INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2005/07–6–857–868
http://www.ijab.org

Palynological Study on Some Taxa of Mimosoideae (Leguminosae)

MOHAMED E. TANTAWY[1], SAYED F. KHALIFA, KARIMA A. HAMED AND HEBA M. ELAZAB
Botany Department, Faculty of Science, Ain Shams University, Cairo-11566, Egypt
[1]Corresponding author's e-mail: hasakola@yahoo.com

ABSTRACT

The pollen morphological characters of 36 taxa of the Mimosoideae representing 30 species, four subspecies and two varieties were investigated by the aid of LM and SEM. The different palynological parameters that have taxonomic significance were: pollen per anther, detection of single and compound grains, associated monads of single and compound grains, polarity, pollen types, detection of pollenkitt, pollen size classes, aperture characters, tectum, thickness of sexine relative to nexine, length of columellae, exine sculpture, and harmomegathic device. An identificatory key was constructed to the studied taxa on the basis of different palynological characters.

Key Words: Mimosoideae; Polllen grains

INTRODUCTION

The pollen morphology of the Mimosoideae aroused much interest from the first observations by Kunth (1819-24). Early observations and commentaries include those of Fritzche (1832), Mohl (1835), Bentham (1865), Rosanoff (1865), Engler (1876) and Mueller (1887-1888). For a palynologist, the group is full of interest because of the diversity and the occurrence of both single and compound grains in three out of seven tribes recognised by Bentham (1865).

The tremendous morphological diversity in the pollen of Mimosoideae and its practical value for systematic studies were reviewed by Guinet (1981a, b), Guinet and Ferguson (1989) and El-Ghazali *et al*. (1997). Hughes (1997) and Nunes *et al.* (2003) indicate that the apertural type, structure of the exine, tectum and its ornamentation, and the high frequency of compound grains (polyads & tetrads) are all palynological parameters useful in the systematic studies of the Mimosoideae thus being morphologically heterogeneous.

Elias (1981) indicates that the characteristic pollen in Mimosoideae is surprising diverse for what phenotypically appears to be such a homogenous group. In the genera, pollen is shed as single units, permanent tetrad, octad, or polyad units, mainly of 16 and 32 grains. Guinet (1981b) records that the most frequent structural grain pattern is granular with porate aperture. Although colporate and extraporate grains are known but the colpate aperture does not exist in the Mimosoideae.

The present study was conducted to show how far the pollen morphological variations, using LM and SEM, could be used to distinct between the studied taxa of Mimosoideae.

MATERIALS AND METHODS

In this work, 36 taxa of Mimosoideae (representing 30 species, four subspecies and two varieties) ranging among wild as well as horticultural taxa were collected (Table I). Bailey (1949), Täckholm (1974) and Boulos (1999) are consulted in the identification of the studied taxa.

Ideally, to obtain the maximum amount of systematic data from SEM studies of pollen, both acetolyzed and non-acetolyzed materials were studied. Valuable systematic characters may be lost in acetolysis and true pollen shape may be greatly changed. Study of fresh (non-acetolyzed pollen) can give greater insight into the functional significance of pollen characters which, in turn, can contribute to better systematic treatment (Harley & Ferguson, 1990).

Preparation of acetolyzed materials. Pollen extraction was prepared for LM and SEM examination according to customary methods of Erdtman (1960) and Moore *et al.* (1991).

Preparation of non-acetolyzed materials. Mature pollen grains at anthesis were investigated using SEM. For SEM investigation conventionally air or critical point dried material was sputter coated (Hesse, 1986).

The terms used to describe the pollen morphology have been adopted according to Kremp (1968) and Punt *et al.* (1994).

RESULTS AND DISCUSSION

The different palynological characters of the studied taxa which were discussed in the view of other investigators were presented in cumulative Tables (II-V) and Plates (I-VIII).

Table I. Collection data and source of collection

No.	Taxa	*Source
1	*Acacia ehrenbergiana* Hayne	12, 16
2	*A. farnesiana* (L.) Willd	6, 10, 16
3	*A. hamulosa* Benth.	16
4	*A. laeta* R. BR. Ex. Benth.	4,16
5	*A. nilotica* subsp. *indica* (Benth.) Bren.	16
6	*A. nilotica* subsp. *tomentosa* (Benth.) Bren.	2, 16
7	*A. oerfota* var. *brevifolia* Boulos	16
8	*A. origena* A. Hunde	16
9	*A. pachycera* var. *pachyceras* Schwartz	16
10	*A. saligna* (Labill.) H. L. Weldl	10, 11
11	*A. senegal* (L.) Willd	16
12	*A. seyal* Delile	8, 12, 16
13	*A. tortilis* subsp. *raddiana* (Sav.)Bren.	12, 14
14	*A. tortilis* subsp. *tortilis* Bren.	14, 16
15	*Adenanthera pavonina* L.	1, 16
16	*Albizia anthelmintica* **(**A. Rich.) Brongn	3
17	*Al. gamblei* Prain	16
18	*Al. julibrissin* Durazz.	2
19	*Al. lebbeck* (L.) Benth.	1, 6
20	*Al. procera* (Roxb.) Benth.	1
21	*Al. stipulata* (Roxb.) L.	1
22	*Anadenanthera peregrina* (L.) Speg.	16
23	*Calliandra haematocephala* Hassk.	2, 5
24	*Dichrostachys cinerea* (L.)Wigh.&Arn.	2, 16
25	***E**nterolobium contortisiliquum* (Vell.) Morong	1, 8
26	*E. schomburgkii*(Benth.) Benth.	16
27	*Faidherbia albida* (Delile) A.Cheval	4, 16
28	*Leucaena glauca* (L.) Benth.	6, 7
29	*Mimosa myriocephala* Baker	16
30	*M. pigra* L.	13
31	*M. pudica* L.	15
32	*Pithecellobium dulce* (Roxb.) Benth.	1, 16
33	*P. lobatum* Benth.	3
34	*Prosopis chilensis* (Molina) Stuntz.	16
35	*P. farcta* (Banks & Solander) Macbr.	9
36	*P. juliflora* (Swartz) DC.	1, 8

* Source of collection

1- Zoo Garden, Giza, Egypt.; 2- Orman Botanic Garden, Giza, Egypt.; 3- Zohria Botanic Garden, Gezira, Cairo, Egypt.; 4- Agricultural Museum Garden, Dokki, Egypt.; 5- Faculty of Education Botanic Garden, Ain Shams University, Roxy, Cairo, Egypt.; 6- Faculty of Science Botanic Garden, Botany Dept., Ain Shams University, Abbassia, Cairo, Egypt.; 7- Herbarium of Ain Shams University, Faculty of Science, Botany Dept., Abbassia, Cairo, Egypt.; 8- Elkobba Palace Botanic Garden, Cairo, Egypt.; 9- Elkatamia-El Suez desert road, Egypt.; 10- Cairo-El Suez road, Cultivated area, Egypt.; 11- Cairo-Alexandria Desert sroad, Cultivated area, Egypt.; 12- Um Hibal Valley, Aswan-Elaliqy road, Egypt.; 13- El Saluga Protectorate Area, Aswan, Egypt.; 14- Feiran Valley, Saint Katherine desert road, South Sinai, Egypt.; 15- Hohenheim Botanic Garden, Botany Dept., University Hohenheim, Stuttgart, Germany.; 16- Herbarium of the Royal Botanic Gardens, Kew, UK.

Identification key of the studied taxa of Mimosoideae based on the palynological characters

I Few numbers of pollen grains per anther (8, polyads per anther)

1A Calymmate polyads, 8-monad, uniplanar, oval with sticky narrow acuteend……. *Calliandra haematocephala*

2A Acalymmate polyads

1B Polyads (16-monad) with Y, H-shaped invaginations

1C Columellae indistinct

1D Sculpturing; psilate .... *Acacia tortilis* subsp *raddiana*

2D Sculpturing; psilate-foveolate .... *A. tortilis* subsp *tortilis*

2C Columellae distinct

1E Sculpturing; micro-reticulate…………… *A. oerfota* var. *brevifolia*

2E Sculpturing; rugulate-fossulate……….. *A. farnesiana*

3E Sculpturing; foveolate

1F Sexine as thick as nexine……………… *A. ehrenbergiana*

2F Sexine thicker than nexine

1G Polyads large to medium in size class [(55) 50 (47.5) m]………… *A. origena*

2G Polyads medium in size class [(45) 42.5 (37.5) µm]……………… *A. nilotica* subsp. *indica*

4E Sculpturing; psilate-foveolate

1H Polyads, rounded, medium in size [(45) 40(35) µm]…… *A. nilotica* subsp *tomentosa*

2H Polyads, semi-rounded, large to medium class[(57.552.5(45) µm]….. *A. pachyceras*

3H. Polyads, rounded to semi-rounded, medium to large in size class [(55) 50 (42.5) µm………… *A. seyal*

2B Polyads (16, 28, 32-monad) with pseudocolpi

1I Polyads (28, 32-monad).

1J. Marked pseudocolpi………………… *Enterolobium contortisiliquum*

2J Faint pseudocolpi…………………………… *E. schomburgkii*

2I Polyads (16-monad).

1K Marked pseudocolpi, ± square in shape……. *Acacia saligna*

2K Marked pseudocolpi, irregular in shape…… *Pithecellobium lobatum*

3B Not so.

1L Polyads (32-monad), very large in size class, sculpturing; foveolate-rugulate……………… *Faidherbia albida*

2L Polyads (16-monad).

1M Sculpturing; psilate…………………… *Acacia hamulosa*

2M Sculpturing, faint reticulate

1N Monads alternated in arrangement with undulating edges……….. *A.laeta*

2N Not so……………………………… *A. senegal*

3M Sculpturing, scabrate-psilate.

1O Polyads large in size class, columellae distinct with uniform in length………………. *Pithecellobium dulce*

2O Polyads large to very large in size class, columellae indistinct……. *Albizia anthelmintica*

4M Sculpturing, psilate-foveolate.

1P Polyads large to very large in size class with viscin threads (non-acetolyzed polyads)………. *Al. lebbeck*

2P Polyads large to very large in size class without viscin threads.

1Q Polyads (8, 12, 16-monad).

1R Polyads large to very large in size class……. *Al. gamblei*

2R Polyads large in size class……………....... *Al. stipulata*

2Q Polyads (6, 12, 16-monad)……………... *Al. julibrissin*

3Q Polyads (12, 16-monad)…………………... *Al. procera*

1I. Numerous number of pollen grains per anther

1S Single pollen grains.

1T Hairy anthers……………………………. *Leucaena glauca*

2T Not hairy anthers. *Prosopis juliflora*

1U Columellae length; longer towards intercolpi, sculpturing; rugulate-fossulate……..

2U Columellae length; uniform.

1V Sculpturing; verrucate………………….. *P. chilensis*

2V Sculpturing; foveolate-psilate…………… *P. farcta*

2S Compound pollen grains…………….

1W Tetrad (4-monad), rhomboidal or tetrahedral…..

1X Tetrads small to medium in size class, rhomboidal or tetrahedral, ellipsoidal to spheroidal in shape……………………………………… *Mimosa pigra*

2X Tetrads minute in size class, tetrahedral, spheroidal in shape…….	*M. pudica*
2W Bitetrad (8-monad), decussate………………………………………	*M.myriocephala*
3W Polyad (16, 24-monad)	
1Y Calymmate polyads, sculpturing; scabrate……………………….	*Anadenanthera peregrine*
2Y Acalymmate polyads.	
1Z Very loosely acalymmate polyads, irregular to spheroidal in shape, sculpturing; verrucate………………………………………..	*Dichrostachys cinerea*
2Z Loosely acalymmate, 16-monad, rounded to oval in shape, sculpturing; scabrate-psilate…………………………………	*Adenanthera pavonina*

Number of pollen per anther. (Table II and Plate I; Fig. 1-3). Eight polyads per anther in 26 out of the studied taxa e.g. *Acacia tortilis* subsp. *raddiana* (Fig. 1), numerous pollen grains (compound) e.g. *Adenanthera pavonina* (Fig. 2) or single in the remaining 10 studied taxa (Fig. 3). Stone *et al.* (2003) uses the number of pollen per anther to differentiate between some *Acacia* species by calculation the number of polyads per flower. It was observed that all the studied species of *Acacia* have polyads per anther and this character was considered unreliable to use in differentiation between the studied *Acacia* species.

Number of associated monads. (Table II & Plate I; Fig. 4-12). The pollen is shed as single grain as in *Leucaena glauca*, *Prosopis chilensis*, *P. farcta* and *P. juliflora* (Fig. 4), 4-monad as in *Mimosa pigra* and *M. pudica* (Fig. 5), 6, 12, 16-monad in *Albizia julibrissin* (Fig. 6), 8-monad in *Calliandra haematocephala* and *Mimosa myriocephala* (Fig. 7), 12, 16-monad in *Albizia anthelmintica*, *Al. lebbeck* and *Al. procera* (Fig. 8), 16-monad in 18 out of the studied taxa e.g. *Accacia franesiana* (Fig. 9), 8, 12, 16-monad in *Albizia gamblei* and *Al. stipulata*, 8, 16, 24-monad in *Dichrostachys cinerea* (Fig. 10), 28, 32-monads in *Faidherbia albida* (Fig. 11), 32-monads in *Enterolobium contortisiliquum* and *E. schomburgkii* (Fig. 12).

It was observed that the basic pollen unit through the majority of the studied taxa is the monads' case. This is in accordance with the concept of Walker and Doyle (1975) "the monads' case of pollen unit considered the basic pollen-unit for dyads, tetrads and polyads in angiosperms". Guinet and Ferguson (1989) suggested that the higher polyad grain number increases the reproductive capacity of species. Thanikaimoni (1986) and Knox and McConchie (1986) state that the cohesion of monads into tetrads and polyads seems to be a functional advantage to entomophily

Table II. Pollen morphology: No. of pollen per anther, No. of associated monads, polarity, pollen type, pollenkitt, shape and symmetry of the studied taxa of Mimosoideae

No.	Characters Taxa	No. of pollen per anther	No. of associated monads	Polarity	Pollen type	Pollenkitt	Shape In: Polar View	Shape In: Equatorial View	Symmetry
1	*Acacia ehrenbergiana*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	R.	R.	S.
2	*A. farnesiana*	8	16-Monad	H	T. Acalymmate	W. Conspicuous	E. To Sr.	E.	S.
3	*A. hamulose*	8	16-Monad	H	L. Acalymmate	W. Conspicuous	R. To Sr.	R.	S.
4	*A. laeta*	8	16-Monad	H	L. Acalymmate	W. Conspicuous	E.	E.	S.
5	*A. nilotica* subsp. *indica*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	R	R.	S.
6	*A. nilotica* subsp. *tomentosa*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	E.	E.	S.
7	*A. oerfota* var. *brevifolia*	8	16-Monad	H	T. Acalymmate	W. Conspicuous	R. To Sr.	Ellipsoidal To	S.
8	*A. origena*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	E.	Spheroidal	S.
9	*A. pachyceras* var. *pachyceras*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	R	Oae.	S.
10	*A. saligna*	8	16-Monad	H	L. Acalymmate	W. Conspicuous	E.	Eae.	S.
11	*A. senegal*	8	16-Monad	H	L. Acalymmate	W. Conspicuous	R	Irregular To	S.
12	*A. seyal*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	E	Spheroidal	S.
13	*A. tortilis* subsp. *raddiana*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	R To Sr.	R. To Sr.	S.
14	*A. tortilis* subsp. *tortilis*	8	16-Monad	H	T. Acalymmate	S. Conspicuous	E.	E. To O.	S.
15	*Adenanthera pavonina*	Numerous	16-Monad	H	L. Acalymmate	N. Conspicuous	R	R. To Sr.	S. Or D.
16	*Albizia anthelmintica*	8	12, 16-Monad	H	L. Acalymmate	S. Conspicuous	E.	E.	S. Or D.
17	*Al. gamblei*	8	8, 12, 16-Monad	H	L. Acalymmate	W. Conspicuous	Sr.	R. To Sr.	S. Or D.
18	*Al. julibrissin*	8	6, 12, 16-Monad	H	L. Acalymmate	W. Conspicuous	E.	E.	S. Or D.
19	*Al. lebbeck*	8	12, 16-Monad	H	L. Acalymmate	N. Conspicuous	R.	Sc.	S. Or D.
20	*Al. procera*	8	12, 16-Monad	H	L. Acalymmate	W. Conspicuous	O. To Sr.	Sc. To E.	S. Or D.
21	*Al. stipulata*	8	8, 12, 16-Monad	H	L. Acalymmate	W. Conspicuous	R	Ellipsoidal To	S. Or D.
22	*Anadenanthera peregrina*	Numerous	16-Monad	H	Calymmate	N. Conspicuous	Sr.	Spheroidal	D.
23	*Calliandra haematocephala*	8	8-Monad	H	Calymmate	N. Conspicuous	R. To Sr.	Ellipsoidal To	D.
24	*Dichrostachys cinerea*	Numerous	8,16, 24-Monad	H	V. L. Acalymmate	N. Conspicuous	E.	Spheroidal	D.
25	*Enterolobium contortisiliquum*	8	32-Monad	H	L. Acalymmate	W. Conspicuous	R. To Sr.	Spheroidal ,	D.
26	*E. schomburgkii*	8	32-Monad	H	L. Acalymmate	W. Conspicuous	E.	Tetrahedral	D.
27	*Faidherbia albida*	8	28, 32-Monad	H	L. Acalymmate	S. Conspicuous	R. To Sr.	R.	D.
28	*Leucaena glauca*	Numerous	Single	I	----	N. Conspicuous	O. To Sr.	E.	Radially S.
29	*Mimosa myriocephala*	Numerous	8-Monad	H	T. Acalymmate	N. Conspicuous	R.	R.	D.
30	*M. pigra*	Numerous	4-Monad	H	T. Acalymmate	N. Conspicuous	O. To Sr.	E.	S.
31	*M. pudica*	Numerous	4-Monad	H	T. Acalymmate	N. Conspicuous	R	Sc.	D.
32	*Pithecellobium dulce*	8	16-Monad	H	L. Acalymmate	S. Conspicuous	Sr.	E.	S. Or D.
33	*Pithecellobium lobatum*	8	16-Monad	H	L. Acalymmate	S. Conspicuous	R.	C.	S. Or D.
34	*Prosopis chilensis*	Numerous	Single	I	----	W. Conspicuous	E.	Sc.	Radially S.
35	*P. farcta*	Numerous	Single	I	----	W. Conspicuous	R.	Sc.	Radially S.
36	*P. juliflora*	Numerous	Single	I	----	S. Conspicuous	E.	Sc. To E.	Radially S.

C: Circular, E: Elliptic, Eae: With Acuminate End., L: Loosely; N: Not, O: Oval, Oae: With Acute End., R: Rounded, S: Strong, S: Symmetric, Sc: Semi Circular, Sr: Semi Rounded, T: Tightly, D: Dissymetric, H: Heteropolar, I: Isopolar, W: Weak

Table III. Pollen morphology: Dimension, shape classes and pollen size classes of the studied taxa of Mimosoideae

No.	Taxa	Dimensions (LM)						Pollen Size Classes
		Single Grains				Compound Grains		
		Polar Axis (P µM)	Equatorial Axis (E µM)	P/E	Shape Classes Sp. Spheroidal	Polyads (µM)	Monads (Longest Axis) (µM) Central & Peripheral	Mi.: Minute S.: Small M.: Medium L.: Large V. L. : Very Large
1	*Acacia ehrenbergiana*	--	--	--	--	(40) 42.5 (47.5)	(10) 12.5 (17.5)	M.
2	*A. farnesiana*	--	--	--	--	(77. 5) 67.5 (52.5)	(25) 20 (15)	L.
3	*A. hamulosa*	--	--	--	--	(57. 5) 52.5 (45)	(12. 5) 15 (17. 5)	L. To M.
4	*A. laeta*	--	--	--	--	(55) 50 (45)	(22. 5) 20 (15)	L. To M.
5	*A. nilotica* subsp. *indica*	--	--	--	--	(45) 42.5 (37.5)	(15) 12.5 (10)	M.
6	*A. nilotica* subsp. *tomentosa*	--	--	--	--	(45) 40 (35)	(15) 12.5 (10)	M.
7	*A. oerfota* var. *brevifolia*	--	--	--	--	(55) 50 (47.5)	(20) 17.5 (15)	M.
8	*A. origena*	--	--	--	--	(55) 50 (47.5)	(17.5) 15 (12.5)	L. To M.
9	*A. pachyceras* var. *pachyceras*	--	--	--	--	(57.5) 52.5 (45)	(17.5) 15 (12.5)	L. To M.
10	*A.saligna*	--	--	--	--	(90) 85 (65)	(32.5) 30 (25)	L.
11	*A. senegal*	--	--	--	--	(50) 45 (40)	(17.5) 15 (12.5)	M. To L.
12	*A. seyal*	--	--	--	--	(55) 50 (42.5)	(20) 17.5 (12.5)	M. To L.
13	*A.tortilis* subsp. *raddiana*	--	--	--	--	(60) 52 (47.5)	(20) 17.5 (15)	L.
14	*A. tortilis* subsp. *tortilis*	--	--	--	--	(50) 47.5 (37.5)	(17.5) 15 (10)	M. To L.
15	*Adenanthera pavonina*	--	--	--	--	(55) 52.5 (42.5)	(22.5) 17.5 (15)	L. To M.
16	*Albizia anthelmintica*	--	--	--	--	(85) 77.5 (65)	(32.5) 30 (25)	L.
17	*Al. gamblei*	--	--	--	--	(105) 95 (57.5)	(40) 35 (27.5)	L. To V. L.
18	*Al. julibrissin*	--	--	--	--	(90) 82.5 (75)	(35) 30 (27.5)	L.
19	*Al. lebbeck*	--	--	--	--	(102) 95 (87.5)	(37.5) 32.5 (27.5)	L. To V. L.
20	*Al. procera*	--	--	--	--	(90) 85 (77.5)	(35) 30 (27.5)	L.
21	*Al. stipulata*	--	--	--	--	(80) 75 (70)	(35) 30 (26)	L.
22	*Anadenanthera peregrina*	--	--	--	--	(37. 5) 32.5 (25)	(12.5) 10 (5)	M.
23	*Calliandra haematocephala*	--	--	--	--	(185) 175 (150)	(50) 42.5 (35) & (80) 70 (57.5)	V. L.
24	*Dichrostachys cinerea*	--	--	--	--	(102.5) 92.5 (75)	(40) 35 (30)	L. To V. L.
25	*Enterolobium contortisiliquum*	--	--	--	--	(105) 97.5 (85)	(32.5) 27.5 (20)	L. To V. L.
26	*E. schomburgkii*	--	--	--	--	(82.5) 77.5 (72.5)	(25) 17.5 (22.5)	L.
27	*Faidherbia albida*	--	--	--	--	(165) 150 (135)	(47.5) 40 (37.5)	V. L.
28	*Leucaena glauca*	(80) 67.5 (42.5)	(80) 67.5 (42.5)	1	Prolate Sp.	--	--	L.
29	*Mimosa myriocephala*	--	--	--	--	(16) 15 (13.75)	(8.75) 7.5 (7)	S.
30	*M. pigra*	--	--	--	--	(27.5) 22.5 (17.5)	(15) 12.5 (10)	S. To M.
31	*M. pudica*	--	--	--	--	(10) 9 (7)	(6) 5 (4)	Mi. To S.
32	*Pithecellobium dulce*	--	--	--	--	(112.5) 105 (92.5)	(45) 40) (32.5)	L. To V. L.
33	*P. lobatum*	--	--	--	--	(117.5) 105 (95)	(42.5) 40 (35)	L. To V. L.
34	*Prosopis chilensis*	(32.5) 30 (20)	(27.5) 22.5 (2o)	1.33	Sub Prolate	--	--	M.
35	*P.farcta*	(27.5) 22.5 (20)	(27.5) 25 (20)	0.9	Oblate Sp.	--	--	S. To M.
36	*P. juliflora*	(35) 27.5 (25)	(35) 27.5 (22.5)	1	Prolate Sp.	--	--	M.

(the common main of the pollination in Mimosoideae). Since the monads often behave as a single harmomegathic.

Polarity. (Table II & Plate II; Fig. 1 & 2). Isopolar (single grains), in *Leucaena glauca, Prosopis chilensis, P. farcta*, and *P. juliflora* (Fig. 1), or heteropolar (compound grains), in 32 taxa e.g. *Albizia julibrissin* (Fig. 2).

Walker and Doyle (1975) suggested that the heteropolar case represents the primitive type of angiosperm. It was observed that the majority of the studied taxa are with heteropolar pollen and it was directly related to possession of a monosulcate pollen aperture.

Pollen type. (Table II & Plate II; Fig. 3 & 4a-c). Calymmate (simple type) was recorded only in *Anadenanthera peregrine* and *Calliandra haematocephala* (Fig. 3), or acalymmate in the remaining (Fig. 4a-c).

Van Campo and Guinet (1961) and Roland (1965) define the calymmate pollen, where the grains (monads) are fused together by their tecta which surround the whole compound grains (as a common tectum) without interruption. In contrast to acalymmate type, where the tectum is interrupted between grains (monads), and may absent from the individual internal walls. Knox and McConchie (1986) suggested that the compound pollen systems cohesion obviously provide pollinating animals with packages of pollen rendering an adequate effect on the fertilization.

Pollenkitt. (Table II & Plate II; Fig. 5 & 6). The pollenkitt may be strongly conspicuous in 13 out of the studied taxa e.g. *Albizia anthelmintic* (Fig. 5), weak conspicuous in 14 out of the studied taxa e.g. *Acacia farnesiana* (Fig. 6), or inconspicuous in nine of the studied taxa.

Walker and Doyle (1975) and Hesse (1980) reported that the most common type of pollen clusters is either sticky pollen grains or polyads. Cerceau-Larrival and Challe (1986) consider that pollen coating substances (pollenkitt) represent a part of the recognition system allowing pollen germination. It was considered that the fundamental plan through 27 of the studied taxa is the sticky pollen. Concerning the importance of pollenkitt, Thanikaimoni (1986), Dobson (1988) and Iwanami *et al.* (1988) remarked that the pollenkitt protects the pollen from the harmful effects of the environment, desiccation especially from radiation hazards by virtue of its ultraviolet absorbing pigments and may provide pollen with species

Table IV. Pollen morphology: Aperture characters of the studied taxa of Mimosoideae

No.	Taxa	Aperture characters (LM & SEM)																	
		Single grains											Compound Grains						
		Pollen Class Tri- & Tetra-Colporate	Ectoaperture (Colpus)					Endoaperture (Pore)				Apocolpium	Pores Occurrence				Colpus	Pseudocolpi	
			Width	Sides	Apices	Membrane	Level	Shape	Costa	Operculum	Level		Distal Face	Proximal Face	Clusters	Border	Shape	Visibility	Shape
1	*Acacia ehrenbergiana*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
2	*A. farnesiana*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
3	*A. hamulosa*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
4	*A. laeta*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	(-)	(-)	(-)	(-)
5	*A. nilotica* subsp. *indica*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
6	*A. nilotica* subsp. *tomentosa*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
7	*A. oerfota* var. *brevifolia*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
8	*A. origena*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
9	*A. pachyceras* var. *pachyceras*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
10	*A. saligna*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	(-)	(-)	M	± Sq.
11	*A. senegal*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
12	*A. seyal*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. &Th.	(-)	Y & H	(-)	(-)
13	*A. tortilis* subsp. *raddiana*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
14	*A. tortilis* subsp. *tortilis*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T. & Th.	(-)	Y & H	(-)	(-)
15	*Adenanthera pavonina*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	C	(-)	M	Irrg.
16	*Albizia. anthelmintica*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
17	*Al. gamblei*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
18	*Al. julibrissin*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
19	*Al. lebbeck*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
20	*Al. procera*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
21	*Al. stipulata*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
22	*Anadenanthera peregrina*	--	--	--	--	--	--	--	--	--	--	--	Indis.	Indis.	Th. & F.	(-)	(-)	(-)	(-)
23	*Calliandra haematocephala*	--	--	--	--	--	--	--	--	--	--	--	(+)	(-)	Th. & F.	(-)	(-)	(-)	(-)
24	*Dichrostachys cinerea*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	T., Th. F	(-)	(-)	(-)	(-)
25	*Enterolobium contortisiliquum*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	M	Irrg.
26	*E. schomburgkii*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	Faint	Irrg.
27	*Faidherbia albida*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
28	*Leucaena glauca*	Tr. & Te.	Re.N	P.	T.	Sm.	Sl.Su.	Ov.	(+)	(+)	Su.	RV S	--	--	--	--	--	--	--
29	*Mimosa myriocephala*	--	--	--	--	--	--	--	--	--	--	--	(+)	Indis.	T. & Th.	(-)	(-)	(-)	(-)
30	*M. pigra*	--	--	--	--	--	--	--	--	--	--	--	(+)	Indis.	Th. & F.	A	(-)	(-)	(-)
31	*M. pudica*	--	--	--	--	--	--	--	--	--	--	--	(+)	Indis.	Th.	Indis.	(-)	(-)	(-)
32	*Pithecellobium dulce*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	(-)	(-)
33	*P.lobatum*	--	--	--	--	--	--	--	--	--	--	--	(+)	(+)	Th. & F.	A	(-)	M	Irrg.
34	*Prosopis chilensis*	Tr. & Te.	Re.B.	P.	T.	F. G.	Sl.Su.	± Cr.	(+)	(+)	Sl.Su.	RV S	--	--	--	--	--	--	--
35	*P. farcta*	Tr. & Te.	Re.B.	P.	R.	F. G.	Sl.Su.	± Cr.	(+)	(+)	Sl.Su.	RV S	--	--	--	--	--	--	--
36	*P. juliflora*	Tr. & Te.	Re.B.	P& C	R.	F. G.	Sl.Su.	± Cr.	(+)	(+)	Su.	RS	--	--	--	--	--	--	--

A= Annulus; B= Broad; Cr= Circular; F= Fine; F= Four; FC= Constricted; G= Granular; Indis= Indiscernible; M= Marked; N= Narrow; Ov= Oval; P= Parallel; Re= Relatively; R= Round; RVS= Relatively very small; RS= Relatively small; Sm= Smooth; Sl= Slightly; Su= Sunken; Tr= Tri; Te= Tetra; T= Tapering; T= Two; Th= Three (+)= Present; (-)= Absent

specific odours.

Pollen Shape. (Table II & Plate III; Fig. 1-5). The shape of both single and compound pollen grains was seen in polar and equatorial view.

Single grains. In polar view: circular in *Prosopis farcta* (Fig. 1a) and semicircular in *Leucaena glauca*, *Prosopis chilensis* and *P. juliflora* (Fig. 1b). In equatorial view: semicircular in *Prosopis farcta*, (Fig. 2a) semicircular-elliptic in *Leucaena glauca* and *Prosopis juliflora* (Fig. 2b) and elliptic in *Prosopis chilensis* (Fig. 2c).

Compound grains. In 27 out of the studied taxa, the polar and equatorial view of the compound grains could be detected. In polar view: rounded in 16 out of the studied taxa e.g. *Albizia julibrissin* (Fig. 3a), semi-rounded in *Acacia pachyceras* var. *pachyceras* (Fig. 3b), rounded to semi-rounded in nine of studied taxa e.g. *Acacia seyal* (Fig. 3c), and oval with more or less acute end in *Calliandra haematocephala* (Fig. 3d). In equatorial view: elliptic in 19 out of the studied taxa e.g. *Albizia julibrissin* (Fig.4a), elliptic-oval in *Enterolobium contortisiliquum* (Fig. 4b), oval-spheroidal in *Acacia saligna*, *A. tortilis* subsp. *tortilis* and *Adenanthera pavonina* (Fig. 4c), semi-rounded in *Acacia senegal* and *Albizia anthelmintica* (Fig. 4d), elliptic-semi-rounded in *Acacia ehrenbergiana* (Fig. 4e), and elliptic with acuminate end in *Calliandra haematocephala* (Fig. 4f).

Indistinct differentiation. Between polar and equatorial views**:** ellipsoidal-spheroidal in *Anadenanthera peregrina*, *Mimosa myriocephala* and *M. pigra* (Fig. 5a), spheroidal tetrahedral in *Mimosa pudica* (Fig. 5b) and irregular ellipsoidal-spheroidal in *Dichrostachys cinerea* (Fig. 5c).

Guinet and Thomas (1990) and Moore *et al.* (1991) reported that the shape of grain is useful in identification and the shape of the pollen unit and the exine structure are more or less strongly dissymmetric when the pollen is permanently compound.

Symmetry. (Table II). The subsequent cases were recorded: **Single grains.** radially symmetric as in *Leucaena glauca*,

Table V. Pollen morphology: Exine, columellae, sculpturing patterns, harmomegathic device and prominent characters of the studied taxa of Mimosoideae

No.	Taxa	Exine (LM &SEM)			Columellae (LM& SEM)		Sculpturing patterns (SEM)	Harmomegathic device (Sem) Aspects (Trp., Y-H., Pd., Dpw. & Iam.)	Prominent characters (LM & SEM)
		Tectum (Trp.) (Tas.)	Perforations (+) (-)	Thickness Of Sexine Relative To Nexine (K. T. & A. T.)	Visibility (D.) (Id.)	Length (Id., Uf. Lti., Ir.)			
1	*Acacia ehrenbergiana*	Trp.	(+)	A. T.	D.	Lti.	Foveolate	Trp. & Y-H.	Y-H.
2	*A. farnesiana*	Trp.	(+)	K. T.	D.	Lti.	Rugulate-Fossulate	Trp. & Y-H.	Y-H.
3	*A. hamulosa*	Trp.	(+)	A. T.	Id.	Id.	Psilate	Trp. & Dpw	---
4	*A. laeta*	Trp.	(-)	K. T.	Id.	Id.	Faint Reticulate	Trp. & Dpw .	Uem
5	*A. nilotica* subsp. *indica*	Trp.	(+)	K. T.	D.	Lti.	Foveolate	Trp. & Y-H.	Y-H.
6	*A. nilotica* subsp. *tomentosa*	Trp.	(+)	K. T.	D.	Lti.	Psilate-Foveolate	Trp. & Y-H.	Y-H.
7	*A. oerfota* var. *brevifolia*	Trp.	(+)	K. T.	D.	Lti.	Micro-Reticulate	Trp .& Y-H.	Y-H.
8	*A. origena*	Trp.	(+)	K. T.	D.	Lti.	Foveolate	Trp. & Y-H.	Y-H.
9	*A. pachyceras* var. *pachyceras*	Trp.	(+)	K. T.	D.	Lti.	Psilate-Foveolate	Trp. & Y-H.	Y-H.
10	*A. saligna*	Trp.	(-)	K. T.	Id.	Id.	Faint Reticulate-Psilate	Trp., Dpw.& Pd.	Marked Pd.
11	*A. senegal*	Trp.	(-)	K. T.	Id.	Id.	Faint Reticulate	Trp. & Dpw.	---
12	*A. seyal*	Trp.	(+)	K. T.	D.	Lti.	Psilate-Foveolate	Trp. & Y-H.	Y-H.
13	*A.tortilis* subsp. *raddiana*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp .& Y-H.	Y-H.
14	*A. tortilis* subsp. *tortilis*	Trp.	(+)	K. T.	Id.	Id.	Psilate	Trp. & Y-H.	Y-H.
15	*Adenanthera pavonina*	Trp.	(-)	K. T.	Id.	Id.	Scabrate-Psilate	Trp., Dpw.& Pd.	Pd. & Uem
16	*Albizia anthelmintica*	Trp.	(+)	K. T.	Id.	Id.	Scabrate-Psilate	Trp. & Dpw.	---
17	*Al. gamblei*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp. & Dpw.	---
18	*Al. julibrissin*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp. & Dpw.	---
19	*Al. lebbeck*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp. & Dpw.	Viscin Threads
20	*Al.procera*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp. & Dpw.	---
21	*Al. stipulata*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp. & Dpw.	---
22	*Anadenanthera peregrina*	Trp.	(+)	K. T.	Id.	Id.	Scabrate	Trp. & Dpw.	Mnp.
23	*Calliandra haematocephala*	Trp.	(+)	K. T.	D.	Uf.	Rugulate-Fossulate	Trp. & Dpw.	Oans.
24	*Dichrostachys cinerea*	Tas.	(+)	K. T.	D.	Ir.	Verrucate	Dpw.	Vlip.
25	*Enterolobium contortisiliquum*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp., Dpw. & Pd.	Marked Pd.
26	*E. schomburgkii*	Trp.	(+)	K. T.	Id.	Id.	Psilate-Foveolate	Trp. & Pd.	Faint Pd.
27	*Faidherbia albida*	Trp.	(+)	K. T.	D.	Uf.	Foveolate-Rugulate	Trp. & Dpw.	---
28	*Leucaena glauca*	Tas.	(+)	K. T.	D.	Lti.	Psilate- Perforate	Iam.	Sha.
29	*Mimosa myriocephala*	Trp.	(-)	Indis.	Id.	Id.	Scabrate	Trp. & Dpw.	Omd.
30	*M. pigra*	Trp.	(+)	Indis.	Id.	Id.	Scabrate	Trp. & Dpw.	Tum.
31	*M. pudica*	Trp.	(+)	Indis.	Id.	Id.	Faint Scabrate	Trp. & Dpw.	Mt.
32	*Pithecellobium dulce*	Trp.	(+)	K. T.	D.	Uf.	Scabrate-Psilate	Trp. & Dpw.	---
33	*P. lobatum*	Trp.	(+)	K. T.	D.	Lti.	Verrucate-Psilate	Trp. & Pd.	Pd.
34	*Prosopis chilensis*	Tas.	(-)	K. T.	D.	Uf.	Verrucate	Iam.	N. Snh.
35	*P. farcta*	Tas.	(+)	K. T.	D.	Uf.	Foveolate-Psilate	Iam.	N. Snh.
36	*P. juliflora*	Tas.	(+)	K. T.	D.	Lti.	Rugulate-Fossulate	Iam.	N. Snh.

A. T. = As Thicker As, D. = Distinct, Dpw. = Depression Of Pollen Wall, Iam.= Invagination Of Aperture Membrane, Id.= Indistinct, Indis. = Indiscernible, Ir. = Irregular, K. T= Thicker Than, Lti. = Longer Towards The Intercolpi, Mnp.= Monads Not Prominently Outlined, Mt.= Minute Tetrahedral, N.= Numerous, Oans.= Oval-Shaped With More Or Less Acute Abruptly Narrow Sticky End, Omd. = Octad Multiplanar Decussate, Pd.= Pseudocolpi Depression, Sha.= Single Grains In Hairy Anther, Snh.= Single Grains In Not Hairy Anther. Tas. = Tectate All Over The Surface, Trp. = Tectum Reduced On The Proximal Face, Tum. = Tetrad Uniplanar Or Multiplanar, Uf. = Uniform, Uem. = Undulating Edges Of Monads, Vlip.= Very Loosely Acalymmate Irregularly Polyad, Y-H. = Y& H-Shaped Farrows, (+) = Present, (-) = Absent.

Prosopis chilensis, P. farcta and P. juliflora.

Compound grains. symmetric in 14 of studied taxa, dissymmetric in nine, and symmetric or dissymmetric in nine. Both symmetric and dissymmetric are present in the same species according to the variations of the number of associated monad. Walker and Doyle (1975) record that when the pollen is shed singly, its shape as well as the aperture locations are nearly always equatorial and highly symmetric.

Dimensions. (Table III). According to Walker and Doyle (1975) and concerning the length of the longest axis of single and compound grains [whatever this axis is polar (P) or equatorial axis (E)], the pollen grain size in this work falls in the size range of the minute-sized (‹ 10 µm), small sized (10-24 µm), medium-sized (25-49 µm), large (50-99 µm) to very large sized grains (100-199 µm).

Pollen shape classes. (Table III). It was applied only on four of the investigated taxa (single grains); oblate spheroidal [P/E= 0.88-1.0 (7:8-8:8)]: in *Prosopis* farcta, subprolate [P/E=1.33-1.14 (8:6-8:3)]: in *Prosopis chilensis*, or prolate spheroidal [P/E=1.0-1.14 (8:8-8:7)]: in *Leucaena glauca* & *Prosopis juliflora.* Erdtman (1943) determine the shape class as the ratio between the polar area (P) and the total breadth (E) of grain in equatorial view when one of the apertures lies exactly at the centre.

Pollen size classes. (Table III). Minute to small in *Mimosa pudica*, small in *Mimosa myriocephala* , small to medium in *Prosopis farcta* and *Mimosa pigra*, medium in seven out of the studied taxa, medium to large in *Acacia senegal*, *A. seyal* and *A. tortilis* subsp. *tortilis*, large to medium in five

Plate I. Pollen morphology: a- Number of pollen per anther; Fig. 1: *Acacia. tortilis* subsp. *raddiana*; 2: *Adenanthera pavonina* ; 3: *Acacia. hamulosa;* b- Number of associated monads: Fig 4: *Leucaena glauca*; 5: *Mimosa pigra*; 6: *Albizia julibrissin*; 7: *Calliandra haematocephala*; 8: *Albizia lebbeck*; 9: *Acacia farnesiana*; 10: *Dichrostachys cinerea*; 11: *Faidheriua albida*; 12: *Enterolobium schomburgkii*.

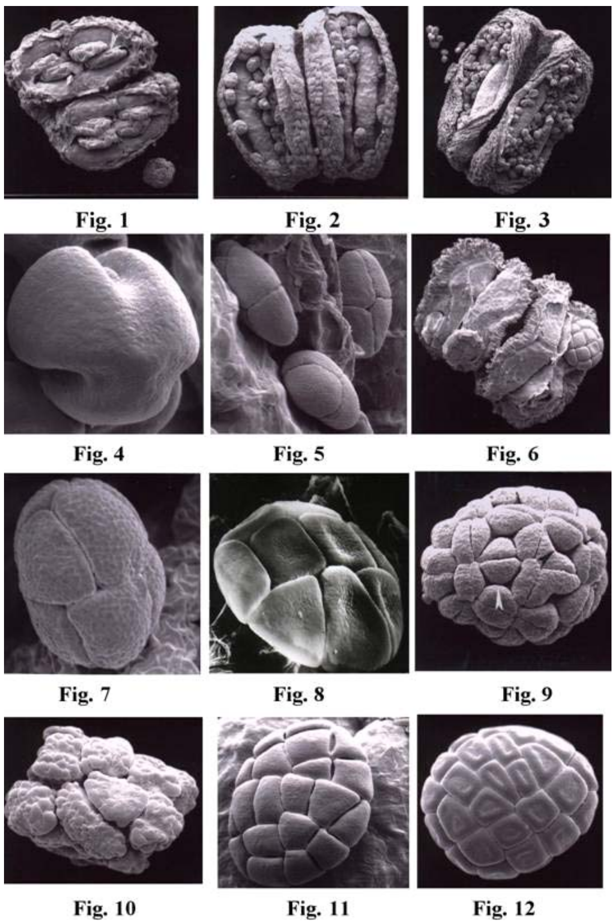
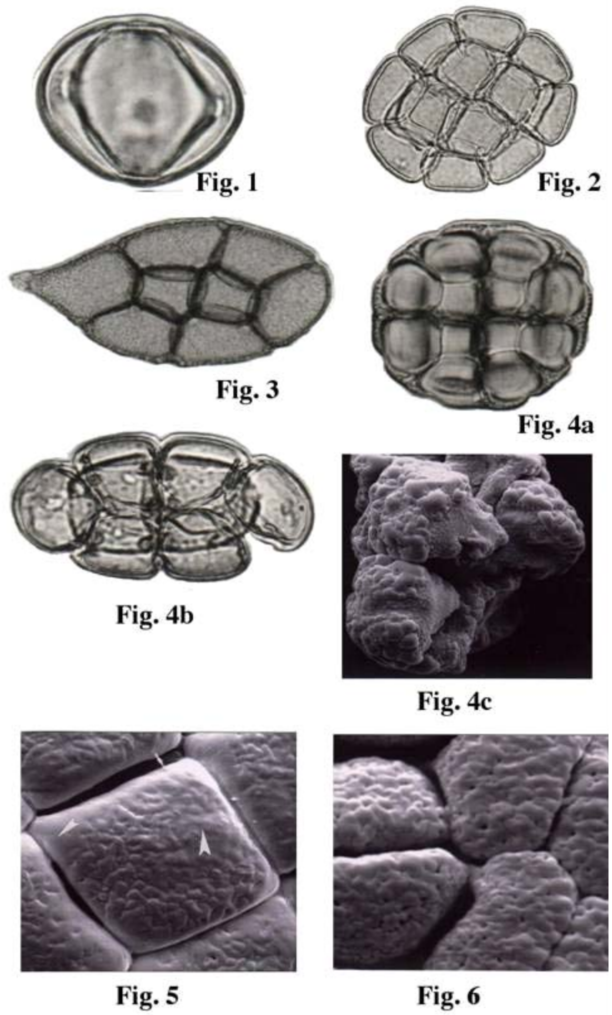


Plate II. Pollen morphology: Fig. 1: *Prosopis chilensis*; 2: *Albizia julibrissin* Polarity; Fig 3: *Calliandra haematocephala;* 4a: *Mimosa pudica*; 4b: *Acacia seyal*; c: *Acacia saligna*; pollen type; Fig. 5: *Albizia anthelmintic*; pollenkitt: 6: *Acacia farnesiana*.



studied taxa, large in nine taxa, large to very large in six taxa, or very large in *Calliandra haematocephala* and *Faidherbia albida.* Walker and Doyle (1975) considered that the primitive angiosperm pollen falls largely in the large-sized class (50-99 µm). Accordingly, the taxa in the present study fall in the range of the minute-sized to very large-sized grains (9-185 µm). Elias (1981) referred to the characteristic pollen in Mimosoideae (a homogenous group) where both the largest (*Calliandra,* 320 µm) and smallest pollen units (*Mimosa,* 6 µm) are found in this subfamily. Hesse (1986), Guinet and Rico (1988) and Guinet and Thomas (1990) suggested that the large to very large compound grains in Mimosoideae encourage biotic agents pollination (insects, birds, bats).

Aperture characters. (Table IV & Plate IV; Fig. 1-7)**.**

In single grains. the aperture characters were studied in *Leucaena glauca*, *Prosopis chilensis*, *P. farcta* and *P. juliflora.*

Pollen class. tricolporate e.g. *Prosopis chilensis* (Fig. 1a), tetracolporate e.g. *Prosopis juliflora* (Fig. 1b). **Ectoaperture.**

Colpus width. relatively narrow in *Leucaena glauca*, and relatively broad in *Prosopis chilensis*, *P. farcta* and *P. juliflora*.

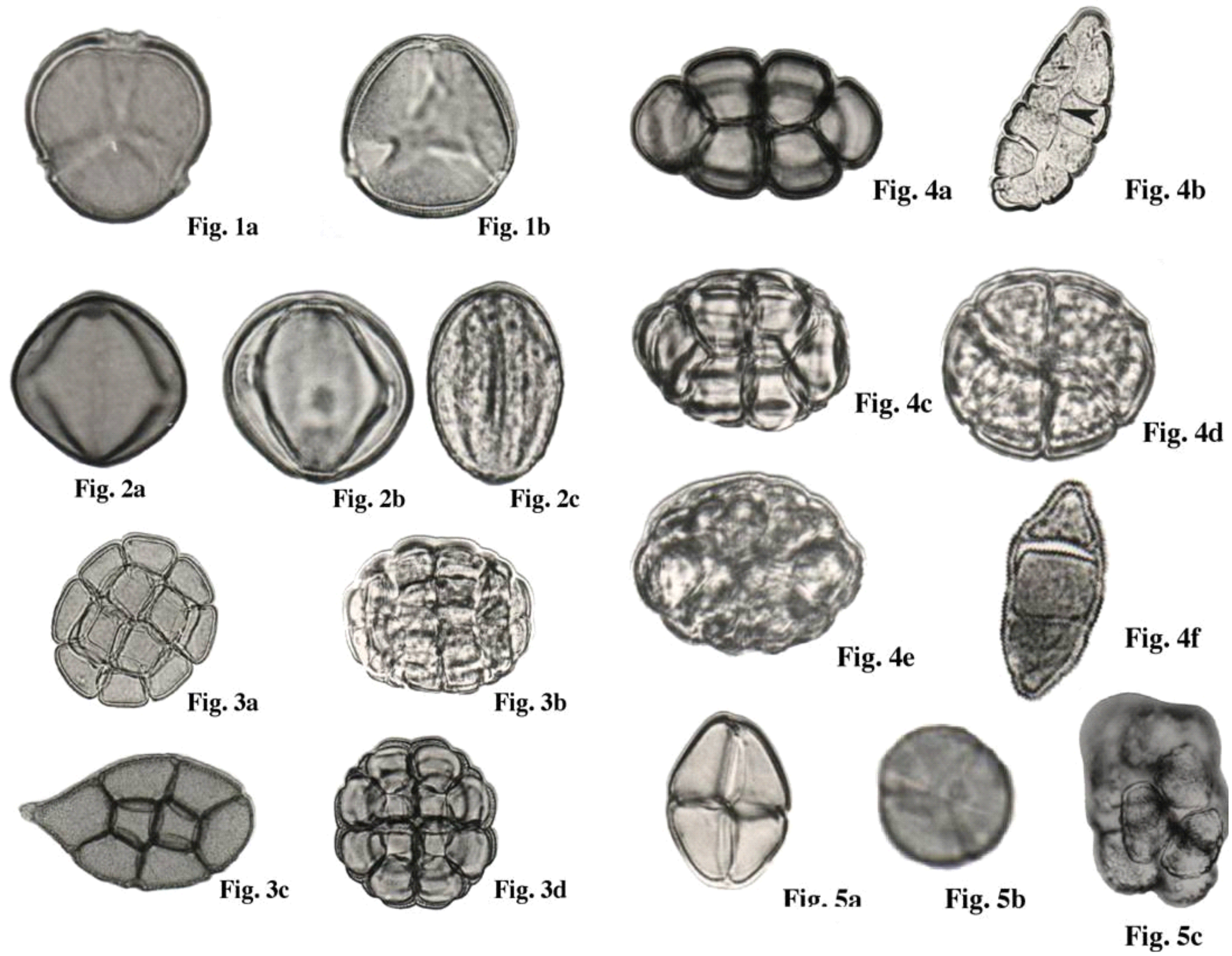
Colpus sides. parallel in *Leucaena glauca, Prosopis chilensis and P. farcta* (Fig. 2a) and parallel or constricted in *Prosopis juliflora* (Fig. 2b).

Colpus apices. tapering in *Leucaena glauca* and *Prosopis chilensis* (Fig. 3a) and rounded in *Prosopis farcta* and *P. juliflora* (Fig. 3b).

Colpus membrane. smooth in *Leucaena glauca* (Fig. 4a) and finely granular in *Prosopis chilensis, P. farcta* and *P. juliflora S* (Fig. 4b)**.**

Plate III. Pollen morphology: Pollen shape: single grains: Fig. 1a: *Prosopis farcta*; b: *P. chilensis*; polar view; Fig 2a: *Prosopis farcta*; 2b: *P. juliflora*; 2c: *P. chilensis;* equatorial view; and compound grains; Fig. 3a: *Albizia julibrissin* ; 3b: *Acacia pachyceras*; 3c: *Acacia seyal*; 3d: *Calliandra haematocephala* polar view.

Plate III. Contd. Pollen morphology: Pollen shape: compound grains; Fig. 4a: *Albizia julibrissin*; 4b: *Enrerolobium controsiliquum*; 4c: *Adenanthera pavonina* ; 4d: *Acacia ehrenbergiana*; 4e: *Calliandra haematocephala*; 4f: *Acacia seyal* ; equatorial view; Fig. 5a: *Mimosa pigra*; 5b: *M. pudica*; 5c: *Dichrostachys cinerea*; indistinct.



Colpus surface level. slightly sunken recorded in the four taxa.

Endoaperture.

Pore shape. oval in *Leucaena glauca* and more or less circular in *Prosopis chilensis, P. farcta* and *P. juliflora.*

Pore costa. in the four taxa.

Pore operculum. in the four taxa.

Pore surface level. sunken in *Leucaena glauca* and *Prosopis juliflora* and slightly sunken in *Prosopis chilensis* and *P. farcta.*

Apocolpium. relatively very small area in *Leucaena glauca*, *Prosopis chilensis* and *P. farcta* and relatively small area in *P. juliflora.*

Compound Grains. The aperture characters were studied in the remainder 32 taxa.

Pore. 1- Occurrence on the distal face in 31 out of 32 taxa e.g. *Adenanthera pavonina* (Figs. 5a-b) and indiscernible in *Anadenanthera peregrine.* On the proximal face: in 27 out of 32 taxa e.g. *Albizia julibrissin*, absent in *Calliandra haematocephala* and indiscernible in four taxa. According to Guinet (1981b), the Mimosoideae seem to be the only group in the Angiosperms that have true (morphologically defined) functional proximal pores, on the individual cells (monads) when the pollen is compound. **2-** Pore clusters (Fig. 6a-d): by two and three in each cluster in 11 taxa e.g. *Acacia nilotica* subsp*. indica*, by threes and fours in 19 taxa e.g. *Adenanthera pavonina*, by two, three and four in *Dichrostachys cinerea* and by threes in *Mimosa pudica*. Considering the aperture number, Moore *et al.* (1991) recorded that the increased number of apertures provides a

Plate IV. Pollen morphology: Aperture characters: single grains; Fig. 1a: *Prosopsis chilensis*; 1b: *P. juliflora*; pollen class; Fig. 2a: *P. farcta*; 2b: *P. juliflora*; colpus sides; Fig. 3a: *Prosopsis chilensis*; 3b: *P. farcta*; colpus apices; Fig. 4a: *Leucaena glauca*; 4 b: *P. farcta* ; colpus memberane.

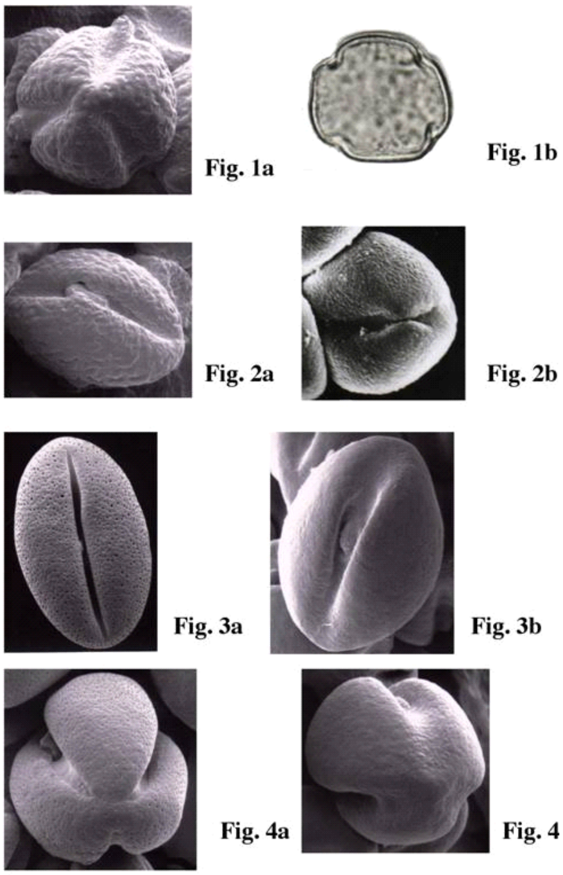
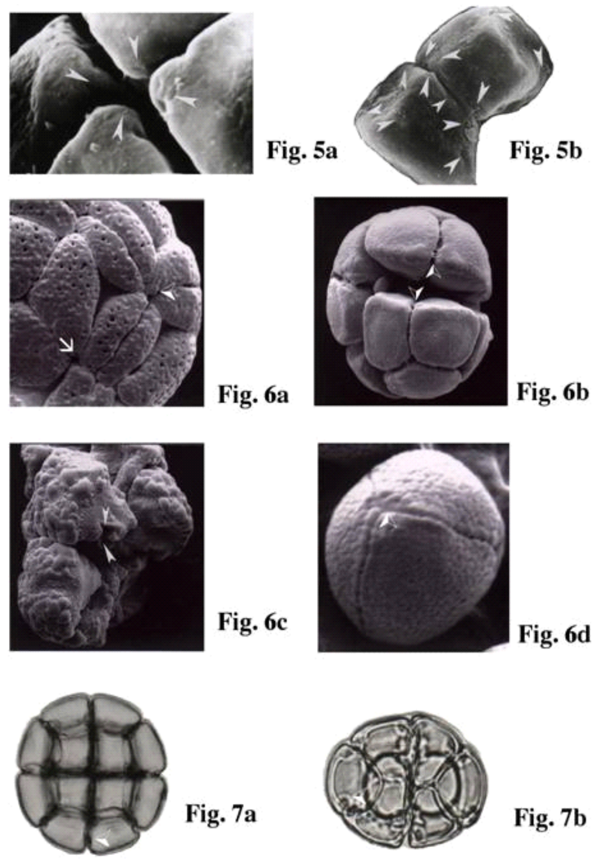


Plate IV. Contd. Pollen morphology: Aperture characters: compound grains; Fig. 5a & b: *Adenanthera pavonina*; pore occurrence; Fig. 6a: *Acacia nilotica*; 6b: *Adenanthera pavonina* ; 6c: *Dichrostachys cinerea*; 6d: *Mimosa pudica*; pore cluster; Fig. 7a: *Albizia procera*; 7b: *Adenanthera pavonina* pore border.



better opportunity for the pollen tube to emerge close to the stigma surface than does a single one. 3- Pore border (Fig. 7a-b): annulus presents in 14 taxa e.g. *Albizia procera*, costa present in *Adenanthera pavonina*, absent in 16 taxa and indiscernible in *Mimosa pudica.*

Colpus was only recorded in the studied 10 *Acacia* spp. with characteristic Y and H-shaped invaginations at central and peripheral monads combined with pores e. g. *Acacia farnesiana*. This distinctive character is used to recognise the different species of *Acacia* (Caccavari, 1986; 2002; Caccavari & Galati, 1998).

Pseudocolpus

Visibility. Faint in *Enterolobium schomburgkii*, marked in four taxa e. g. *Enterolobium contortisiliquum*, and absent in 27 taxa.

Shape. Irregular in three taxa e. g. *Enterolobium contortisiliquum*, and more or less square in *Acacia saligna*. Wodehouse (1935) reported that pseudocolpi are interpreted as a mechanism accommodating the changes in volume due to fluctuations in relative humidity of the atmosphere. Considering the aperture type in the present study, the type was recorded in 22 out of the studied taxa type in *Leucaena glauca*, three species of *Prosopis* and 10 species of *Acacia*. Guinet (1981b) reported the presence of porate and the colporate types; whereas, the colpate type is absent in Mimosoideae.

Exine. (Table V & Plate V; Fig. 1-3). **A- Tectum** (Figs. 1a-b): reduced on the proximal faces in 31 out of the studied taxa e.g. *Albizia julibrissin* and the tectum present all over the surface of grains in *Dichrostachys cinerea*, *Leucaena glauca, Prosopis chilensis, P. farcta,* & *P. juliflora.*

B- Perforations (Figs. 2a-b). Perforate tectum in 30 studied taxa e.g. *Acacia seyal*, imperforate in the rest of the studied taxa e.g. *Acacia senegal*. Thanikaimoni (1986) suggested that the thinning of development of perforations in the proximal part of the monads of pollen dyads tetrads and

Plate V. Pollen morphology: Fig. 1a: *Albizia julibrissin*; 1b: *Prosopis farcta*; Exine and columellae: single grains; Fig. 2a: *Acacia seyal*; 2b: *A. senegal*; tectum perforations; Fig. 3a: *A. hamulosa*; 3b: *A. nilotica* subsp. *tomentosa*; thickness of sexine relative to nexine; Fig. 4a: *A. nilotica* subsp. *tomentosa*; 4b: *Faidherbia albida*; 4c: *Dichrostachys cinerea*; length of columellae.

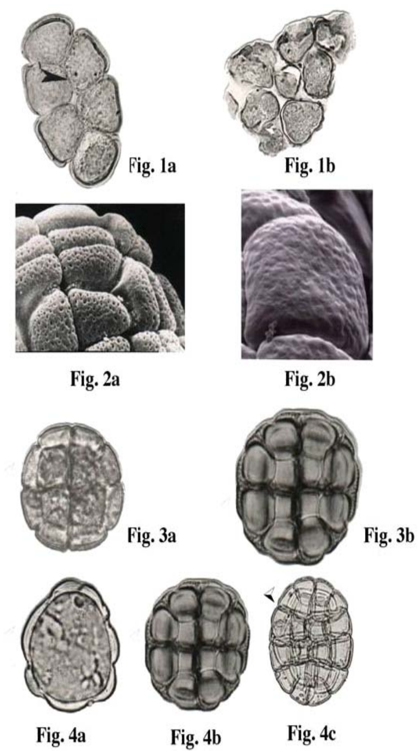


Plate VI. Pollen morphology: Fig. 1: *Acacia hamulosa*; 2: *Leucaena gluca*; 3: *Albizia julibrissin*; 4: *Prosopis farcta*; 5: *A. nilotica* subsp. indica; 6: *Faidherbia albida*; 7: *Acacia farnesiana*; 8: *Prosopis juliflora*; sculpturing patterns.

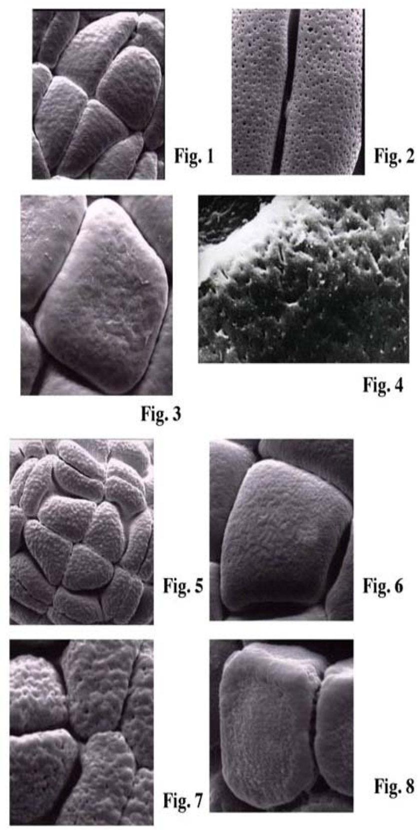
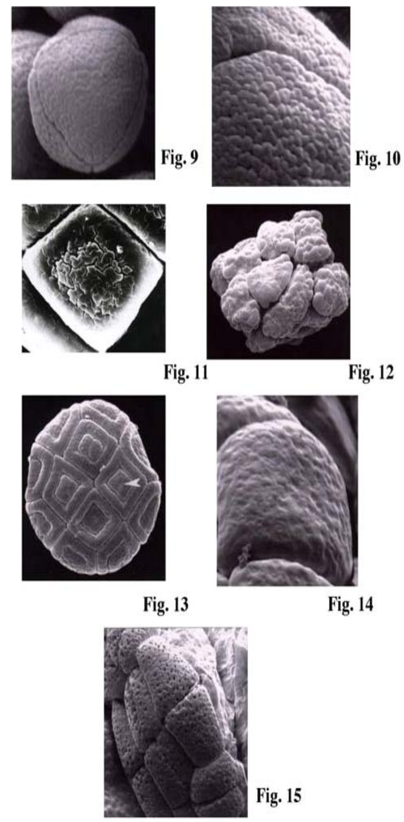


Plate VI. Contd. Pollen morphology: Fig. 9: *Mimosa pudica*; 10: *M. pigra*; 11: *Pithecellobium labatum*; 12: *Dichrostachys cinerea*; 13: *Acacia saligna*; 14: *A. senegal*; 15: *A. oerfota* var. *brevifolia*; sculpturing patterns.



polyads enables them to function as a single harmome (Figs. 3a-b): sexine as thick as nexine in *Acacia ehrenbergiana* and *A. hamulosa*, sexine thicker than nexine in 31 studied taxa e.g. *Acacia nilotica* subsp. *tomentosa*, and indiscernible in three *Mimosa* species.

Columellae. (Table V & Plate V; Fig. 4a-c). **A-** Visibility: distinct in 17 studied taxa, and indistinct in 19 taxa. **B-** Length (Fig. 4a-c): longer towards the intercolpi in 11 studied taxa e.g. *Acacia nilotica* subsp. *tomentosa*, uniform in five taxa e.g. *Faidherbia albida*, irregular in *Dichrostachys cinerea* and indistinct in 19 taxa.

Sculpturing patterns. (Table V & Plate VI; Fig. 1-15). The following patterns were recorded in the studied taxa: psilate: in *Acacia hamulosa* and *A. tortilis* subsp. *tortilis* (Fig.1), psilate-perforate: in *Leucaena glauca* (Fig. 2), psilate-foveolate: in 11 studied taxa e.g. *Albizia julibrissin* (Fig. 3), foveolate-psilate: in *Prosopis farcta* (Fig. 4), foveolate: in *Acacia ehrenbergiana, A. nilotica* subsp. *indica* and *A. origena* (Fig. 5), foveolate-rugulate: in *Faidherbia albida* (Fig. 6), rugulate-fossulate: in *Acacia farnesiana* (Fig. 7), *Calliandra haematocephala* and *Prosopis juliflora*, scabrate-psilate: in *Adenanthera pavonina, Albizia anthelmintica* and *Pithecellobium dulce* (Fig. 8), faint scabrate: in *Mimosa pudica* (Fig. 9), scabrate: in *Anadenanthera peregrina*, *Mimosa myriocephala* and *M. pigra* (Fig.10), verrucate-psilate: in *Pithecellobium lobatum* (Fig. 11), verrucate: in *Dichrostachys cinerea* and *Prosopis chilensis* (Fig.12), faint reticulate-psilate: in *Acacia saligna* (Fig. 13), faint reticulate: in *Acacia laeta* and *A. senegal* (Fig. 14), and micro-reticulate: in *Acacia oerfota* var. *brevifolia* (Fig. 15).

Gerham and Barker (1981), Ferguson and Skvarla (1982) and Ferguson (1990) conclude that there is no specific correlation between definite sculpture type and a distinct pollinating insect vector. Moreover, Guinet and Ferguson (1989) reported that the great diversity of the exine ornamentation appears related to pollinator diversity in Mimosoideae.

Plate VII. Pollen morphology: Fig. 1a & b: *Albizia gamblei*; 2a & b: *Acacia farnesiana*; 3a -c: *A. saligna*; harmomegathic device.

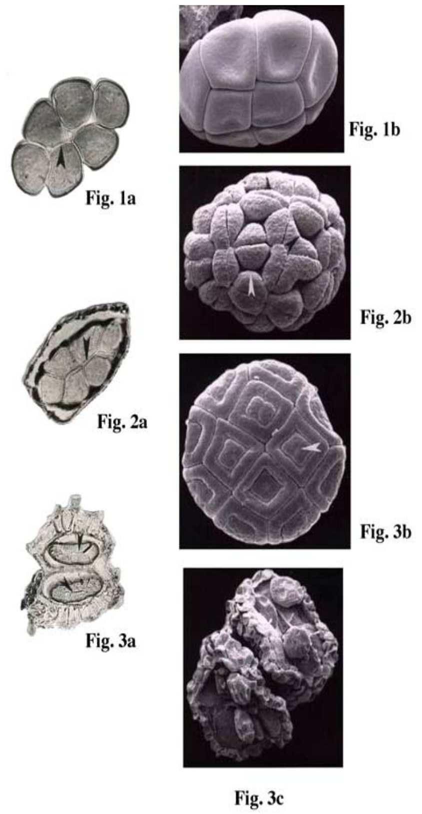


Plate VII. Contd. Pollen morphology: Fig. 4a & b: *Enterolobium schomburgkii*; 5a & b: *Dichrostachys cinerea*; 6: *Prosopis juliflora*; harmomegathic device.

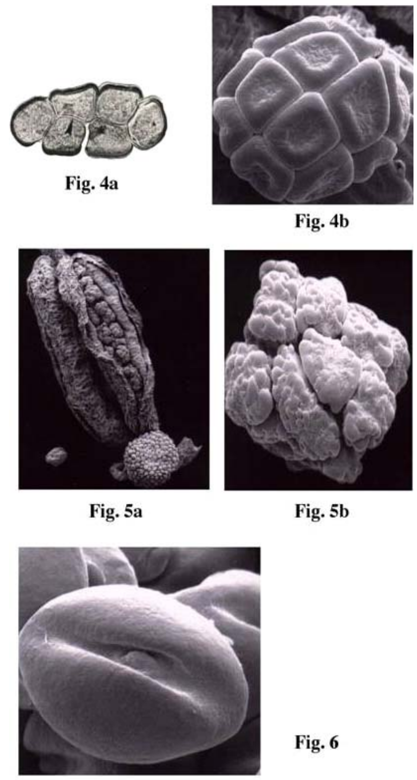
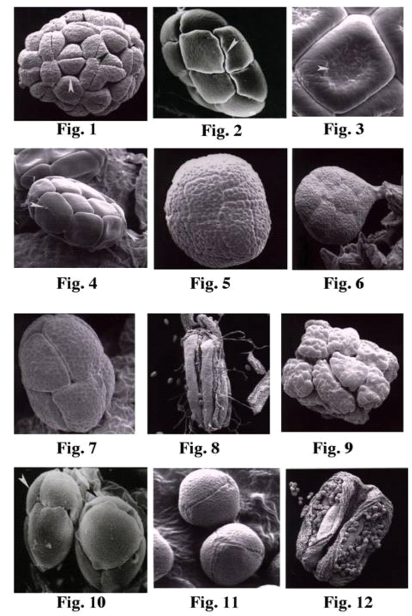


Plate VIII. Pollen morphology: Fig. 1: *Acacia farnesiana*; 2: *A. laeta*; 3: *A. saligna*; 4: *Albizia lebbeck*; 5: *Anadenanthera peregrine*; 6: *Calliandra haematocephala*; 7: *Mimosa myriocephala*; 8: *Leucaena glauca*; 9: *Dichrostachys cinerea;* 10: *Mimosa pigra*; 11: *M. pudica* -12: *Prosopis chilensis*; prominent characters.



Harmomegathic device. (Table V & Plate VII; Fig. 1-6). The investigated taxa possess certain harmomegathic mechanisms which were represented by the following aspects of: **A-** reduction of the tectum on the proximal face and depression of pollen wall: in 16 out of the studied taxa e.g. *Albizia gamblei* (Fig. 1a & b). **B-** reduction of the tectum on the proximal face and Y& H-shaped farrows: recorded only in 10 of *Acacia* species of the studied taxa e.g. *Acacia farnesiana* (Fig. 2 a & b). **C-** reduction of the tectum on the proximal face, pseudocolpi and depression of pollen wall: in *Acacia saligna*, *Adenanthera pavonina* and *Enterolobium contortisiliquum* (Fig. 3a-c). **D-** reduction of the tectum on the proximal face, pseudocolpi depression: in *Enterolobium schomburgkii* and *Pithecellobium lobatum* (Fig. 4 a & b). **E-** depression of pollen wall: in *Dichrostachys cinerea* (Fig. 5 a & b). **F**- invagination of aperture membrane (confined to single grains): in *Leucaena glauca, Prosopis chilensis, P. farcta* and *P. juliflora* (Fig. 6). Thanikaimoni (1986) recorded that the harmomegathic device in the *Acacia* species represented by three aspects to enable the compound grains to function as a single unit. **1-** represented by Y and H invaginations of apertures and reduction of tectum on the proximal part of the monads (applied in 10 *Acacia* species of the present work). **2-** was achieved by depression of their pollen wall and reduction of tectum on the proximal part of the monads (applied in *Acacia hamulosa, A. laeta & A. senegal* in the present work). **3-** was represented by the presence of pseudocolpi, depression of the pollen wall and reduction of tectum on the proximal part of the monads of polyads (applied in *Acacia saligna* in the present work). Muller (1980) discussed the close correlation between aperture length, harmomegathic mechanism and pollen shape and pointed out that long colpi function most efficiently in prolate grains while pores are associated with more spherical or oblate pollen. The same author recorded that the harmomegathic device in the colporate grains mostly represented by invagination of the aperture membrane.

Prominent characters. (Table V & Plate VIII; Fig. 1 - 12). Some prominent characters were recorded in one or more species as diagnostic characters: **1-** Y and H-shaped invaginations (furrows) only in 10 of *Acacia* sp. of the studied taxa e.g. *Acacia farnesiana* (Fig. 1)]. **2-** Monads alternated in arrangement with undulating edges in *Acacia laeta* (Fig. 2) and *Adenanthera pavonina.* **3-** Pseudocolpi depression (faint or marked) in *Acacia saligna, Adenanthera pavonina, Enterolobium, contortisiliquum, Enterolobium schomburgkii* and *Pithecellobium lobatum* (Fig. 3). **4-**

Viscin threads in *Albizia lebbeck* (Fig. 4). Hesse (1986) interprets the presence of viscin threads as to combine a large number of pollen together leading to more successful pollination. **5-** Monads not prominently outlined in *Anadenanthera peregrine* (Fig. 5). **6**- Octads oval in shape (uniplanar) with more or less acute abruptly narrow sticky end in *Calliandra haematocephala* (Fig. 6). In agreement to the observation in the present work, Guinet and Ferguson (1989) observe that in *Calliandra haematocephala*, the viscid coating locate on the narrow part of the octads. The latter is oriented outward the anther at anthesis to facilitate the adhesion of the octads to the pollinator body. **7-** Multiplanar decussate octad (bitetrad) in *Mimosa myriocephala* (Fig. 7). **8-** Single pollen grains in hairy anther in *Leucaena glauca* (Fig. 8). Stone *et al.* (2003) reported that *Leucaena* is the only genus within the Mimosoideae that have a hairy anther. **9-** Very loosely irregular acalymmate polyads in *Dichrostachys cinerea* (Fig. 9). **10-** Uniplanar (rhomboidal) or multiplanar (tetrahedral) tetrads in *Mimosa pigra* (Fig. 10). **11-** Minute tetrahedral tetrads In *Mimosa pudica* (Fig. 11). **12-** Single pollen grains in smooths anther in *Prosopis sp*. (Fig. 12).

CONCLUSION

The pollen morphological characters in the current study were considered diagnostic at the generic and specific level of studied Mimosoideae. Thus, facilitate the construction of key for the distinction of the studied taxa.

REFERENCES

Bailey, L.H., 1949. *Manual of Cultivated Plants*. The MacMillan Company, NY

Bentham, G., 1865. *In:* Bentham and J.D. Hooker (eds.) *Genera Plantarum,* Vol. I. Reeves, London

Boulos, L., 1999. *Flora of Egypt*. p. 419. Vol. I, Al Hadara Publ., Cairo, Egypt

Caccavari, M.A., 1986. Estudio de los caracteres del pollen en las *Mimosa–Lepidotae*. *Pollen et Spores,* 28: 29–42

Caccavari, M.A., 2002. Pollen morphology and structure of Tropical and Subtropical American genera of the Piptadenia group (Leguminosae: Mimosoideae). *Grana.*, 41: 130–41

Caccavari, M.A. and B. Galati, 1998. Pollen development in *Mimosa balansae*. *Phytomorphol.,* 48: 371–81

Cerceau–Larival, M.T. and J. Challe, 1986. Biopalynology and Maintenance of Germination Capacity of Stored Pollen in Some Angiosperm Families. *In:* Blackmore and I.K. Ferguson, (eds.), *Pollen and Spores: Form and Function.* pp. 151–64. Academic Press, London.

Dobson, H.E.M., 1988. Survey of pollen and pollenkitt lipids–chemical cues to flower visitors. *American J. Bot.,* 75: 170–82

Elias, T.S., 1981. *Mimosoideae*. *In:* Polhill, R.M. and P.H. Raven, (eds.), *Advances in Legume Systematics,* pp. 143–51. part 1. R. Bot. Gard., Kew

El–Ghazali, G.E.B., A.M. Satti and S.I. Tsuji, 1997. Intra–specific pollen polymorphism in *Mimosa pigra* L. (Mimosoideae). *Grana,* 36: 279–83

Engler, A., 1876. Beiträge zur Kenntnis der Antheren– bildung der Metaspermen. Jahrb. *Wissensch. Bot.,* 10: 275–313

Erdtman, G., 1943. *An Introduction to Pollen Analysis*. p. 239. Waltham Mass.

Erdtman, G., 1960. The Acetolysis Method. A revised description. *Seven Bot. Tidskr,* 54: 561–4

Ferguson, I.K., 1990. The significance of some pollen morphology characters of the tribe Amorpheae and of the genus *Mucuna* (Tribe: Phaseoleae). *Review of Palaeobotany and Palynol.,* 64: 129–36

Ferguson, I.K. and J.J. Skvarla, 1982. Pollen morphology in relation to pollinators in Papilionioideae (Leguminosae), *Bot. J. Linn. Soc.,* 84: 183

Fritzsche, C.J., 1832. *Beiträge zur Kenntniss des Pollen,* Vol. 1, p. 48. Berlin, Stetting and Elbing.

Graham, A and G. Barker, 1981. Palynology and tribal classification in the Caesalpinioideae. *In:* R.M. Polhill and P.H. Raven, (eds.), *Advances in Legume Systematics,* pp. 801–33. Kew: Royal Botanic Gardens.

Guinet, Ph., 1981a. Comparative account of pollen characters in the Leguminosae. *In:* R.M. Polhill and P.H. Raven (eds.). *Advances in Legume Systematics. Part 2.* pp. 789–99

Guinet, Ph., 1981b. Mimosoideae: the characters of their pollen grains. *In:* R.M. Polhill and P.H. Raven (eds.), *Advances in Legume Systematics. Part 2.* pp. 835–55

Guinet, Ph. and I.K. Ferguson, 1989. Structure, evolution and biology of pollen Leguminosae. *In:* C.H. Stirton and J.L. Zarucchi, (eds.), *Advances in Legume Biology. Monogr. Syst. Bot. Mo. Bot. Gard.,* 2: 77–103

Guinet, Ph. and A. Le Thomas, 1990. Current Knowledge and interpretation of the pollen characters in Annonaceae and Leguminosae, subfamily Mimosoideae. *Rev. Palaeobot. Palynol.,* 64: 109–27

Guinet, Ph. and L. Rico, 1988. Pollen characters in the genera *Zygia, Marmaroxylon* and *Cojoba* (Leguminosae, Mimosoideae, Ingeae: a comparison with related genera. *Pollen Spores,* 30: 313–28

Harley, M.M. and I.K. Ferguson, 1990. The role of the SEM in pollen morphology and plant systematics. *In:* Claugher, D. (ed.) *Scanning Electron Microscopy in Taxonomy and Functional Morphology. Sys. Assoc. Spe.,* pp. 45–68, Clarendon Press, Oxford

Hesse, M., 1980. Entwicklungageschicht und Ultrastruktur von pollenkitt und Exine bei nahe verwandten entomophilen und anemophilen Angiospermensippen der Alismataceae, Liliaceae, Juncaceae, Cyperaceae, Poaceae, und Araceae. *Plant Systematics and Evolution,* 134: 229–67

Hesse, M., 1986. Nature, form and function of pollen–connecting threads in angiosperms. *In:* Blackmore and I.K. Ferguson (eds.), *Pollen and Spores.* pp. 109–18. Form and Function. Academic Press, London

Hughes, C.E., 1997. Variation in anther and pollen morphology in *Leucaena* Benth. (Leguminosae–Mimosoideae). *Bot. J. Linn. Soc.,* 123: 177–96

Iwanami, Y., T. Sasakuma and Y. Yamada, 1988. *Pollen: Illustrations and Scanning Electronmicrographs.* p. 198. Kodansha, Tokyo

Knox, R.B. and C.A. McConchie, 1986. Structure and Function of compound pollen. *In:* Blackmore and I.K. Ferguson, (eds.), *Pollen and Spores: Form and Function.* pp. 265–82. Academic Press, London

Kremp, G.O.W., 1968. *Morphologic Encyclopaedia of Palynology*. 2nd ed., p. 263. Univ. Arizona Press, Tucson

Kunth, C.S., 1819–1824. Mimosés et Autres Plantes Légumineuses du Nouveau Continent. *In:* Humboldt, F.W. and A.J. Bonpland, (eds.), *Voyage aux Régions Equinoctiales du Nouveau Continent,* p. 223. Part 6, Botanique, Sect. 4

Mohl, M., 1835. Sur la structure et les formes dés grains de pollen. *Ann. Sc. Nat., Bot. Sér.,* 2–3: 148–81; 220–36; 304–47

Moore, P.D., J.A. Webb and M.E. Collinson, 1991. *Pollen Analysis.* 2nd ed. p. 216. Blackwell Scientific Publications, Oxford, London

Mueller, V.F., 1887–1888. *Iconography of Australian species of Acacia and cognate genera.* Decades I–XIII. Meibourne

Muller, J., 1980. Form and function in angiosperm pollen. *Ann. Missouri Bot. Gard.,* 66: 593–632

Nunes, A.D., T.T. Carrijo and V. Goncalves–Esteves, 2003. Palynology of Species of Leguminosae (Mimosoideae) occurring in the Parquet Nacional da Resting de Jurubatiba, rio de Janeiro. Brazil. *Acta Microscopica,* 12: 37–8

Punt, W., S. Blackmore, S. Nilsson and A. Le Thomas, 1994. *Glossary of Pollen and Spore Terminology.* p. 71. Stockholm, Sweden

Roland, F., 1965. Précisions sur la structure et l'ultrastructure d'une tetrade calymmée. *Pollen Spores,* 7: 5–8

Rosanoff, S., 1865. Zur Kenntniss des Baues ind Entwicklung sgeschichte des Pollens der Mimosaceae. *Jahrb. Wiss. Bot.,* 4: 441–50

Stone, G.N., N.E. Raine, M. Prescott and P.G. Willmer, 2003. Pollination ecology of acacias (Fabaceae, Mimosoideae). *Australian Syst. Bot.,* 16: 103–18

Täckholm, V., 1974. *Students Flora of Egypt*. p. 888. Cairo University Press, Cairo, Egypt

Thanikaimoni, G., 1986. Pollen apertures: form and function. *In:* Blackmore and I.K. Ferguson, (eds.), *Pollen and Spores: Form and Function.* pp. 119–36. Academic Press, London

Van Campo, M. and P. Guinet, 1961. Les pollens composées. L'exemple des Mimosacées. *Pollen Spores,* 3: 201–18

Walker, J. W. and J.A. Doyle, 1975. The bases of angiosperm phylogeny: palynology. *Ann. Missouri Bot. Gard.,* 62: 664–723

Wodehouse, R.P., 1935. *Pollen Grains, Their Structure, Identifications and Significance in Science and Medicine.* p. 574. Mc. Graw–Hill Book Co., New York and London

(Received 10 August 2005; Accepted 15 September 2005)