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A PALYNOLOGICAL STUDY OF SOME CULTIVATED TREES FROM KARACHI

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Abstract

The pollen morphology of 25 species belonging to 23 genera distributed in 13 families have been examined by light microscopy and scanning electron microscope. Generally pollen grains occur singly and rarely in polyads. Pollen grains generally 3-colporate in families viz., Bignoniaceae, Myrtaceae, Mimosaceae, Anacardiaceae, Apocynaceae, Caesalpiniaceae, Caricaceae, Moringaceae, Rhamnaceae and Sapotaceae. However, in Bignoniaceae and Myrtaceae both colporate and colpate types of pollen grains are found. In the family Malvaceae pantoporate pollen grains are found. The shapes of pollen grains are also different. Generally pollen grains are sub-prolate, prolate and prolate-spheroidal, rarely oblate and spheroidal. Tectum generally reticulate or rugulate in addition to this scabrate and echinate.

Introduction

Palynology is the study of pollen and spores. The term palynology was first proposed by Hyde & William (1945). Palynological studies are not only helpful in solving many taxanomic problems but it also play an important role in daily life, for instance aeropalynology is the study of palynology in relation to airborne pollen grains and spores which are the main source of different types of allergies like asthma and hay fever. It is also useful in Melissopalynology with its use in honey study. It also gives evolutionary mechanism of different type of corolla. The morphological studies of the pollen is very important. It is also applicable in genetic study, forensic science in tracing history of vegetation, which consist of individual species, community and climate change study. It is also applicable in gas, coal and oil industries. Apart from this it is also used in the field of agriculture, forestry, arechaeology and plant geography. There are some reports available on pollen morphology of some of dicots families from various parts of the world. Different families have been studied by different workers such as Apocynaceae has been studied by Schill & Leuenberger (1972) and van Campo *et al*., (1979). The families Caesalpiniaceae and Mimosaceae have been studied by Ferguson (1981), Graham & Barker (1981), Guinet (1981), Ferguson & Pear (1984), Lock (1988) and (Perveen & Qaiser, 1998a,b). Pollen morphology of Malvaceae has been studied by Christensen (1986), Culhane & Blackmore (1988), Perveen *et al*., (1994). Palynology of family Sapotaceae has been studied by Harley (1991). Pollen of families i.e., Anacardiaceae, Bignoniaceae, Caricaceae, Meliaceae, Moringaceae, Myrtaceae, Rhamnaceae and Zygophyllaceae have been studied by Erdtman (1952). The present report gives an account of pollen morphology of 25 tree species growing in Karachi University Campus.

Material and Methods

Freshly polleniferous material of 25 species were collected mostly from Karachi. The list of voucher specimens is deposited in KUH. The pollen grains were prepared for light (LM) and scanning microscopy (SEM) by the standard method, described by Erdtman (1952). For light microscopy, the pollen grains were mounted in unstained glycerin jelly and observations were made with a Nikon Type-2 microscope, under (E40, 0.65) and oil immersion (E100, 1.25), using 10 x eyepiece. For SEM studies, pollen grains suspended in a drop of water were directly transferred with a fine pipette to a metallic stub using double sided cellotape and coated with gold in a sputtering chamber (Ion sputter JFC-1100). Coating was restricted to 150A. The S.E.M examination was carried out on a Jeol microscope JSM-T200. The measurements are based on 15-20 readings from each specimen. Polar length, equatorial diameter, colpi length, pore diameter and exine thickness were measured.

The terminology used is in accordance with Erdtman (1952); Faegri & Iversen (1964); Kremp (1965) and Walker & Doyle (1976).

General characters of pollen grains

Pollen grains generally radially symmetrical isopolar rarely a polar, usually free often united in polyads. Tricolporats rarely tricolpate, occasionally porate. Tectum various type, from psilate spinulose. However, reticulate or reticulate-rugulate are more common tectum types. Shape class varies from oblate two prolate-spheroidal or sub-prolate-prolate, rarely spheroidal.

Observations and Results

Key to the families

1 + Single pollen grains ……..…..……..…….. 2
- Pollen grains in Polyads ……....…… Mimosaceae (p.p.)

2 + Pollen grains colpate, colporate ……..…..…… 3
- Pollen grains porate ……..…..…… Malvaceae

3 + Pollen grains colpate ……....……...…….…… 4
- Pollen grains colporate ……....……. 6

4 + Polar length 10-14.5 µm ……...…..…..…… Zygophyllaceae
- Polar length 14.7-25.2 µm ……..……...…… 5

5 + Colpi length 14.7-16.8 µm ……...…… Bignoniaceae (p.p.)
- Colpi length 0.1(2.78)1.5µm ……....…… Myrtaceae (p.p.)

6 + Pollen grains prolate-spheroidal ..…….…….…….. 7
- Pollen grains oblate, prolate, sub prolate, spheroidal ……..……..... 9

7 + Tectum psilate ……..…….…… Sapotaceae

- Tectum reticulate-striate ...……..……... 8

8 + Tectum reticulate ……..……..…… Meliaceae
- Tectum striate …….……..……... Anacardiaceae

9 + Polar length 6.4-14.7µm …….....… Apocynaceae and Myrtaceae (p.p)
- Polar length more than 14.7 µm …….…….……Caesalpiniaceae
Moringaceae,
Caricaceae.
Bignoniaceae (p.p)
Mimosaceae (p.p)
Rhamnaceae

Anacardiaceae

***Mangifera indica* L.**

P/E ratio: 1.14
Size: Polar axis P 21(26.25)33.6 µm and equatorial diameter E 21(22.89)27.3 µm

Prolate-spheroidal, tricolporate, trilobed colpi length 17.85 (19.0) 19.95 µm and breadth 8.4 (10.08), 9.10.5µm. Mesocolpium 16.8 (22.05) 29.4 µm. Apocolpium 9.45(11.97) 15.75µm. Exine 0.84 (1.029) 1.26µm thick. Sexine thicker than nexine. Tectum striate.

Apocynaceae

1. *Plumeria acutifolia* Poir.

P/E ratio: 1.53
Size: Polar axis P 8.4(10.29)14.7µm and equatorial diameter 5.25(6.72)6.3µm.

Prolate, tricolporate provided with 2 pseudocolpi and one normal colpi length 6.3 (8.61) 18.5µm and breadth 2.1 (2.52) 4.2 µm. Mesocolpium 6.3 (9.03) 12.6 µm. Apocolpium 5.25 (5.355) 6.3 µm. Exine 1.05 (1.89) 2.1µm thick. Sexine as thick as nexine. Tectum sub-psilate.

Bignoniaceae

1. *Millingtonia hortensis* L. f. (Fig. 1 A, B)

P/E ratio: 1.12
Size: Polar axis P 25.2 (28.56) 29.4µm and equatorial diameter E 22.05 (25.41) 27.3µm.

Prolate-spheroidal, tricolporate, Triangular, obtuse, colpi 14.7(16.59)16.8µm long and 3.15(4.2)5.25 wide. Mesocolpium 18.9 (20.58) 21µm. Apocolpium 23.1 (25.305) 26.25 µm. Exine 0.63(1.638) 2.1µm thick. Sexine thicker than nexine. Tectum reticulate .

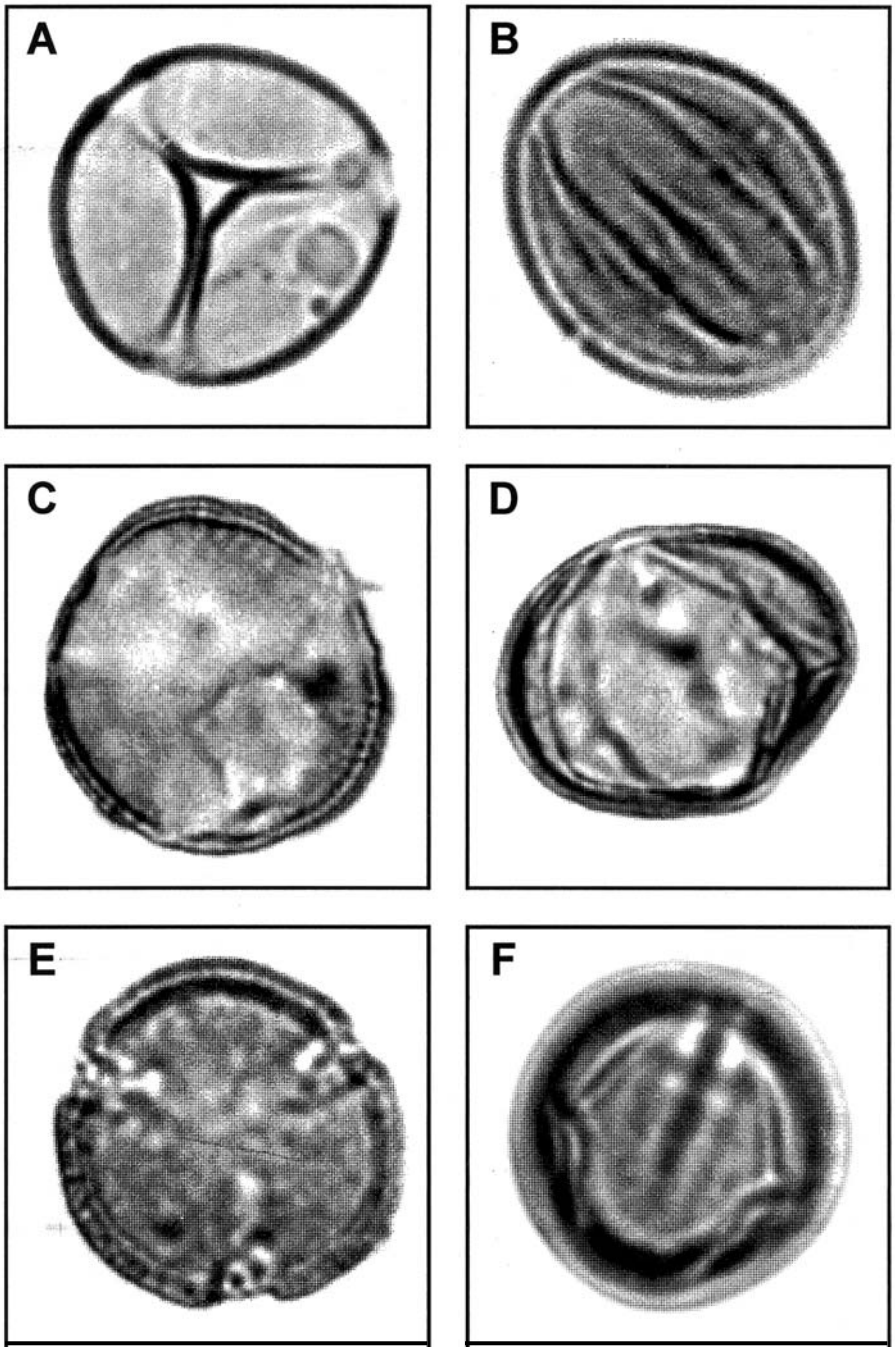

Fig. 1. Light micrographs (LM) *Millingonia hortensis*: A- Polar view, B- Equatorial view; *Tecomella undulata*: C- Polar view, D- Equatorial view; *Carica papaya*: E- Polar view, F- Equatorial view.

2. *Tecomella undulata* (Roxb.) Seeman. (Fig. 1C, D)

P/E Ratio: 1.27
Size: Polar axis P 25.2 (27.3) 29.4 µm and equatorial diameter 18.9 (21.42) 25.2µm.

Sub-prolate, tricolporate, trilobed, colpi length 16.8 (18.9) 18.9µm and breadth 8.4 (10.5) 12.6 µm. Mesocolpium 2.1 (4.2) 6.3 µm. Apocolpium 21 (23.142) 25.2µm. Exine 2.1 (2.625) 3.99 µm thick. Sexine is thicker than nexine. Tectum reticulate.

Key to the species of Bignoniaceae

1 + Sub-prolate, 3-colpate …..……..……..… *Tecomella undulata*

\- Prolate – spheroidal, tri-colporate ..……. *Millingtonia hortensis*

Caesalpiniaceae

1. *Caesalpinia pulcherrima* L. (Fig. 3A, B)

P/E ratio: 1.35
Size: Polar axis P 58.8 (63.84) 67.2 µm and equatorial diameter E 37.8 (47.25) 63µm

Prolate, tricolporate, triangular, colpi 39.9 (45.78) 52.5µm length and 14.7 (20.58) 25.2µm width, colpal membrane reticulate, ora La. Longate. Mesocolpium 23.1(29.61) 33.6µm. Apocolpium 54.6 (58.59) 63µm. Exine 2.1(2.31) 3.15µm thick. Sexine thicker than nexine. Tectum reticulate-rugulate.

2. *Cassia fistula* L.

P/E ratio: 1.18
Size: Polar axis P 25.2 (27.3) 29.4µm and equatorial diameter 18.9 (23.1) 25.2 µm.

Sub-prolate, tricolporate, non-angular, colpi length 21 (23.1) 25.2 µm and breadth 12.6 (12.81) 14.7 µm. Mesocolpium 1.89 (4.2) 5.25 µm. Apocolpium 8.4 (9.24) 10.5µm. Exine 1.05(2.1) 2.1µm thick. Sexine thicker than nexine. Tectum reticulate-rugulate.

3. *Cassia javanica* L.

P/E ratio: 1.33
Size: Polar axis P 23.1(25.83) 27.3µm and equatorial diameter 17.85(19.32)21 µm

Prolate, tricolporate, triangular, colpi length 10.5(12.18) 14.7 µm and width 2.1(2.877) 3.99 µm, ora la longate. Mesocolpium 2.73 (3.78) 4.2 µm. Apocolpium 18.9 (21.63) 23.1 µm. Exine 2.1(2.31)3.15µm thick. Sexine as thicker as nexine. Tectum reticulate-rugulate.

4. *Cassia siamea* Lamk. (Fig. 2E, F)

P/E ratio: 1.25
Size: Polar axis P 29.4(31.71) 33.705 µm and equatorial diameter E. 23.1(25.2)27.3µm. Sub-prolate,tricolporate, triangular convex colpi length 23.1(25.2)27.3 µm and breadth 10.5 (12.39) 13.65µm mesocolpium, 16.8 (18.585) 21µm. Apocolpium 25.2(27.09)29.4 µm. Sexine thinner than nexine. Tectum reticulate-rugulate.

5. *Delonix regia* (Bojer) Rafin. (Fig. 2A, B)

P/E ratio: 1.26
Size: Polar axis P 16.8(19.95) 21µm and equatorial diameter 12.6(15.75) 16.8 µm

Sub-prolate, tricolporate, triangular colpi length 6.3(9.45) 10.5µm and breadth 2.1 (4.935) 6.3 µm, ora la longate. Mesocolpium 12.6 (16.38) 18.9 µm. Apocolpium 14.7 (17.85) 18.9 µm. Sexine thicker than nexine. Tectum reticulate-rugulate.

6. *Parkinsonia aculeata* L. (Fig. 2C, D; Fig. 3C, D)

P/E ratio: 1.21
Size: Polar axis P 18.9 (19.95) 21 µm and equatorial diameter 13.65 (16.38) 17.85 µm.

Sub-prolate, tricolporate, Non-angular, costae, colpi, length 16.8 (18.375) 19.95 µm and breadth 8.4 (9.45) 10.5µm, la longate. Mesocolpium 12.6 (13.44) 14.7 µm. Apocolpium 14.7 (17.01) 18.9µm. Exine 1.05 (2.1) 2.1 µm thick. Sexine thicker than nexine. Tectum medium reticulate.

7. *Peltophorum roxburghii* (G.Don) Degener.

P/E ratio: 1.28
Size: Polar axis P 44.1 (58.59) 63 µm and equatorial diameter E. 37.8(45.57) 56.7 µm.

Sub-prolate, tricolporate, non-angular circular, colpi length 8.4(13.65) 16.8µm and breadth 6.3(9.24) 12.6µm. Mesocolpium 25.2(36.33) 42 µm. Apocolpium 39.9 (53.97) 58.8µm. Exine 2.1 (2.394) 2.94 µm thick. Sexine thicker than nexine. Tectum coarsely reticulate.

8. *Tamarindus indica* Linn.

P/E ratio: 1.17
Size: Polar axis P 27.3(34.65)35.7µm and equatorial diameter E 23.1(29.61)31.5µm.

Sub-prolate, tricolporate, non-angular circular, colpi length 18.9(20.58)21µm and breadth 5.25(6.51)8.4µm. Mesocolpium 12.6(19.74)21µm. Apocolpium 29.4 (30.87) 33.6 µm. Exine 2.1 (2.52) 3.15 µm thick. Sexine thicker than nexine. Tectum striate–reticulate.

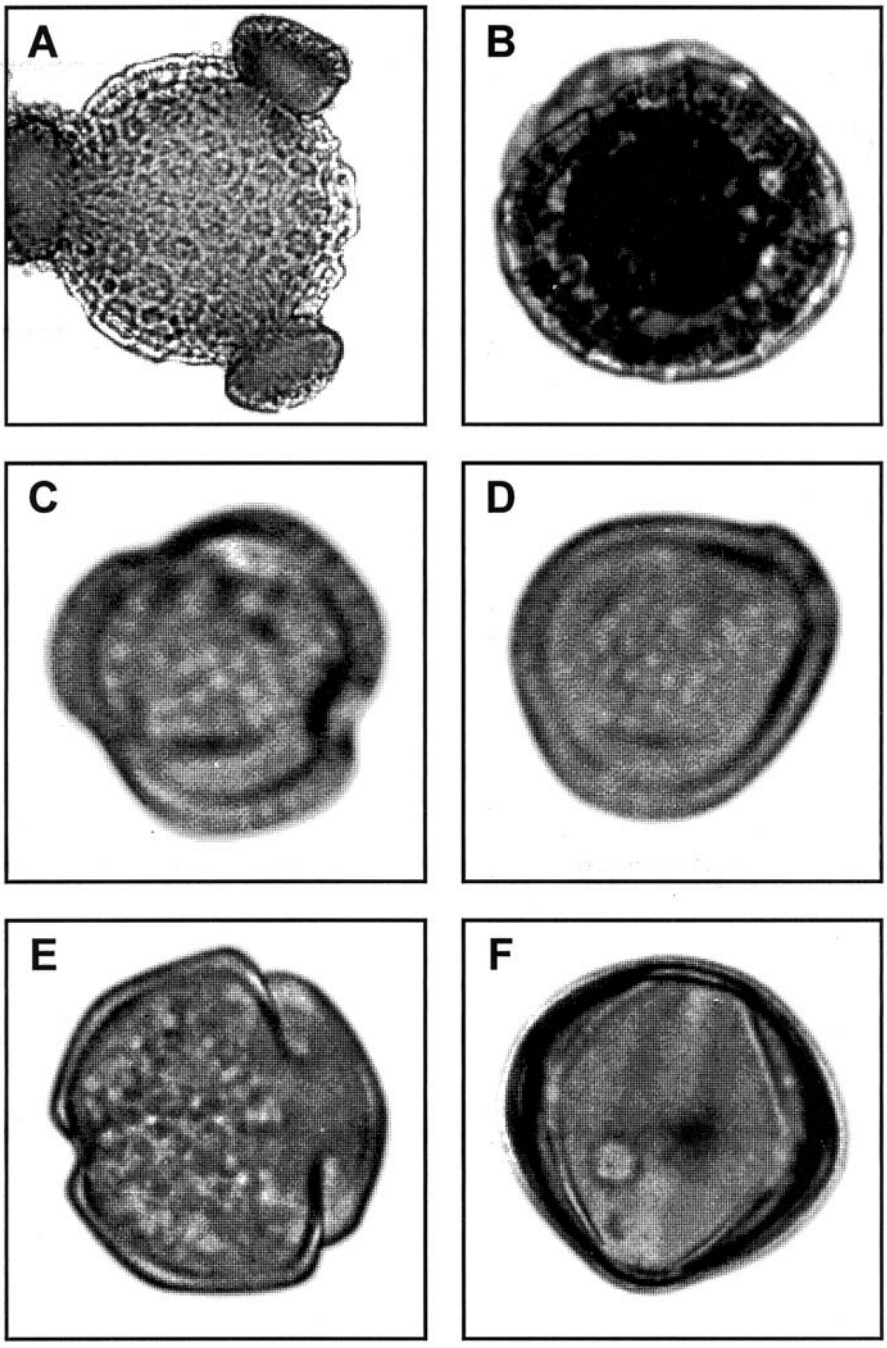

Fig. 2. Light micrographs (LM) *Delonix regia*: A- Polar view, B- Equatorial view; *Parkinsonia aculeata*: C- Polar view, D- Equatorial view; *Cassia siamea*: E- Polar view, F- Equatorial view.

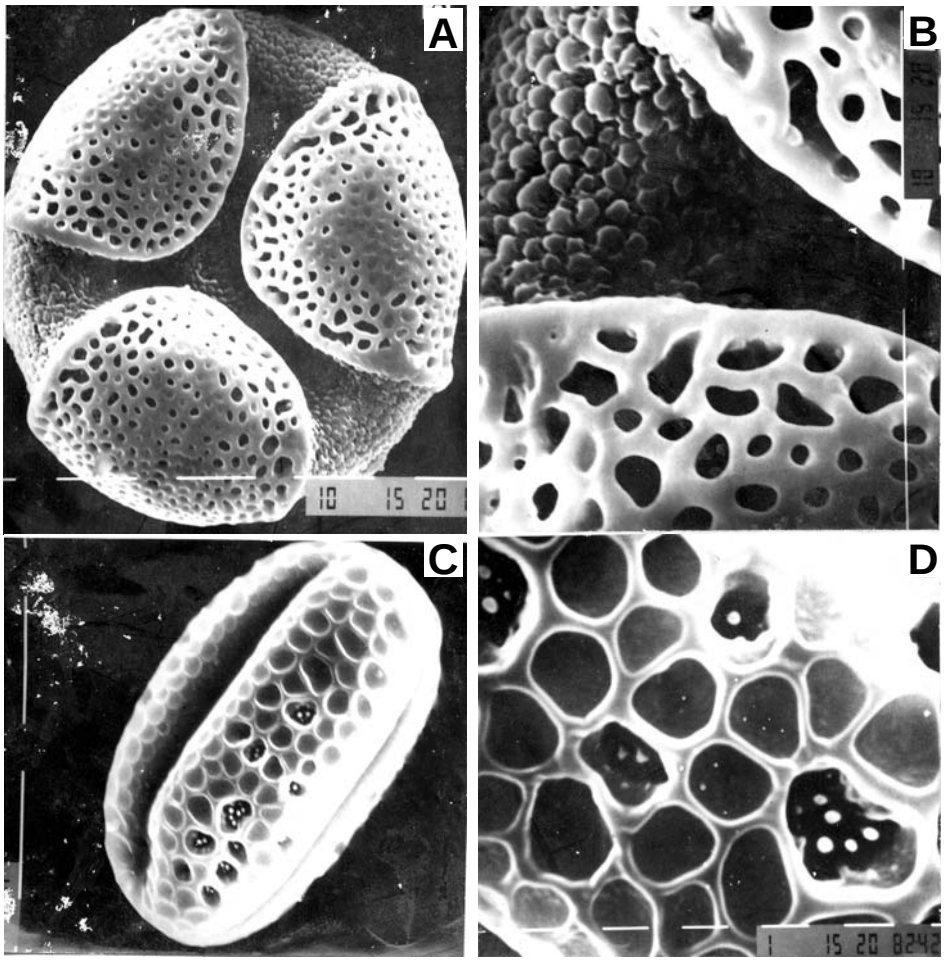

Fig. 3. Scanning micrographs *Caesalpinia pualcherima*: A- Equatorial view, B- Exine pattern; *Parkinsonia aculeata*: C- Equatorial view, D- Exine pattern.
Scale bar A, C= 10 µm; Scale bar B, D= 1 µm.

Key to the species

1 + Prolate ……..…….. 2
- Sub-prolate ……..…….…… 3

2 + Sexine as thick as nexine ……...……..…….. *Cassia javanica*
- Sexine is thicker than nexine ……..…… *Caesalpinia pulcherrima*

3 + Concave in polar view ……..…… 4
- Convex in polar view ……..…….. *Cassia siamea*

4 + Mesocolpium 25.1-42 µm ……..……..…… *Peltophorum roxburghii*
- Mesocolpium 12.6-18.9µm ……..……. 5

5 + Colpi 6.3-10.5µm ……..…… *Delonix regia*
- Colpi 21-25.2µm ……..……..…… 6

6 + Apocolpium 8.4-10.5µm ……..……. *Cassia fistula*
- Apocolpium 29.4-33.6µm ……..……...…… 7

7 + Tectum striate–reticulate ……..……..…….. *Tamarindus indica*
- Tectum medium–reticulate ……..…..…… *Parkinsonia aculeata*

Caricaceae

Carica papaya L. (Fig. 1E, F)

P/E ratio: 1.67
Size: Polar axis P 12.6(15.435)18.9µm and equatorial diameter E 7.35(9.24)12.6µm.

Prolate, 3-colporate triangular colpi length 10.5(12.39)14.7µm and breadth 2.1(4.2)7.35µm. Mesocolpium 8.4(11.235)14.7µm. Apocolpium 6.3(7.35)9.45µm. Exine 0.525(0.63)1.05µm thick. Sexine is thicker than nexine.

Malvaceae

Thespesia populnea (Roxb.) Kostel.

P/E ratio: 1.02
Size: Polar axis P 67.2(73.5)79.8µm and equatorial diameter E 65.1(71.925)75.6µm.

Prolate-spheroidal, pantoporate, echinate, pore size 8.4(9.24)12.6 µm. Mesoporium 3.36(4.158)4.2 µm. Apoporium 31.5(34.65)36.75 µm. Spine length about 6.93(7.98) 8.4 µm. Exine 3.57 (3.88) 4.2 µm thick. Sexine as thick as nexine. Tectum echinate (Fig. 7).

Meliaceae

Azadirachta indica (L.) A. Juss.

P/E ratio: 1.00
Size: Polar axis P 33.6 (41.37) 44.1 µm and equatorial diameter E 33.6 (41.16) 44.1µm.

Prolate-spheroidal, 3,4-colporate, ora distinct, circular-lalongate, ends of colpi not well-defined. Sexine thinner than nexine. Tectum reticulate.

Mimosaceae

1. *Albizia lebbeck* (L.) Benth.

P/E ratio: 1.072
Size: Polyads 14 celled, bilateral, flattened length about 7.77 (79.59) 80.85 µm and breadth 71.4 (74.235) 76.65 µm, polyad length 21 (23.31) 25.2 µm and breadth 16.8 (19.005) 19.95 µm. Sexine thicker than nexine. Exine 2.1 (2.604) 3.99 µm thick. Tectum sub-psilate.

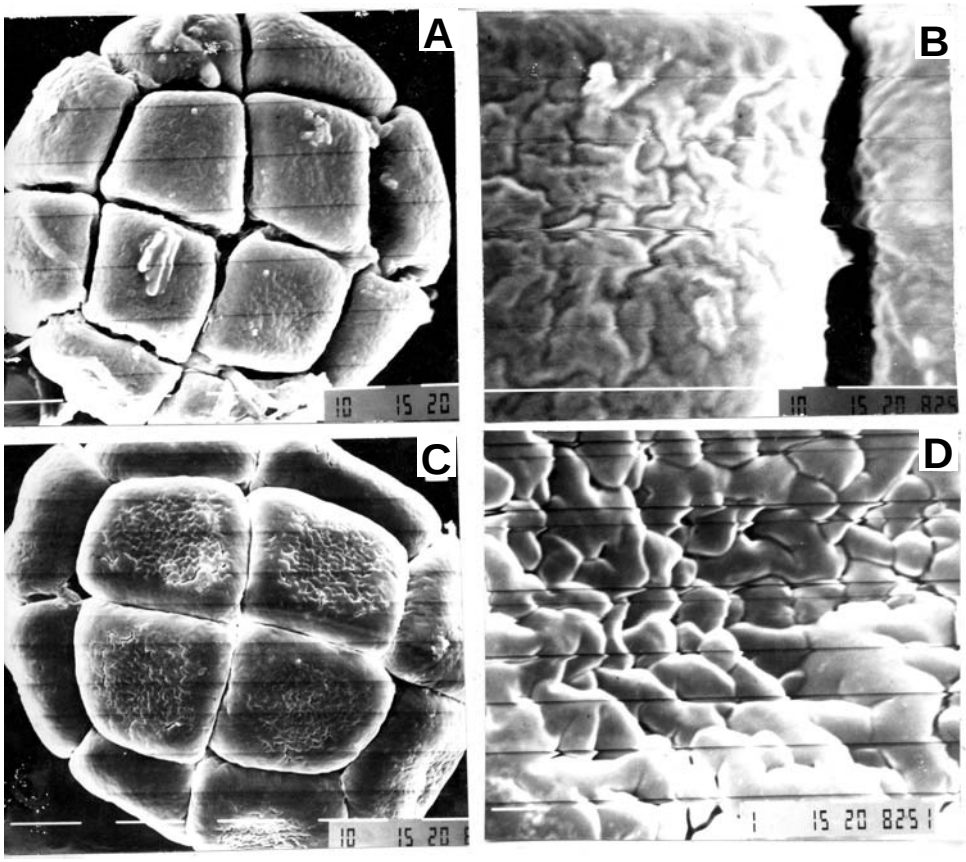

Fig. 4. Scanning micrographs *Albizzia lebbexk*: A- Polyods, B- Exine pattern; *Pithecellobium dulce*: C- Polyads, D- Exine pattern.
Scale bar A, B, C= 10 µm; Scale bar D= 1 µm.

2. *Leucaena leucocephala* (Lam.) De Wit.

P/E Ratio: 1.34
Size: Polar axis P 39.9 (42.42) 46.2 µm and equatorial diameter E 29.4 (31.5) 33.6 µm.

Prolate, tricolporate, non-angular, colpi length 15.75 (17.01) 18.9 µm and breadth 7.35 (8.61) 10.5 µm. Mesocolpium 22.05 (23.31) 26.25 µm. Apocolpium 35.7 (39.48) 49.95 µm. Exine 2.1 (2.373) 3.15 µm thick. Sexine thicker than nexine. Tectum sub-psilate.

3. *Pithecellobium dulce* (Roxb.) Benth.

P/E Ratio: 1.16
Size: Polyads 12 celled, bilateral, flattened, longest diameter about 73.5 (74.55) 77.7 µm and breadth 63 (64.05) 65.1 µm. Polyad length 21 (21.21) 22.05 µm and breadth 16.8 (15.96) 19.95 µm. Sexine thicker than nexine. Tectum sub-psilate.

Key to the species of Mimosaceae

1 + Pollen grains polyads ……..……..…… 2
- Pollen grains free ……..…. *Leucaena leucocephala*

2 + Polyads 14 celled ……..……... *Albizia lebbeck*
- Polyads 12 celled ……..……..… *Pithecellobium dulce*

Moringaceae

Moringa oleifera Lam.

P/E ratio: 01
Size: Polar axis P 23.1(23.73)27.3µm and equatorial diameter E 22.05(23.52)27.3µm.

Spheroidal, tricolporate, trilobed, colpi length 21(21.63) 25.2µm and breadth 12.6(13.02)14.7µm. Mesocolpium 14.7(15.12)16.8µm. Apocolpium 10.5 (11.76) 13.65 µm. Exine 2.7 (2.226) 3.024 µm thick. Sexine as thick as nexine ora slightly lalongate. Tectum reticulate.

Myrtaceae

1. *Callistemon citrinus* Curt.

P/E Ratio: 1.31
Size: Polar axis P 14.7 (16.59) 16.8 µm and equatorial diameter 11.5 (12.6) 13.86 µm.

Sub-prolate, 3-colpate, syncolpate, triangular, colpi 5.25 (6.3) 7.35 µm long and 2.1 (2.415) 3.15 µm width, polar areas slightly depressed. Mesocolpium 9.45 (10.5) 11.55 µm. Apocolpium 13.65 (14.385) 14.7µm. Exine 2.1(2.268) 2.94µm thick. Sexine as thicker as nexine ora lalongate, narrow. Tectum scabrate.

2. *Eucalyptus globulus* Parker.

P/E Ratio: 0.73
Size: Polar axis P 13.65 (14.59) 14.7 µm and equatorial diameter E 17.85(19.74) 22.05µm.

Oblate, tricolporate and 4-colporate or parasyncolpate, colpi 4.2 (6.3) 8.4 µm long and 1.89 (2.079) 2.11 µm width, polar area slightly depressed. Mesocolpium 6.3 (6.615) 8.4µm. Apocolpium 7.14 (7.35) 7.56µm. Exine 1(2.331) 3.36 µm thick. Tectum scabrate.
3. *Psidium guajava* L.

P/E Ratio: 1.16
Size: Polar axis P 12.6 (154.35)17.85 µm and equatorial diameter E 11.55(132.3) 14.7µm.

Sub-prolate, tricolporate, triangular straight, syncolpate, colpi length 2.1(2.7825)3.15µm and breadth 1.05(1.6275)2.1µm. Mesocolpium 11.55 (12.495) 13.65µm. Apocolpium 6.3 (7.644) 9.45µm. Exine 0.84 (1.68) 2.1 µm thick. Ora with a costa. Tectum scabrate (Fig. 9).

Key to the species

1 + Oblate, 3-4 colporate ..…….……. *Eucalyptus globulus*
- Sub-prolate, 3-colporate ……...…….…… 2

2 + Mesocolpium 9.45 -11.55µm ……..…….. *Callistemon citrinus*
- Mesocolpium 11.55-13.65µm …..…….……..……. *Psidium guajava*

Rhamnaceae

Ziziphus nummularia (Burm.f.) Wight & Arn.

P/E Ratio: 01
Size: Polar axis P 18.9 (23.94) 25.2 µm and equatorial diameter E 18.9 (23.94) 25.2 µm.

Spheroidal, tricolporate, triangular and non-angular, colpi length 8.4 (10.5) 11.55µm and breadth 3.15 (6.09) 7.35µm. Mesocolpium 14.7(19.74) 21µm. Apocolpium 9.45 (11.13) 11.55µm. Exine 0.63 (1.05) 1.47µm thick. Sexine is thicker than nexine. Tectum striate-rugulate.

Sapotaceae

Manilkara zapota L.

P/E ratio: 1.02
Size: Polar axis P 29.4 (33.49) 38.5 µm and equatorial diameter E 29.4(32.55) 37.8 µm.

Prolate-spheroidal, tricolporate, Non-angular, elliptic, colpi length 21(25.2)27.3 µm and breadth 8.4 (10.71) 12.6µm. Mesocolpium 21(24.78) 31.5µm. Apocolpium 12.6(15.345) 19.95µm. Exine 2.1(2.205)3.15µm thick. Sexine as thick as nexine, Tectum psilate.

Zygophyllaceae

1. *Guaiacum officinale* L.

P/E ratio: 1.14
Size: Polar axis P 10 (26.25) 14.5µm and equatorial diameter E 18.9 (22.47) 25.2 µm.

Sub-prolate, 3-colpate, triangular, obtuse, colpi length 8.4(9.55) 10.5µm and breadth 2.1 (3.465) 4.2µm. Mesocolpium 14.7 (16.38) 16.8µm. Apocolpium 5(12.81) 13.65µm. Exine 2.1 (2.268) 3.15µm thick. Sexine is thicker than nexine. Tectum reticulate.

Discussion

Pollen grains are usually free rarely polyads in Mimosaceae (Perveen & Qaiser, 1998b). The shapes of pollen grains are mostly sub-prolate rarely oblate, tricolporate or colpate rarely porate. Tectum mostly reticulate rarely psilate often echinate or scabrate. The most striking difference found is in apertural types, on the basis of apertural types 4 distinct pollen types are recognized I: Non aperture –type, II: Colpate-type, III: Porate - type, and, IV: Colporate - type. Pollen type-I is easily recognized by its non-aperturate pollen. In this pollen type *Albizia lebbeck* and *Pithecellobium dulce* (Mimosaceae) are found. Both taxa have polyads. However Polyads are separated from each other on the basis of number of cells, such as *Pithecellobium dulce* has 12-celled while *Albizia lebbeck* has 14 celled polyads. Guinet (1981) also reported polyads in family Mimosaceae. Pollen type-II is easily delimited by its colpate pollen, four species are found viz., *Tecomella undulata* (Bignoniaceae), *Callistemon citrinus, Psidium guajava* (Myrtaceae) and *Guaiacum officinale* (Zygophyllaceae). These species are further separated on the basis of polar length, which ranges from 25-29 µm in *Tecomella undulata* whereas, in *Guaiacum officinale, Psidium guajava* and *Callistemon citrinus* pollen grains have 10-17 um in polar length. Pollen type-III: Porate is easily recognized by having porate pollen grains, one species is included in this type i.e., *Thespesia populnea* (Malvaceae). Pollen type-IV:Colporate type pollen is easily delimited by its colporate pollen grains. This type includes *Mangifera indica (*Anacardiaceae*), Plumeria acutifolia (*Apocynaceae*), Millingtonia hortensis* (Bignoniaceae), *Caesalpinia pulcherrima, Cassia fistula, Cassia javanica, Cassia siamea, Delonix regia, Parkinsonia aculeata, Peltophorum roxburghii, Tamarindus indica* (Caesalpiniaceae), *Carica papaya (*Caricaceae*), Azadirachta indica (*Meliaceae), *Moringa oleifera* (Moringaceae), *Eucalyptus globulus (*Myrtaceae), *Ziziphus nummularia (*Rhamnaceae), *Manilkara zapota* (Sapotaceae) and *Leucaena leucocephala* (Mimosaceae). Colporate pollen type is further separated into 4 sub-type on the basis of pollen shape i.e., sub-type-I: Prolate-spheroidal, sub-type-II: Prolate and sub-prolate, Sub-type-III: Spheroidal and sub-type-IV: Oblate. In sub-type-I pollen grains are prolate-spheroidal in shape, four species are included representing 4 families i.e *Mangifera indica* (Anacardiaceae), *Millingtonia hortensis* (Bignoniaceae) *Azadirachta indica* (Meliaceae), *Manilkara zapota* (Sapotaceae). In sub-type-II, Prolate and sub-prolate pollen grains are found this pollen type is distributed in 4 i.e., *Plumeria acutifolia* (Apocynaecae), *Caesalpinia pulcherrima, Cassia fistula, Cassia javanica, Cassia siamea, Delonix regia, Parkinsonia aculeata, Peltophorum roxburghii* and *Tamarindus indica* (Caesalpiniaceae) and *Carica papaya* (Caricaceae) *Leucaena leucocephala* (Mimosaceae) .In sub type -III: Pollen grains are Spheroidal in shape, 2 species are included in this subtype, distributed in 2 families i.e., *Moringa oleifera* (Moringaceae) and *Ziziphus nummularia* (Rhamnaceae). In sub-type-IV: Oblate pollen are found. Only a single species is found i.e.,*Eucalyptus globulus* (Myrtaceae).

In the present study the family Malvaceae is stenopalynous in nature (Erdtman, 1952). However, Mimosaceae, Myrtaceae, Bignoniaceae are eurypalynous families having more than one type of pollen. Similarly, exine ornamentation also reveals great variation such as reticulate tectum is found in families like Bignoniaceae, Meliaceae, Moringaceae and Zygophyllaceae (Qaiser & Perveen, 1997). In Caesalpiniaceae, reticulate- rugulate and striate reticulate tectum is found. Striate tectum is also found in Anacardiaceae and Sapotaceae. In Rhamnaceae finely striate-rugulate tectum is found. However, sub-psilate, scabrate and echinate tectum is found in Apocynaceae, Myrtaceae and Malvaceae respectively.

Palynology is significantly helpful at the generic and specific level.

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