POLLEN MORPHOLOGY OF TWENTY ONE SPECIES FOUND IN DEE DOTE AREA, PYIN OO LWIN TOWNSHIP, MANDALAY REGION

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Abstract

The pollen morphology on some families was distributed in Dee Dote Area, Pyin Oo Lwin Township in Mandalay Region was conducted. The plant specimens of 21 species belonging to 19 genera of 12 families had been collected, identified and classified. The pollen grains were prepared by the standard method described by Erdtman(1960). The studied species were one species of Hypoxidaceae, Papaveraceae, Zygophyllaceae, Passifloraceae, Onagraceae, Cleomaceae, Rubiaceae, Gentianaceae, Boraginaceae; two species of Convolvulaceae, Solanaceae and eight species of Malvaceae. The pollen units of twenty one species were monad and aperture types were found as colpate, porate and colporate. The present results showed that three groups of aperture position had been recognized as viz., sulcate, panto and zono. The only one specie was occurred as sulcate, five species were pantoaperturate and fifteen species were zonoaperturate. The shapes of pollen grains were spheroidal, oblate, suboblate to oblate-spheroidal, prolate, subprolate to prolate-spheroidal. The sculpture patterns were varied from psilate, granulate, striate, echinate, obscurely to distinctly reticulate. A pollen key had been prepared mainly on the basis of palynological data. The pollen characteristics are fundamental for taxonomic classification because the pollen grains present the shape, size, and ornamentation of the exine defined for each species, genus and family.

Keywords: Pollen Morphology, Dee Dote Area, families, pollen key

Introduction

Palynology is the study of spores and pollen grains. Spores and pollen grains have a number of morphological and ultrastructural features. These palynological features have provided a wealth of characters that have been important in inferring phylogenetic relationships of plants. In addition, the features of spores and pollen grains can often be used to identify a particular plant taxon. 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). The exine may be smooth or ornamented and this distinctive ornamentation permits 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 necessary 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.

The study area is located along the Dee Dote stream in Pyin Oo Lwin Township, Mandalay Region. It lies between North Latitudes of 21° 42' 30" and 21° 42' 45" and between East Longitudes of 95° 21' 20" and 95° 21' 35". The study area is a foothill of Shan Plateau and has a general elevation of between 100 meters and 300

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meters above the sea level. Mean average temperature of the study area is 19.4°C and it receives annual rainfall of 1421.17 mm (Source from Universal Transverse Mercator).

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).

The aim of the present work was to construct pollen key for the plant identification of the studied species and to evaluate the morphological difference systematically in pollen grains of collected flowering plants in the Dee Dote Area.

Materials and Methods

The specimens were collected from Dee Dote Area, Pyin Oo Lwin Township in Mandalay Region from March to August 2019. The specimens were identified by referring to Hooker (1879), Backer (1965) and Dassanayake (1998). Myanmar names of the collected species were referred to Hundley and Chit Ko Ko (1987), and Kress *et al.* (2003). Pollen samples were freshly collected from the anthers of blooming flowers and stored in glass vial with glacial acetic acid.

Pollen samples were acetolysed by the method of Erdtman (1960). The acetolysis solution was mixed using a measuring cylinder: 9 parts of glacial acetic acid and 1 part of concentrated sulphuric acid was added. Acetolysis mixture 1cc was poured into the test-tube containing the pollen samples and stirred with a glass rod. The test-tube was heated in a water-bath at 80°C for 15 minutes. The test-tube was allowed to cool, and the sample diluted with distilled water and centrifuged for 30 minutes at 3000 rpm. After centrifuging and decanting, a few drops of dilute glycerine jelly was added to the residue, then transferred and stored in air-tight glass vial. The mounted slides were observed under light microscope to study the pollen morphology. For each species more than 10 pollen grains were measured and recorded. The terminology used in the accordance with Erdtman (1971), Hoen (1999) and Hesse *et al.* (2009).

Results

The present study was carried out with 21 species belonging to 12 families which were systematically arranged into the classification system of APG IV (Byng *et al.* 2016). The genera and species under the families were also arranged by alphabetically as shown in Table 1.

Table 1. List of studied species collected from Dee Dote Area

Group	Order	Family	No.	Scientific name	Myanmar name
Monocots	Asperagales	Hypoxidaceae	1.	*Curculigo trichocarpa* (Wight) Bennett & Raizoda	Taw htan
Eudicots	Ranunculales	Papaveraceae	2.	*Argemone mexicana* L.	Khaya
	Zygophyllales	Zygophyllaceae	3.	*Tribulus terrestris* L.	Sule

	Malpighiales	Passifloraceae	4.	*Passiflora foetida* L.	Chin gya; Taw suka
	Myrtales	Onagraceae	5.	*Ludwigia octovalvis* (Jacq.) P.H. Raven	Lay nyin gyi
	Malvales	Malvaceae	6.	*Fioria vitifolia* (L.) Mattei	Thin paung
			7.	*Grewia abultilifolia* Vent ex Juss.	Tayaw ah
			8.	*G. asiatica* L.	Thayaw
			9.	*G. eriocarpa* Juss.	Unknown

Table 1. Continued

Group	Order	Family	No.	Scientific name	Myanmar name
Eudicots	Malvales	Malvaceae	10.	*Malachra capitata* (L.) L.	Sinma hmwe sok
			11.	*Melhania hamiltoniana* Wall.	Unknown
			12.	*Pavonia odorata* Willd.	Bala
			13.	*Waltheria indica* L.	Bauk phyu
	Brassicales	Cleomaceae	14.	*Cleome viscosa* L.	Gant galar
	Gentianales	Rubiaceae	15.	*Morinda tinctoria* var. *tomentosa* Hook.f.	Nibase
		Gentianaceae	16.	*Canscora diffusa* (Vahl) R. Br. ex Roem. & Schult	Kyauk pan
		Boraginaceae	17.	*Trichodesma indicum* (L.) Lehm.	Pan hmauk hkon
	Solanales	Convolvulaceae	18.	*Ipomoea hederifolia* L.	Myat lay ni
			19.	*Merremia vitifolia* (Burm. f.) Hallier f.	Sa pyit nwe
		Solanaceae	20.	*Physalis minima* L.	Bauk pin
			21.	*Solanum virginianum* L.	Myay boke hkayan

Description of Pollen Morphology

1. ***Curculigo trichocarpa*** (Wight) Bennett & Raizoda. India J. Forest. 4: 68. 1981. (Figure 1. A, B)

Hypoxis trichocarpa Wight, Icon. Pl. Ind. Orient. 6: t. 2045. 1853.

Monosulcate, oblate, small to medium, 22.5-25.0 × 40-45 µm in length and breadth; amb semicircular or boat-shaped; sulcate 1.25-2.50 × 35-40 µm in length and breadth; exine 1.25-2.50 µm thick, sexine as thick as nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 1.25-2.50 µm in width, the muri simplibaculate, about 1.25 µm wide.

2. ***Argemone mexicana*** L., Sp. Pl. 1:508-509. 1753. (Figure 2. A,B)

Tricolpate, subprolate, small to medium, 30.0-37.5 × 22.5-30.0 µm in length and breadth; amb rounded; colpi ¾ way up to the pole, 22.5-32.5 × 2.50-3.75 µm in length and breadth; exine 1.3-2.5 µm thick, sexine thicker than nexine; sculpturing obscurely reticulate.

3. ***Tribulus terrestris*** L., Sp. Pl. 1: 387. 1753. (Figure 3. A,B)

Polyporate (about 24), pantoporate, spheroidal, medium, 30-45 µm in diameter; amb circular; pori circular, 1.3-2.5 µm in diameter; interporal space 2.5-7.5 µm; exine 2.5-5.0 µm thick, sexine thicker than nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 2.5-7.5 µm in width, the muri simplibaculate, 1.25-2.50 µm wide

4. ***Passiflora foetida*** L., Sp. Pl. 2: 959. 1753. (Figure 4. A,B)

Tricolpate, oblate-spheroidal, large, 60.0-62.5 × 62.5-67.5 µm in length and breadth; amb rounded; colpi syncolpate; exine 2.5-3.8 µm thick, sexine as thick as nexine; sculpturing distinctly reticulate, the lumina heterobrochate, studded with small rods, 5.0-10.0 µm in width, the muri duplibaculate 1.3-2.5 µm wide.

5. ***Ludwigia octovalvis*** (Jacq.) P. H. Raven, Kew Bull. 15 (3): 476. 1962. (Figure 5. A,B)

Triporate, suboblate, small to medium, 25.0-32.5 × 37.5-42.5 µm in length and breadth; amb rounded triangular; pori circular, 10.0-12.5 µm in diameter; annulus present; exine 1.25-2.50 µm thick, sexine thicker than nexine; sculpturing granulate.

6. ***Fioria vitifolia*** (L.) Mattei, Bol. Ort. Bot. Palermo n. s. 2: 71. 1917. (Figure 6. A,B)

Polyporate (about 24), pantoporate, spheroidal, large, 87.5-95.0 µm in diameter; amb circular; pori circular, 3.8-5.0 µm in diameter, interporal space 15.0-22.5 µm; exine 5.0-7.5 µm thick, sexine thicker than nexine; sculpturing echinate, spines 12.5-15.0 µm in length, cylindrical, tips pointed, straight, basal cushion 3.8-5.0 µm in height, interspinal space 15.0-22.5 µm.

7. ***Grewia abultilifolia*** Vent ex Juss. Ann. Mus. Natl. Hist. Nat. 4: 92. 1804. (Figure 7. A,B)

Tricolporate, subprolate, medium to large, 52.5-57.5 × 40-50 µm in length and breadth; amb circular; colpi ¾ way up to the pole, 42.5-47.5 × 2.5-5.0 µm in length and breadth; pori circular, 10.0-12.5 µm in diameter; exine 1.25-2.50 µm thick, sexine as thick as nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 2.5-5.0 µm in width, the muri simplibaculate, about 1.25 µm wide.

8. ***Grewia asiatica*** L. Mant. Pl. 122. 1767. (Figure 8. A,B)

Tricolporate, prolate, medium to large, 50.0-57.5 × 35.0-42.5 µm in length and breadth; amb rounded triangular; colpi ¾ way up to the pole, 37.5-42.5 × 5.0-7.5 µm in length and breadth; pori lalongate, 6.3-7.5 × 7.5-10.0 µm in length and breadth; exine 2.50-3.75 µm thick, sexine as thick as nexine; sculpturing distinctly reticulate,

the lumina heterobrochate, 2.5-5.0 µm in width, the muri simplibaculate, about 1.25 µm wide

9. ***Grewia eriocarpa*** Juss., Ann. Mus. Natl. Nat. 4: 93. 1804. (Figure 9. A, B)

Tricolporate, subprolate, medium, 37.5-42.5 × 30-35 µm in length and breadth; amb rounded triangular; colpi longicolpate, 35-40 × 2.5-5.0 µm in length and breadth; pori circular 5.0-7.5 µm in diameter; exine 1.3-2.5 µm thick, sexine thicker than nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 2.50-3.75 µm in width, the muri simplibaculate, about 1.3 µm wide.

10. ***Malachra capitata*** (L.) L., Syst. Nat. ed. 12 2: 458. 1767. (Figure 10. A, B)

Sida capitata L., Sp. Pl. 2: 685-686. 1753.

Polyporate (about 72), pantoporate, spheroidal, very large, 112.5-125.5 µm in diameter; amb circular; pori circular, 2.5-3.8 µm in diameter, interporal space 7.5-12.5 µm; exine 5.0-7.5 µm thick, sexine thicker than nexine; sculpturing echinate, spines 15.0-17.5 µm in length, tips pointed, straight, basal cushion absent, interspinal space 7.5-12.5 µm.

11. ***Melhania hamiltoniana*** Wall. Pl. Asiat. Rar. 1: 69-70, pl. 77. 1830. (Figure 11. A, B)

Triporate, oblate-spheroidal, medium to large, 50.0-57.5 × 57.5-62.5 µm in length and breadth; amb circular; pori circular, 7.5-10.0 µm in diameter; exine 2.50-3.75 µm thick, sexine as thick as nexine; sculpturing echinate, spines 7.5-12.5 µm in length, tips pointed, straight, basal cushion absent, interspinal space 7.5-15.0 µm.

12. ***Pavonia odorata*** Willd., Sp. Pl. 3: 837. 1822. (Figure 12. A, B)

Polyporate (about 40), pantoporate, spheroidal, large to very large, 95.0-102.5 µm in diameter; amb circular; pori circular, 2.5-5.0 µm in diameter; interporal space 10.0-17.5 µm; exine 1.3-5.0 µm thick, sexine thicker than nexine; sculpturing echinate, spines 12.5-17.5 µm in length, basal cushion absent, tips pointed, straight, intespinal space, 5.0-15.0 µm.

13. ***Waltheria indica*** L., Sp. Pl. 2: 673. 1753. (Figure 13. A, B)

Pentacolporate, oblate-spheroidal, medium, 42.5-47.5 × 47.5-50.0 µm in length and breadth; amb circular; colpi ½ way up to the pole, 20-25 × 5-10 µm in length and breadth; pori lolongate, 7.5-8.8 × 3.8-5.0 µm in length and breadth; exine 2.5-3.8 µm thick, sexine as thick as nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 1.25-2.50 µm in width, the muri simplibaculate, about 1.25 µm wide.

14. ***Cleome viscosa*** L. Sp. Pl. 2: 672. 1753. (Figure 14. A, B)

Tricolporate, subprolate, small to medium, 27.5-30.0 × 22.5-25.0 µm in length and breadth; amb triangular; colpi longicolpate, 25.0-27.5 × 2.5-5.0 µm in length and breadth; pori lalongate 6.25-7.50 × 7.5-10.0 µm in length and breadth; exine 1.3-2.5 µm thick, sexine thicker than nexine; sculpturing obscurely reticulate.

15. ***Morinda tinctoria*** var. ***tomentosa*** Hook. f., Fl. Brit. India. 3: 156.1880.(Figure 15. A, B)

Tricolporate, subprolate, medium, 37.5-47.5 × 35.0-37.0 µm in length and breadth; amb rounded-triangular; colpi longicolpate, 32.5-42.5 × 7.5-10.0 µm in length and breadth; pori circular, 2.5-7.5 µm in diameter; exine 2.50-3.75 µm thick, sexine thicker than nexine; sculpturing distinctly reticulate, the lumina heterobrochate, 1.3-2.5 µm in width, the muri simplibaculate, about 1.3 µm wide.

16. ***Canscora diffusa*** (Vahl) R. Br. ex Roem. & Schult. Syst. veg. (ed. 15 bis) 3: 301. 1818 (Figure 16. A, B)

Tricolporate, prolate, small, 22.5-25.0 × 15.0-17.5 µm in length and breadth; amb rounded triangular; colpi longicolpate, 20.0-22.5 × 1.3-2.5 µm in

length and breadth; pori circular, 2.5-5.0 µm in diameter; exine 1.3-2.5 µm thick, sexine as thick as nexine; sculpturing striate.

17. ***Trichodesma indicum*** (L.) Lehm., Pl. Asperif. Nucif. 193. 1818. (Figure 17. A, B)

Borago indica L., Sp. Pl. 1: 137. 1753

Tricolporate, subprolate, small, 22.5-25.0 × 17.5 - 20.0 µm in length and breadth; amb rounded triangular; colpi longicolpate, 20.0- 22.5 × 2.5-5.0 µm in length and breadth; pori lolongate, 6.25-7.50 × 3.8-5.0 µm in length and breadth; exine 1.25-2.50 µm thick, sexine thicker than nexine; sculpturing obscurely reticulate.

18. ***Ipomoea hederifolia*** L. Syst. Nat. ed. 10: 925. 1759. (Figure 18. A, B)

Polyporate, (about 40), pantoporate, spheroidal, large to very large, 92.5-110.0 µm in diameter, amb circular; pori circular, 2.50-6.25 µm in diameter; interporal space 7.5-12.5µm; exine 5.0-7.5 µm thick; sexine as thick as nexine; sculpturing echinate; spines 7.5-12.5 µm in length, straight; basal cushion 3.75-5.00 µm in height, interspinal space

5.0-12.5 µm.

19. ***Merremia vitifolia*** (Burm. f.) Hallier f. Bot. Jahrb. Syst. 16 (4-5): 552. 1893. (Figure 19.A, B)

Pentacolpate, suboblate, medium to large, 50-55 × 65-70 µm in length and breadth; amb circular; colpi longicolpate, 45-50 × 7.5-12.5 µm in length and breadth; exine 2.50-3.75 µm thick, sexine thinner than nexine; sculpturing striato-reticulate, the lumina heterobrochate, 1.25-2.50 µm in width, the muri simplibaculate, about 1.3 µm wide.

20. ***Physalis minima*** L., Sp. Pl. 1: 183-184. 1753 (Figure 20. A, B)

Tricolporate, suboblate, small to medium, 25.0-27.5 × 30-35 µm in length and breadth; amb rounded triangular; colpi longicolpate 20.0-22.5 × 2.50-3.75 µm in length and breadth; pori circular 7.5-10.0 µm in diameter; exine 1.3-2.5 µm thick, sexine thicker than nexine; sculpturing psilate.

21. ***Solanum virginianum*** L., Sp. Pl. 1: 187. 1753. (Figure 21. A, B)

Tricolporate, oblate-spheroidal, small to medium, 25.0-27.5 × 27.5-30.0 µm in length and breadth; amb rounded triangular; colpi longicolpate, 21.25-25.00 × 3.8-5.0 µm in length and breadth; pori lalongate, 7.50-8.75 × 7.5-12.5 µm in length and breadth; exine 1.3-2.5 µm thick, sexine thicker than nexine; sculpturing psilate.

A pollen key to the studied species by structure of pollen characters

1. Aperture one, sulcate pollen ---------- 1. *Curculigo trichocarpa*
1. Aperture three or more, not sulcate pollen ---------- 2
2. Aperture colpate or porate ---------- 3
2. Aperture colporate ---------- 12
3. Colpi present ---------- 4
3. Colpi absent ----------6
4. Pentacolpate; sculpture striato-reticulate -------- 19. *Merremia vitifolia*
4. Tricolpate; sculpture not striato-reticulate ---------- 5
5. Shape oblate-spheroidal; colpi syncolpate ---------- 4. *Passiflora foetida*
5. Shape subprolate; colpi not syncolpate ---------- 2. *Argemone mexicana*
6. Triporate ----------7
6. Polyporate ---------- 8
7.Shape suboblate; annulus present; sculpture granulate -----5. *Ludwigia octovalvis*
7.Shape oblate-spheroidal; annulus absent; sculpture echinate ----------
---------- 11. *Melhania hamiltoniana*

8. Size of pollen less than 50 μm ; sculpture distinctly reticulate ---------- 3. *Tribulus terrestris*
8. Size of pollen more than 80 μm; sculpture echinate ---------- 9
9. Basal cushion present ---------- 10
9. Basal cushion absent ---------- 11
10. Number of pore about (40); interporal space less than 13 μm ---------- 18. *Ipomoea hederifolia*
10. Number of pore about (24); interporal space more than14.5 μm --------- 6. *Fioria vitifolia*
11. Number of pore about (72); tips of spine pointed ---------- 10. *Malachra capitata*
11.Number of pore about (40); tips of spine blunt ---------- 12. *Pavonia odorata*
12. Pentacolporate ---------- 13. *Waltheria indica*
12. Tricolporate ----------13
13. Pori lolongate ----------17. *Trichodesma indicum*
13. Pori not lolongate ---------- 14
14. Pori lalongate ---------- 15
14. Pori circular ---------- 17
15. Shape oblate-spheroidal; sculpture psilate ----------21. *Solanum virginianum*
15. Shape not oblate-spheroidal; sculpture not psilate ----------16
16. Shape prolate; sexine as thick as nexine; sculpture distinctly reticulate ---------- 8. *Grewia asiatica*
16. Shape subprolate; sexine thicker than nexine; sculpture obscurely reticulate ---------- 14. *Cleome viscosa*
17. Length of pollen grains less than 30μm ----------18
17. Length of pollen grains more than 37μm ----------19
18. Shape prolate; sculpture striate ---------- 16. *Canscora diffusa*
18. Shape suboblate; sculpture psilate ---------- 20. *Physalis minima*
19.Colpi ¾ way up to the pole; size of pori more than 9 μm in diameter ---------- 7. *Grewia abultilifolia*
19.Colpi longicolpate; size of pori less than 8 μm in diameter ---------- 20

20. Shape subprolate; breadth of colpi less than 5.5 μm ---------- 9. *Grewia eriocarpa*
20. Shape prolate-spheroidal; breadth of colpi less than 7.0 μm ---------- 15. *Morinda tinctoria* var. *tomentosa*

DISCUSSION AND CONCLUSION

The present research exhibited great diversity in pollen morphology of 21 species belonging to 19 genera of 12 families have been identified and studied. Among flowering plants, one species of *Curculigo trichocarpa* (Wight) Bennett & Raizoda was monocots and 20 species were eudicots. The pollen morphology was classified on the basis of aperture type, shape, sizes and sculpture pattern of exine.

In this study, the apertures types of pollen were found as sulcate, colpate, porate and colporate. Apertures are very important morphological characters in relation to the identification of pollen grains. According to Moore *et al.* (1991), the apertures are the first characteristics used when identifying variations of pollen grains or spores fossils. Monosulcate pollen grain was found in *Curculigo trichocarpa* (Wight) Bennett & Raizoda. This character is considered to be primitive characters of Angiosperms. These finding are agreed with reported by Walker & Doyle (1975).

Simpson (2006) stated that, tricolpate pollen grains evolved from a monosulcate type, which is consider being ancestral in the angiosperms. Many eudicots have pollen grains with more than three apertures, of a great variety of number, shapes and position. The present of tri- apertures is considered an intermediate and adavanced character. Tricolpate pollen grains were found in two species: *Argemone mexicana* L., *Passiflora foetida* L. and pentacolpate was found in one species: *Merremia vitifolia* (Burm. f.) Hallier f.; triporate were found in two species: *Ludwigia octovalvis* (Jacq.) P.H. Raven, *Melhania hamiltoniana* Wall., polyporate pollen grains were found in five species: *Tribulus terrestris* L., *Fioria vitifolia* (L.) Mattei, *Malachra capitata* (L.) L., *Pavonia odorata* Willd., *Ipomoea hederifolia* L.; pentacolporate was occurred in one species: *Waltheria indica* L. and the remaining of nine species were tricolporate. These results were confirmed with those described by Erdtman (1971).

In addition to the aperture, there are other important characters which can be applied to pollen morphology. In this study, the equatorial view of pollen shape is described by the polar axis and equatorial diameter /ratio. In the studied of pollen grains, the shapes of pollen were found as oblate, suboblate, oblate spheroidal, spheroidal, prolate spheroidal, prolate and subprolate.

The sizes of pollen grains were different from each other. The grains sizes were varied from small, medium, large to very large. The smallest size of pollen grain was
(22.5 - 25.0 x 15.0 - 17.5 um) in *Canscora diffusa* (Vahl.) R. Br. ex Roem. & Schult. and the largest size was (112.5 - 125.5 um) in *Malachra capitata* (L.) L.

Iwanami *et al.* (1988) recorded that, the outer surface of the exine is marked with various kinds of sculpture and ornamentation. The sculpture of the pollen grain is a fairly constant characteristic which is an excellent means of identification of species. In this study, the sculpture patterns of exine were observed as psilate, granulate, striate, striato-reticulate, echinate, obscurely or distinctly reticulate. According to Simpson (2006), anemophilous flowers tend to be smooth (psilate) and entomophilous flowers tend to have elaborately sculptured pollen. In 21 species of exine ornamentation, the psilate sculptures of two species are anemophilous flowers with abiotic agent of dispersal and the varied sculptures of nineteen species are entomophilous flowers with biotic agent of dispersal.

The present results three groups of aperture position have been recognized viz., sulcate, panto- and zono-. Sulcus is an elongated latitudinal ectoaperture present on the surface of most monocotyledon and primitive dicotyledons pollen crossing the polar axis at right angle. The aperture of *Curculigo trichocarpa* (Wight) Bennett & Raizoda was observed as sulcate group.

The pantoaperturate describes, the pollen grains with the aperture spread over the surface and zonoaperturate, which the aperture situated at the equator. The species of *Tribulus terrestris* L., *Fioria vitifolia* (L.) Mattei, *Malachra capitata* (L.) L., *Pavonia odorata* Willd., *Ipomoea hederifolia* L. were occurred as pantoaperturate group and the remaining of fifteen species were zonoaperturate group.

According to the resulting data, pollen morphology of different genera in 12 families was variable from each other. Species belonging to same family also differ in pollen morphology. Variation has not only been found within the family but within the same genera. It was concluded that, this data base useful in identification, comparison of different species within the same family and identification comparison of pollen grains in rest of the study area.


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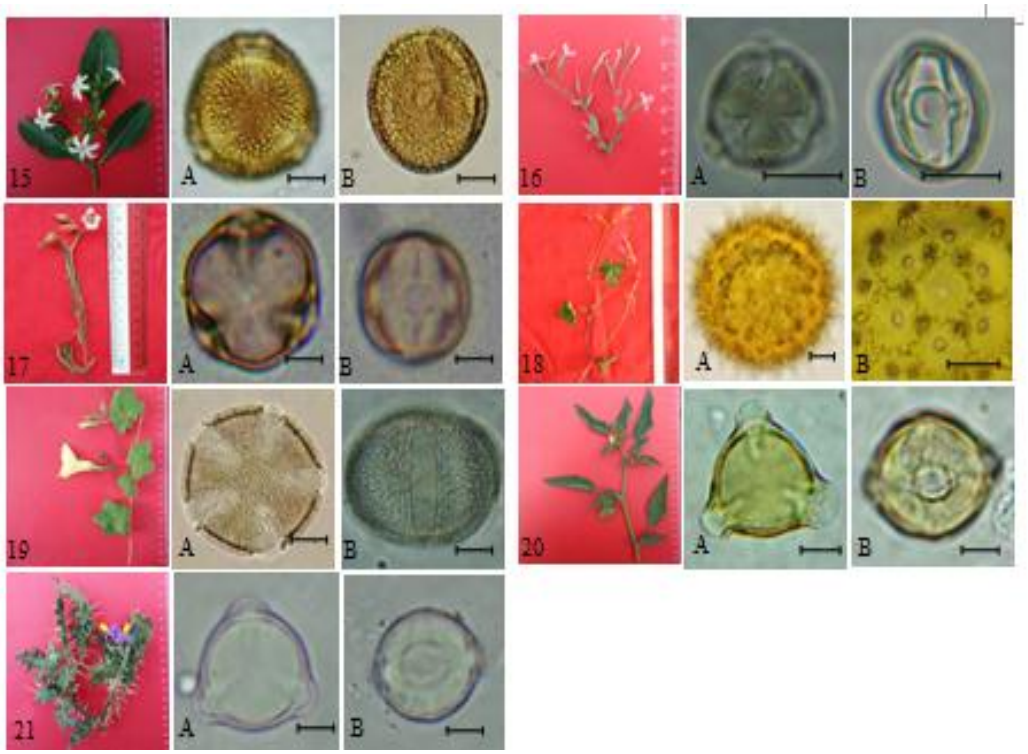

Figure 1. Inflorescences, A. Polar view, B. Equatorial view of *Curculigo trichocarpa* (Wight) Bennett & Raizoda
2. Inflorescences, A. Polar view, B. Equatorial view of *Argemone mexicana* L.
3. Inflorescences, A. Surface view, B. Close-up view of *Tribulus terrestris* L.
4. Inflorescences, A. Polar view, B. Equatorial view of *Passiflora foetida* L.
5. Inflorescences, A. Polar view, B. Equatorial view of *Ludwigia octovalvis* (Jacq.) P.H. Raven
6. Inflorescences, A. Surface view, B. Close-up l view of *Fioria vitifolia* (L.) Mattei
7. Inflorescences, A. Polar view, B. Equatorial view of *Grewia abultilifolia* Vent ex Juss.
8. Inflorescences, A. Polar view, B. Equatorial view of *G. asiatica* L.
9. Inflorescences, A. Polar view, B. Equatorial view of *G. eriocarpa* Juss.
10. Inflorescences, A. Surface view, B. Close-up view of *Malachra capitata* (L.) L.
11. Inflorescences, A. Polar view, B. Equatorial view of *Melhania hamiltoniana* Wall.
12. Inflorescences, A. Surface view, B. Close-up view of *Pavonia odorata* Willd.
13. Inflorescences, A. Polar view, B. Equatorial view of *Waltheria indica* L.
14. Inflorescences, A. Polar view, B. Equatorial view of *Cleome viscosa* L.
15. Inflorescences, A. Polar view, B. Equatorial view of *Morinda tinctoria* var. *tomentosa* Hook.f.
16. Inflorescences, A. Polar view, B. Equatorial view of *Canscora diffusa* (Vahl) R. Br. ex Roem. & Schult
17. Inflorescences, A. Polar view, B. Equatorial view of *Trichodesma indicum* (L.) Lehm.
18. Inflorescences, A. Surface view, B. Close-up view of *Ipomoea hederifolia* L.
19. Inflorescences, A. Polar view, B. Equatorial view *Merremia vitifolia* (Burm. f.) Hallier f.
20. Inflorescences, A. Polar view, B. Equatorial view of *Physalis minima* L.
21. Inflorescences, A. Polar view, B. Equatorial view of *Solanum virginianum* L.

Scale bar- 10µm

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