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Exploring Pollen Morphology Diversity within the Fabaceae Family: A Study from Annamalai Nagar, Chidambaram

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Key words: Acetolysis, Caesalpinioidea, Euripalynous, Faboidea, Mimosoideae, Palynology

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Abstract

The purpose of this study was to ascertain the Fabaceae family's pollen morphology. Three sub-families belong to this family: Faboideae, Mimosoideae, and Caesalpinioideae. Eighteen plant taxa were gathered from Annamalai Nagar, Chidambaram, for the pollen morphology studies. Pollen unit, size class, shape class, measurement of polar and equatorial diameter, polarity, symmetry, aperture, P/E ratio, and ornamentation are all included in the morphology of the pollen. Annamalai Nagar, the current investigation geographical area, lies between latitudes 11˚20' and 11˚25'N and longitudes 79˚40' to 79˚45'E. Fresh flower buds were collected from the plants before the point of anthesis. The collected flower buds were crushed, acetolysed, followed by mounting. To differentiate the pollen grains of the various species under study, it is essential to consider differences in the pollen unit, size and measurement of polar and equatorial diameter (µm), aperture types, exine ornamentation, polarity, symmetry, and P/E ratio. Grains from the 18 species collected ranged from monad, polyad, and tetrad. Shapes of many kinds were observed. Pollen grain sizes were very small, small, medium, large, and very large. The statistical analysis of the Arithmetic mean, standard deviation, standard error, and range of pollen grains were also measured. There were both heteropolar and isopolar grains. From the gathered species, the aperture was distinguished from inaperture, tricolpate, and tricolporate. The majority of the ornamentation was foveolate. As a result, the Fabaceae family is euripalynous, and it is critical to inspect pollen grains to have a thorough understanding of the various varieties within this family.

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Introduction

The present study is about the study of pollen morphology of some Fabaceae members of Chidambaram. Fabaceae is the third biggest angiosperm family and has enormous ecological and economic value. It is worldwide in distribution, comprising 751 genera and 19,500 species. Now this Fabaceae (also known as Papilionaceae) family is divided into three sub-families Faboideae, Mimosoideae, and Caesalpinioideae). This family includes trees, shrubs, climbers, and aquatic plants, the majority of which are herbs. Most often, they are xerophytes. Typically, their roots are taproots with branches. The stem is upright, generally herbaceous or woody, and it climbs with tendrils. The leaves are simple, trifoliate or palmate, pinnately complex, always alternating with leafy stipules. Flowers are rarely solitary, inflorescence is of racemose type. Flowers are entire, irregular, zygomorphic, bisexual, and perigynous. A legume or pod is a fruit. The family Fabaceae includes both dehiscent and indehiscent legumes. They have marginal placentation. Endosperm might be present in seeds or not. Pollen almost are of the same type, tricolporate, prolate, isopolar, and radially symmetrical (Khan *et al.*, 2020). The Fabaceae family of crops is nutritionally valuable due to their ability to fix atmospheric nitrogen for protein synthesis. Socioeconomically, they are important for health and human nutrition, providing wood, dyes, resins, insecticides, fibers, and fodder. Legumes in this family economically fix nitrogen, converting atmospheric nitrogen into useful compounds for plant growth. They adapt well to various environments through associations with nitrogen-fixing bacteria, such as Rhizobium in root nodules, converting nitrogen into ammonia for plant use. This natural fertilization enhances their agricultural importance and ecological adaptability (Asfaw Mengistu, M, Abebe Bekele F, 2021). Ethnobotanical studies reveal that *Crotalaria* species has antimicrobial, anti-inflammatory, wound healing, and antioxidant properties (Kataria *et al.*, 2010). *Acacia* species are used to treat dysentery, asthma, constipation, fever, and gastric issues (Ahmed *et al.*, 2014).

Palynology is a science that studies pollen, spores, and other palynomorphs with diameters ranging from 5 to 200 µm (Gasma *et al.*, 2020). The male reproductive unit of higher vascular plants, including Gymnosperms and Angiosperms, is known as a pollen grain. (Chatterjee *et al.*, 2014). It is worth noting that pollen grains can be found on practically every surface in nature and exist in an endless variety of shapes and sizes, each with its intricate surface decoration.

These grains, along with spores, are often referred to as the "fingerprints" of plants due to their unique characteristics. As such, studying the shape and morphology of pollen grains is essential for identifying and recognizing them in a variety of situations (Awachat, 2010). For the pollen morphological studies, 18 plant taxa were collected from Annamalai Nagar, Chidambaram, Tamil Nadu (Table 1). The pollen morphology incorporated pollen unit, size classes, shape classes, measurement of polar and equatorial diameter (µm), polarity, symmetry, aperture, P/E ratio and ornamentation.

Material and methods

Study area

The present study area Annamalai Nagar lies between longitude 79˚40' to 79˚45'E and latitude 11˚20' to 11˚25'N and is located in the survey of India (SOI) topo sheet No. 58 M/15 (Raja Kumar *et al.*, 2016). Annamalai Nagar Township, located to the east of Chidambaram is the taluk headquarters of Cuddalore district in Tamil Nadu. Spanning approximately 1000 acres, the campus is positioned north of the Coleroon River, which ultimately flows into the Bay of Bengal (Chidambaram *et.al.* 2009).

The district has a hot tropical climate and the summer season is at its peak from March to May. There will be moderate rainfall during the southwest monsoon and a major amount of rainfall will occur in the northeast monsoon season. Cool winter is felt from January to February. The normal rainfall varies from 1150 to 1250 mm annually (Chockalingam *et al.*, 2021). (Fig.1).

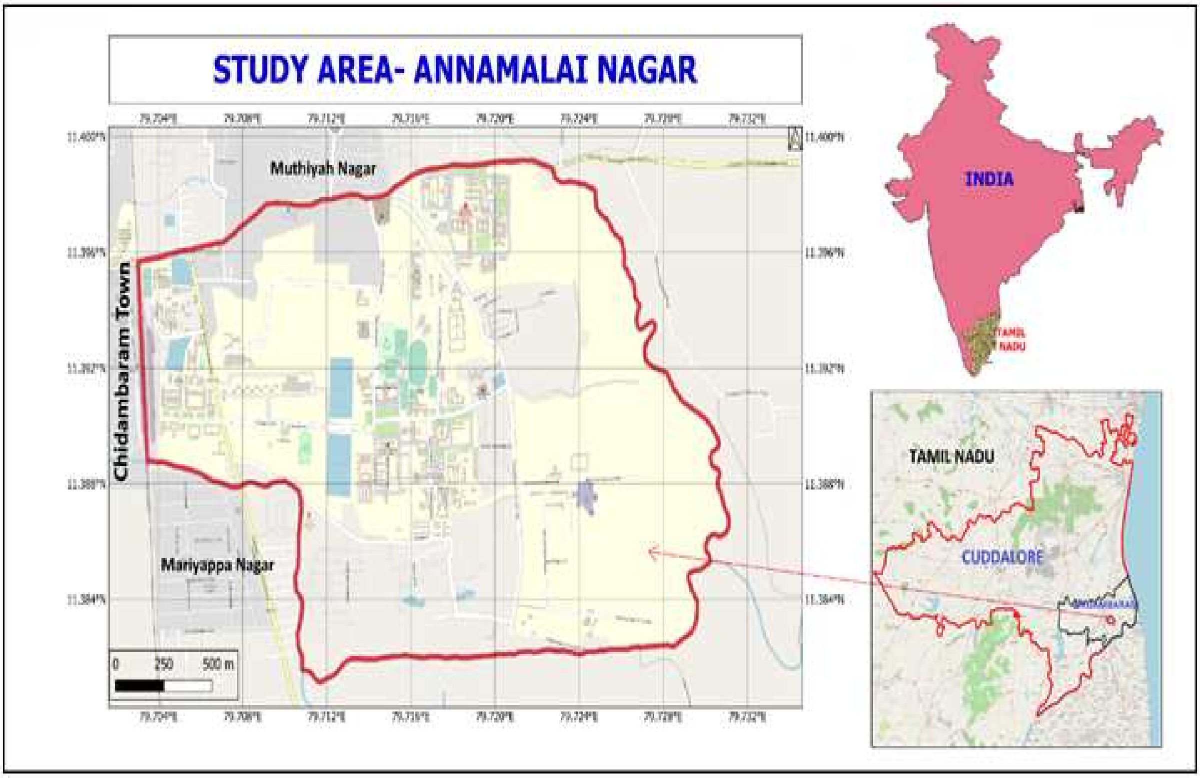

Fig. 1. Map of the study area Annamalai Nagar, Chidambaram.

Collection and preparation of pollen grain

The flower buds of the family Fabaceae were collected in Annamalai Nagar from trees, herbs, shrubs and climbers as well, during the flowering period of each taxa. The detailed description of each taxa were explained (Table 1). Prior to anthesis, flower buds were collected directly from the plants. Using forceps, the anthers were separated and added 5 ml of Ethanol (70%) and crushed with a help of glass rod and sieved in a glass centrifuge tubes. The samples were centrifuged for 5 minutes and saved the pellets. Added 5 ml of glacial acetic acid, centrifuged for 5 minutes and pellets were saved. 5 ml of acetolysis mixture (9:1 ratio of acetic anhydride and sulfuric acid) were added and heated at 100^{o} C for 7-10 minutes, centrifuged and the pellets were saved (Erdtman G, 1963). Again, added 5 ml of glacial acetic acid, centrifuged and saved the pellets. Serially washed and centrifuged the samples at least three times to remove the excess chemicals. The samples were mounted in glycerine jelly on microscopic slides, coved with cover slips and sealed by paraffin wax for microscopic study. Pollen morphology including pollen type, size class, and shape class, measurement of polar and equatorial diameter (µm), P/E ratio, aperture, symmetry, polarity and ornamentation (Table 2) were observed using Olympus Light microscope attached with Optika camera.

Microphotographs were taken by both 400 (40X) and 1000 (100X) magnification. The scale attached in the figure was 10 µm and 20 µm (Plate 1, 2 and 3).

Statistical analysis

The measurement of polar and equatorial diameter (µm) was determined by counting 30 grains of each taxa (n=30). Arithmetic mean, standard deviation, range, standard error of both polar and equatorial diameter were noted (Table 3).

Results

The provided data in the Table 1 contains the general description of 18 plant taxa of the family Fabaceae. Members of this family includes trees, shrubs, climbers and aquatic herbs, including their scientific name, common name, Tamil name, habit, flowering period, and pollinator. In which, 12 species were discussed from the sub-family Caesalpinioideae, 5 species from the sub-family Faboideae and only one species from the sub-family Mimosoideae. The micromorphological characteristics of the collected species were observed by light microscope. Pollen unit, shape classes, size class, measurement of polar and equatorial diameter (µm), P/E ratio, polarity, aperture, symmetry and ornamentation were discussed from the collected taxa (Table 2).

Table 1. List of plants collected from the family Fabaceae showing the common details.

S. No.	Collected taxa	Sub-family	Common name	Tamil name	Habit	Flowering period	Pollinators
1.	*Bauhinia tomentosa* L.	Caesalpinioideae	Yellow bell orchid tree	Thiruvathi	Small tree	Nov-Jan	Bats and birds
2.	*Caesalpinia pulcherrima* (L.) Sw.	Caesalpinioideae	Peacock flower	Mayil kondrai	Small tree	Apr-Dec	Butterflies
3.	*Cassia fistula* L.	Caesalpinioideae	Goldern shower tree	Sarakondrai	Small tree	Mar-Jul	Insects
4.	*Crotalaria juncea* L.	Faboideae	Indian hemp	Sanappayir	Shrub	May-Sept	Insects
5.	*Delonix regia* (Boj. ex Hook.) Raf.	Caesalpinioideae	Red flame tree	Neruppu kondrai	Tree	Mar-Sept	Insects and nectar feeding birds
6.	*Mimosa pudica* L.	Caesalpinioideae	Touch-me-not plant	Thottar surungi	Creeper	Nov-Mar	Insects
7.	*Peltophorum pterocarpum* (DC.) K.Heyne	Caesalpinioideae	Yellow flame tree	Perungondrai	Tree	Mar-May	Insects and sunbirds
8.	*Pongamia pinnata* (L.) Pierre (1898)	Faboideae	Indian beech tree	Pungai maram	Tree	Apr-Jun	Bees, wasps and thrips
9.	*Prosopis juliflora* (Sw.) DC.	Mimosoideae	Mesquite	Seemai karuvelan maram	Tree	Aug-Sept	Bees
10.	*Samanea saman* (Jacq.) Merr.	Caesalpinioideae	Monkey pod	Thoongumoonji maram	Tree	Mar-May	Bees
11.	*Senna alata* (L.) Roxb.	Caesalpinioideae	Candle brush	Vandukolli	Shrub	Sept-Dec	Bees and wasps
12.	*Senna auriculata* (L.) Roxb.	Caesalpinioideae	Matura tea tree	Avarampoo	Tree	Throughout the year	Bees
13.	*Senna occidentalis* L.	Caesalpinioideae	Ant bush	Ponnaavarai	Shrub	Feb-Apr	Scarab beetles and bees
14.	*Sesbania bispinosa* (Jacq.) W.Wight	Faboideae	Prickly sesban	Thakkaippoondu	Herb	Sept-Nov	Bees
15.	*Tamarindus indica* L.	Caesalpinioideae	Tamarind tree	Puliyamaram	Tree	Apr-Jun	Bees
16.	*Tephrosia purpurea* (L.) Pers.	Faboideae	Fish poison	Kolinchi	Herb	Throughout	Butterflies
17.	*Vachellia nilotica* (L.) P.J.H.Hurter & Mabb.	Caesalpinioideae	Gum Arabic tree	Karuvela maram	Tree	Jun-Aug	Bees and insects
18.	*Vigna radiate* (L.) R. Wilczek	Faboideae	Green gram	Paasi payaru	Herb	Oct-Dec	Insects

Description of the taxonomic group and its constituent species

Sub-family Caesalpinioideae

Bauhinia tomentosa L.

Table 2, 3. Fig. 3. Fig. 3.1

Pollen grain with monad unit, Prolate, 75.2 µm size in polar view, 109.6 µm in equatorial view, very large grain. The P/E ratio of 145, isopolar, radially symmetrical, 3- colporate with rugulate ornamentation.

Caesalpinia pulcherrima (L.) Sw.

Table 2, 3. Fig. 3. Fig. 3.2 and 3.3

Pollen grain with monad unit, Prolate-Spheroidal, 71.5 µm size in polar view and 70.6 µm in equatorial view, large grain. The P/E ratio of 101, isopolar, radially symmetrical, 3-colporate with rugulate ornamentation.

Cassia fistula L.

Table 2, 3. Fig. 3. Fig. 3.4 and 3.5.

Pollen grain with monad unit, Prolate-Spheroidal, 24.5 µm size in polar view and 26.2 µm in equatorial view, medium sized grain. The P/E ratio of 1.15. Isopolar, radially symmetrical, 3-colporate with psilate ornamentation.

Delonix regia (Boj. ex Hook.) Raf.

Table 2, 3. Fig. 3. Fig. 3.6 and 3.7

Pollen grain with monad unit, Prolate-Spheroidal, 52.7 µm size in polar view and 58.5 µm in equatorial view, large grain. The P/E ratio of 111. Isopolar, radially symmetrical with 3-colporate with reticulate ornamentation.

Mimosa pudica L.

Table 2, 3. Fig. 3. Fig. 3.8.

Pollen grain with tetrad unit, shape Prolate-Spheroidal, 8.6 µm size in polar view and 8.5 µm in equatorial view, very small grain. The P/E ratio of 101. Heteropolar, bilaterally symmetrical, inaperturate with psilate ornamentation.

Peltophorum pterocarpum (DC.) K.Heyne

Table 2, 3. Fig. 4. Fig. 4.1 and 4.2.

Pollen grain with monad unit, Prolate-Spheroidal, 57.1 µm size in polar view and 61.3 µm in equatorial view, large grain. The P/E ratio of 107. Isopolar, radially symmetrical, 3-colporate with reticulate ornamentation.

Table 2. Pollen micro morphological characteristics of the studied taxa of the family Fabaceae.

S. No.	Plant taxa	Pollen unit	Shape classes	Size class of pollen	P/E Ratio	Polarity	Aperture	Symmetry	Ornamentation
1.	*B. tomentosa*	Monad	Prolate	Very large grain	145	Isopolar	Tricolporate	Radial	Regulate
2.	*C. pulcherrima*	Monad	Prolate-Spheroidal	Large grain	101	Isopolar	Tricolporate	Radial	Regulate
3.	*C. fistula*	Monad	Prolate-Spheroidal	Medium sized grain	106	Isopolar	Tricolporate	Radial	Psilate
4.	*C. juncea*	Monad	Sub-prolate	Small grain	123	Isopolar	Tricolporate	Radial	Psilate
5.	*D. regia*	Monad	Prolate-Spheroidal	Large grain	111	Isopolar	Tricolporate	Radial	Reticulate
6.	*M. pudica*	Tetrad	Prolate-Spheroidal	Very small grain	101	Heteropolar	Inaperturate	Bilateral	Psilate
7.	*P. pterocarpum*	Monad	Prolate-Spheroidal	Large grain	107	Isopolar	Tricolporate	Radial	Reticulate
8.	*P. pinnata*	Monad	Prolate-Spheroidal	Medium sized grain	109	Isopolar	Tricolporate	Radial	Psilate
9.	*P. juliflora*	Monad	Prolate-Spheroidal	Medium sized grain	110	Isopolar	Tricolporate	Radial	Psilate
10.	*S. saman*	Polyad	Spheroidal	Very large grain	100	Heteropolar	Inaperturate	Bilateral	Psilate
11.	*S. alata*	Monad	Prolate-Spheroidal	Medium sized grain	111	Isopolar	Tricolporate	Radial	Psilate
12.	*S. auriculata*	Monad	Prolate-Spheroidal	Medium sized grain	106	Isopolar	Tricolporate	Radial	Psilate
13.	*S. occidentalis*	Monad	Prolate-Spheroidal	Medium sized grain	106	Isopolar	Tricolporate	Radial	Psilate
14.	*S. bispinosa*	Monad	Prolate-Spheroidal	Medium sized grain	103	Isopolar	Tricolporate	Radial	Reticulate
15.	*T. indica*	Monad	Prolate-Spheroidal	Medium sized grain	102	Isopolar	Tricolporate	Radial	Striate
16.	*T. purpurea*	Monad	Prolate-Spheroidal	Medium sized grain	113	Isopolar	Tricolporate	Radial	Psilate
17.	*V. nilotica*	Polyad	Prolate-Spheroidal	Medium sized grain	108	Heteropolar	Inaperturate	Bilateral	Psilate
18.	*V. radiata*	Monad	Prolate-Spheroidal	Medium sized grain	101	Isopolar	Tricolpate	Radial	Reticulate

Samanea saman (Jacq.) Merr.

Table 2, 3. Fig. 3. Fig. 3.9.

Pollen grain with Polyad unit (more than 25 grains), Spheroidal, 102.6 µm size in polar view and 103.6 µm in equatorial view, very large grain. The P/E ratio of 100. Heteropolar, bilaterally symmetrical, inaperturate with psilate ornamentation.

Senna alata (L.) Roxb.

Table 2, 3. Fig 4. Fig. 4.3 and 4.4.

Pollen grain with monad unit, Prolate-Spheroidal, 24.6 µm size in polar view and 27.5 µm in equatorial view, medium sized grain. The P/E ratio of 111. Isopolar, radially symmetrical, 3-colporate with psilate ornamentation.

Table 3. Quantitative analysis of pollen micro morphological features of taxa in polar and equatorial diameter (µm), n=30.

S. No.	Plant taxa	Polar axis (µm) (n=30)		Equatorial axis (µm) (n=30)	
		(R) x ± $S_{\bar{x}}$	s	(R) x ± $S_{\bar{x}}$	s
1.	*B. tomentosa*	(58-141) 75.2 ± 23.70	4.32	(76-146) 109.6 ± 16.84	3.07
2.	*C. pulcherrima*	(56-82) 71.5 ± 7.29	1.33	(56-83) 70.6 ± 6.65	1.21
3.	*C. fistula*	(21-28) 24.5 ± 1.75	0.32	(24-30) 26.2 ± 1.67	0.30
4.	*C. juncea*	(18-22) 19.8 ± 1.08	0.19	(20-28) 24.4 ± 2.28	0.41
5.	*D. regia*	(45-60) 52.7 ± 3.61	0.65	(49-66) 58.5 ± 4.24	0.77
6.	*M. pudica*	(8-9) 8.6 ± 0.47	0.08	(8-9) 8.5 ± 0.50	0.09
7.	*P. pterocarpum*	(49-66) 57.1 ± 4.21	0.76	(51-69) 61.3 ± 5.11	0.93
8.	*P. pinnata*	(20-27) 24.1 ± 1.99	0.36	(23-29) 26.5 ± 1.54	0.28
9.	*P. juliflora*	(21-26) 23.9 ± 1.47	0.26	(23-32) 26.4 ± 2.78	0.50
10.	*S. saman*	(92-115)102.6 ± 6.81	1.24	(93-116)103.6 ± 6.23	1.13
11.	*S. alata*	(20-29) 24.6 ± 2.26	0.41	(22-34) 27.5 ± 3.20	0.58
12.	*S. auriculata*	(25-30) 27.4 ± 1.61	0.29	(27-32) 29.3 ± 1.56	0.28
13.	*S. occidentalis*	(30-35) 32 ± 1.25	0.22	(29-36) 34 ± 1.55	0.28
14.	*S. bispinosa*	(20-30) 24.8 ± 2.53	0.46	(29-36) 25.7 ± 1.55	0.28
15.	*T. indica*	(27-43) 36.5 ± 4.38	0.80	(30-42) 37.4 ± 3.33	0.60
16.	*T. purpurea*	(21-26) 22.8 ± 1.28	0.23	(23-29) 25.9 ± 1.92	0.35
17.	*V. nilotica*	(35-47) 41.3 ± 3.52	0.64	(36-55) 44.9 ± 6.18	1.12
18.	*V. radiata*	(32-46) 38.4 ± 2.85	0.52	(32-47) 39 ± 3.74	0.68

[R= range; x= Arithmetic mean (µm); $S_{\bar{x}}$= standard deviation (µm); s = standard error (µm) and n = number of pollen grains measured (µm)].

Senna auriculata (L.) Roxb.

Table 2, 3. Fig. 4. Fig. 4.5 and 4.6.

Pollen grain with monad unit, Prolate-Spheroidal, 27.4 µm size in polar view and 29.3 µm in equatorial view, medium sized grain. The P/E ratio of 106. Isopolar, radially symmetrical, 3-colporate with psilate ornamentation.

Senna occidentalis L.

Table 2, 3. Fig. 4. Fig. 4.7 and 4.8.

Pollen grain with monad unit, Prolate-Spheroidal, 32 µm size in polar view and 34 µm in equatorial view, medium sized grain. The P/E ratio of 106. Isopolar, radially symmetrical, 3-colporate with psilate ornamentation.

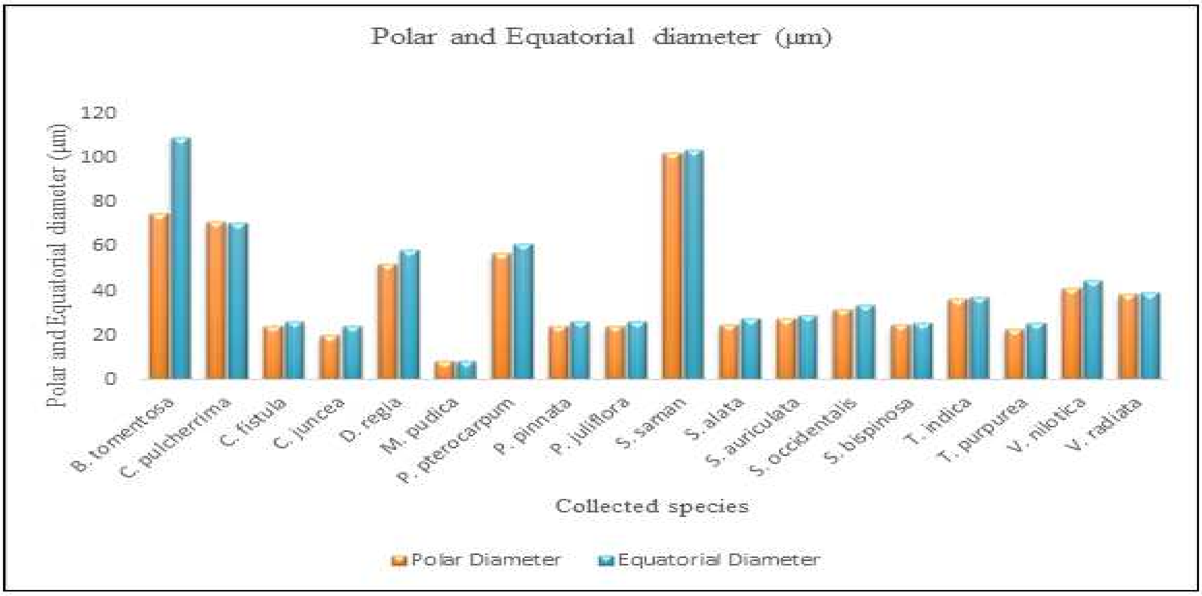

Fig. 2. Polar and equatorial diameter of the collected pollen grains.

Tamarindus indica L.

Table 2, 3. Fig. 5. Fig. 5.1 and 5.2.

Pollen grain with monad unit, Prolate-spheroidal, 36.5 µm size in polar view and 37.4 µm in equatorial view. The P/E ratio of 1.05. Isopolar, radially symmetrical, 3-colporate with striate ornamentation.

Vachellia nilotica (L.) P.J.H.Hurter & Mabb.

Table 2, 3. Fig. 4. Fig. 4.9.

Pollen grain with polyad unit (12-16 grains), Prolate-spheroidal, 41.3 µm size in polar view and 44.9 µm in equatorial view. The P/E ratio of 1.04. Heteropolar, bilaterally symmetrical, inaperturate with psilate ornamentation.

Sub-family faboideae

Crotalaria juncea L.

Table 2, 3. Fig. 5. Fig. 5.3 and 5.4.

Pollen grain with monad unit, shape Sub-prolate, 19.8 µm size in polar view and 24.4 µm in equatorial view, small grain. The P/E ratio of 123, isopolar, radially symmetrical with 3-colporate with psilate ornamentation.

Pongamia pinnata (L.) Pierre

Table 2, 3. Fig. 5. Fig. 5.5 and 5.6.

Pollen grain with monad unit, Prolate-Spheroidal, 24.1 µm size in polar view and 26.5 µm in equatorial view, medium sized grain. The P/E ratio of 109. Isopolar, radially symmetrical, 3-colporate with psilate ornamentation.

Sesbania bispinosa (Jacq.) W.Wight

Table 2, 3. Fig. 5. Fig. 5.7 and 5.8.

Pollen grain with monad unit, Prolate-Spheroidal, 24.8 µm size in polar view and 25.7 µm in equatorial view, medium sized grain. The P/E ratio of 103. Isopolar, radially symmetrical, 3-colporate with reticulate ornamentation.

Tephrosia purpurea (L.) Pers.

Table 2, 3. Fig. 6. Fig. 6.1 and 6.2.

Pollen grain with monad unit, Prolate-Spheroidal, 22.8 µm size in polar view and 25.9 µm in equatorial view, medium sized grain. The P/E ratio of 113. Isopolar, radially symmetrical, 3-colporate with psilate ornamentation.

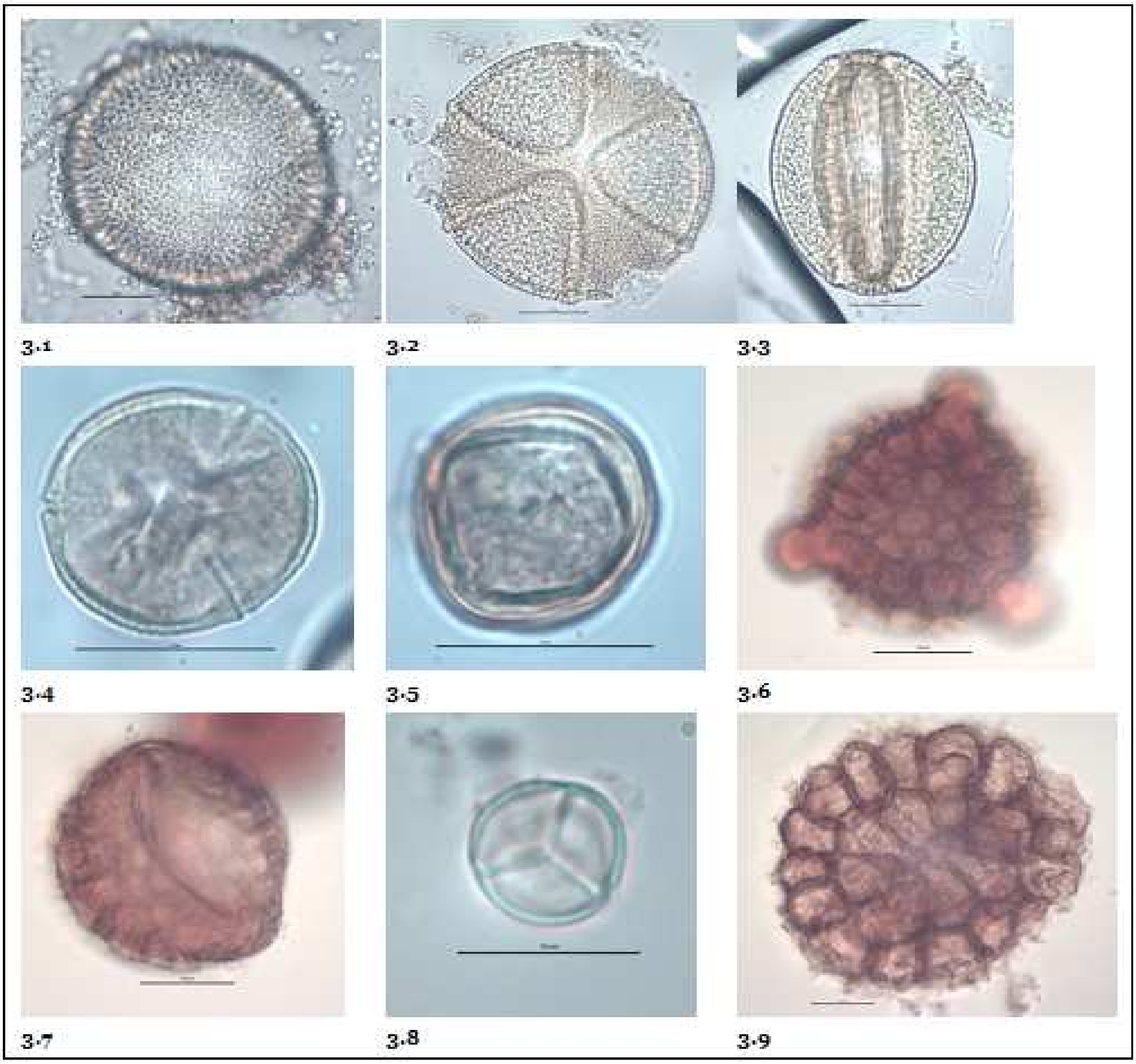

Fig. 3. Light micrographs of collected pollen grains of Fabaceae. I. Caesalpinioideae. Fig. 3.1. *Bauhinia tomentosa* L. 3.2 and 3.3. *Caesalpinia pulcherrima* (L.) Sw. 3.2. Polar view. 3.3. Equatorial view. 3.4 and 3.5. *Cassia fistula* L., 3.4. Polar view. 3.5. Equatorial view. 3.6 and 3.7. *Delonix regia* (Boj. ex Hook.) Raf., 3.6. Polar view. 3.7. Equatorial view. 3.8. *Mimosa pudica* L., polar view. 3.9. *Samanea saman* (Jacq.) Merr. Scale bar: 20 µm (Fig. 3.1-3.7, 3.9) and 10 µm (Fig. 3.8). Magnification: 40X (Figure 3.1-3.3, 3.6, 3.7 and 3.9) and 100X (Fig. 3.4, 3.5 and 3.8).

Vigna radiata (L.) R. Wilczek

Table 2, 3. Fig. 6. Fig. 6.3 and 6.4.

Pollen grain with monad unit, Prolate-Spheroidal, 38.4 size in polar diameter and 39 in equatorial diameter, medium sized grain. The P/E ratio of 101. Isopolar, radially symmetrical, 3 colpate with reticulate ornamentation.

Sub-family Mimosoideae

Prosopis juliflora (Sw.) DC.

Table 2, 3. Fig. 6. Fig. 6.5 and 6.6.

Pollen grain with monad unit, Prolate-Spheroidal, 23.9 µm size in polar view and 26 µm in equatorial view, medium sized grain. The P/E ratio of 110. Isopolar, radially symmetrical, 3-colporate with psilate ornamentation.

Quantitative assessment

These pollen morphology of 18 taxa (Table 2) were observed in the present study. The pollen grains were observed under the light microscope. Pollen characters used in this study included pollen unit, shape classes, size class of pollen, measurement of polar and equatorial diameter (µm), P/E ratio, polarity, symmetry, aperture, and ornamentation. Among the 18 taxa, 15 taxa shows monad (single grain), 2 taxa were polyad (more than 4 grains) and only one was tetrad (4 grains). In an equatorial perspective, multiplying the ratio of the polar axis to the equatorial axis by 100 provides a measure of the shape (Erdtman G, 1952). Four types of shapes were observed (Prolate-Spheroidal, Sub-prolate, Spheroidal and Prolate). Prolate-Spheroidal shape was observed in *C. pulcherrima, C. fistula, D. regia, M. pudica, P. pterocarpum, P. pinnata, P. juliflora, S. alata, S. auriculata, S. occidentalis, S. bispinosa, T. indica, T. purpurea*, *V. nilotica* and *V. radiata*.

The Sub-prolate shape was observed only in *C. juncea*, similarly from Prolate (*B. tomentosa*), Sub-prolate (*C. juncea*) and Spheroidal (*S. saman*).

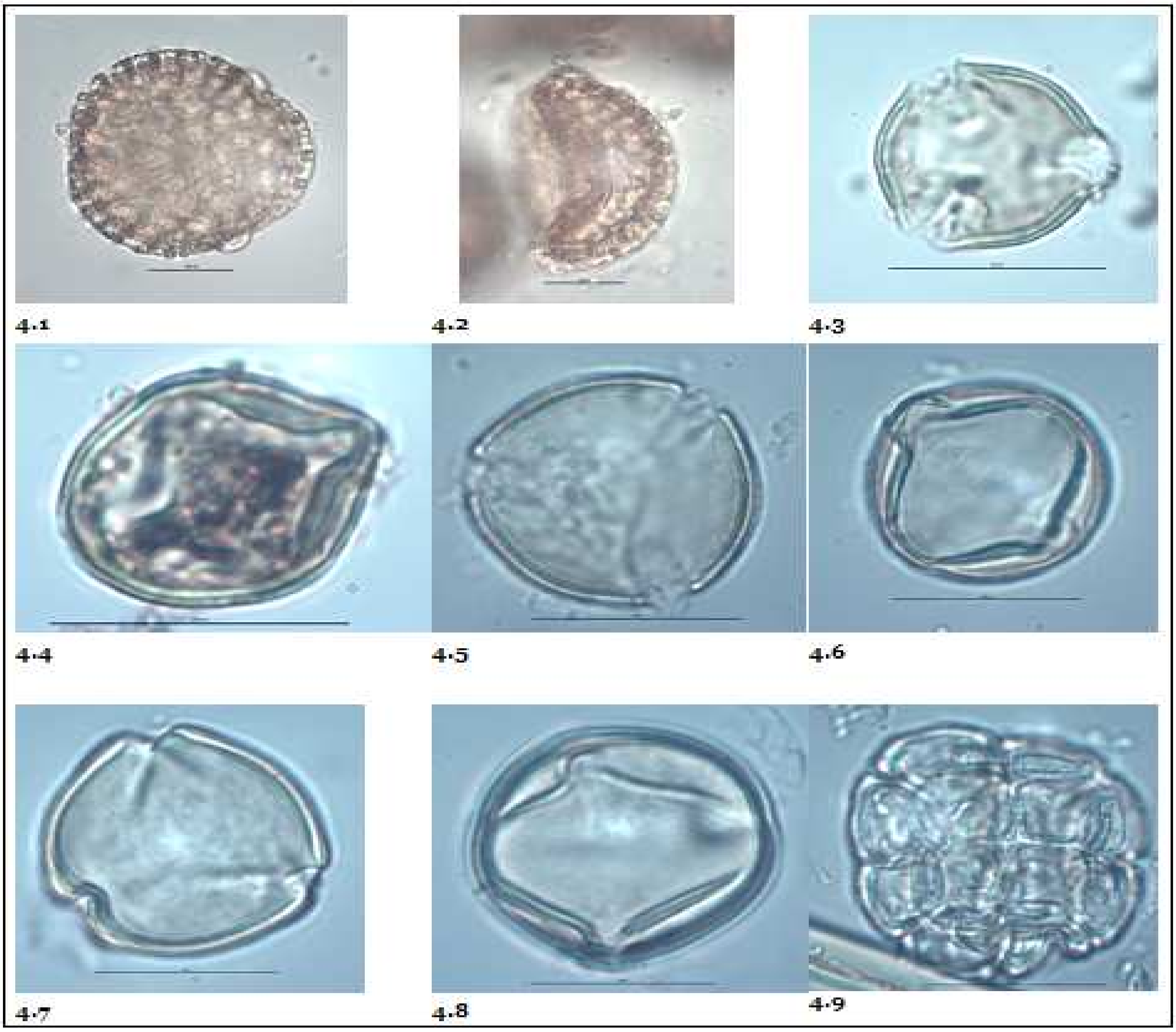

Fig. 4. Light micrographs of collected pollen grains of Fabaceae. I. Caesalpinioideae: Fig. 4.1 and 4.2. *Peltophorum pterocarpum* (DC.) K.Heyne. 4.1. Polar view. 4.2. Equatorial view. 4.3 and 4.4. *Senna alata* (L.) Roxb. 4.3. Polar view. 4.4. Equatorial view. 4.5 and 4.6. *Senna auriculata* (L.) Roxb. 4.5. Polar view. 4.6. Equatorial view. 4.7 and 4.8. *Senna occidentalis* L. 4.7. Polar view. 4.8. Equatorial view. 4.9. *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb. Scale bar: 20 µm (Fig. 4.1-4.9). Magnification: 40X (Fig. 4.1 and 4.2) and 100X (4.3-4.9).

The observed pollen grains were very small, small, medium, large and very large in size class. Three species were heteropolar others were isopolar, similarly three species were bilaterally symmetrical and others were radially symmetry (*M. pudica, S. saman* and *V. nilotica*). Aperture differentiated from inaperture (lack of aperture), tricolpate (pore absent) and tricolporate (colporate- colpi and pori present) from the collected species. Ornamentations observed were regulate (ridges run more or less irregularly), psilate (surface even/diameter of pits < 1 µm), reticulate (definite reticulate pattern) and striate (elements parallel instead of reticulate) (Bhattacharya, K., *et al.* 2006). The polar and equatorial diameter (µm) was measured by arithmetic mean of 30 counts (n=30) of pollen grains (Table 3).

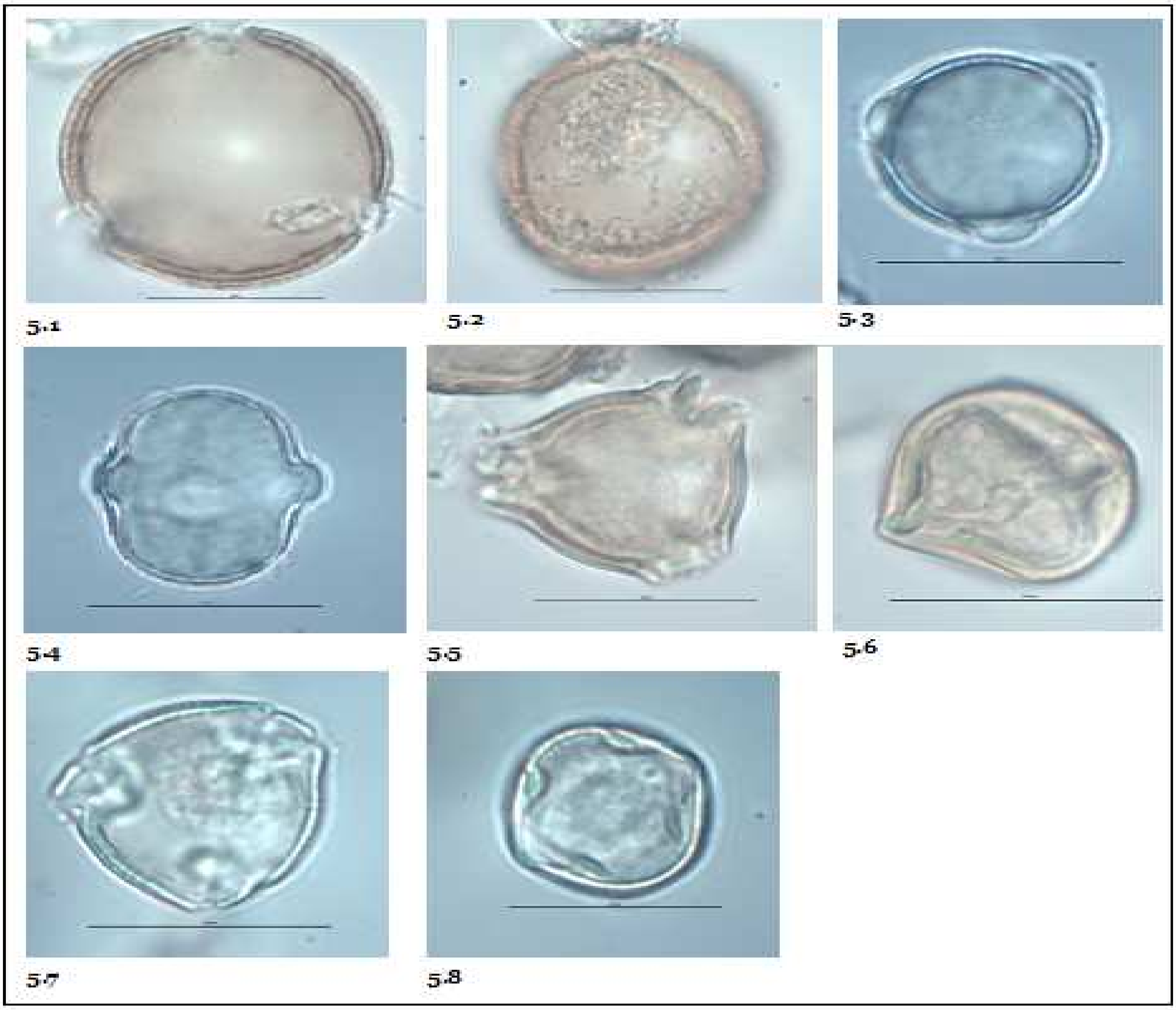

Fig. 5. Light micrographs of collected pollen grains of Fabaceae. I. Caesalpinioideae: Fig. 5.1 and 5.2. *Tamarindus indica* L. 5.1. Polar view. 5.2. Equatorial view. II. Faboideae. Figure 5.3 and 5.4. *Crotalaria juncea* L. 5.3. Polar view. 5.4. Equatorial view. 5.5 and 5.6. *Pongamia pinnata* (L.) Pierre 5.5. Polar view. 5.6. Equatorial view. 5.7 and 5.8. *Sesbania bispinosa* (Jacq.) W.Wight. 5.7. Polar view. 5.8. Equatorial view. Scale bar: 20 µm (Fig. 5.1-5.9). Magnification: 100X (Fig. 5.1-5.8).

Discussion

The current investigation delves into the examination of pollen morphology across various members of the Fabaceae family in Annamalai Nagar, Chidambaram. This family, being the third largest within angiosperms, carries significant ecological and economic importance, boasting a global presence with 751 genera and 19,500 species. Our study focused on analyzing pollen morphology of 18 taxa within this family, collecting pollen grains before flowering and subjecting them to acetolysis treatment for observation under a light microscope. Our research documented variations in pollen units (monad, tetrad, and polyad) across different shape categories (prolate, sub-prolate, spheroidal, and prolate-spheroidal), highlighting differences in sizes, polar and equatorial diameters, aperture, and other characteristics. These findings align with numerous previous studies by various authors such as Jamwal (2021), Amina Z. Abo-Elnaga (2022), El Kholy *et al.* (2023), and others, which also investigated pollen morphology within the Fabaceae family.

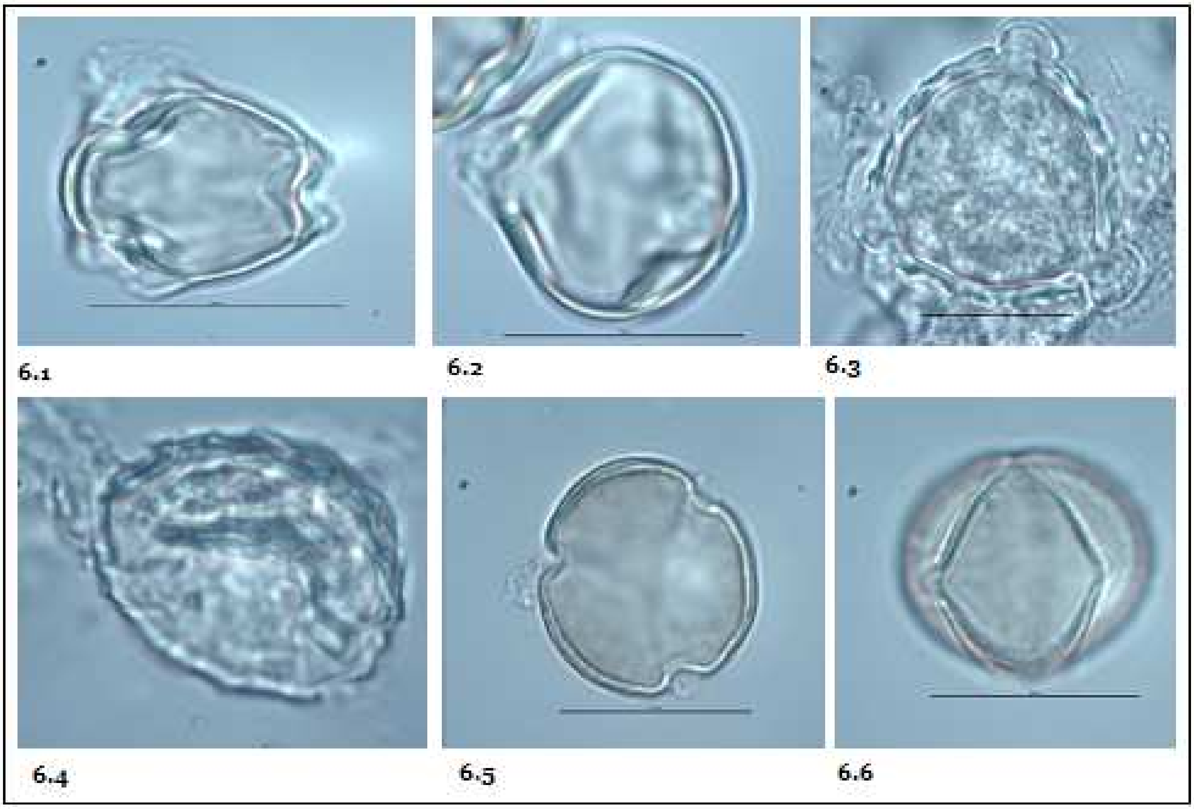

Fig. 6. Light micrographs of collected pollen grains of Fabaceae. II. Faboideae. Fig. 6.1 and 6.2. *Tephrosia purpurea* (L.) Pers. 6.1. Polar view. 6.2. Equatorial view. 6.3 and 6.4. *Vigna radiate* (L.) R. Wilczek. 6.3. Polar view. 6.4. Equatorial view. III. Mimosoideae. Figure 6.5 and 6.6. *Prosopis juliflora* (Sw.) DC. 6.5. Polar view. 6.6. Equatorial view. Scale bar: 20 µm (Fig. 6.1-6.6). Magnification: 100X (Fig. 6.1-6.6).

For instance, *Mimosa pudica* has been extensively studied, with consistent observations across studies by Bahadur, S., *et al.* (2022), Shubharani *et al.* (2013), and Jumah (1991) regarding its pollen characteristics. Similarly, *Senna occidentalis* was reported by Bahadur *et al.* (1991) with specific details on its pollen grain, although our study noted a psilate surface pattern in contrast to the previously reported reticulate pattern. Our findings on *Acacia nilotica* and *Samanea saman* corroborate with observations made by Jumah (1991) and other researchers regarding their pollen structure and symmetry. Additionally, similarities were found with previous studies on *Cassia fistula*, *Peltophorum pterocarpum*, and *Delonix regia*, further supporting the consistency of our findings across different investigations.

Interestingly, Shubharani *et al.* (2013) also observed several species, including *Caesalpinia pulcherrima*, *Peltophorum pterocarpum*, *Cassia fistula*, *Pongamia pinnata*, *Samanea saman*, and *Mimosa pudica*, from bee foraging plants, with observations slightly resembling our own.

In summary, our study contributes to the collective understanding of Fabaceae pollen morphology, highlighting both consistencies and variations across different taxa and corroborating with previous research efforts. These findings underscore the importance of continued research in elucidating the intricate details of plant reproductive biology within this diverse plant family.

Conclusion

In this study, we conducted a thorough investigation into the pollen morphology of 18 taxa belonging to the Fabaceae family, sourced from Annamalai Nagar, Chidambaram. Utilizing light microscopy, we meticulously examined various pollen characteristics, including shape, size, polarity, symmetry, aperture types, and ornamentation.

Our findings revealed a predominance of monad pollen units across the sampled taxa, with only a few displaying polyad or tetrad arrangements. The most prevalent shape observed was Prolate-Spheroidal, although Sub-prolate, Spheroidal, and Prolate shapes were also identified in select species. Notably, significant diversity was observed in pollen grain size, ranging from very small to very large classes.

Regarding polarity and symmetry, most taxa exhibited isopolar grains with radial symmetry, while a few showed heteropolarity and bilateral symmetry. Aperture types varied, with inaperture, tricolpate, and tricolporate differentiations detected among the collected species.

Furthermore, our examination of ornamentation patterns revealed a variety of structures, including regulate, psilate, reticulate, and striate arrangements, underscoring the intricate nature of pollen morphology within the Fabaceae family.

Overall, this study provides detailed insights into the morphological diversity of Fabaceae pollen, highlighting the importance of comprehensive morphological analyses in botanical research. Our findings contribute to a deeper understanding of taxonomic relationships and ecological adaptations within this diverse plant family.

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