Studies on Singapore Pollen

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The pollen flora of Singapore and Malaya has been studied very little despite the wealth of the lush tropical vegetation. In well-known works on pollen morphology (Wodehouse, 1935; Erdtman, 1952) few of the indigenous plants of Southeast Asia have been described and most of the descriptions are based on herbarium material. About five years ago, when several requests were made for identification of certain pollens in connection with a few allergic cases reported in the local hospitals, an interest developed in the study of Singapore pollen. Since then a reference pollen collection of about 400 local species has been built up in the Botany Department of the University of Singapore, and a study on the morphological characters of the pollen of these plants has been undertaken. This paper is the first report of these studies. The valuable works of Cranwell (1953), Erdtman (1943, 1952), Faegri and Iversen (1964), Hyde and Adams (1958), Nair (1965), and Wodehouse (1935), and the journals Grana Palynologica, Botanical Review (Faegri, 1956), and Pollen et Spores were consulted as chief sources of reference. The pollen characters of about 85 species which have not been described in these earlier works are dealt with here, and another eight species are redescribed to indicate the variations displayed by local forms.

Materials and Methods

Pollen grains used in the present study were collected from the fresh open flowers of plants growing in Singapore and South Malaya as well as from dried flowers of herbarium specimens. Fresh pollen material was gathered by the natural shedding method (Wodehouse, 1935). The anthers in such flowers were examined periodically for signs of dehiscence and the dehisced anthers were then tapped gently, so that the grains fell into a vial containing glacial acetic acid. These were stored until it was convenient to use them for acetolysis. The dried anthers from herbarium specimens were teased and macerated in a vial with glacial acetic acid. The acetolysis method outlined by Erdtman (1952) was followed to obtain the necessary preparations, and glycerine jelly was used for mounting. Blue and yellow filters were helpful in determining the sporoderm characters accurately and for photomicrography.

At least 20 grains were measured in each case to obtain the average measurements recorded here. Differences in size and shape of the pollen grains are attributed to the presence of hygroscopic substances in the pollen grains and the degree of absorption of stains, jelly, etc. (Wodehouse, 1935). Size measurements of fresh as well as processed pollen grains were compared to establish the possible variations in size and shape of the grains caused by acetolysis and staining procedures. Very few minor variations were noticed and these do not merit recording. To determine the size, shape, exine sculpture, and LO-pattern, the methods employed by Erdtman (1952) and Nair (1965) were followed, and the descriptive terms used are in conformity with their published works.

The data for each species are arranged as follows: species name, authority, figure number if any, details of herbarium or voucher specimens, nature of apertures, shape and/or size of the individual grain or tetrad, exine thickness and its surface pattern. When the material used was obtained from an herbarium specimen, the specimen number is marked with an asterisk (e.g., Santiria laevigata SBGH, 30474*). In other cases (e.g., Gloriosa superba SUH, R101) pollen was collected from fresh flowers, and voucher specimens are deposited in the herbarium. The symbols SUH and SBGH denote Singapore University Herbarium and Singapore Botanic Garden Herbarium, respectively. The majority of the voucher specimens are deposited in the herbarium of the University of Singapore,

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and others in the herbarium of Singapore Botanic Gardens.

**Observations and Discussion**

In this presentation the families are cited in accordance with the System of Engler and Diels, *Syllabus der Pflanzenfamilien*, 1936 (see Lawrence, 1951, for details). The size measurements do not exclude the processes of the exine. In the measurements given, the polar diameter is mentioned first, followed by the equatorial diameter unless the grains are bilateral. In such cases the terms length (l), breadth (b), and height (h) are so denoted. All measurements are in microns. Exine thickness is mentioned only for certain species where it is 1μ or more; where it is not mentioned it may be assumed that the thickness is less than 1μ.

**Monocotyledons**

**Palmae**

*Cyrtostachys lakka* Becc. (Fig. 1) (Suh, R123). Grains bilateral, monosulcate, \( l = 30\mu \), \( b = 17\mu \), \( h = 15\mu \), exine smooth.

*Elaeis guineensis* Jacq. (Fig. 2) (Suh, 3534). Grains triangular in polar view, trichotomosulcate, \( 22 \times 33\mu \); exine smooth, finely reticulate.

Pollen structure of these two genera appears to be unrecorded so far. About 75 species belonging to 55 genera have been described (Erdtman, 1952). In discussing the origin of the oil palm plant, the trichotomosulcate condition is used as a basis for comparison with fossil pollen grains (Zeven, 1964).

**Liliaceae**

*Gloriosa superba* L. (Fig. 28) (Suh, R101). Grains bilateral, furrow visible, \( l = 35\mu \), \( b = 33\mu \), \( h = 19\mu \); exine 1μ thick, and slightly thicker at proximal face, reticulate.

The genus *Gloriosa* is considered along with seven other genera belonging to three suborders—Veratraceae, Uvulaceae, and Tricyrtceae (Erdtman, 1952; Nair, 1965). Further details about pollen of this well-known species are recorded here.
Figs. 1-16. Drawings of pollen grains. (Abbreviations used: Ev, equatorial view; Lv, lateral view; Pv, polar view; Sv, surface view. Figure numbers followed by the letter "a" refer to drawings which show the LO analysis of the same pollen. All magnifications X764.)

Fig. 1, Cyrtostachys lakka (Sv). Figs. 2, 2a, Elaeis guineensis (Pv). Fig. 3, Myrica farquhariana (Pv). Figs. 4, 4a, Cinnamomum zeylanicum. Fig. 5, Nepenthes gracilis (Pv). Fig. 6, Pygeum polystachyum (Ev). Fig. 7, Acacia auriculiformis (Pv). Figs. 8, 8a, Brownea coccinea (Pv). Figs. 9, 9a, Caesalpinia sappan (Pv and Ev). Figs. 10, 10a, Agrostistachys sessilifolia (Pv). Fig. 11, Hymenaea aminifera (Ev). Fig. 12, Flemingia congesta (Ev). Fig. 13, Chisocheton divergens (Ev). Fig. 14, Dracantemon mangiferum (Ev). Fig. 15, Harpulia zanguebarica (Ev). Fig. 16, Schoutenia kunsleri (Pv).
51μ, b = 28μ, h = 25μ; exine almost smooth. Pollen of only one species of this family has been described before—T. minor collected from Cuba (Erdtman, 1952).

**MYRISTICACEAE**

*Myristica fragrans* Hoult. (SUH, S102). Grains bilaterally symmetrical, 1-sulcate, 1 = 46μ, b = 35μ, h = 31μ; exine 1μ thick, exine baculate, coarsely reticulate.

Only *M. sebifera* has been studied before, and it has smaller pollen grains than *M. fragrans* (Erdtman, 1952).

**LAURACEAE**

*Cinnamomum zeylanicum* Nees. (Fig. 4) (SUH, 5002a). Grains nonaperturate, prolate spheroidal, 39 × 39μ, striations absent; exine with wartlike projections, foveolate.

Pollen of *C. camphora* has been described (Erdtman, 1952). It is similar to *C. zeylanicum*, but the grains are smaller.

**CAPPARIDACEAE**

*Crataeva religiosa* Forst. (SUH, R103). Grains 3-colporate, subprolate, 20 × 17μ; exine smooth, slightly thicker at the poles, foveolate.

Pollen of species of this genus seems not to have been described before, but the grains are 3-colporate like those of species of *Cadaba* and *Forchhammeria* (Erdtman, 1952).

**CRUCIFERAE**

*Brassica rapa* L. (SUH, R16a). Grains 3-colpate, oblate spheroidal, 15 × 19μ; exine baculate, OL-pattern reticulate.

Pollen grains of *B. arvensis, B. campestris*, and *B. juncea* are spheroidal in shape and bigger than those of *B. rapa* (Hyde and Adams, 1958; Nair, 1965).

**NEPENTHACEAE**

*Nepenthes dominii* Hert. (Fig. 31) (SUH, 3781*) Vietch and *N. gracilis* (Korth) (Fig. 5) (SUH, 167-1). Grains of both species in tetrahedral tetrads, tetrad diameter 22μ (*N. gracilis*) and 24μ (*N. dominii*), each grain more or less inaperturate; exine 2μ thick, spinulose, length of spinule 0.5μ.

The pollen grains of *N. dominii*, described here for the first time, resemble those of 15 other species recently reported by Basak and Subramanyam (1966) in both size and wall characteristics. Pollen grains of *N. gracilis* from both high altitude and coastal regions were studied; there were no differences in size or structure of the grains from the two types of locality. The illustration presented in this paper (Fig. 5) is of pollen collected at an elevation of 5,150 feet, Cameron highlands, Malaya. Pollen characters of *N. alata*, *N. phyllanthora*, and *N. viellardi* are summarized (Erdtman, 1952).

**ROSAEAE**

*Pygeum polystachyum* Hook. (Fig. 6) (SUH, 4433). Grains triangular in polar view, pore oval in shape (5 × 4μ), suboblate to oblate spheroidal, 18.5 × 21μ; exine psilate, OL-pattern indistinct.

No previous description is available of pollen of this genus (Erdtman, 1952; Nair, 1965).

**LEGUMINOSAE**

*Mimosoideae*

*Acacia auriculaeformis* A. Cunn. (Figs. 7, 32) (SUH, R104). Grains in polyads of 16 cells, 8 cells centrally placed (4 upon 4) surrounded at the periphery by 8 cells. Each grain inaperturate, exine smooth. Average diameter of polyad 32μ.

Seven other species of *Acacia* have been described previously and all of them have polyads (16- or 32-celled), with or without distinct apertures (Erdtman, 1952; Hyde and Adams, 1958; Nair, 1965; Wodehouse, 1935). General description of polyads and positional relationship of individual grains in them are discussed in detail by Wodehouse (1935).

*Entada spiralis* Ridl. (Fig. 34) (SUH, 366*). Grains 3-colporate, subprolate, 30 × 35μ, tegillate, OL-pattern faintly reticulate.

The shape of *E. scandens* pollen grains and pollen characters of *E. phaseoloides* are previously recorded (Erdtman, 1952).
Mimosa pudica Mill. (SUH, J70-2). Grains in tetrahedral and decussate tetrads, each grain inaperturate, average diameter of tetrads 9μ.

Though the tetrad condition in this genus is well known, no description is available of pollen of any species (Erdtman, 1952; Wodehouse, 1935).

Caesalpinioideae

Baubinia kockiana Korth. (SUH, R105).
Grains 3-colporate, prolate, 40 × 26μ; exine smooth, 2μ thick.

The pollen of two other species, B. coronata and B. faberi, have been described. In B. faberi
Burseraceae

Pterocarpus indicus Willd. (Fig. 35) (SUH, R109). Grains triangular in polar view, 3–4 porate, oblate spheroidal, 24×27µ; exine granular, 1µ thick, rugulate.

Three species other than E. glauca have been described previously (Erdtman, 1952; Nair, 1965). Though the wall and pore characters are similar in all of them, differences in size are significant.

Flemingia congesta Roxb. (Fig. 12) (SUH, G110). Grains triangular in polar view, 3-colp Tate, pore 4µ in diameter, oblate spheroidal, 23×26µ; exine undulating, reticulate.

Papilionoideae

Derris sinuata Benth. (SUH, 748). Grains 3-colpate, prolate spheroidal to subprolate, 26×35µ; exine slightly granular.


The wall and pore characters of D. umbellatum are similar to those of the other three species described previously (Nair, 1965).
MELIACEAE

*Chisocheton divergens* Blume. (Figs. 13, 36) (SUH, 1487). Grains 3-porate, pores oval in shape (6 × 5 μ), oblate spheroidal, 31 × 33 μ; exine psilate, 1 μ thick, OL-pattern indistinct.

* Dysoxylum caulisflorum* Hienn. (SUH, 1485*). Grains 4-colporate, ora lalongate, prolate spheroidal, 35 × 34 μ; exine psilate, rugulate.

*Melia indica* Brand. (SUH, W138*). Grains 4-colporate, ora lalongate, protolate spheroidal, 35.5 × 33.5 μ; exine psilate, rugulate.

*Sandoricum indicum* Cav. (SUH, K958*). Grains 3-colporate, ora lalongate, prolate spheroidal, 34 × 31 μ; exine psilate, foveolate.

No previous description of pollen is available for *Chisocheton, Dysoxylum*, and *Sandoricum* (Erdtman, 1952; Nair, 1965). The characters of *Melia indica* clearly agree with those of *M. azedarach*, previously described by Erdtman (1952). *Chisocheton* pollen shows the 3-porate condition, which is rather unusual for a member of Meliaceae (Erdtman, 1952, p. 268). Further investigation thus seems to be necessary not only for other species of *Chisocheton* but also for other genera of Meliaceae to evaluate the stenopalynous condition of the family.

EUPHORBIACEAE

*Agrostistachys sessilifolia* Pax, and K. Hoffm. (Fig. 10) (SUH, R4427). Grains 3-colporate, ora lalongate, prolate spheroidal, 19 × 18 μ; exine granular, 1 μ thick, rugulate.

*Aporosa frutescens* Benth. (SUH, 236*). Grains 3-colporate, ora lalongate, prolate, 17 × 15 μ; exine finely granular, reticulate.

*Blumeodendron tokbrai* Kurz. (SBGH, CWL 347*). Grains 3-porate, pore 1 μ in diameter, prolate, 20 × 17 μ; exine granular, foveolate.

*Excoecaria affinis* Endl. (SUH, R111). Grains 3-colpoidorate, pores 2 μ in diameter, spheroidal, 29 × 29 μ; exine finely granular, reticulate.

*Longetia malayana* Pax. and K. Hoffm. (Fig. 37) (SUH, Ridley, 112*). Grains oligoforate, pores 4 μ in diameter, spheroidal, 33.5 × 33.5 μ; exine spiny, spines 5 μ long.

The eurypalynous condition of Euphorbiaceae is further confirmed by these observations on five species. Pollen of *Agrostistachys sessilifolia* resembles that of *A. malabaricus* in shape and pore characters, but are smaller in size (Erdtman, 1952). In *Longetia malayana* the pollen grains are spiny, oligoporate, and spheroidal, while those of *L. buxoides* are without spines, 5–6 colp(oid)ate and suboblate (Erdtman, 1952). The former are bigger than the latter. The present report appears to be the first record for species of *Aporosa, Blumeodendron*, and *Excoecaria*.

ANACARDIACEAE

*Mangifera indica* L. (SUH, R113). Grains triangular in polar view, 3-colporate, subprolate, 29 × 24 μ; exine baculate, rugulate.

*Dracantomelon mangiferum* Blume. (Figs. 14, 38) (SUH, 98a). Grains 4-colporate, ora lalongate, oblate spheroidal, 26 × 29 μ; exine smooth.

Grains of *Mangifera indica* are larger and have a very small ora compared with those of *M. foetida*, previously described (Erdtman, 1952). No previous description is available for pollen characters of *Dracantomelon* species (Erdtman, 1952; Nair, 1965).

SAPINDACEAE

*Arfenillea arborescens* Pierre. (SUH, K4438). Grains 3-colporate, subprolate, 26 × 21 μ; exine smooth, striate.

*Harpullia zanguebarica* Radlk. (Fig. 15) (SUH, K683). Grains 3-colporate, ora lalongate, subprolate, 27 × 22 μ; exine psilate, striate.

*Otophora imbricata* Blume. (SUH, K689). Grains 3-colporate, prolate, 31 × 24 μ; exine baculate, 2 μ thick, thicker in the region of the equator, finely reticulate.

*Pometia alnifolia* Radl. (SUH, R122). Grains triangular in polar view, 3-porate, pore 2 μ wide, aspidote, suboblate, 22 × 28 μ; exine granular, reticulate.
No previous description is available for members of these genera, and pollen characters of the above species agree with the general characters of the family (Erdtman, 1952; Nair, 1965; Wodehouse, 1935).

**TILIACEAE**

_Scboutenia kunstleri_ King. (Fig. 16) (SUH, R115). Grains 3-porate, pores 4μ wide, each pore surrounded by a 4μ-thick rim, oblate spheroidal, 48 × 48μ; exine 1μ thick, with blunt spinules about 2.5μ high.

This description supplements that of Erdtman (1952).

**MALVACEAE**

_Bombycidendron vidalianum_ Merrill and Rollet (Fig. 17) (SUH, R118). Grains polyporate, pore 5μ in diameter, oblate spheroidal, 122 × 122μ; exine clavate, 2μ thick, foveolate, height of clava 17μ, width 9μ.

_Hibiscus tiliaceus_ L. (SUH, R117). Grains polyporate, pores 5μ in diameter, oblate spheroidal, 105 × 105μ; exine spiny, interpolar area reticulate, spines 19μ in length, foveolate.

_Neesia altissima_ Blume. (Fig. 18) (SBGH, Brink, 5884*). Grains 3-porate, pores 6μ in diameter, rim around pores 5μ thick, aspidote, prolate spheroidal, 42 × 42μ; exine granular, foveolate.

_Urena lobata_ L. (Figs. 21, 39, 40) (SUH, R116). Grains polyporate, pores 5μ in diameter, prolate spheroidal, 105 × 105μ; exine spiny, spines 14μ long, reticulate.

Prominent spines are present in all the three species of _Hibiscus_ previously described, and variations noticed in the size of the grain and spines serve as useful diagnostic characters. Pollen characters of _Bombycidendron_, _Neesia_, and _Urena_ are not mentioned in previous work (Erdtman, 1952; Nair, 1965; Wodehouse, 1935).

**BOMBACACEAE**

_Coelostegia borneensis_ Becc. (Figs. 19, 41) (SUH, 3465). Grains triangular in polar view, 3-syncolpate, oblate spheroidal, 11 × 13μ; exine psilate.

_Coelostegia griffithii_. Benth. (Fig. 42) (SUH, FMS4222*). Grains 3-porate, pores 3μ in diameter, exine subpsilate, oblate spheroidal, 31 × 34μ, foveolate.

No description of pollen in this genus is available in previous work (Erdtman, 1952; Nair, 1965).

**THEACEAE**

_Ploiarium alternifolium_ Melchior. (SUH, 1770a). Grains 3-colporate, prolate spheroidal, 31 × 28μ; exine tegillate, reticulate. Pollen of this genus has not been described in earlier work (Erdtman, 1952; Nair, 1965).

**DIPTEROCARPACEAE**

_Dryobalanops oblongifolia_ Dyer. (Fig. 20) (SUH, FMS2734*). Grains 3-colporate, suboblate, 25 × 29μ; exine granular, rugulate.

_Vatica wallichii_ Dyer. (SUH, K557*). Grains 3-colporate, subprolate, 25 × 20μ; exine granular, 1μ thick, foveolate.

The species of only two genera of this family, _Dipterocarpus_ and _Monotes_, are dealt with in previous work, and two other genera are considered here. In general, very little information is available on pollen of Dipterocarpaceae, an important family in Southeast Asia (Erdman, 1952; Nair, 1965; Wodehouse, 1935).
Figs. 40–48. Photomicrographs of pollen grains. (Abbreviations as for Figs. 1–27.)

Fig. 40, Urena lobata, part of Figure 39 enlarged to show the pores and spines, ×988. Fig. 41, Coelostegia borneensis, ×4953. Fig. 42, Coelostegia griffithii, ×3646. Fig. 43, Carica papaya, ×3294. Fig. 44, Barringtonia racemosa (Ev), ×2635. Fig. 45, Mimusops elongii, ×3294. Fig. 46, Fagraea fragrans, ×3294. Fig. 47, Vinca rosea, ×2553. Fig. 48, Ipomea pulchella, ×1647.

CARICACEAE

Carica papaya L. (Figs. 22, 43) (SUH, 1742a). Grains 3-colporate, oblate spheroidal, 30 × 32μ; exine granular, 1μ thick, reticulate.

This information supplements the earlier description of papaya pollen (Erdtman, 1952).

BEGONIACEAE

Begonia semperflorens Hook. (Fig. 23) (SUH, 3541). Grains 3-colporate, prolate, 20 × 14μ; exine psilate, striate.

Four other species of Begonia are described by Erdtman (1952), and all show similar characters.
LECITHIDACEAE

Barringtonia racemose Roxb. (Fig. 44) (SUH, 2693a). Grains 3-syncolpate, margins of the colpa thickened (corresponding to the "Planchnonia type" in Erdtman, 1952), prolate, $48 \times 34\mu$; exine psilate, $3\mu$ thick.

Gustavia gracillima Miers. (SUH, R3494). Grains 3-colpate, prolate spheroidal, $18 \times 16\mu$; exine psilate, 1$\mu$ thick.

Another species of each of these genera is described by Erdtman (1952). In Gustavia mexicana, grains are colporoidate, and in G. gracillima they are colpate.

THYMELAEACEAE

Gonystylus maingayi Hook. (SUH, 508*). Grains oligoforate, pores 2–3$\mu$ in diameter, prolate spheroidal, $46 \times 46\mu$; exine subpsilate, wavy reticulate.

Only the size of the grains is given by Erdtman (1952) for G. maingayi, and therefore other details are mentioned here. Small spinuloid excrescences reported for G. bancanus (the only other species described) are absent in G. maingayi.

MELASTOMACEAE

Anplectrum divaricatum Triana. (SUH, 2634*). Grains 3-colpate, the colpi alternating with 3 pseudocolpi, prolate, $20 \times 11\mu$; exine psilate, indistinct.

Clidemia hirta D. Don. (SUH, 2878a). Grains 3-colpate, the colpi alternating with 3 pseudocolpi, peroblate, $15 \times 13\mu$, exine psilate.

Marumia nemorosa Blume. (SUH, 272*). Grains 3-colpate, the colpi alternating with 3 pseudocolpi, subprolate to prolate, $14 \times 11\mu$, exine smooth.

Melastoma molle Wall. (SUH, 355*). Grains 3-colporoidate, the colpi alternating with 3 pseudocolpi, peroblate, $19 \times 16\mu$, exine psilate.

Melastoma malabathricum was previously described (Nair, 1965); the characters are similar to those of M. molle, mentioned above. Members of Anplectrum, Clidemia, Marumia and

Rhodamnia trinervia Blume. (SUH, 5022a). Grains triangular in polar view, 3-colpate, subprolate, $17 \times 13\mu$; exine psilate, 1$\mu$ thick, thicker at the region of the equator.

Rhodomyrtus tomentosa Weight. (SUH, Gilililand 363a). Grains triangular in polar view, aspidote, 3-porate, pore 1–2$\mu$ wide, suboblate, $17 \times 20\mu$; exine psilate, 1$\mu$ thick, thicker in the region of the asps.

Unlike those of Eugenia jambos, the pollen grains of E. choorobicha (the only other species previously described) are longicolpate. Members of the genera Decaspermum, Melaleuca, Rhodamnia, and Rhodomyrtus have not been considered previously (Erdtman, 1952; Nair, 1965; Wodehouse, 1935). The family Myrtaceae is considered a stenopalynous one, the pollen being characterized by the presence of 2–3–4 colpi, sometimes syncolpate or colpate. An exceptional condition was observed in Rhodomyrtus tomentosa, which has 3-porate pollen grains.

MELASTOMACEAE

Anplectrum divaricatum Triana. (SUH, 2634*). Grains 3-colpate, the colpi alternating with 3 pseudocolpi, prolate, $20 \times 11\mu$; exine psilate, indistinct.

Clidemia hirta D. Don. (SUH, 2878a). Grains 3-colpate, the colpi alternating with 3 pseudocolpi, peroblate, $15 \times 13\mu$, exine psilate.

Marumia nemorosa Blume. (SUH, 272*). Grains 3-colpate, the colpi alternating with 3 pseudocolpi, subprolate to prolate, $14 \times 11\mu$, exine smooth.

Melastoma molle Wall. (SUH, 355*). Grains 3-colporoidate, the colpi alternating with 3 pseudocolpi, peroblate, $19 \times 16\mu$, exine psilate.

Melastoma malabathricum was previously described (Nair, 1965); the characters are similar to those of M. molle, mentioned above. Members of Anplectrum, Clidemia, Marumia and
Miconia have not been described previously (Erdtman, 1952; Nair, 1965; Wodehouse, 1935).

ARALIACEAE

Arctophyllum diversifolium Blume. (SUH, 124*). Grains 3-colporate, ovoid-lanceolate, subprolate to prolate, 23 × 20μ; exine granular, 1μ thick.

Schefflera biternata Harms. (SUH, S103). Grains 3-colporate, ovoid-lanceolate, prolate, 34 × 24μ; exine psilate, rugulate.

No detailed account seems to have been made previously on the species of these two genera. The length of the axis is briefly mentioned by Erdtman (1952) for the genus Schefflera.

ERICACEAE

Guettardia fragrantissima Wall. (SUH, 677*). Grains in tetrad, each grain 3-colporate, tetrad diameter 30μ; exine psilate.

Only G. trichophylla has been considered before, and, as in some other genera of the family (e.g., Rhododendron, Pieris), its pollen grains are arranged in tetrahedral tetrads (Erdtman, 1952; Nair, 1965).

MYRSINACEAE

Aegiceras majus Gaertn. (SUH, 256a). Grains 3-colporate, subprolate, 20 × 16μ; exine psilate, vaguely foveolate.

Ardisia littoralis Andr. (SUH, 602a). Grains 3-colporate, oblate spheroidal, 13 × 13μ; exine psilate, 1μ thick, reticulate.

Two other species of Ardisia have been described earlier; the pollen of the different species is similar (Erdtman, 1952; Nair, 1965). Aegiceras pollen has not been described before.

PLUMBAGINACEAE

Plumbago alba Hort. ex. Pasq. (SUH, R121). Grains 3-colpate, subprolate, 49 × 42μ; exine baculate, 2μ thick, coarsely reticulate.

The pollen of P. alba resembles that of P. capensis, the only species previously described (Erdtman, 1952).

SAPOTACEAE

Palaquim obovatum King and Gamble. (SUH, K4409). Grains 6-colporate, ovoid-lanceolate, subprolate, 25 × 21μ; exine smooth, 2μ thick.

Payena lucida A. DC. (SUH, K609a). Grains 4-colporate, ovoid-lanceolate, subprolate, 32.5 × 27μ; exine smooth, foveolate.

Mimusops elengi L. (Fig. 45) (SUH, 6018). Grains 4-colporoidate, subprolate, 38 × 31μ; exine smooth, faintly reticulate.

Only wall character is described for pollen of Mimusops blanitrea (Erdtman, 1952). The genera Palaquim and Payena are not mentioned in earlier work (Erdtman, 1952; Nair, 1965; Wodehouse, 1935).

LOGANIACEAE

Fagraea fragrans Roxb. (Fig. 46) (SUH, 307a). Grains 3-colpate, prolate to subprolate, 30 × 26μ; exine baculate, coarsely reticulate.

Two other species, Fagraea imperialis and F. morindaefolia, have been previously described; their pollen grains are porate and colpate, respectively, unlike those of F. fragrans which are colpate. Other species also should be studied to determine variations.

APOCYNACEAE

Vinca rosea L. (Fig. 47) (SUH, 293a). Grains triangular in polar view, 3-colpate, ovoid-lanceolate, subprolate, 47 × 37μ; exine psilate, 1μ thick, OL-pattern faintly foveolate.

Only the shape of V. rosea pollen grains is briefly mentioned by Erdtman (1952); other characters are given here.

CONVOLVULACEAE

Erycibe princei Wall. (SUH, 613*). Grains 3-colpate, subprolate, 28 × 22μ; exine tegillate, fossulate.

Ipomoea pulchella Roth. (Fig. 48) (SUH, R120). Grains polyforate, pores 5μ in diameter,
spiny (spines average 10μ in length and a circlet of collemellae surrounds the base), oblate spheroidal, 66 × 66μ.

Two other species of Ipomoea have been described earlier. The presence of prominent spines is an important character of all (Erdtman, 1952; Nair, 1965). This appears to be the first description for Erycibe.

**VERBENACEAE**

*Clerodendron villosum* Blume. (Fig. 25) (SUH, 5091a). Grains 3-colporate, suboblate, 16 × 19μ; exine spinulate, 2μ thick, foveolate.

*Vitex trifolia* Linn. (SUH, 3251a). Grains 3-colporate, oblate, 17 × 26μ; exine granular, reticulate.

Two other species of *Clerodendron* have been described; wall and spine characters are similar in all of them (Erdtman, 1952; Nair, 1965). *Vitex* species have not been considered earlier.

**ACANTHACEAE**

*Acanthus ebracteatus* Vahl. (SUH, R109). Grains 3-colporate, prolate, 40 × 26μ; exine baculate, 1μ thick, finely reticulate.

Pollen of eight species of *Acanthus* has been described earlier (Bhoj Raj, 1961). The characters of *A. ebracteatus* pollen agree with the other species.

**RUBIACEAE**

*Ixora congesta* Roxb. (SUH, 5015a). Grains 3-colporate, colloid streaks perpendicular to the colpi are present, oblate spheroidal, 26 × 26μ; exine slightly granular, 2μ thick, reticulate.

*Morinda umbellata* (SUH, 302a). Grains 3-colpoidorate, oblate spheroidal, 30 × 32μ; exine baculate, 2μ thick, reticulate.

*Massaneda erythropylla* Schum. and Thonn. Beskr. (SUH, 5029). Grains 4-porate, pore diameter 2μ, prolate spheroidal to subprolate, 19 × 17μ; exine granular, reticulate.

*Timonius peduncularis* Ridl. (Fig. 26) (SBG, Burkill, SFN.15515*). Grains oblate spheroidal, 24 × 24μ; exine baculate, coarsely reticulate.

Another species of *Morinda* has been described (Erdtman, 1952; Nair, 1965). The others are not considered in previous work. The phenomenon of pollen dimorphism reported by Baker (1956) in *Faramea occidentalis* and *Radgea jasminioides* was not observed in any of the four Rubiaceous forms described here.

**COMPOSITAE**

*Ageratum conyzoides* L. (SUH, S104). Grains 3-colporate, prolate spheroidal, 20 × 20μ; exine spiny, spines 5μ in length.

*Helianthus angustifolius* L. (Fig. 27) (SUH, S105). Grains 3-colporate, prolate spheroidal, 22 × 22μ; exine spiny, spines 6μ in length.

Additional details to those mentioned by Erdtman (1952) are given here for *Ageratum conyzoides*. Pollen of *Helianthus angustifolius* and *H. annuus* (previously described) are similar, but the former is smaller in size (Erdtman, 1952). Cranwell (1953) has described the pollen of *H. trionum* and *H. diversifolius*, the former with spines and the latter without.

**SUMMARY**

The pollen grain morphology of about ninety species representing forty families of angiosperms (3 of monocots, 37 of dicots) collected in Singapore and Malaysian regions are studied and the observations are recorded in this paper. These include new descriptions for forty-nine genera and eighty-four species. Eight species are redescribed to record the structural variations of local pollen grains. The pollen characters of most of the species described presently, conform to generic or specific characters reported in case of their respective families. The variations observed in size, wall, or pore characteristics of other members belonging to *Leguminosae*, *Meliaceae*, *Euphorbiaceae*, *Anacardiaceae*, *Dipterocarpaceae*, *Caricaceae*, *Myrtaceae* and *Rubiaceae* are comparatively discussed with reference to previous literature.
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LITERATURE CITED


