families of monochlamydeae. *Bot. Notiser*, 118, Fasc. 3
- Rao, A.N. and E.T. Ong, 1974. Pollen of tropical plants. *J. Palynol.*, 10: 1–37
- Saad, S.I., 1960. The sporoderm stratification in the Malvaceae. *Pollen et Spores*, 2: 13–41
- Saad, S.I., 1972. Pollen structure in relation to phylogeny. *J. Palynol.*, 8: 37–53
- Wodehouse, R.P., 1935. *Pollen Grains. Their Structure, Identification and Significance in Science and Medicine*. Mc Graw – Hill, New York, London

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