4. OBSERVATIONS

In all, a total of 57 species of Malvaceae belonging to 20 genera are recorded from Karnataka state in the present study. Of them, 41 are wild and 16 are cultivated. However, due to paucity of time, only 50 species belonging to 19 genera could be investigated palynologically. Nevertheless, five species out of the 50, being new records for the state, are described in detail and illustrated appropriately. In perspective, all the observations are dealt under the following two main headings:

4.1 MORPHOLOGICAL OBSERVATIONS

The five new records for the state are described and illustrated as under:


Fig. 4.1

An erect annual or perennial undershrub. Branches green, downy intermingled with soft spreading hairs. Leaves on primary axis upto 25 cm; lamina upto 15 cm long and 13.5 cm broad; ovate, deeply cordate at base, apex acute to acuminate, margin irregularly crenate-dentate, densely pubescent with few simple hairs especially on lower surface; petiole thin, upto 15.5 cm; stipules 3-4 mm, subulate often recurved. Flowers axillary, solitary, peduncle 2-4 cm long, jointed 2-4 mm below the flower. Calyx c. 6-7 mm long, 5-6 mm across, lobed upto the middle, lobes 5, triangular and acuminate, densely
*Abutilon bidentatum* var. *major* (Blatt & Hallb.) Bhandari
A. Habit sketch; B. Calyx; C. Petal; D. Androecium; E. Gynoecium; F. Fruit; G. Mericarp and H. Seed.
Observations

pubescent with stellate and simple hairs outside and with long simple hairs inside. Corolla yellow, c.13-15 mm in diameter, petals 5, asymmetrical, 5-7 x 4-6 mm stellate hairy at base. Staminal column c.3 mm long, stellate hairy, filaments c. 1-1.5 mm long, Ovary c.3-3.5 mm long, 3.5-4 mm across; style c.3 mm long, branches 3-3.5 mm long; stigma discoid. Schizocarp c.9-10 mm long, 10-11 mm across; mericarps 13-18, oblong, gradually acuminate, bidentate at apex, margins densely stellate hairy, 3-seeded. Seeds c.1.5 mm across, reniform, minutely stellate hairy, black or brownish black.


**Type**: INDIA, RAJASTAN, Jaisalmar, Nov. 1918. Blatter 5644 (Holotype : BLAT !)

**Distribution**: INDIA, RAJASTAN, MAHARASTRA, KARNATAKA, Dharwad Dt., Dharwad.

**Fls. & Frts.**: Aug.-Dec.


Fig. 4.2
Abutilon ramosum (Cav.) Guill. et Perr.
a. Habit sketch; b. Calyx; c. Petal; d. Androecium; e. Gynoecium;
f. Fruit; g. Mericarp and h. Seed.
Observations

Robust much branched undershrubs 1.5-2.0 m tall. Old stem bark ash-coloured, young stems terete, densely tomentose with minute stellate and long simple hairs intermixed with short glandular hairs. Leaves on primary axis upto 20.5 cm; lamina upto 13.5 ×13.00 cm, 7-9 nerved, partly trifid, broadly ovate, cordate and often keeled at base, apex acute to acuminate, stellate pubescent more so on lower surface. Petioles upto 9 cm long densely tomentose with long simple hairs. Stipules linear upto 11 mm long, stellate and simple hairy, caducous. Flowers axillary, solitary or 2-3 flowered pedunculate cymes. Peduncle, upto 1.5-3.5 cm long, tomentose with short stellate hairs, long simple hairs and medium sized glandular hairs. Pedicel upto 10mm in cymes and upto 3 cm when solitary, articulated 1-2 mm below the flower. Calyx narrowly campanulate c.5.0 × 5.5 mm, divided to the middle, lobes broadly triangular and acuminate, densely stellate tomentose with scattered glandular hairs externally. Corolla yellow, 1.3 cm -1.6 cm in diameter; petals obovate, asymmetric 5-7 × 4.5 – 6 mm, stellate hairy at base. Staminal column c.2.5 mm, antheriferous towards apex, stellate hairy along column and base; filaments c.1.5 mm. Ovary 2 ×1.5 mm, style c.2.5-3 mm, branches c.2 mm; stigmas discoid to subglobose. Schizocarp c.9-10 mm before dehiscence; mericarps 5-8 with 7 being the most common, each with two long, villose spreading awns. Seeds 3 per mericarp, c.2 × 2 mm, reniform (more correctly subcordate), minutely puberulous with stellate hairs, brownish black.

Basionym : *Sida ramosa* Cav., Diss. 1:28. t. 6. f. 1 (1785).

Type : Senegal, Adanson (MA; Photo !)
**Observations**

*Distribution*: INDIA, KASHMIR, RAJASTAN, GUJARAT, PANJAB, UTTAR PRADESH, MAHARASTRA, TAMIL NADU, ANDRA PRADESH, KARNATAKA, Belgaum (Belagavi) Dt. Gokak.

*Frts.*: Sept.-Mar.


Fig. 4.3

An undershrub upto 1.2 m high with woody stems. Young branches stellate hairy. Leaves upto 9.5 cm long, lamina oblong or narrowly ovate, shallowly cordate or truncate at base, acute to acuminate at apex, margin coarsely serrate, 5-nerved at base, upper surface sparcely and lower surface densely pubescent with characteristic tri-and tetrabrachiate stiff hairs. Petioles upto 2 cm long. Stipules 4-5 mm long, subulate to linear with stellate and simple hairs. Flowers solitary, axillary; pedicel 2.2 cm long, accrescent upto 5cm. Involucre bracts 7-9, ciliate, 6-7 mm long, narrow connate at the very base. Calyx campanulate, densely hispid, lobes ovate, triangular, acute. Corolla yellow, turning red; petals c. 15 ×13 mm, obovate, asymmetric, obtuse or truncate. Staminal column c.8-10 mm long, glabrous, antheriferous throughout except at base. Ovary c. 1.5mm long, obovoid. Style 8-10mm long, branched, branches 10, c.1.5-2.5 mm long; stigmas capitate. Schizocarp globose, depressed above. Mericarps 5, woody, c.5-6 mm with 3 stout horns each with stiff retrorse barbs. Seeds 2 × 3 mm, reniform, some what beaked, glabrous, brownish.
**FIGURE - 4.3**

*Pavonia grewioides* Hochst. ex Boiss.

a. Habit sketch; b. Stipules; c. Epicalyx; d. Calyx; e. Petal; f. Androecium;
g. Gynoecium; h, i. Mericarps; h. Dorsal view; i. Ventral view; j, k. Seeds;
j. Lateral view and k. Ventral view.

*Pavonia grewioides* Hochst. ex Boiss.

a. Habit sketch; b. Stipules; c. Epicalyx; d. Calyx; e. Petal; f. Androecium;
g. Gynoecium; h, i. Mericarps; h. Dorsal view; i. Ventral view; j, k. Seeds;
j. Lateral view and k. Ventral view.
Observations


**Type** : ABYSSINIA alt. 4000, 24 Aug. 1854, Schimper s.n. (K)

**Distribution** : INDIA, In dry deciduous forests upto 608m. MAHARASTRA, GUJARAT, KARNATAKA, Haveri Dt. Karjagi, rare.

**Fls. & Frts.** : Aug.-Jan.


**Fig. 4.4**

Erect annual or perennial herbaceous undeshrub to 1.5 m tall. Stem green, terete with simple patent hairs. Leaves upto 12 cm; lamina broadly ovate or orbicular upto 8×7 cm, cordate at base, acute to acuminate at apex, margins irregularly create or serrate, 5-7 nerved at base. Stipules 5-6 mm long, subulate, ciliate. Flowers solitary, axillary or more or less few flowered paniculate axillary or terminal inflorescences (due to reduction of leaves). Pedicels upto 6 mm, densely stellate hairy, Calyx 5-5.5 mm long, 4-4.5 mm across, companulate, divided to the middle, densely simple hairy outside, glabrous within except margins; lobes 5, triangular, acute to acuminate, faintly 3-nerved. Corolla c.1.5-1.8 cm in diameter, orange-yellow; petals 6×7 mm, obovate, asymmetric, rounded or notched at apex, glabrous. Staminal column 5 mm
Sida elongata Blume var. balica (Miq.) Borss.
a. Habit sketch; b. Calyx; c. Petal; d. Androecium; e. Gynoecium;
f-h. Mericarps; f. Dorsal view; g. Ventral view; h. Lateral view and i. Seeds.
Observations

long, artheriferous at apex, simple hairy on the tube. Ovary ovoid, 1.5×2 mm yellowish green, glabrous; style branched in the middle, branches 5, 1.5 mm long, stigmas discoid. Schizocarp c.3 × 3.5 mm, almost glabrous; mericarps 5, 2.5 × 2 mm, shorter than calyx, trigonous with rounded angles, smooth on the sides, thin-walled with a short 2-fid, hairy beak at apex. Seeds 2 ×1.5 mm, trigonous, pale brown or brownish-black, glabrous or minutely hairy at hilum.

Type : TIMOR, Zollinger 704Z (P.U.)


Distribution : MALESIA (MALAYSIA) (Java and lesser Sunda Islands) INDIA, KERALA, Malappuram Dt. Kanjrrakkadavu, KARNATAKA, Dharwad Dt. Dharwad.


Fig. 4.5

Annual herbs or penennial undershrubs, 1 to 3 m tall with several branches from the base or middle, little branched until fruiting. Stems minutely soft pubescent intermixed with stellate hairs. Petioles upto 23 cm (progressively smaller upwards). With the climax leaf almost sessile in inflorescence. Lamina orbicular to ovate upto 26×24 cm, deeply or shallowly cordate at base, acute to acuminate at apex, margin entire, slightly undulate, softly and minutely tomentose with stellate hairs on veins beneath. Stipules 3-5 mm long, subulate. Inflorescence an elongated terminal racemose panicle,
Wissadula contracta (Link) R. E. Fries
a. Habit sketch; b. Stipules; c. Calyx; d. Petal; e. Androecium
f. Gynoecium; g. Fruit; h. Seed.
Observations

essentially leafless. Flowers white, 10-14 mm in diameter; pedicels jointed, 3-8 mm long, calyx 2.5-3.5 mm long, c. half divided; petals 5, 4-6 mm long, obovate-obcordate, stellate hairy at base. Stamens 10-15, staminal column 1-1.5 mm long, stellate hairy at base; filaments 1 ½ times longer than the column. Ovary c. 1.5 mm in diameter, some what conical, glabrous; styles 2-6 (5 being the most common); stigmas discoid to subcapitate, white. Mericarps 2-6 (5 being the most common) destitute of false partition, puberulent, depressed at base, apically bulbous and apiculate. Seeds 3 in each mericarp, pendulous, reniform, warty with stellate hairs; hilum with prominent white simple hairs.


Type : INDIA: Leschenault s.n. (holotype : G-DC. !)

Distribution : INDIA, (rarely cultivated in gardens); SRI LANKA, MALAYSIA, tropical AMERICA, KARNATAKA, Dharwad Dt. Dharwad.


4.2 PALYNOLOGICAL OBSERVATIONS

The pollen grains of 50 species of Malvaceae belonging to 19 genera are described based on SEM microphotographs. The structural features of exine, however, are described based on LM observations. The palynological terms used are a combination of Wodehouse (1935), Erdtman (1956), Praglowski and Punt (1973), Nilsson and Muller (1978), Praglowski and Raj (1979), Christensen (1986b) and Punt et al. (1994). Although, we have followed the classification of Malvaceae proposed by Paul and Nayar (1988)
and Paul (1993) for Indian taxa, for the sake of convenience the genera and the species included in them are treated in alphabetical order. The observations and measurements of LM studies are given in parentheses.

4.2.1 Genus *Abelmoschus* Medik.

1. *Abelmoschus esculentus* (Figs. 4.6 a, b and 4.56 a,b): Pollen grains spheroidal, polypantobrevicolporate and echinate (spinose). Size c. 84 × 78 µm, diameter c. 81 µm. Apertures c. 30, almost half the number of spines, alternating with spines in alternate spirals only; brewicolporate and operculate; colpus c. 9.09 µm long, operculum almost circular, c. 4.55 µm in diameter. Spines c. 60, long, conical with rounded apex, c. 16.50 µm in mean length; plus very few spinules, interspinal distance c. 17.92 µm; basal cushion c. 2.00 µm in height and c. 9.50 µm in diameter; microgranular and microporate. (Exine c. 2.5-3.5 µm thick, sexine thinner than nexine and columellate). Tectum microporate.

2. *Abelmoschus ficulneus* (Figs. 4.7 a, b and 4.56 c,d): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 114 × 112 µm, diameter c. 113 µm. Apertures c. 32, almost half the number of spines, alternating with spines in alternate spirals only; brewicolporate and operculate; colpus c. 11.66 µm long; operculum circular, c. 7.50 µm in diameter. Spines c. 64, long, conical with rounded apex, c. 18.00 µm in mean length; interspinal distance c. 26.00 µm; basal cushion c. 2.70 µm in height and c. 13.00 µm in diameter; microreticulate and microporate. (Exine c. 2.50 µm thick, sexine slightly thinner than nexine and columellate). Tectum microreticulate and microporate.

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3. *Abelmoschus manihot* (Figs. 4.8 a, b and 4.56 e, f): Pollen grains spheroidal, polypantobrewicolporate and echinate. Size c. 140 × 134 µm, diameter c. 137 µm. Apertures c. 34, half the number of spines, alternating with spines in alternate spirals only; brewicolporate and operculate; colpus c. 13.13 µm long; operculum circular, c. 9.16 µm in diameter. Spines c. 68, long, conical with rounded apex, c. 25.08 µm in mean length; interspinal distance c. 30.00 µm; basal cushion c. 1.00 µm in height and c. 17.33 µm in diameter, microporate and microreticulate. (Exine c. 2.50 µm thick, sexine thinner than nexine and columellate). Tectum minutely microreticulate and microporate.

4. *Abelmoschus moschatus* (Figs. 4.9 a, b and 4.56 g, h): Pollen grains spheroidal, polypantobrewicolporate and echinate. Size c. 95 × 93 µm, diameter c. 94 µm. Apertures c. 19, half the number of spines, alternating with spines in alternate spirals only; brewicolporate and operculate; colpus c. 10.91 µm long, operculum somewhat oval c. 7.73 µm in width. Spines c. 38, long, conical with rounded apex and vertical groves at base, c. 22.82 µm long; interspinal distance c. 28.09 µm; basal cushion c. 2.91 µm in height and c. 13.64 µm in diameter, microreticulate and microporate. (Exine c. 2.50 µm thick, sexine thinner than nexine and columellate). Tectum minutely microreticulate and microporate.

4.2.2 Genus *Abutilon* Miller

5. *Abutilon bidentatum* (Figs. 4.10 a, b and 4.57 a, b): Pollen grains polar, suboblate to spheroidal, mammillated, trizonocolporate and echinate. Size c. 59 × 55 µm, diameter c. 57 µm. Apertures 3, colporate, (costate) and operculate;
Observations

colpus c. 9.00 μm. Spines c. 120, short, conical with rounded apex and broad base, c. 4.31 μm long; interspinal distance c. 8.80 μm; basal cushion distinct, c. 5.13 μm in diameter, micro verrucate and microporate. (Exine c. 2.50 μm thick, sexine thinner than nexine and columellate). Tectum micro verrucate and microporate.

6. *Abutilon hirtum* (Figs. 4.11 a, b and 4.57 c, d): Pollen grains polar, suboblate to spheroidal, mammillated, trizonocolporate and echinate. Size c. 73 × 69 μm, diameter c. 71 μm. Apertures 3, colporate, (costate) and operculate; colpus c. 11.74 μm, operculum c. 6.98 μm. Spines c. 150, short, conical with rounded apex and slightly bulbous broad base, c. 4.76 μm long; interspinal distance c. 8.62 μm; basal cushion distinct, c. 6.90 μm in diameter, micro verrucate and microporate. (Exine c. 2.50 μm thick, sexine slightly thinner than nexine and columellate). Tectum micro reticulate, sparcely micro verrucate and microporate.

7. *Abutilon indicum* (Figs. 4.12 a, b and 4.57 e, f): Pollen grains polar, suboblate to spheroidal, mammillated, trizonocolporate and echinate. Size c. 62 × 58 μm, diameter c. 60 μm. Apertures 3, colporate, (costate) and operculate; colpus c. 10.85 μm long. Spines c. 106, short, conical with rounded apex and slightly broad base, c. 4.46 μm long; interspinal distance c. 7.69 μm; basal cushion distinct, c. 6.60 μm in diameter, micro verrucate and microporate. (Exine c. 2.00 μm thick, sexine slightly thinner than nexine and columellate). Tectum micro reticulate, sparcely micro verrucate and microporate.
8. **Abutilon pannosum** (Figs. 4.13 a, b and 4.57 g, h): Pollen grains polar, suboblate to spheroidal, mammillated, trizonocolporate and echinate. Size c. 56 $\times$ 52 $\mu$m, diameter c. 54 $\mu$m. Apertures 3, colporate, (costate) and operculate; colpus c. 12.69 $\mu$m long. Spines c. 158, short, conical with rounded apex and broad base, c. 3.54 $\mu$m long; interspinal distance c. 7.80 $\mu$m; basal cushion distinct, c. 5.60 $\mu$m in diameter, microverrucate and microporate. (Exine c. 2.50 $\mu$m thick with sexine and nexine more or less equally thick and columellate). Tectum microverrucate and microporate.

9. **Abutilon persicum** (Figs. 4.14 a, b and 4.58 a, b): Pollen grains polar, suboblate to spheroidal, mammillated, trizonocolporate and echinate. Size c. 60 $\times$ 54 $\mu$m, diameter c. 57 $\mu$m. Apertures 3, colporate, (costate) and operculate; colpus c. 10.42 $\mu$m long, operculum c. 5.00 $\mu$m. Spines c. 100, very short, conical with rounded apex and very broad base, c. 2.42 $\mu$m long; interspinal distance c. 9.49 $\mu$m; basal cushion very poorly developed. (Exine c. 2.00 $\mu$m thick, sexine and nexine more or less equally thick and columellate). Tectum microspinulose, microverrucate and microporate.

10. **Abutilon ramosum** (Figs. 4.15 a, b and 4.58 c, d): Pollen grains polar, almost spheroidal, mammillated, trizonocolporate and echinate. Size c. 39 $\times$ 37 $\mu$m, diameter c. 38 $\mu$m. Apertures 3, colporate, (costate) and operculate; colpus c. 10.00 $\mu$m long. Spines c. 110, short, conical with rounded apex and broad base, c. 3.69 $\mu$m long; interspinal distance c. 6.15 $\mu$m; basal cushion distinct, c. 4.93 $\mu$m in diameter, microverrucate and microporate. (Exine c. 2.00 $\mu$m thick, sexine and nexine more or less equally thick and columellate). Tectum microverrucate and microporate.
11. Abutilon striatum (Figs. 4.16 a, b and 4.58 e, f): Pollen grains polar, suboblate to spheroidal, mammillated, trizonocolporate and echinate. Size c. 46 $\times$ 44 $\mu$m, diameter c. 45 $\mu$m. Apertures 3, colporate, (costate) and operculate; colpus c. 12.00 $\mu$m, operculum c. 3.00 $\mu$m. Spines c. 102, short, conical with rounded apex and broad base, c. 3.58 $\mu$m long; interspinal distance c. 7.27 $\mu$m; basal cushion distinct, c. 5.33 $\mu$m in diameter, microverrucate and microporate. (Exine c. 2.50 $\mu$m thick, sexine and nexine are more or less equally thick and columellate). Tectum microverrucate and microporate.

4.2.3 Genus Alcea L.

12. Alcea rosea (Figs. 4.17 a, b and 4.58 g, h): Pollen grains spheroidal, polypantoporate and echinate. Size c. 110 $\times$ 108 $\mu$m, diameter c. 109 $\mu$m. Apertures c. 150 or more, porate, operculate, c. 3.5 $\mu$m in diameter; operculum c. 3.00 $\mu$m. Spines >150, long, conical with rounded apex and constricted at base; c. 11.66 $\mu$m long; interspinal distance c. 15.17$\mu$m; basal cushion not well developed, c. 5.5 $\mu$m in diameter. (Exine c. 4.50 $\mu$m thick, sexine c. three times thinner than nexine and columellate). Tectum macro-to microverrucate and microporate.

4.2.4 Genus Bombyx Medik.

13. Bombyx micranthus (Figs. 4.18 a, b and 4.59 a, b): Pollen grains, spheroidal, polypantocolporate and echinate. Size c. 58 $\times$ 56 $\mu$m, diameter c. 57 $\mu$m. Apertures c. 22 almost half the number of spines, alternating with spines in alternate spirals only; colporate and operculate; colpus c. 7.74 $\mu$m long; operculum circular or elliptic, c. 3.87$\mu$m in diameter. Spines c. 44, long,
conical with rounded apex and constricted at base; c. 10.00 μm long; plus very few spinules, interspinal distance c. 14.26 μm basal cushion distinct, c. 9.03 μm in diameter, microreticulate and microporate. (Exine c. 3.00 μm thick, sexine and nexine more or less equally thick and columellate.) Tectum minutely microverrucate and sparcely microporate.

4.2.5 Genus Decaschistia Wight & Arn.

14. Decaschistia trilobata (Figs. 4.19 a, b and 4.59 c, d): Pollen grains spheroidal, polypantoporate and echinate. Size c. 117 × 117 μm, diameter c. 117 μm. Apertures c. 64 equal to the number of spines and alternating with spines in all spirals, porate and operculate; operculum circular, c. 10.00 μm in diameter. Spines c. 64, long, conical or subcylindrical with pointed or blunt rounded apex, constricted at base; c. 19.50 μm long; interspinal distance c. 25.75 μm; basal cushion not well developed c. 5.87 μm in diameter, microporate. (Exine c. 7.50 μm thick, sexine half the thickness of nexine, and columellate.) Tectum microverrucate to microspinulose and microporate.

4.2.6 Genus Fiona Mattei

15. Fiona vitifolia (Figs. 4.20 a, b and 4.59 e, f): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 83 × 77 μm, diameter c. 80 μm. Apertures c. 30, half the number of spines, alternating with spines in alternate spirals only, brevicolporate and operculate; colpus c. 10.00 μm; operculum c. 4.00 μm. Spines c. 60, long, almost uniformly conical with rounded apex and broad base, c. 20.58 μm long; interspinal distance c. 18.00 μm; basal cushion slightly raised, c. 1.00-1.50 μm in height, c. 10.00 μm in diameter,
Observations

microreticulate and microporate. (Exine c. 5.00 μm thick, sexine half of the thickness of nexine and columellate.) Tectum microverrucate to microspinulose and microporate.

4.2.7 Genus *Gossypium* L.

16. *Gossypium sp.* (Figs. 4.21 a, b and 4.59 g, h): Pollen grains suboblate to spheroidal, mammillated, pantocolporate and echinate. Size c. 67 × 57 μm, diameter c. 62 μm. Apertures 12-14, colporate; colpus c. 4.50 μm long. Spines c. 160, long, conical with rounded apex and broad base, c. 7.55 μm long; interspinal distance c. 8.50 μm; basal cushion well developed, c. 2.33 μm in height, c. 5.33 μm in diameter, microverrucate and microporate. (Exine c. 3.00 μm thick, sexine slightly thicker than nexine and columellate). Tectum microreticulate and microporate.

4.2.8 Genus *Hibiscus* L.

17. *Hibiscus acetosella* (Figs. 4.22 a, b and 4.60 a, b): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 100 × 98 μm, diameter c. 99 μm. Apertures c. 26, half the number of spines, alternating with spines in alternate spirals only; brevicolporate and operculate; colpus c. 11.36 μm; operculum circular or ellipsoidal, c. 7.73 μm. Spines c. 52 μm, very long, slender, conical with rounded apex and constricted at base, c. 25.36 μm long; interspinal distance c. 24.64 μm; basal cushion indistinct, c. 0.80 μm in height. (Exine c. 6.00 μm thick, sexine half the thickness of nexine and columellate). Tectum microgranulate.
18. **Hibiscus cannabinus** (Figs. 4.23 a, b and 4.60 c, d): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 100 × 98 µm, diameter c. 99 µm. Apertures c. 38, half the number of spines, alternating with spines in alternate spirals only; brevicolporate and operculate; colpus c. 10.83 µm; operculum c. 8.33 µm in diameter. Spines c. 76, long, conical with blunt rounded apex and constricted at base, c. 16.25 µm long; interspinal distance c. 21.33 µm; basal cushion less distinct, c. 1.66 µm in height and c. 10.00 µm in diameter. (Exine c. 6.00 µm thick, sexine half the thickness of nexine and columellate). Tectum microverrucate, minutely microreticulate and microporate.

19. **Hibiscus hirtus** (Figs. 4.24 a, b and 4.60 e, f): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 85 × 83 µm, diameter c. 84 µm. Apertures c. 29, brevicolporate and operculate; colpus c. 12.50 µm; operculum circular or ellipsoidal, c. 4.16 µm in diameter. Spines c. 58 plus a few spinules, the former conical with rounded apex and broad base, c. 15.50 µm long. Some spines bifurcated or possessing lateral extensions. Interspinal distance c. 18.91 µm; basal cushion very distinct, c. 3.00 µm in height and c. 9.00 µm in diameter, microreticulate and microporate. (Exine c. 3.00 µm thick with sexine and nexine more or less equally thick and columellate). Tectum microverrucate and microporate.

20. **Hibiscus hispidissimus** (Figs. 4.25 a, b and 4.60 g, h): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 110 × 104 µm, diameter c. 107 µm. Apertures c. 25, half the number of spines, brevicolporate
Observations

and operculate; colpus c. 15.83 μm long; operculum circular or ellipsoidal, c. 10.83 μm in diameter. Spines c. 50, long, conical with acute rounded apex and broad base, c. 25.83 μm long; interspinal distance c. 26.58 μm; basal cushion very distinct, well developed c. 6.67 μm in height c. 18.33 μm in diameter, microporate and minutely microverrucate and microgranulate. (Exine c. 6.50 μm thick, sexine half the thickness of nexine and columellate). Tectum microgranulate.

21. Hibiscus lobatus (Figs. 4.26 a, b and 4.61 a, b): Pollen grains spheroidal, polypantoporate and echinate. Size c. 82 × 78 μm, diameter c. 80 μm. Apertures c. 32, half the number of spines, porate (?) and operculate; operculum circular c. 5.00 μm in diameter. Spines c. 64, long, conical with blunt rounded apex; constricted at base, c. 12.16 μm long. Interspinal distance c. 17.58 μm; basal cushion indistinct. (Exine c. 3.00 μm thick, sexine thinner than nexine and columellate). Tectum microverrucate and microporate.

22. Hibiscus lunariifolius (Figs. 4.27 a, b and 4.61 c, d): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 118 × 112 μm, diameter c. 115 μm. Apertures c. 35, half the number of spines, alternating with spines in alternate spirals only; brevicolporate and operculate; colpus c. 10.00 μm long; operculum circular c. 4.16 μm in diameter. Spines c. 70, long, variable in width, mostly conical, straight or slightly arched with blunt rounded apex and broad or narrow base, c. 18.50 μm long; interspinal distance c. 26.42 μm; basal cushion very distinct, c. 4.80 μm in height and c. 13.67 μm in diameter, microreticulate and microporate. (Exine c. 4.00 μm thick, sexine
Observations

slightly thinner than nexine and columellate). Tectum microverrucate and microporate.

23. **Hibiscus mutabilis** (Figs. 4.28 a, b and 4.61 e, f): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 107 × 103 μm, diameter c. 105 μm. Apertures c. 36, half the number of spines, alternating with spines in alternate spirals only; brevicolporate and operculate; colpus c. 7.50 μm; operculum c. 5.38 μm in diameter. Spines c. 72, long, subconical with blunt rounded apex and constricted at base, c. 17.50 μm long; interspinal distance c. 21.17 μm; basal cushion not well developed, microporate. (Exine c. 3.00 μm thick, sexine slightly thinner than nexine and columellate). Tectum microverrucate to microspinulose and microporate.

24. **Hibiscus panduriformis** (Figs. 4.29 a, b and 4.61 g, h): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 92 × 88 μm, diameter c. 90 μm. Apertures c. 41, half the number of spines, brevicolporate and operculate; colpus c. 8.67 μm long; operculum circular, c. 6.66 μm in diameter. Spines c. 82, long, uniformly conical with rounded apex and distinctly constricted at base, c. 15.00 μm long; interspinal distance c. 21.16 μm; basal cushion very distinct, depressed around spine base, c. 2.31 μm in height and c. 10.53 μm in diameter, microverrucate and microporate. (Exine c. 5.50 μm thick, sexine slightly thinner than nexine and columellate). Tectum microverrucate to microspinulose and microporate.

25. **Hibiscus radiatus** (Figs. 4.30 a, b and 4.62 a, b): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 140 × 134 μm,
Observations
diameter c. 137 µm. Apertures c. 75, almost half the number of spines, alternating with spines in alternate spirals only, brevicolporate and operculate; colpus c. 7.50 µm long; operculum c. 7.00 µm in diameter. Spines c. 150, long, conical with rounded apex and constricted at base; c. 20.33 µm long; interspinal distance c. 17.67 µm; basal cushion c. 2.31 µm in height, c. 10.00 µm in diameter, minutely microporate. (Exine c. 6.5 µm thick, sexine thinner than nexine and columellate). Tectum microverrucate and minutely microporate.

26. Hibiscus sabdariffa (Figs. 4.31 a, b and 4.62 c, d): Pollen grains spheroidal, distinctly polypantocolporate and echinate. Size c. 104 × 102 µm, diameter c. 103 µm. Apertures c. 35, half the number of spines, alternating with spines in alternate spirals only, distinctly colporate and operculate; colpus c. 17.14 µm long; operculum c. 10.59 µm. Spines c. 70, long, straight or arched, conical with rounded apex and constricted at base, c. 18.64 µm long; interspinal distance c.22.30 µm; basal cushion very distinct, c. 1.25 µm in height, c. 11.71 µm in diameter, minutely verrucate and microporate. (Exine c. 5.00 µm thick, sexine two times thinner than nexine and columellate). Tectum microverrucate to microspinulose and minutely microporate.

27. Hibiscus schizopetalus (Figs. 4.32 a, b and 4.62 e, f): Pollen grains suboblate to spheroidal, polypantobrevicolporate and echinate. Size c. 105 × 99 µm, diameter c. 102 µm. Apertures c. 60, distribution not regular, brevicolporate and operculate; colpus c. 10.00 µm; operculum c. 6.00 µm. Spines c. 76, short, stumpy, subcylindrical with rounded apex, base not
constricted, merging with basal cushion, c. 11.46 μm long; interspinal distance c. 21.46 μm; basal cushion distinct, c. 1.33 μm in height, c. 11.33 μm in diameter. (Exine c. 3.00 μm thick, sexine thinner than nexine and columellate). Tectum microverrucate to microspinulose and minutely microporate.

28. **Hibiscus trionum** (Figs. 4.33 a, b and 4.62 g, h): Pollen grains suboblate to spheroidal, polypantocolporate and echinate. Size c. 101 × 99 μm, diameter c. 100 μm. Apertures c. 40, colporate and operculate; colpus c. 10.00 μm long; operculum c. 5.00 μm in diameter. Spines c. 80, short, stumpy with blunt rounded apex and constricted at base, c. 10.19 μm long; interspinal distance c. 20.25 μm; basal cushion distinct, but poorly developed, c. 1.25 μm in height, c. 8.00 μm in diameter. (Exine c. 5.60 μm thick, sexine thinner than nexine and columellate). Tectum microverrucate and sparcely microporate.

4.2.9 Genus **Kydia** Roxb.

29. **Kydia calycina** (Figs. 4.34 a, b and 4.63 a, b): Pollen grains spheroidal, pantoporate and echinate. Size c. 74 × 72 μm, diameter c. 73 μm. Apertures c. 10-12, brevicolporate and operculate. Spines c. 112 plus a few spinules, the former comparatively short, subconical with blunt rounded apex and slightly constricted at base, c. 9.80 μm long; interspinal distance c. 10.20 μm; basal cushion not well developed c. 6.92 μm in diameter, microporate. (Exine c.5.00 μm thick, sexine thicker than nexine and columellate). Tectum sparcely microverrucate and microporate.

4.2.10 Genus **Malachra** L.

30. **Malachra capitata** (Figs. 4.35 a, b and 4.63 c, d): Pollen grains spheroidal, truly polypantoporate and echinate. Size c. 98 × 96 μm, diameter
c. 97 µm. Apertures c. 138, almost equal to the number of spines, all alternating with spines, truly porate and operculate; pore size c. 3.13 µm in diameter; operculum c. 2.88 µm in diameter. Spines c. 138, long, conical, straight or slightly bent with rounded apex and constricted at base, c. 13.88 µm long interspinal distance c. 13.81 µm; basal cushion less well developed, c. 7.33 µm in diameter, microverrucate and microporate. (Exine c. 7.5 µm thick, sexine about three times thinner than nexine and columellate), Tectum sparcely microverrucate and also sparcely microporate.

4.2.11 Genus Malva L.

31. Malva sylvestris (Figs. 4.36 a, b and 4.63 e, f): Pollen grains spheroidal, and polypantoporate and echinate. Size c. 134 × 134 µm, diameter c. 134 µm. Apertures c. 100 or more, half the number of spines, porate and operculate (most operculi lost during acetolysis); pore c. 2.00 µm in diameter; operculum c. 1.5 µm in diameter. Spines c. 200 or more, variable in length, conical with rounded apex and merging with basal cushion at base, c. 8.21 µm long; interspinal distance c. 8.58 µm; basal cushion smooth, c. 4.19 µm in diameter (Exine c. 6.00 µm thick, sexine two to three times thinner than nexine and columellate), Tectum microgranulate and microporate.

4.2.12 Genus Malvastrum A. Gray

32. Malvastrum coromandelianum (Figs. 4.37 a, b and 4.63 g, h): Pollen grains spheroidal, mammillated, pantocolporate and echinate. Size c. 70 × 68 µm, diameter c. 69 µm. Apertures c. 12, colporate and operculate; colpus c. 8.85 µm long; operculum c. 4.86 µm. Spines c. 220 or more, short, conical
Observations

with rounded apex and broad base, c. 4.00 μm long; interspinal distance c. 6.61 μm; basal cushion distinct, c. 3.08 μm in height and c. 4.69 μm in diameter, microverrucate and microporate. (Exine c. 3.00 μm thick, sexine slightly thinner than nexine). Tectum microverrucate and microporate.

4.2.13 Genus Malvaviscus Cav.

33. Malvaviscus penduliflorus (Figs. 4.38 a, b and 4.64 a, b): Pollen grains suboblate to spheroidal, polypantobrevicolporate and echinate. Size c. 147 × 133 μm, diameter c. 140 μm. Apertures c. 49, brevicolporate and operculate, operculum c. 3.64 μm. Spines c. 98 plus few spinules; the former short, subconical to subcylindrical, with blunt and rounded apex and constricted at base; c. 13.36 μm long; interspinal distance c. 15.17 μm; basal cushion very poorly developed, c. 0.80 μm in height, c. 6.00 μm in diameter, microporate. (Exine c. 6.50 μm thick, sexine about two times thinner than nexine and columellate). Tectum microverrucate and microporate.

4.2.14 Genus Pavonia Cav.

34. Pavonia grewioides (Figs. 4.39 a, b and 4.64 c, d): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 109 × 105 μm, diameter c. 107 μm. Apertures many, brevicolporate and operculate; colpus c. 8.18 μm, operculum c. 4.55 μm in diameter. Spines c. 82 plus few spinules; the former long, conical with rounded apex and constricted at base; c. 19.64 μm long; spinules short, slender with rounded apex, c. 2.5-3.00 μm long; interspinal distance c. 23.20 μm. Basal cushion indistinct. (Exine c. 6.00 μm thick, sexine about two times thinner than nexine and columellate). Tectum sparcely microverrucate.
35. **Pavonia odorata** (Figs. 4.40 a, b and 4.64 e, f): Pollen grains spheroidal, polypantobrevicolporate and echinate. Size c. 77 x 75 μm, diameter c. 76 μm. Apertures c. 62 (equal to the number of spines and alternating with spines in all spirals); brevicolporate and operculate; colpus c. 7.22 μm; operculum c. 2.78 μm. Spines c. 62, long, uniformly conical with rounded apex and constricted at base; c. 16.22 μm; long; interspinal distance c. 17.50 μm; basal cushion indistinct. (Exine c. 5.00 μm thick, sexine three times thinner than nexine and columellate). Tectum minutely microverrucate or granulate, microporate around the spine base.

36. **Pavonia zeylanica** (Figs. 4.41 a, b and 4.64 g, h): Pollen grains spheroidal, polypantobrevicolporate, and echinate. Size c. 90 x 88 μm, diameter c. 89 μm. Apertures c. 74, alternating with spines in all spirals; brevicolporate and operculate; colpus c. 6.88 μm long; operculum c. 1.88 μm in diameter. Spines c. 74 plus a few spinules, the former mostly conical with rounded apex and constricted at base; c. 15.69 μm long; spinules of variable length c. 4.00-7.00 μm long; interspinal distance c. 20.94 μm; basal cushion very poorly developed, c. 1.17 μm in height and c. 8.00 μm in diameter. (Exine c. 6.00 μm thick, sexine about two times thinner than nexine and columellate). Tectum, sparcely verrucate, microverrucate and microporate.

4.2.15 Genus **Sida** L.

37. **Sida acuta** (Figs. 4.42 a, b and 4.65 a, b): Pollen grains spheroidal, mammillated, pantocolporate and echinate. Size c. 60 x 58 μm, diameter c. 59 μm. Apertures <than 10, colporate and operculate; colpus c. 7.10 μm long.
Observations

Spines c. 190, very short, conical with rounded apex and broad base, c. 4.11 μm long and 4.00 μm wide at base; interspinal distance c. 9.64 μm, basal cushion very distinct, c. 5.79 μm in diameter, very distinctly microverrucate and microporate. (Exine c. 2.50-3.00 μm thick, sexine and nexine are more or less equally thick. Tectum microverrucate and microporate.

38. *Sida alnifolia* (Figs. 4.43 a, b and 4.65 c, d): Pollen grains spheroidal, mammillated, pantocolporate and echinate. Size c. 76 × 74 μm, diameter c. 75 μm. Apertures > 12, but < 15; colporate (costate) and operculate; colpus c. 8.46 μm. Spines c. > than 250, short, like a round bottom flask with bulbous base and long cylindrical neck with rounded apex, c. 5.53 μm long; interspinal distance c. 6.58 μm, basal cushion highly well differentiated, microreticulate and microporate, c. 5.15 μm in diameter. (Exine c. 2.5-3.00 μm thick, sexine slightly thinner than nexine). Tectum microreticulate, microverrucate and microporate.

39. *Sida cordata* (Figs. 4.44 a, b and 4.65 e, f): Pollen grains spheroidal, mammillated, polypantobrevicolporidate and echinate. Size c. 60 × 60 μm, diameter c. 60 μm. Apertures c. 30, brevicolporidate, distinctly stellate, (costate); colpus c. 7.14 μm in length. Spines c. 200, very short, with bulbous base and short neck with rounded apex, c. 3.36 μm long; interspinal distance c. 8.03 μm; basal cushion very distinct with a ring of nodules around spine base, microreticulate and microporate, c. 5.14 μm in diameter. (Exine c. 2.5-3.00 μm thick, sexine and nexine equally thick). Tectum microverrucate and microporate.
40. **Sida cordifolia** (Figs. 4.45 a, b and 4.65 g, h): Pollen grains spheroidal, mammillated, pantobrevicolporidate and echinate. Size c. 59 × 57 µm, diameter c. 58 µm. Apertures < than 10, brevicolporidate, (costate) and operculate; colpus c. 5.00 µm long. Spines c. 200, short, conical, straight or bent with rounded apex and slightly broad base, c. 4.85 µm long; interspinal distance c. 7.55 µm; basal cushion distinct, c. 4.64 µm in diameter, microverrucate and microporate (Exine c. 2.5-3.00 µm thick, sexine and nexine equally thick). Tectum microverrucate and microporate.

41. **Sida elongata** var. **balica** (Figs. 4.46 a, b and 4.66 a, b): Pollen grains spheroidal, mammillated, polypantocolporidate and echinate. Size c. 57 × 53 µm, diameter c. 55 µm. Apertures > 25, but <30, colporidate and operculate; colpus c. 4.00 µm in diameter, some what stellate. Spines > than 180, very short with bulbous base and short neck with rounded apex, c. 3.67 µm long; interspinal distance c. 7.93 µm; basal cushion very distinct with a ring of nodules around spine base, microverrucate and microporate c. 5.47 µm in diameter. (Exine c. 2.5-3.00 µm thick, sexine and nexine more or less equally thick). Tectum microverrucate and microporate.

42. **Sida mysorensis** (Figs. 4.47 a, b and 4.66 c, d): Pollen grains spheroidal, mammillated, polypantocolporidate and echinate. Size c. 63 × 61 µm, diameter c. 62 µm. Apertures < 30, colporidate and operculate; colpus triradiate or stellate, c. 4.44 µm in diameter. Spines c. >250, very short, conical with a broad bulbous base and short neck with rounded apex, c. 4.41 µm long; interspinal distance c. 8.15 µm; basal cushion very distinct with a ring of
Observations

interconnected nodules around spine base, c. 5.33 μm in diameter, microverrucate and microporate. (Exine c. 2.5-3.00 μm thick, sexine and nexine more or less equally thick). Tectum microverrucate and microporate.

43. Sida rhomboidea (Figs. 4.48 a, b and 4.66 e, f): Pollen grains spheroidal, mammillated, pantocolporidate and echinate. Size c. 57 × 55 μm, diameter c. 56 μm. Apertures < than 15, colporidate and operculate; colpus c. 6.00 μm in length. Spines c. 250, short, conical with comparatively narrow base and rounded apex c. 4.23 μm long; interspinal distance c. 6.66 μm; basal cushion distinct with a ring of nodules around spine base, microverucate and microporate c. 4.87 μm in diameter. (Exine c. 2.5-3.00 μm thick, sexine and nexine are equally thick). Tectum microverrucate and microporate.

44. Sida spinosa (Figs. 4.49 a, b and 4.66 g, h): Pollen grains spheroidal, mammillated, pantocolporate and echinate. Size c. 57 × 55 μm, diameter c. 56 μm. Apertures < than 10, colporate and operculate; colpus c. 7.85 μm long. Spines > than 250, very short, conical with broad base and rounded apex, c. 2.82 μm long; interspinal distance c. 6.69 μm; basal cushion distinct with a ring of nodules around spine base, microreticulate, microverrucate and microporate c. 4.21 μm in diameter. (Exine c. 2.5 μm thick, sexine and nexine more or less equally thick). Tectum microverrucate and microporate.

4.2.16 Genus Talipariti Fryx.

45. Talipariti tiliaceus (Figs. 4.50 a, b and 4.67 a, b): Pollen grains spheroidal, polypantocolporate and echinate. Size c. 99 × 97 μm, diameter c. 98 μm. Apertures c.21, half the number of spines and alternating with spines
Observations

in alternate spirals only, colporate and operculate; colpus c.16.04 μm long; operculum c.7.33 μm in diameter. Spines c. 42, very long, slender, straight or arched with narrow base and rounded apex, constricted at base, c. 24.45 μm long; interspinal distance c. 25.46 μm, basal cushion indistinct. (Exine c. 4.5 μm thick, sexine about half the thickness of nexine). Tectum minutely scrobiculate and almost imperforate.

4.2.17 Genus Thespesia Soland ex Corr.

46. Thespesia lampas (Figs. 4.51 a, b and 4.67 c, d): Pollen grains spheroidal, probably polyzonocolporate and echinate. Size c. 75 × 73 μm, diameter c. 74 μm. Apertures 12-14 with 6-7 Apertures in two circles of one each on either side of the equator, colporate and operculate; colpus c. 14 μm long located between two juxtaposed spines; operculum c. 5.00 μm. Spines c. 66, perfectly conical with rounded apex and broad base, c. 8.50 μm long; interspinal distance c. 20.50 μm; basal cushion distinct, c. 2.25 μm in height, c. 6.50 μm in diameter, microreticulate and microporate. (Exine c. 3.00 μm thick, sexine slightly thicker than nexine and columellate). Tectum sparcely microverruculate and microporate.

47. Thespesia populnea (Figs. 4.52 a, b and 4.67 e, f): Pollen grains spheroidal, probably polyzonocolporate and echinate. Size c. 67 × 63 μm, diameter c. 65 μm. Apertures 12-14 with 6-7 Apertures in two circles of one each on either side of the equator, colporate and operculate; colpus c. 9.00 μm; operculum c. 2.60 μm. Spines c. 90, long, conical with broad base and subcylindrical neck with rounded apex, c. 8.59 μm long; interspinal distance
c. 12.90 μm; basal cushion distinct, c. 2.27 μm in height and c. 8.18 μm in diameter, microporate. (Exine c. 2.5-3.00 μm thick, sexine thicker than nexine and columellate). Tectum microreticulate, sparsely microverrucate and microporate.

48. *Thespesia populneoides* (Figs. 4.53 a, b and 4.67 g, h): Pollen grains spheroidal, mammillated, polyzonocolporate and echinate. Size c. 79 × 75 μm, diameter c. 77 μm. Apertures 12-14 with 6-7 in two circles of one each on either side of the equator, colporate and operculate; colpus c. 12.22 μm long; operculum c. 6.00 μm. Spines c. 80, some what subconical with rounded apex and less broad base, c. 8.56 μm long; interspinal distance c. 13.39 μm; basal cushion very distinct, c. 3.11 μm in height and c. 8.44 μm in diameter, distinctly microporate. (Exine c. 2.5-3.00 μm thick, sexine thicker than nexine and columellate). Tectum microreticulate and microporate.

4.2.18 Genus *Urena* L.

49. *Urena sinuata* (Figs. 4.54 a, b and 4.68 a, b): Pollen grains spheroidal, polyptoporate and echinate. Size c. 101 × 97 μm, diameter c. 99 μm. Apertures c. 82, in distinct spirals, always alternating with spines, porate, Apertures circular and operculate; operculum c. 7.73 μm. Spines c. 82 equal to the number of Apertures, long, conical or subconical with blunt rounded apex and constricted at base, c. 18.87 μm long; both interspinal and interporal distance c. 18.40 μm; basal cushion poorly developed, c. 10.57 μm in diameter, minutely microporate. (Exine c. 7.50 μm thick, sexine about one and
half times thinner than nexine and columellate). Tectum microverrucate to microspinulose and sparcely microporate.

4.2.19 Genus *Wissadula* Medik.

50. *Wissadula contracta* (Figs. 4.55 a, b and 4.68 c, d): Pollen grains polar, suboblate to spheroidal, mammillated, trizonocolporate and echinate. Size c. 53 × 47 μm, diameter c. 50 μm. Apertures 3, colporate, (costate) and operculate; colpus c. 6.75 μm long. Spines >200, very short, conical with broad base and rounded apex, c. 3.39 μm long; interspinal distance c. 4.47 μm; basal cushion distinct, c. 3.83 μm in diameter, microverrucate and microporate. (Exine c. 2.50 μm thick, sexine slightly thicker than nexine). Tectum microverrucate to microspinulose and microporate.

Having described the morphology of pollen grains in detail based on SEM and LM studies, the observations are as summarized in Tables 4.1-4.5 in accordance with the tribal classification of Malvaceae adopted by Paul and Nayar (1988) and Paul (1993) for the Indian taxa.
Abelmoschus esculentus (L.) Moench
a. Whole pollen grain,  b. Part of pollen grain showing spines
Abelmoschus ficulneus (L.) Wight & Arn. ex Wight

a. Whole pollen grain,  b. Part of pollen grain showing spines
Abelmoschus manihot (L.) Medik.
a. Whole pollen grain,  b. Part of pollen grain showing spines
Abelmoschus moschatus Medik.
a. Whole pollen grain, b. Part of pollen grain showing spines
*Abutilon bidentatum var. major* (Blatt. & Hallb.) Bhandari

a. Whole pollen grain,  b. Part of pollen grain showing spines
Abutilon hirtum (Lam.) Sweet

a. Whole pollen grain, b. Part of pollen grain showing spines
"Abutilon indicum" (L.) Sweet

a. Whole pollen grain, b. Part of pollen grain showing spines
Abutilon pannosum (Forst. f.) Schlecht.

*a.* Whole pollen grain,  
*b.* Part of pollen grain showing spines
Abutilon persicum (Burm. f.) Merr.
a. Whole pollen grain,  b. Part of pollen grain showing spines
Abutilon ramosum (Cav.) Guill. et Perr.
a. Whole pollen grain, b. Part of pollen grain showing spines
Abutilon striatum Dickson ex Lindl.
a. Whole pollen grain, b. Part of pollen grain showing spines
Alcea rosea L.
a. Whole pollen grain,  
b. Part of pollen grain showing spines
Bombyx micranthus (L.f.) Riedl.
a. Whole pollen grain,  b. Part of pollen grain showing spines
Decaschistia trilobata\textsuperscript{ Wight}
a. Whole pollen grain, b. Part of pollen grain showing spines
*Fioria vitifolia* (L.) Mattei

a. Whole pollen grain,  b. Part of pollen grain showing spines
**Gossypium sp.**

a. Whole pollen grain,  
b. Part of pollen grain showing spines
Hibiscus acetosella Welw. ex Hiern.
a. Whole pollen grain,  b. Part of pollen grain showing spines
**FIGURE - 4.23**

*Hibiscus cannabinus* L.

a. Whole pollen grain,  
b. Part of pollen grain showing spines
*Hibiscus hirtus* L.
a. Whole pollen grain, b. Part of pollen grain showing spines
**Hibiscus hispidissimus** Griff.

a. Whole pollen grain,  
b. Part of pollen grain showing spines
Hibiscus lobatus (Murray) Kuntze
a. Whole pollen grain,  b. Part of pollen grain showing spines
Hibiscus lunariifolius Willd.
a. Whole pollen grain,  b. Part of pollen grain showing spines
**Hibiscus mutabilis** L.

a. Whole pollen grain, b. Part of pollen grain showing spines
Hibiscus panduriformis Burm. f.
a. Whole pollen grain,  b. Part of pollen grain showing spines
**Hibiscus radiatus** Cav.

a. Whole pollen grain,  
 b. Part of pollen grain showing spines
Hibiscus sabdariffa L.
a. Whole pollen grain,  b. Part of pollen grain showing spines
**FIGURE - 4.33**

*Hibiscus trionum* L.

a. Whole pollen grain, b. Part of pollen grain showing spines
FIGURE - 4.35

Malachra capitata (L.) L.

a. Whole pollen grain,  b. Part of pollen grain showing spines
**FIGURE - 4.37**

*Malvastrum coromandelianum* (L.) Garcke

a. Whole pollen grain, b. Part of pollen grain showing spines
FIGURE - 4.38

Malvaviscus penduliflorus DC.

a. Whole pollen grain, b. Part of pollen grain showing spines
Pavonia grewioides Hochst. ex Boiss.
a. Whole pollen grain,  b. Part of pollen grain showing spines
Figure 4.40

*Pavonia odorata* Willd.

a. Whole pollen grain,  b. Part of pollen grain showing spines
Pavonia zeylanica (L.) Cav.
a. Whole pollen grain, b. Part of pollen grain showing spines
Sida acuta Burm. f.
a. Whole pollen grain,  b. Part of pollen grain showing spines
*Sida alnifolia* L.
a. Whole pollen grain, b. Part of pollen grain showing spines
**FIGURE - 4.44**

*Sida cordata* (Burm. f.) Borss.

a. Whole pollen grain, b. Part of pollen grain showing spines
Sida cordifolia L.
a. Whole pollen grain, b. Part of pollen grain showing spines
Sida elongata Blume var. balica (Miq.) Borss.
a. Whole pollen grain,  b. Part of pollen grain showing spines
**FIGURE - 4.47**

*Sida mysorensis* Wight & Arn.

a. Whole pollen grain,  
b. Part of pollen grain showing spines
Sida rhomboidea Roxb.
a. Whole pollen grain,  b. Part of pollen grain showing spines
Figure 4.49

*Sida spinosa* L.

a. Whole pollen grain,  b. Part of pollen grain showing spines
Talipariti tiliaceus (L.) Fryx.
a. Whole pollen grain,  b. Part of pollen grain showing spines
*Thespesia lampas* (Cav.) Dalz. & Gibs.
a. Whole pollen grain,  b. Part of pollen grain showing spines
Thespesia populnea (L.) Soland. ex Corr.
a. Whole pollen grain,  b. Part of pollen grain showing spines
*Thespesia populneoides* (Roxb.) Kostel.

a. Whole pollen grain,  

b. Part of pollen grain showing spines
**FIGURE - 4.54**

*Urena sinuata* L.

a. Whole pollen grain,  
   b. Part of pollen grain showing spines
**Wissadula contracta** (Link) R. E. Fries

a. Whole pollen grain,  b. Part of pollen grain showing spines
FIGURE - 4.56

a & b: *Abelmoschus esculentus* (L.) Moench
   a. Whole pollen grain (20 × 11)
   b. Part of pollen grain (40 × 8.2)

c & d: *Abelmoschus ficulneus* (L.) Wight & Arn. ex Wight
   c. Whole pollen grain (40 × 6.7)
   d. Part of pollen grain (40 × 11)

e & f: *Abelmoschus manihot* (L.) Medik.
   e. Whole pollen grain (40 × 5.3)
   f. Part of pollen grain (40 × 11)

g & h: *Abelmoschus moschatus* Medik.
   g. Whole pollen grain (20 × 11)
   h. Part of pollen grain (40 × 11)
FIGURE - 4.57

a & b: *Abutilon bidentatum* var. *major* (Blatt. & Hallb.) Bhandari
   a. Whole pollen grain (40 × 8.2)
   b. Whole pollen grain (40 × 8.2)

c & d: *Abutilon hirtum* (Lam.) Sweet
   c. Whole pollen grain (20 × 11)
   d. Whole pollen grain (20 × 11)

e & f: *Abutilon indicum* (L.) Sweet
   e. Whole pollen grain (20 × 8.2)
   f. Whole pollen grain (40 × 8.2)

g & h: *Abutilon pannosum* (Forst. f.) Schlecht.
   g. Whole pollen grain (40 × 8.2)
   h. Whole pollen grain (40 × 11)
FIGURE - 4.58

a & b: *Abutilon persicum* (Burm. f.) Merr.
   a. Whole pollen grains (20 x 8.2)
   b. Whole pollen grains (20 x 11)


c & d: *Abutilon ramosum* (Cav.) Guill. et Perr.
   c. Whole pollen grains (20 x 11)
   d. Whole pollen grain (40 x 11)


e & f: *Abutilon striatum* Dickson ex Lindl.
   e. Whole pollen grain (40 x 8.2)
   f. Whole pollen grain (40 x 11)


g & h: *Alcea rosea* L.
   g. Whole pollen grain (20 x 11)
   h. Part of pollen grain (40 x 11)
**FIGURE - 4.59**

a & b: *Bombyx micranthus* (L.f.) Riedl.
   a. Whole pollen grain (40 x 11)
   b. Whole pollen grain (40 x 11)

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c & d: *Decaschistia trilobata* Wight
   c. Whole pollen grain (40 x 11)
   d. Part of pollen grain (40 x 11)

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e & f: *Fioria vitifolia* (L.) Mattei
   e. Whole pollen grain (20 x 11)
   f. Part of pollen grain (40 x 11)

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g & h: *Gossypium* sp.
   g. Whole pollen grain (20 x 8.2)
   h. Whole pollen grain (20 x 11)
a & b: *Hibiscus acetosella* Welw. ex Hiern.
   a. Whole pollen grain (20 x 11)
   b. Part of pollen grain (40 x 11)

c & d: *Hibiscus cannabinus* L.
   c. Whole pollen grain (20 x 11)
   d. Part of pollen grain (40 x 11)

e & f: *Hibiscus hirtus* L.
   e. Whole pollen grain (20 x 11)
   f. Part of pollen grain (40 x 11)

g & h: *Hibiscus hispidissimus* Griff.
   g. Whole pollen grain (20 x 11)
   h. Part of pollen grain (40 x 11)
FIGURE - 4.61

a & b: *Hibiscus lobatus* (Murray) Kuntze
   a. Whole pollen grain (20 × 11)
   b. Whole pollen grain (40 × 8.2)

c & d: *Hibiscus lunariifolius* Willd.
   c. Whole pollen grain (20 × 11)
   d. Part of pollen grain (40 × 11)

e & f: *Hibiscus mutabilis* L.
   e. Whole pollen grain (20 × 11)
   f. Whole pollen grain (20 × 11)

g & h: *Hibiscus panduriformis* Burm. f.
   g. Whole pollen grain (20 × 11)
   h. Part of pollen grain (40 × 11)
FIGURE - 4.62

a & b: *Hibiscus radiatus* Cav.
   a. Whole pollen grain (20 x 11)
   b. Part of pollen grain (40 x 11)

c & d: *Hibiscus sabdariffa* L.
   c. Whole pollen grain (20 x 11)
   d. Whole pollen grain (40 x 6.7)

e & f: *Hibiscus schizopetalus* (Dyer) Hook. f.
   e. Whole pollen grain (20 x 11)
   f. Part of pollen grain (40 x 11)

g & h: *Hibiscus trionum* L.
   g. Whole pollen grain (20 x 11)
   h. Part of pollen grain (40 x 11)
a & b: *Kydia calycina* Roxb.
   a. Whole pollen grain (20 × 11)
   b. Part of pollen grain (40 × 11)

c & d: *Malachra capitata* (L.) L.
   c. Whole pollen grain (20 × 11)
   d. Part of pollen grain (40 × 11)

e & f: *Malva sylvestris* L.
   e. Whole pollen grain (40 × 11)
   f. Whole pollen grain (40 × 11)

g & h: *Malvastrum coromandelianum* (L.) Garcke
   g. Whole pollen grain (20 × 11)
   h. Whole pollen grain (40 × 11)
a & b: *Malvaviscus penduliflorus* DC.
   a. Whole pollen grain (20 x 8.2)
   b. Part of pollen grain (40 x 8.2)

c & d: *Pavonia grewioides* Hochst. ex Boiss.
   c. Whole pollen grain (20 x 8.2)
   d. Whole pollen grain (20 x 11)

e & f: *Pavonia odorata* Willd.
   e. Whole pollen grain (20 x 11)
   f. Part of pollen grain (40 x 11)

g & h: *Pavonia zeylanica* (L.) Cav.
   g. Whole pollen grain (40 x 11)
   h. Whole pollen grain (40 x 11)
FIGURE - 4.65

a & b: *Sida acuta* Burm. f.
  a. Whole pollen grain (20 x 11)
  b. Whole pollen grain (40 x 11)

c & d: *Sida alnifolia* L.
  c. Whole pollen grain (40 x 11)
  d. Whole pollen grain (40 x 11)

e & f: *Sida cordata* (Burm. f.) Borss.
  e. Whole pollen grain (40 x 11)
  f. Whole pollen grain (40 x 11)

g & h: *Sida cordifolia* L.
  g. Whole pollen grains (20 x 8.2)
  h. Part of pollen grains (20 x 11)
a & b: Sida elongata Blume var. balica (Miq.) Borss.
   a. Whole pollen grain (20 x 11)
   b. Whole pollen grain (40 x 11)

c & d: Sida mysorensis Wight & Arn.
   c. Whole pollen grain (20 x 11)
   d. Whole pollen grain (40 x 11)

e & f: Sida rhomboidea Roxb.
   e. Whole pollen grains (20 x 11)
   f. Whole pollen grain (40 x 11)

g & h: Sida spinosa L.
   g. Whole pollen grains (20 x 11)
   h. Whole pollen grain (20 x 11)
FIGURE - 4.67

a & b: *Talipariti tiliaceus* (L.) Fryx.
   a. Whole pollen grain (20 x 11)
   b. Part of pollen grain (40 x 11)

c & d: *Thespesia lampas* (Cav.) Dalz. & Gibs.
   c. Whole pollen grain (20 x 11)
   d. Part of pollen grain (40 x 11)

e & f: *Thespesia populnea* (L.) Soland. ex Corr.
   e. Whole pollen grain (20 x 11)
   f. Part of pollen grain (40 x 11)

g & h: *Thespesia populneoides* (Roxb.) Kostel.
   g. Whole pollen grain (20 x 11)
   h. Part of pollen grain (40 x 11)
FIGURE - 4.68

a & b: *Urena sinuata* L.
   a. Whole pollen grain (20 × 11)
   b. Part of pollen grain (40 × 11)

c & d: *Wissadula contracta* (Link) R. E. Fries
   c. Whole pollen grain (20 × 11)
   d. Whole pollen grain (40 × 11)