

Original Research Article

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Pollen Atlas of Santiniketan, West Bengal, with Reference to Aeropalynology

Soumi Ghosh and Sudhendu Mandal*

UGC-DRS Department of Botany, Visva-Bharati, Santiniketan-731235, India

**Corresponding author*

A B S T R A C T

The paper deals with the preparation of a pollen atlas with a pollen key of the angiospermic flora of Santiniketan and the adjoining region which will provide sufficient indication for the identification of airborne pollen grains. Pollen morphology of 101 plant species belonging to 40 different families naturally growing in Santiniketan area have been examined by light microscopy. Pollen morphology on the basis of aperture and exine sculpturing type varies from Inaperturate- Echinate, Inaperturate-Crotanoid, Monosulcate-Psilate, Monosulcate-Reticulate, Monoporate-Psilate, Triporate-Psilate, Triporate-Reticulate, Tetraporate-Verrucate, Pentaporate-Microreticulate, Pantoporate-Psilate, Pantoporate-Echinate, Pantoporate-Microreticulate, Tricolpate-Psilate, Tricolpate-Reticulate to microreticulate, Tricolpate- faintly reticulate, Tricolpate-Microechinate, Tricolpate-Regulate, Hexacolpate-Reticulate, Tricolporate-Psilate, Tricolporate-Reticulate to microreticulate, Tricolporate-Finelyreticulate to faintlyreticulate, Tricolporate- Echinate to microechinate, Tricolporate-Verrucate, Tricolporate-Crotanoid, Tricolporate-Granulate, Tricolporate-Obscure, Tri-Tetraporate-Reticulate, Tetraporate-reticulate, Tricolporate-Psilate, Polyads, Pollinia etc. Prolate, Per- prolate, Sub-prolate, Prolate-spheroidal, Spheroidal, Oblate- spheroidal, Sub- oblate, Oblate etc. types of pollen shapes are obtained. A pollen key has been prepared mainly on the basis of apertural configuration and distribution and also on the nature of surface ornamentation, shape, size, etc.

Keywords

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Introduction

Pollen, the male gametophyte of flowering plants is the male partner in the fertilization process. The wall of pollen grains consist of two layers, exine (outer wall) and intine (inner wall). This exine maybe smooth or ornamented and this distinctive ornamentation permit the identification of the pollen grains. The sculpturing of the exine and the constant features make pollen grains appreciably recognizable feature

through which parent genera or even species can be recognized (Harris 1955; Moore and Webb 1978).

The classical background which emphasized the importance of the study of the whole pollen grain was first carried out by Wodehouse (1935). The second great worker was Erdtman (1952) who enlightened the path of modern comparative pollen morphology study.

The study of morphology of pollen grains is basic necessity of palynology because of its fundamental value lies in the recognition and identification of grains found in various conditions (Arora and Modi 2008). Pollen characters are categorized into different groups like pollen units, polarity, shape, size, aperture types and surface pattern etc.

At the time of anthesis pollen grains are released from anthers. These pollen grains are reached to the sigma through air or insects. During this process a huge amount of pollen grains are dispersed into the air and is the well known cause of pollinosis i.e; pollen allergy. Now a day pollen allergy is one of the most important problems to human beings throughout the world.

The classification of pollen morphotypes responsible for allergic disorders is to be formulated which will lead to an index key for identification of airborne pollen grains (Mandal and Chanda 1981). The pollen grains are also present in honey.

The pollen grains are carried to bee hive when bees collect nectar from flower. Honey produced from that particular hive will contain that particular type of pollen. So determining the vegetation of a region can be done by examines that honey sample, as that sample contains pollen grains those inhabitants. The determination of geographical origin is generally based on the entire pollen spectrum being consistent with the flora of a particular region (Louveaux et al. 1978).

Pollen morphological studies of the family are therefore very significant to identify the pollen grains present in honey samples and for these, it is necessary to know the pollen morphology. The identification of plants from their pollen is a very good tool to the botanists and ecologists to reconstruct past assemblages of plants and identify periods

of environmental change (Faegri and Iversen 1989; Moore et al. 1991).

Morphological characteristics of pollen grains also can be useful phylogenetic marker in studies of plant taxonomy because many pollen traits are influenced by the strong selective forces involved in various reproductive processes, including pollination, dispersal and germination (Erdtman 1952; Moore et al. 1991; Nowicke and Skvarla 1979; Stuessy 1990).

The aim of the present work was to study and compare pollen characteristics of some plant species growing in Santiniketan area which will provide the glimpses of regional flora at a glance.

Materials and Methods

The present study was carried out with 101 plant species belonging to 40 different families which were abundantly found in Santiniketan area during March to September. Fresh and mature flowers are collected at the time of anthesis from the field. Pollen grains from these flowers were collected and mounted on glass slides with saffranin stained glycerine jelly and sealed with nailpolish for study. The slides were observed under light microscope in 10X and 40X magnification (objective lens) to study the pollen morphology.

For each species more than 10 pollen grains were considered and the following parameters were observed and measured: Aperture type, Surface pattern, Equatorial outline, Polar outline, Size (μm) and Shape. Exine sculpturing types are based mainly on appearance under LM. The photographs were taken at 40X magnification. Pollen descriptions are provided in alphabetical order by family, genus and species. The terminology used in

accordance with Erdtman 1952, Fageri and Iverson 1964.

Results and Discussion

In the present study, different types of pollen were found which include Inaperturate-Crotanoid, Inaperturate-Echinate, Monosulcate- Psilate, Monosulcate-Reticulate, Monoporate- Psilate, Triporate-Psilate, Triporate- Reticulate, Tetraporate-Verrucate, Pentaporate-Microreticulate, Pantoporate- Psilate, Pantoporate-Echinate, Pantoporate- Microreticulate, Tricolpate-Psilate, Tricolpate-Reticulate to microreticulate, Tricolpate- Faintlyreticulate, Tricolpate- Microechinate, Tricolpate-Regulate, Hexacolpate-Reticulate, Tricolpate- Psilate, Tricolporate-Reticulate to microreticulate, Tricolporate-Finelyticulate to faintlyreticulate, Tricolporate-Echinate to microechinate, Tricolporate-Verrucate, Tricolporate-Crotanoid, Tricolporate-Granulate, Tricolporate-Obsecure, Tri-Tetraporate-Reticulate, Tetraporate-reticulate, Tricolporate-Psilate, Polyads, Pollinia. Among these types Tricolporate-Psilate type is much abundant than other types followed by Tricolporate- Reticulate type. Majority of the Pollen grains are

Prolate in shape. Per-prolate, Sub-prolate, Prolate-spheroidal, Spheroidal, Oblate-spheroidal, Sub-oblate, Oblate etc. types of pollen shape are obtained.

Inaperturate type of pollen grains are found in *Croton* and *Jatropha* with crotonoid type of sculpturing. *Alpinia* within Zingiberaceae are also inaperturate. However, *Bridelia*, *Pedilanthus* and *Euphorbia* within Euphorbiaceae has Tricolporate-Crotanoid pattern; *Ricinus* and *Acalypha* has Tricolporate type with reticulate and psilate pattern respectively.

Monosulcate type is found in Amaryllidaceae, Costaceae, Liliaceae and Magnoliaceae. Monoporate and tetraporate types are present in *Sporobolus* and *Alangium* respectively.

Tricolporate-Echinate type is restricted to asteraceae family where pollens of different species are differing on their pollen size. Pollen grains of Lamiaceae are generally colpate, either tri or hexa. Papaveraceae and Scrophulariaceae (except *Scoparia* with Tricolporoidate type) have tricolpate type.

Convolvulaceae generally has Pantoporate-Echinate type of pollen (except *Merrimia* and *Evolvulus*). However *H. rosa-sinensis* and *B. diffusa* also has Pantoporate-Echinate type, but these pollen grains differ in their spine character. Amaranthaceae has Pantoporate-Psilate type pollen.

Pollen of Apocynaceae are generally Tricolporate type, however *Holarrhena* has Triporate type. Sterculiaceae pollen has Tricolporate and Triporate types. Acanthaceae has tricolporate type of pollen grains, exception is found in *Adhatoda* with Tetraporate and *Ruellia* with Tricolpate type of aperture.

Lythraceae, Moringaceae, Myrtaceae has Tricolporate- Psilate type pollen grains. Passifloreae, Polygonaceae, Rubiaceae has Tricolporate- Reticulate, except *Ixora* has Psilate type. Majority of Solanaceae has Tricolporate- Psilate, except *Cestrum* and *Petunia* having reticulate type. Tiliaceae has tricolporate- microreticulate type.

Verbenaceae pollen varies from Tricolpate to tricolporate type.

Tables Pollen characters based on Aperture Type, Surface pattern, Equatorial outline, Polar outline, Size (μm) and Shape

Acanthaceae

Species Name	Aperture Type	Surface Pattern	Size (μm)	Equatorial outline	Polar outline	Shape
<i>Adhatoda vasica</i> Nees	Tetracolporate	Reticulate	39.60 x 23.10	Rectangular	Elliptical	Prolate
<i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees	Tricolporate	Reticulate	36.30 x 23.10	Elliptical	Circular	Prolate
<i>Justicia diffusa</i> Willd.	Tricolporate	Reticulate	33.00 x 18.7	Elliptical-obtuse-convex	Rectangular	Prolate
<i>Peristrophe bicalyculata</i> Nees	Tricolporate	Reticulate	34.10 x 22	Elliptical	Circular to triangular	Prolate
<i>Ruellia tuberosa</i> L.	Tricolporate	Regulate	59.40 x 33.00	Elliptical	Circular	Prolate

Alangiaceae

Species Name	Aperture Type	Surface Pattern	Size (μm)	Equatorial outline	Polar outline	Shape
<i>Alangium salviifolium</i> (L. F.) Wangerin	Tetraporate	Verrucate	57.75 x 57.75	Circular	Circular	Spheroidal

Amaranthaceae

Species Name	Aperture Type	Surface Pattern	Size (μm)	Equatorial outline	Polar outline	Shape
<i>Aerva lanata</i> (L.) Juss.	Pantoporate	Psilate	24.75 x 24.75	Circular	Circular	Spheroidal
<i>Amaranthus viridis</i> L.	Pantoporate	Psilate	19.80 x 19.80	Circular	Circular	Spheroidal

Amaryllidaceae

Species Name	Aperture Type	Surface Pattern	Size (μm)	Equatorial outline	Polar outline	Shape
<i>Agave cantula</i> Roxb.	Monosulcate	reticulate	49.50 x 39.60	Elliptical	Circular	Sub-prolate
<i>Crinum asiaticum</i> L.	Monosulcate	Reticulate	105.6 x 39.60	Elliptical	Elliptical	Per-prolate

Apocynaceae

Species Name	Aperture Type	Surface Pattern	Size (μm)	Equatorial outline	Polar outline	Shape
<i>Adenium obesum</i> (Forssk.) Roem. et Schult	Tricolporate	Faintly reticulate	36.30 x 23.10	Elliptical	Circular	Prolate
<i>Catharanthus roseus</i> (L.) G. Don	Tricolporate	Psilate	37.30 x 23.10	Elliptical	Circular	Prolate
<i>Holarrhena antidysenterica</i> (L.) Wall.	Triporate	Reticulate	12.10 x 23.10	Elliptical	Circular	Oblate
<i>Rauwolfia serpentina</i> (L.) Benth.	Tricolporate	Psilate	60.00 x 81.00	Elliptical	Triangular-obtuse- plane	Oblate
<i>Tabernaemontana divaricata</i> (L.) R.Br.	3-4 Colporate	Finely reticulate	30.80 x 25.30	Elliptical	Circular	Sub-prolate
<i>Thevetia peruviana</i> (Pers.) K.Schum.	Tricolporate	Reticulate	66.00 x 79.20	Elliptical	Triangular-obtuse- convex	Sub-oblate

Asclepiadaceae

Species Name	Aperture Type	Surface Pattern	Size(µm)	Equatorial outline	Polar outline	Shape
<i>Calotropis procera</i> R.Br.	Pollinia	Psilate obscure	-	-	-	-

Asteraceae

Species Name	Aperture Type	Surface Pattern	Size(µm)	Equatorial outline	Polar outline	Shape
<i>Eclipta alba</i> (L.) Hassk.	Tricolporate	Microechinate	14.30 x 14.30	Circular	Circular	Spheroidal
<i>Parthenium hysterophorous</i> L.	Tricolporate	Echinate	15.40 x 15.40	Circular	Circular	Spheroidal
<i>Tridax procumbens</i> L.	Tricolporate	Echinate	23.10 x 23.10	Circular	Circular	Spheroidal
<i>Xanthium strumarium</i> L.	Tricolporate	Echinate	19.80 x 19.80	Circular	Circular	Spheroidal

Averrhoaceae

Species Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Averrhoa carambola</i> L.	Tricolporate	Psilate	16.50 x 12.65	Elliptical	Elliptical	Sub-prolate

Bignoniaceae

S.pecies Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Campsis grandiflora</i> (Thunb) K. Schum	Tricolporate	Reticulate	38.50 x 24.20	Elliptical	Circular	Prolate

Bixaceae

Species Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Bixa orellana</i> L.	Tricolporate	Psilate	29.70 x 20.62	Elliptical	Circular	Prolate

Bombacaceae

Species Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Bombax ceiba</i> L.	Tricolporate	Reticulate	28.30 x 56.00	Elliptical	Triangular-obtuse-plane	Oblate

Boraginaceae

Species Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Heliotropium indicum</i> L.	Tricolporate	Psilate	31.35 x 16.50	Elliptical	Circular to rectangular	Prolate

Caesalpinaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Bauhinia acuminata</i> L.	Tricolporate	Reticulate	115.50 x 115.50	Circular	Circular	Spheroidal
<i>Cassia fistula</i> L.	Tricolporate	Psilate	28.05 x 16.50	Elliptical	Triangular-obtuse-convex	Prolate
<i>Cassia siamea</i> Lamk	Tricolporate	Psilate	39.60 x 24.75	Elliptical	Triangular-obtuse-convex to circular	Prolate
<i>Delonix regia</i> (Bojer) Raf.	Tricolporate	Reticulate	42.90 x 33.00	Elliptical	Circular	Sub-prolate

<i>Saraca indica</i> L.	Tricolporate	Reticulate	42.07 x 23.92	Elliptical	Circular	Prolate
<i>Millettia peguensis</i> Ali.	Tricolpate	Psilate	19.80 x 13.20	Elliptical	Triangular- obtuse-convex	Prolate

Capparidaceae

Species Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Cleome rutidosperma</i> Dc.	Tricolporate	Psilate	18.15 x 12.78	Elliptical	Circular	Prolate

Combretaceae

Species Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Quisqualis indica</i> L.	Tricolporate	Granulate	39.60 x 25.30	Elliptical	Triangular-obtuse- convex to circular	Prolate

Convolvulaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Argyreia nervosa</i> Boj.	Pantoporate	Echinate, tips acute	101.20 x 101.20	Circular	Circular	Spheroidal
<i>Evolvulus nummularis</i> L.	5 Porate	Microreticulate	34.1 x 34.1	Circular	Circular	Spheroidal
<i>Ipomoea aquatica</i> Forssk.	Pantoporate	Echinate, tips obtuse	94.60 x 94.60	Circular	Circular	Spheroidal
<i>Ipomoea carnea</i> Jace.	Pantoporate	Echinate, pointed tips	97.90 x 97.90	Circular	Circular	Spheroidal
<i>Merremia vitifolia</i> Hallier f.	Pantoporate	Microreticulate	50.60 x 50.60	Circular	Circular	Spheroidal

Costaceae

Species Name	Aperture Type	Surface Pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Costus speciosus</i> (Koenig) J. E. Sm.	Monosulcate	Psilate	148.50 x 148.50	Circular	Circular	Spheroidal

Euphorbiaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Acalypha indica</i> L.	Tricolporate	Psilate	14.85 x 8.25	Elliptical	Circular	Prolate
<i>Bridelia tomentosa</i> Bl.	Tricolporate	Crotanoid	22.00 x 14.30	Elliptical	Circular	Prolate
<i>Croton tiglium</i> L.	Inaperturate	Crotanoid	39.60 x 39.60	Circular	Circular	Spheroidal
<i>Euphorbia milii</i> Ch. Des Moulins	Tricolporate	Crotanoid	31.90 x 23.10	Elliptical	Circular	Prolate
<i>Jatropha podagrica</i> Hook.	Inaperturate	Crotanoid	83.60 x 83.60	Circular	Circular	Spheroidal
<i>Pedilanthus tithymaloides</i> (L.) Poit.	Tricolporate	Crotanoid	15.30 x 19.25	Elliptical	Circular to triangular	Sub- oblate
<i>Ricinus communis</i> L.	Tricolporate	Reticulate	20.90 x 17.60	Elliptical	Circular	Prolate

Lamiaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Anisomeles indica</i> (L.) O. Kuntz	Tricolpate	Faintly Reticulate	33.00 x 36.30	Elliptical	Circular	Oblate-Spheroidal
<i>Hyptis suaveolens</i> Poir.	Hexacolpate	Reticulate	33.00 x 42.90	Elliptical	Circular	Sub-oblate
<i>Ocimum sanctum</i> L.	Hexacolpate	Reticulate	25.85 x 34.10	Elliptical	Circular	Sub-oblate

Lecythidaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Barringtonia acutangula</i> (L.) Gaertn.	Tricolporate	Verrucate	33.00 x 29.70	Elliptical	Circular	Prolate-spheroidal

Liliaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Asparagus racemosus</i> Willd.	Monosulcate	Psilate	9.90 x 18.70	Elliptical	Elliptical	Oblate

Lythraceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Lagerstromea speciosa</i> (L.) Pers.	Tricolporate	Psilate	33.00 x 23.10	Elliptical	Circular	Prolate

Magnoliaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Michelia champaca</i> L.	Monosulcate	Psilate	24.75 x 37.40	Elliptical	Circular	Oblate

Malvaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Hibiscus rosa-sinensis</i> L.	Pantoporate	Echinate, tips obtuse	132.00 x 132.00	Circular	Circular	Spheroidal

Mimosaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Albizia lebbek</i> (L.) Benth.	Inaperturate	Psilate	66.00 x 33.00	Elliptical	circular	Perprolate
<i>Calliandra umbrosa</i> Benth.	Inaperturate	Psilate	-	-	circular	Balloon shaped

Moringaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Moringa oleifera</i> Lamk.	Tricolporate	Psilate	30.52 x 14.85	Elliptical	Triangular-obtuse-convex to circular	Per-prolate

Myrtaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Callistemon citrinus</i> (Curtis) Skeels	Tricolporate	Psilate	15.67 x 17.32	Elliptical	Triangular-obtuse-plane	Oblate-spheroidal
<i>Psidium guajava</i> L.	Tricolporate	Psilate	13.20 x 19.80	Elliptical	Triangular-obtuse-plane	Oblate

Nyctaginaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Boerhaavia diffusa</i> L.	Pantoporate	Echinata	89.10 x 89.10	Circular	Circular	Spheroidal

Oxalidaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Oxalis corniculata</i> L.	Tricolporate	Microreticulate	21.45 x 23.10	Elliptical	Circular	Oblate-spheroidal

Papaveraceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Argemone mexicana</i> L.	Tricolpate	Reticulate	29.70 x 23.10	Triangular to circular	Circular	Sub-prolate

Papilionaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Abrus precatorius</i> L.	Tricolporate	Reticulate	28.60 x 18.48	Elliptical	Elliptical	Prolate
<i>Butea monosperma</i> (Lam.) Taub.	Tricolporate	Obscure pattern	37.40 x 20.90	Elliptical	Triangular-obtuse-convex	Prolate
<i>Clitoria ternatea</i> L.	Tricolporate	Psilate	42.90 x 23.10	Elliptical	Triangular-obtuse-convex	Prolate
<i>Crotalaria retusa</i> L.	Tricolporate	Psilate	25.08 x 15.67	Elliptical	Triangular-obtuse-convex	Prolate
<i>Erythrina indica</i> Lamk	Tricolporate	Reticulate	39.6 x 33.00	Elliptical	Triangular-obtuse-convex	Sub-prolate
<i>Pongamia pinnata</i> (L.) Pierre	Tricolporate	Psilate	23.10 x 17.05	Elliptical	Triangular-obtuse-plane	Prolate
<i>Sesbania sesban</i> (L.) Merr.	Tricolporate	Reticulate	24.75 x 18.15	Elliptical	Triangular-obtuse-convex	Prolate
<i>Tephrosia purpurea</i> Pers.	Tricolporate	Reticulate	24.75 x 16.50	Elliptical	Triangular-obtuse-convex	Prolate

Passifloreae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Carica papaya</i> L.	Tricolporate	Finely reticulate	25.80 x 19.80	Elliptical	Circular	Sub-prolate

Poaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Sporobolus diander</i> Beauv.	Monoporate	Psilate	19.80 x 19.80	Circular	Circular	Spheroidal

Polygonaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Antigonon leptopus</i> Hook. & Arn.	Tricolporate	Reticulate	59.40 x 41.25	Elliptical	Circular	Prolate

Rubiaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Ixora coccinea</i> L.	Tricolporate	Psilate	25.57 x 18.97	Elliptical	Triangular-obtuse-convex	Prolate
<i>Hemelia patens</i> Jacq.	Tricolporate	Micro reticulate	18.7 x 15.40	Elliptical	Triangular-obtuse-convex to circular	Sub-prolate
<i>Mitragyna parviflora</i> (Roxb.) Korthals	Tricolporate	Faintly reticulate	16.50 x 14.30	Elliptical	Circular	Sub-prolate
<i>Morinda tinctoria</i> Roxb. var. <i>tomentosa</i>	Tricolporate	Reticulate	15.00 x 16.00	Elliptical	Circular	Oblate-spheroidal
<i>Oldenlandia corymbosa</i> L.	Tricolporate	reticulate	13.20 x 8.25	Elliptical	Circular	Prolate

Rutaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Murraya paniculata</i> (L.) Jack.	Tricolporate	Microreticulate	48.40 x 22.27	Elliptical	Circular	Per-prolate

Scrophulariaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Lindernia ciliata</i> (Colsm.) Pennel	Tricolpate	Psilate	22.00 x 15.40	Elliptical	Triangular-obtuse-convex	Prolate
<i>Mazus rugosus</i> Lour.	Tricolpate	Psilate	19.80 x 12.37	Elliptical	Triangular-obtuse-convex	Prolate
<i>Scoparia dulcis</i> L.	Tricolporoidate	Psilate	14.85 x 6.60	Elliptical	Triangular-obtuse-convex	Per-prolate

Solanaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Cestrum diurnum</i> L.	Tricolporate	Microreticulate	29.70 x 18.15	Elliptical	Circular	Prolate
<i>Petunia hybrida</i> (Hook.) Hort ex vilm.	Tricolporate	Reticulate	23.10 x 12.37	Elliptical	Triangular-obtuse-convex	Prolate
<i>Physalis minima</i> L.	Tricolporate	Psilate	28.87 x 18.97	Elliptical	Triangular-obtuse-convex	Prolate
<i>Solanum diphyllum</i> L.	Tricolporate	Psilate	13.20 x 9.90	Elliptical	Triangular-obtuse-convex	Sub-prolate
<i>Solanum macranthum</i> Dunal	Tricolporate	Psilate	18.15 x 11.55	Elliptical	Circular	Prolate
<i>Solanum nigrum</i> L.	Tricolporate	Psilate	20.45 x 14.85	Elliptical	Triangular-obtuse-convex	Prolate
<i>Solanum xanthocarpum</i> Schrad. & Wendl.	Tricolporate	Psilate	23.10 x 16.50	Elliptical	Triangular-obtuse-convex	Prolate

Sterculiaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Helicteres isora</i> L.	Triporate	Psilate	23.10 x 18.56	Elliptical	Triangular-obtuse-convex	Sub- prolate
<i>Kleinhovia hospita</i> Linn.	Tricolporate	Reticulate	21.00 x 9.90	Elliptical	Triangular-obtuse-plane	Prolate

Tiliaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Grewia asiatica</i> Linn.	Tricolporate	Microreticulate	51.97 x 28.87	Elliptical	Circular	Prolate
<i>Corchorus aestuans</i> L.	Tricolporate	Microreticulate	28.60 x 18.97	Elliptical	Circular	Prolate

Verbenaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Clerodendrum indicum</i> (L.) Kuntze.	Tricolpate	Microechinate	83.60 x 52.80	Elliptical	Circular	Prolate
<i>Clerodendrum inerme</i> (L.) Gaertn.	Tricolpate	Microechinate	51.15 x 36.30	Elliptical	Triangular to circular	Prolate
<i>Clerodendrum splendens</i> G.Don	Tricolpate	Microechinate	51.15 x 33.00	Elliptical	Circular	Prolate
<i>Lantana camara</i> L.	Tricolporate	Psilate	32.17 x 17.67	Elliptical	Triangular to circular	Prolate
<i>Petrea volubilis</i> Jacq.	Tricolporate	Micro-reticulate	36.30 x 22.27	Elliptical	Triangular-obtuse-convex	Prolate
<i>Vitex negundo</i> L.	Tricolpate	Micro-reticulate	26.40 x 15.67	Elliptical	Circular	Prolate

Zingiberaceae

Species Name	Aperture Type	Surface pattern	Size (µm)	Equatorial outline	Polar outline	Shape
<i>Alpinia zerumbet</i> Burt & R. M. Smith	Inaperturate	Echinate	82.50 x 82.50	Circular	Circular	Spheroidal

Pollen Key

1. Inaperturate

- A. Spheroidal
- B. Echinate

C. Diam 82.50 x 82.50 (µm).....*Alpinia zerumbet*

BB. Crotonoid pattern

C. Diam 39.60 x 39.60 (µm).....*Croton tiglium*

CC. Diam 83.60 x 83.60 (µm).....*Jatropha podagrica*

2. 1-Sulcate

- A. Per prolate
- B. Reticulate

- C. Diam 105.6 x 39.60 (µm).....*Crinum asiaticum*
- AA. Sub-prolate
- B. Reticulate
- C. Diam 49.50 x 39.60 (µm).....*Agave cantula*
- AAA. Spheroidal
- B. Psilate
- C. Diam 148.50 x 148.50 (µm).....*Costus speciosus*
- AAAA. Oblate
- B. Psilate
- C. Diam 9.90 x 18.70 (µm).....*Asparagus racemosus*
- CC. Diam 24.75 x 37.40 (µm).....*Michelia champaca*
- 3. 1-Porate**
- A. Spheroidal
- B. Psilate
- C. Diam 19.80 x 19.80 (µm).....*Sporobolus diander*
- 4. 3 -Porate**
- A. Subprolate
- B. Psilate
- C. Size 23.10 x 18.56 (µm).....*Helicteres isora*
- AA. Oblate
- B. Reticulate
- C. Size 12.10 x 23.10 (µm).....*Holarrhena antidysenterica*
- 5. 4-Porate**
- A. Spheroidal
- B. Verrucate
- C. Diam 57.75 x 57.75 (µm).....*Alangium salviifolium*
- 6. 5-Porate**
- A. Spheroidal
- B. Microreticulate
- C. Diam 34.1 x 34.1 (µm).....*Evolvulus nummularis*
- 7. Pantoporate**
- A. Spheroidal
- B. Psilate
- C. Diam 19.80 x 19.80(µm).....*Amaranthus viridis*
- CC. Diam 24.75 x 24.75(µm).....*Aerva lanata*
- BB. Echinata
- C. Diam 89.10 x 89.10(µm).....*Boerhaavia diffusa*
- CC. Diam 94.60 x 94.60(µm).....*Ipomoea aquatica*
- CCC. Diam 97.90 x 97.90(µm).....*Ipomoea carnea*
- CCCC. Diam 101.20 x 101.20(µm).....*Argyreia nervosa*
- CCCCC. Diam 132.00 x 132.00(µm).....*Hibiscus rosa-sinensis*
- BBB. Microreticulate
- C. Diam 50.60 x 50.60(µm).....*Merremia vitifolia*
- 8. 3 – Colpate**
- A. Prolate
- B. Psilate
- C. Size 19.80 x 12.37 (µm).....*Mazus rugosus*
- CC. Size 19.80 x 13.20 (µm).....*Millettia peguensis*
- CCC. Size 22.00 x 15.40 (µm).....*Lindernia ciliate*

- BB. Microechinate
 - C. Size 51.15 x 33.00 (µm).....*Clerodendrum splendens*
 - CC. Size 51.15 x 36.30 (µm).....*Clerodendrum inerme*
 - CCC. Size 83.60 x 52.80 (µm).....*Clerodendrum indicum*
- BBB. Microreticulate
 - C. Size 26.40 x 15.67 (µm).....*Vitex negundo*
- BBBB. Regulate
 - C. Size 59.40 x 33.00 (µm).....*Ruellia tuberosa*
- AA. Sub-Prolate
 - B. Reticulate
 - C. Size 29.70 x 23.10 (µm).....*Argemone mexicana*
- AAA. Spheroidal
 - B. Reticulate
 - C. Size 115.50 x 115.50 (µm).....*Bauhinia acuminata*
- AAAA. Oblate spheroidal
 - B. Faintly reticulate
 - C. Size 33.00 x 36.30 (µm).....*Anisomeles indica*

9. 6- Colpate

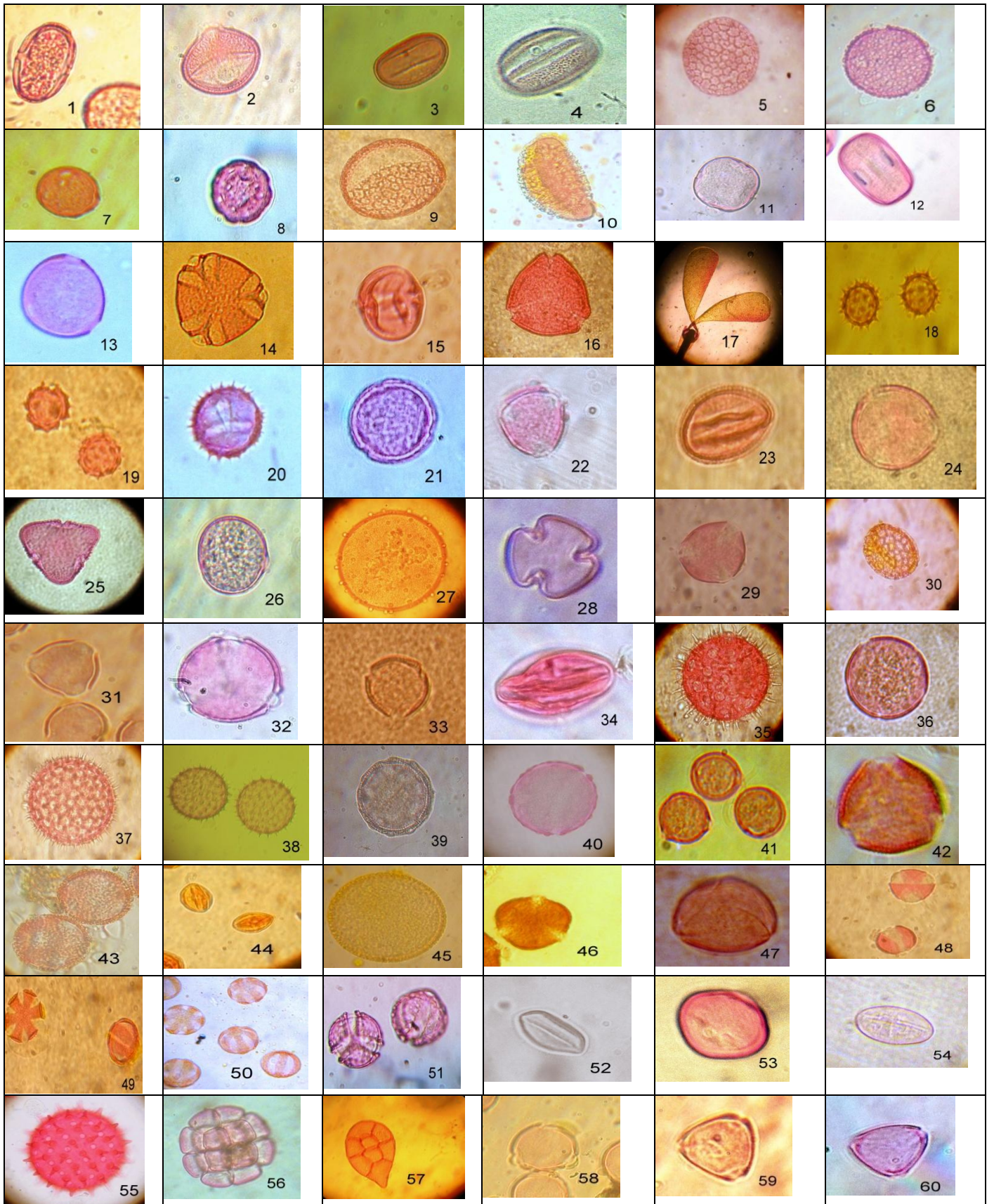
- A. Sub-oblite
- B. Reticulate
 - C. Size 25.85 x 34.10 (µm).....*Ocimum sanctum*
 - CC. Size 33.00 x 42.90 (µm).....*Hyptis suaveolens*

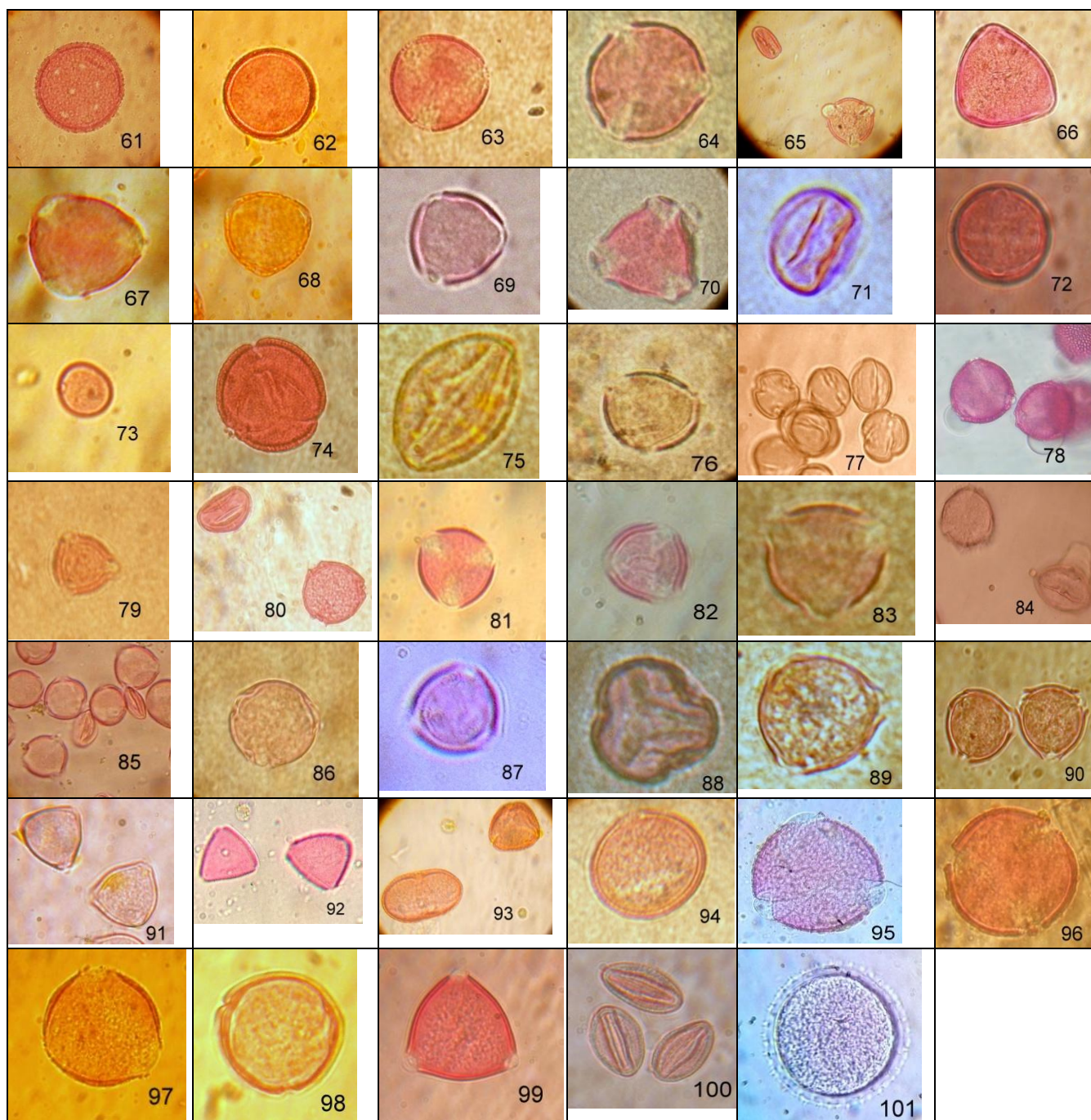
10. 3 – Colporate

- A. Perprolate
- B. Psilate
 - C. Size 30.52 x 14.85 (µm).....*Moringa oleifera*
- BB. Microreticulate
 - C. Size 48.40 x 22.27 (µm).....*Murraya paniculata*
- AA. Prolate
 - B. Psilate
 - C. Size 14.85 x 8.25 (µm).....*Acalypha indica*
 - CC. Size 18.15 x 11.55 (µm).....*Solanum macranthum*
 - CCC. Size 18.15 x 12.78 (µm).....*Cleome rutidosperma*
 - CCCC. Size 20.45 x 14.85 (µm).....*Solanum nigrum*
 - CCCCC. Size 23.10 x 16.50 (µm).....*Solanum xanthocarpum*
 - CCCCCC. Size 23.10 x 17.05 (µm).....*Pongamia pinnata*
 - CCCCCC. Size 25.08 x 15.67 (µm).....*Crotalaria retusa*
 - CCCCCC. Size 25.57 x 18.97 (µm).....*Ixora coccinea*
 - CCCCCC. Size 28.87 x 18.97 (µm).....*Physalis minima*
 - CCCCCC. Size 28.05 x 16.50 (µm).....*Cassia fistula*
 - CCCCCC. Size 29.70 x 20.62 (µm).....*Bixa orellana*
 - CCCCCC. Size 31.35 x 16.50 (µm).....*Heliotropium indicum*
 - CCCCCC. Size 32.17 x 17.67 (µm).....*Lantana camara*
 - CCCCCC. Size 33.00 x 23.10 (µm).....*Lagerstromia speciosa*
 - CCCCCC. Size 37.30 x 23.10 (µm).....*Catharanthus roseus*
 - CCCCCC. Size 39.60 x 24.75 (µm).....*Cassia*
 - CCCCCC. Size 42.90 x 23.10 (µm).....*Clitoria ternatea*
- BB. Reticulate
 - C. Size 13.20 x 8.25 (µm).....*Oldenlandia corymbosa*
 - CC. Size 20.90 x 17.60 (µm).....*Ricinus communis*
 - CCC. Size 21.00 x 9.90 (µm).....*Callicarpa tomentosa*
 - CCCC. Size 23.10 x 12.37 (µm).....*Petunia hybrid*
 - CCCC. Size 24.75 x 16.50 (µm).....*Tephrosia purpurea*

- CCCCCC. Size 24.75 x 18.15(µm).....*Sesbania sesban*
 CCCCCC. Size 28.60 x 18.48 (µm).....*Abrus precatorius*
 CCCCCCCC. Size 33.00 x 18.70 (µm).....*Justicia diffusa*
 CCCCCCCCC. Size 34.10 x 22.00 (µm).....*Peristrophe bicalyculata*
 CCCCCCCCCC. Size 36.30 x 23.10 (µm)*Andrographis paniculata*
 CCCCCCCCCC. Size 38.50 x 24.20 (µm).....*Campsis grandiflora*
 CCCCCCCCCC. Size 42.07 x 23.92 (µm).....*Saraca indica*
 CCCCCCCCCC. Size 59.40 x 41.25 (µm).....*Antigonon leptopus*
- BBB. Microreticulate
 C. Size 28.60 x 18.97 (µm).....*Corchorus aestuans*
 CC. Size 29.70 x 18.15 (µm).....*Cestrum diurnum*
- CCC. Size 36.30 x 22.27 (µm).....*Petrea volubilis*
 CCCC. Size 51.97 x 28.87 (µm).....*Grewia asiatica*
- BBBB. Faintlyreticulate
 C. Size 36.30 x 23.10 (µm).....*Adenium obesum*
 BBBBB. Obscure
 C. Size 37.40 x 20.90 (µm).....*Butea monosperma*
- BBBBBB. Granulate
 C. Size 39.60 x 25.30 (µm).....*Quisqualis indica*
 BBBBBBB. Crotonoid
 C. Size 22.00 x 14.30 (µm).....*Bridelia tomentosa*
 CC. Size 31.90 x 23.10 (µm).....*Euphorbia milii*
- AAA. Sub- prolate
 B. Psilate
 C. Size 13.20 x 9.90 (µm).....*Solanum diphyllum*
 CC. Size 16.50 x 12.65 (µm).....*Averrhoa carambola*
- BB. Reticulate
 C. Size 39.6 x 33.00 (µm).....*Erythrina indica*
 CC. Size 42.90 x 33.00 (µm).....*Delonix regia*
- BBB. Microreticulate
 C. Size 18.7 x 15.40 (µm).....*Hemelia patens*
- BBBB. Finelyreticulate
 C. Size 25.80 x 19.80 (µm)*Carica papaya*
- BBBBB. Faintlyreticulate
 C. Size 16.50 x 14.30 (µm).....*Mitragyna parviflora*
- AAAA. Prolate-Spheroidal
 B. Verrucate
 C. Size 33.00 x 29.70 (µm).....*Barringtonia acutangula*
- AAAAA. Spheroidal
 B. Echinata
 C. Size 15.40 x 15.40 (µm).....*Parthenium hysterophorous*
 CC. Size 19.80 x 19.80 (µm).....*Xanthium strumarium*
 CCC. Size 23.10 x 23.10 (µm).....*Tridax procumbens*
- BB. Microechinate
 C. Size 14.30 x 14.30 (µm).....*Eclipta alba*
- AAAAAA. Oblate-spheroidal
 B. Psilate
 C. Size 15.67 x 17.32 (µm).....*Callistemon viminalis*
- BB. Reticulate
 C. Size 15.00 x 16.00 (µm).....*Morinda tinctoria*
- BB. Micro reticulate
 C. Size 21.45 x 23.10 (µm).....*Oxalis corniculata*

- AAAAAAA. Sub-oblate
 B. Reticulate
 C. Size 66.00 x 79.20 (μm).....*Thevetia parviflora*
 BB. Crotonoid
 C. Size 15.30 x 19.25 (μm).....*Pedilanthus tithymaloides*
 AAAAAAAA. Oblate
 B. Psilate
 C. Size 13.20 x 19.80 (μm).....*Psidium guajava*
 CC. Size 60.00 x 81.00 (μm).....*Rauwolfia serpentine*
 BB. Reticulate
 C. Size 28.30 x 56.00 (μm).....*Bombax ceiba*
- 11. 3-4 Colporate**
 A. Sub-Prolate
 B. Reticulate
 C. Diam 30.80 x 25.30 (μm).....*Tabernaemontana divaricata*
- 12. 4- Colporate**
 B. Prolate
 B. Reticulate
 C. Diam 39.60 x 23.10 (μm).....*Adhatoda vasica*
- 13. 3- Colporoidate**
 A. Per-Prolate
 B. Psilate
 C. Diam 14.85 x 6.60 (μm).....*Scoparia dulcis*
- 14. Polyads**
 A. Polyads in form of Pollinia.....*Calotropis procera*
 AA. Polyads not in form of Pollinia
 B. Polyads with 12 cells.....*Albizia lebbeck*
 BB. Polyads with 8 cells.....*Calliandra umbrosa*





1. <i>Adhatoda vasica</i>	2. <i>Andrographis paniculata</i>	3. <i>Justicia diffusa</i>	4. <i>Peristrophe paniculata</i>	5. <i>Ruellia tuberosa</i>
6. <i>Alangium salviifolium</i>	7. <i>Aerva lanata</i>	8. <i>Amaranthus viridis</i>	9. <i>Agave cantala</i>	10. <i>Crinum asiaticum</i>
10. <i>Adenium obesum</i>	12. <i>Catharanthus roseus</i>	13. <i>Holarrhena antidysenterica</i>	14. <i>Rauwolfia serpentina</i>	15. <i>Tabernaemontana Divaricate</i>
16. <i>Thevetia peruviana</i>	17. <i>Calotropis procera</i>	18. <i>Eclipta alba</i>	19. <i>Parthenium hysterophorus</i>	20. <i>Tridax procumbens</i>
21. <i>Xanthium strumarium</i>	22. <i>Averrhoa carambola</i>	23. <i>Campsis grandiflora</i>	24. <i>Bixa orellana</i>	25. <i>Bombax ceiba</i>

26. <i>Heliotropium indicum</i>	27. <i>Bauhinia acuminata</i>	28. <i>Cassia fistula</i>	29. <i>Cassia siamea</i>	30. <i>Delonix regia</i>
31. <i>Saraca indica</i>	32. <i>Millettia peguensis</i>	33. <i>Cleome rutidosperma</i>	34. <i>Quisqualis indica</i>	35. <i>Argyrea nervosa</i>
36. <i>Evolvulus nummularis</i>	37. <i>Ipomoea aquatica</i>	38. <i>Ipomoea carnea</i>	39. <i>Merremia vitifolia</i>	40. <i>Costus speciosus</i>
41. <i>Acalypha indica</i>	42. <i>Bridelia tomentosa</i>	43. <i>Croton tiglium</i>	44. <i>Euphorbia milii</i>	45. <i>Jatropha podagrica</i>
46. <i>Pedilanthus tithymaloides</i>	47. <i>Ricinus communis</i>	48. <i>Anisomeles indica</i>	49. <i>Hyptis suaveolens</i>	50. <i>Ocimum sanctum</i>
51. <i>Barringtonia acutangula</i>	52. <i>Asparagus racemosus</i>	53. <i>Lagerstromea speciosa</i>	54. <i>Michelia champaca</i>	55. <i>Hibiscus rosa-Sinensis</i>
56. <i>Albizzia lebbek</i>	57. <i>Calliandra umbrosa</i>	58. <i>Moringa oleifera</i>	59. <i>Callistemon citrinus</i>	60. <i>Psidium guajava</i>
61. <i>Boerhaavia diffusa</i>	62. <i>Oxalis corniculata</i>	63. <i>Argemone mexicana</i>	64. <i>Abrus precatorius</i>	65. <i>Butea monosperma</i>
66. <i>Clitoria ternatea</i>	67. <i>Crotalaria retusa</i>	68. <i>Erythrina indica</i>	69. <i>Pongamia pinnata</i>	70. <i>Sesbania sesban</i>
71. <i>Tephrosia purpurea</i>	72. <i>Caricca papaya</i>	73. <i>Sporobolus diander</i>	74. <i>Antigonon leptopus</i>	75. <i>Ixora coccinea</i>
76. <i>Hemelia patens</i>	77. <i>Mitragyna parviflora</i>	78. <i>Morinda tinctoria</i>	79. <i>Oldenlandia corymbosa</i>	80. <i>Murraya paniculata</i>
81. <i>Lindernia ciliata</i>	82. <i>Mazus rugosus</i>	83. <i>Scoparia dulcis</i>	84. <i>Cestrum diurnum</i>	85. <i>Petunia hybrida</i>
86. <i>Physalis minima</i>	87. <i>Solanum diphyllum</i>	88. <i>Solanum macranthum</i>	89. <i>Solanum nigrum</i>	90. <i>Solanum Xanthocarpum</i>
91. <i>Helicteres isora</i>	92. <i>kleinhovia hospita</i>	93. <i>Grewia asiatica</i>	94. <i>Corchorus aestuans</i>	95. <i>Clerodendrum Indicum</i>
96. <i>Clerodendrum inerme</i>	97. <i>Clerodendrum splendens</i>	98. <i>Lantana camara</i>	99. <i>Petrea volubilis</i>	100. <i>Vitex negundo</i>
101. <i>Alpinia zerumbet</i>				

Though Papilionoideae, Caesalpinoideae, Mimosoideae are subfamily of Leguminosae, polar view of Papilionoideae pollen shows Triangular-obtuse-convex type and in Caesalpinoideae Circular to Triangular-obtuse-convex type. However Mimosoideae pollens are in forms of polyad. Pollinia found in Asclepiadaceae.

In conclusion, the pollen grains of 101 angiospermic plants reflect a great variety of morphological characters, such as aperture condition, size variation and exine patterns. This pollen atlas along with the index key has helped in the aeropalynological investigation, i.e. trapping of airborne pollen

and their identification. Identification of airborne pollen grains is one of the major requirements for specifically naming the aeroallergen for which a sound knowledge in pollen morphology is necessary, otherwise it becomes difficult to make a comparative analysis in identification of pollen types at a lower taxonomical unit.

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