

POLLEN FLORA OF PAKISTAN-XLVII. EUPHORBIACEAE

ANJUM PERVEEN AND M. QAISER

*Department of Botany,
University of Karachi, Karachi Pakistan*

Abstract

Pollen morphology of 40 species representing 6 genera viz., *Andrachne*, *Chrozophora*, *Dalechampia*, *Euphorbia*, *Mallotus* and *Phyllanthus* of the family Euphorbiaceae from Pakistan has been examined by light and scanning electron microscope. Euphorbiaceae is a eurypalynous family. Pollen grains usually radially symmetrical, isopolar, prolate-spheroidal to sub-prolate or prolate often oblate-spheroidal, colporate (tri rarely 6-7), colpi generally with costae, colpal membrane psilate to sparsely or densely granulated, ora la-longate, sexine as thick as nexine or slightly thicker or thinner than nexine. Tectal surface commonly reticulate or rugulate - reticulate rarely striate or verrucate. On the basis of exine pattern 5 distinct pollen types viz., *Andrachne-aspera* - type, *Chrozophora oblongifolia*-type, *Euphorbia hirta*-type and *Mallotus philippensis* - type and *Phyllanthus urinaria* - type are recognized.

Introduction

Euphorbiaceae, a family of about 300 genera and 7950 species is cosmopolitan in distribution, more especially in tropical and temperate regions (Willis, 1973; Mabberley, 1978). In Pakistan it is represented by 24 genera and 90 species (Radcliffe-Smith, 1986). Euphorbiaceae is one of the most diverse family, ranges from the herb, shrub and tall tree *Hevea* of the Amazonian rain forest to small cactus like succulents of Africa and Asia Herb, shrub and tree often with milky sap, leaves mostly alternate, flowers unisexual, ovary superior and usually trilocular.

The family is of considerable economic importance for rubber plant (*Hevea*), castor oil (*Ricinus communis*), cassava and tapioca (*Manihot*) and tung oil (*Aleurites fordii*). The family is also known for its ornamental plants like *Croton*, *Acalypha* and *Euphorbia* etc. Pollen morphology of various members of the family Euphorbiaceae have been studied by different workers from time to time. Erdtman (1952) seems to be the first one to study the pollen morphology of the family Euphorbiaceae. However, later on the pollen of various genera of the family were examined in relation to taxonomy and phylogeny. Punt (1962) examined pollen morphology of the family Euphorbiaceae in relation to its taxonomy. Weber & El-Ghobary (1985) studied pollen of four succulent species of the genus *Euphorbia*. El-Ghazaly & Raj (1986) examined pollen morphology of the genus *Andrachne*. Pollen morphology of some genera of family Euphorbiaceae have been examined by Saad & El-Ghazaly (1988). Pollen morphology of the family has also been studied by Erdtman (1960, 1969), Punt (1961), Miller & Webster (1962), Kohler (1965), Scheill (1973), Meewis & Punt (1983), Lobreau-Callen, Suarez-Cervera (1989, 1993), El-Ghazaly & Chaudhary (1993), Nowicke (1994), Takahashi *et al.*, (1995) and Kasetsinsombat *et al.*, (2000).

No information is available on the pollen morphology of various species of Euphorbiaceae found in Pakistan. In the present studies an attempt has been made to give an account on the pollen morphology of the family Euphorbiaceae comprising of 6 genera and 40 species from Pakistan.

Materials and Methods

Pollen samples were obtained from the herbarium specimens of the Karachi University Herbarium (KUH) or from fresh specimens collected from the field. The list of voucher specimens is deposited in KUH. The pollen slides were prepared for light (LM) and scanning microscopy (SEM) by the standard methods described by Erdtman (1952). For light microscopy, the pollen grains were mounted in unstained glycerine jelly and observations were made with a Nikon Type-2 microscope, under (E40, 0.65) and oil immersion (E100, 1.25), using 10x eye piece. For SEM studies, pollen grains suspended in a drop of water were directly transferred with a fine pipette to a metallic stub using double sided cellotape and coated with gold in a sputtering chamber (Ion sputter JFC-1100). Coating was restricted to 150A. The S.E.M examination was carried out on a Jeol microscope JSM-T200. The measurements are based on 15-20 readings from each specimen. Polar length, equatorial diameter, colpi length, and exine thickness were measured (Table 1).

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

Observations

General pollen characters of the family Euphorbiaceae

Pollen grains usually radially symmetrical, isopolar, prolate-spheroidal, or sub-prolate to prolate often oblate-spheroidal. Generally tri- colporate (rarely 6-7), colpi with costae, colpal membrane psilate to sparsely or densely granulated, ora la-longate, sexine as thick as nexine, or slightly thicker or thinner than nexine. Tectal surface commonly fine - coarse reticulate or rugulate - reticulate rarely striate or verrucate. On the basis of aperture number, exine pattern and pollen shape class, 5 distinct pollen types are recognized viz., *Andrachne aspera*- type, *Chrozophora oblongifolia* - type, *Euphorbia hirta* - type, *Mallotus philippensis* - type and *Phyllanthus urinaria*-type

Key to the pollen types

- 1 + Pollen grains tricolporate 2
- Pollen grains 6-7-colporate *Chrozophora oblongifolia*-type
- 2 + Tectum verrucate *Mallotus philippensis*-type
- Tectum not as above 3
- 3 + Tectum reticulate-rugulate or reticulate-foveolate *Phyllanthus urinaria*-type
- Tectum reticulate rarely striate 4
- 4 + Tectum striate *Andrachne aspera*-type
- Tectum fine-coarse reticulate *Euphorbia hirta*-type

I. *Andrachne aspera*-type

Pollen class: 3-colporate, zonoaperturate

P/E ratio: 1.35-1.51

Table 1. General pollen characters of species studied in the family Euphorbiaceae.

Name of Species	Shape	P/E ratio	Polar length of Pollen in μm (P)	Equatorial Diameter in μm (E)	Colpus Length in μm	Exine Thickness in μm	Tectum
<i>Ardrachne aspera</i> Spreng	Pr.	1.39	23.8(26.61±0.41)29.41	14.70(19.13±0.49)21.72	15.41(19.13±0.57)21.01	2.66(2.81±0.06)2.91	Striate
<i>A. cordifolia</i> (Wall ex Decn) Mull.	Pr.	1.35	31.25(33.5±0.43)35	22.5(24.93±0.2)25.25	25(29.03±0.32)32.6	2.5(2.67±0.04)2.75	C. Rt.
<i>A. telephitoides</i>	Pr.	1.51	32.5(37.26±0.52)40	22.5(24.52±0.42)26.25	26.65(32.54±0.54)35	3(3.75±0.26)4.75	C. Rt.
<i>C. tinctoria</i> (L.) Raf.	Ob-Sp.	0.94	44.8(45.30±0.24)46.67	50.26(54.38±0.68)57.44	25.13(30.08±0.92)32.31	1.14(1.47±0.02)1.54	C. Rt.
<i>Chrozophora oblongifolia</i> (Del.) Adr. Juss ex. Speng	Ob-Sp.	0.84	47.5(50.01±0.56)52.5	52.5(59.05±0.45)60	17.5(21.91±0.91)25	3.75(3.8±0.03)4	C. Rt.
<i>Detlechampia scandens</i> L.	Sub-Pr.	1.23	65.5(70.4±0.69)73	50(51.13±1.3)70	37.5(40.57±0.76)47.5	5.25(8.46±1.4)11.25	C. Rt.
<i>Euphorbia aserhajizhaines</i> Brodz.	Sub-Pr	1.22	27.5	22.5	25	2.75(3.03±0.59)3.75	M. Rt.
<i>E. caducifolia</i> Haines	Ob-Sp.	0.94	32.31(34.81±0.5)37.69	32.31(37.18±0.63)39.49	23.33(28.01±0.61)30.51	3.23(3.87±0.24)6.10	Rt
<i>E. caeladenia</i> Boiss.	Ob-Sp.	0.96	35(31.17±0.45)30	30.25(32.5±0.7)32.5	27.5(33.7±0.37)30.5	4.75	M. Rt.
<i>E. clarkeana</i> Hook	Sub-Pr	1.22	21.01(24.17±0.48)27.32	17.5(19.90±0.44)23.12	19.61(22.61±0.57)25.91	1.96(2.29±0.09)2.66	F. Rt.
<i>E. cornigera</i> Boiss.	Pr-Sp.	1.02	32.5(34.52±0.38)37.5	30(33.60±0.50)35	28.75(30.75±0.85)37.5	2.75(3.43±0.13)3.75	M. Rt.
<i>E. cyrtophylla</i> Prokh	Ob-Sp.	0.97	31.25(34.52±0.63)42.5	30(35.3±0.97)47.5	25(28.5±0.65)37.5	3(4.22±0.32)6.25	M. Rt.
<i>E. densa</i> Schrenk	Pr-Sp.	1.07	25(28.5±1.14)32.5	22.5(26.64±0.91)28.75	22.5(25.22±0.71)27.15	2.5(2.78±0.02)3.75	M. Rt.
<i>E. dracunculoides</i> Lam.	Pr-Sp.	1.12	32.31(36.89±0.78)39.84	28.92(32.74±1.3)39.49	25.13(27.69±1.90)35.91	2.51(3.59±0.15)3.95	Rt
<i>E. falcata</i> L.	Pr-Sp.	0.96	25.11(36.11±1.20)46.25	26.25(35.45±1.0)40.51	22.5(32.58±1.20)40.25	3(3.5±0.18)4.5	M. Rt.
<i>E. grossheimii</i> Prokh.	Pr-Sp.	ob-sp	25.25(28.36±0.38)32.5	24.75(32.5±1.07)32.5	22.5(26.4±0.65)30.0	2.25(2.07±0.4)3.0	M. Rt.
<i>E. helioscopia</i> L.	Ob-Sp.	0.95	33.75(35.83±0.33)37.5	30(37.48±0.7)41.75	20.75(29.41±0.02)32.5	2.75(3.0±0.12)4.5	M. Rt.
<i>E. heterophylla</i> L.	Pr-Sp.	1.05	2.10(46.6±1.08)57.5	35(43.16±0.8)47.5	30.0(35.98±1.49)50	-	C. Rt.
<i>E. hirta</i> L.	Pr-Sp.	1.13	11.50(17.01±0.17)18.21	12.80(14.90±0.31)16.8	14.01(15.30±0.44)16.81	1.41(1.45±0.03)1.68	M. Rt.
<i>E. hyper cifolia</i> L.	Pr.	0.79	18.21(20.40±0.30)21.72	14.12(14.70±0.22)15.41	16.81(19.40±0.44)21.12	1.54(2.05±0.06)2.24	M. Rt.

Table 1. (Cont'd.)

Name of Species	Shape	P/E ratio	Polar length of Pollen in μm (P)	Equatorial Diameter in μm (E)	Colpus Length in μm	Exine Thickness in μm	Tectum
<i>E. indica</i> Lam.	Pr.	1.41	29.41(31.36±0.46)35.11	21.01(22.21±0.30)25.21	26.61(29.81±0.76)33.61	c. 3.8	M. Rt.
<i>E. maddenii</i> Boiss.	Ob-Sp.	0.96	30.75(32.20±0.90)37.5	32.5(33.34±0.19)35.25	22.5(25.85±0.75)30.25	2.75(2.81±0.66)3.75	M. Rt.
<i>E. micractina</i> Boiss.	Ob-Sp.	0.89	35(38.18±0.48)48.75	40.25(42.64±0.53)45.25	27.5(32.32±0.48)35	2.75(3.30±0.3)4	R. R
<i>E. microsciadia</i> Boiss	Pr-Sp.	1.09	32.5(35.44±1.0)45	27.5(32.31±0.99)38.75	26.25(30.75±1.30)26.25	2.5(2.85±0.08)3.75	M. Rt.
<i>E. multifurcata</i> Rech. & Aellen et Esta	Sub-Pr	1.18	33.75(38.87±0.7)40.25	30.25(32.7±0.44)37.5	27.5(33.7±0.3)37.5	2.25(2.91±0.16)3.75	M. Rt.
<i>E. osyridea</i> Boiss.	Pr-Sp.	1.05	32.5(36.4±0.7)43.75	30(34.5±0.47)41.25	27.5(30.78±0.65)37.5	2.75(3.41±0.19)4.75	M. Rt.
<i>E. pamirica</i> Prokh	Ob-Sp.	1.06	30.25(35.48±0.9)40.0	28.75(35.38±0.71)38.75	25(27.59±0.90)35	3.75(3.90±0.13)5	M. Rt.
<i>E. prolifera</i> Buch. - Ham.	Sub-Pr	1.16	27.5(37.88±13.36)42.5	28.75(32.65±0.5)37.5	25.25(32.82±0.85)37.5	2.5(3.45±0.13)4.75	R. R
<i>E. prostrata</i> Ait.	Sub-Pr	1.16	19.6(22.16±0.43)26.6	18.21(19.01±0.27)21.12	16.96(18.61±0.46)19.61	2.61(2.78±0.01)2.01	M. Rt.
<i>E. sororia</i> Schrenk	Ob-Sp.	0.91	30(34.79±0.90)37.71	35(37.72±1.08)42	27.5(30.55±0.78)32.5	2.75(2.91±1.1)3.0	R. R
<i>E. taliana</i> A. Rodeliffe-Smith	Ob-Sp.	0.94	22.5(29.88±3.36)32.5	25.25(31.55±0.67)32.5	22.5(24.7±0.38)27.75	2.5(2.73±0.017)2.75	M. Rt.
<i>E. thymifolia</i> L.	Pr-Sp.	1.13	22.5(24.40±0.72)30	17.5(21.52±1.02)22.5	20.25(23±0.61)27.5	-	F. Rt.
<i>E. tibetica</i> Boiss.	Pr-Sp.	1.15	27.5(30.2±0.48)32.75	22.5(26.4±0.65)30	22.5(27.7±0.65)30	2.25(2.57±0.039)2.75	M. Rt.
<i>E. wallichii</i> Hook.	Pr-Sp.	1.01	40.0(46.2±1.13)50	35.1(46.2±1.0)52.5	4(4.25±0.24)1.8	25(35.4±2.37)40	R. R
<i>E. hispida</i> Boiss	Sub-Pr	1.18	30(31.68±0.32)35.0	22.7(28.56±0.33)32.5	25.0(28.58±0.32)38.5	2.75(2.97±0.5)3.75	F. Rt.
<i>Mallotus philippensis</i> (Lam.) Mull.	Ob-Sp.	0.93	18.75(19.62±1.58)20.75	17.75(19.03±1.34)23.5	5(6.62±0.03)10	1.25(2.06±0.193)2.75	verrucate
<i>Phyllanthus amarus</i> Schum & Thonn.	Sub-Pr.	1.23	17.75(19.03±1.34)23.5	12.5(15.36±0.26)17.5	12.5(15.96±0.38)19.75	1.25(2.06±0.193)2.75	R. F.
<i>P. fraternus</i> Webster	Sub-Pr.	1.26	15.75(17.62±1.58)20.75	13.75(15.52±0.36)17.5	15(18.37±0.63)22.5	c. 1um	M. Rt.
<i>P. rotundifolius</i> Klein ex Willd.	Pr.	1.45	26.61(28.51±0.40)31.51	15.4(19.61)22.4	21.23(21.28)26.61	1.41(1.47±0.02)1.54	Regulate
<i>P. virgatus</i> Forst	Pr. Sp.	1.01	16.25(19.25±0.8)20.8	12.5(18.91±0.38)22.5	2(2.2±0.03)5	0.75(1.08±0.16)1.25	C. Rt.
<i>P. urinaria</i> L.	Pr.	1.39	20(22.4±0.27)25	12.75(15.91±0.29)12.75	15.5(17.63±0.7)19.75	2(2.75±0.05)1.95	R. R.

Abbreviations: Ob-Sp= Oblate-spheroidal, Sub-Pr= Sub-prolate, Pr= Prolate, C.Rt= Coarsely reticulate, M.Rt.= Medium reticulate, F.Rt.= Finely reticulate

Aperture: Ectoaperture-colpus not sunken long margin irregular, end acute
Endoaperture: circular.

Exine: Sexine thicker than nexine.

Ornamentation: Tectum striate

Outline: Equatorial view elliptic, polar view trilobed. .

Measurements: Polar axis (P) 28 (26.01 ± 0.4) 29.5 μm , Equatorial diameter E 14.70 (19.1 ± 0.49) 21.72 μm , and colpus length 15.4 (19.15 ± 0.57) 21.5 μm long. Colpal membrane granulated. Exine 2.66 (2.81 ± 0.06) 2.91 μm thick.

Species included: *Andrachne aspera* Spreng.

II: *Chrozophora oblongifolia*-type (Fig.1. A & B).

Pollen class: 6-7-colporate, 6-7-zonocolporate. .

P/E ratio: 0.84-0.94.

Aperture: Ectoaperture-colpus long, sunken, narrow, end acute. Endoaperture circular

Exine: Sexine thicker than sexine or as thick as nexine.

Ornamentation: Coarsely reticulate.

Outline: Equatorial view oblate pole side slightly rounded polar view 6-7 -lobed

Measurements: Polar axis (P) 44.5 (48.1 ± 0.61) 52.2 μm . Equatorial diameter (E) 50.26 (55.12 ± 0.1) 60.21 μm . Mesocolpium 1.25 ($20. \pm 0.12$) 27.5 μm colpus 17.5 (24.2 ± 0.25) 32.5 μm . Exine 1.44 (2.7 ± 0.37) 4.2 μm thick.

Species included: *Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng and *C. tinctoria* (L.) Raf.

Key to the species

- 1 + Exine 1.44 μm thick *Chrozophora tinctoria*
- Exine 3-4.4 μm thick *Chrozophora oblongifolia*

III: *Euphorbia hirta* -type (Fig. 1.C -F; Fig.2 A-F).

Pollen class: 3-colporate, 3-zonocolpate.

P/E ratio: 0.89-1.16.

Shape: Prolate-spheroidal to sub-prolate or prolate rarely oblate-spheroidal.

Aperture: Ectoaperture-colpus not sunken long margin irregular, end acute.
Endoaperture: circular.

Exine: Sexine thicker or thinner than nexine or as thick as nexine.

Ornamentation: Tectum fine-coarsely reticulate.

Outline: Equatorial view elliptic, polar view trilobed.

Measurements: Polar axis (P) 11 (34.5 ± 1.25) 57.5 μm , Equatorial diameter 12.8 (30.10 ± 1.25) 47.5 μm and colpus length 14.5 (42 ± 0.31) 50 μm long. Colpal membrane granulated. Mesocolpium 7.5 (12.5 ± 1.11) μm . Apocolpium 2.5 (5 ± 0.11) 7.5 μm . Exine 2.2 (4.11 ± 1.11) 6.5. P.A.I. 3.23.

Species included: *Andrachne telephioides* L., *A. cordifolia* (Wall ex Decn.) Muell., *Dalechampia scandens* L., *Euphorbia indica*, *E. hypericifolia* Less. Ex Kar. Kir., *E. hispida* Boiss., *E. thymifolia* L., *E. heterophylla* L., *E. aserbajdzanica* Bordzk., *E. densa* Schrenk., *E. osyridea* Boiss., *E. caeladenia* Boiss., *E. multifurcata* Rech. Aellen & Estand, *E. grossheimii* Prokh., *E. tibetica* Boiss., *E. cornigera* Boiss., *E. wallichii* Hook. F., *E. helioscopia* L., *E. falcate* L., *E. maddenii* Boiss., *E. microsciadia* Boiss., *E. prolifera* Buch.-Ham., *E. talaina* A.Radeliffe-Smith, *E. cyrtophylla* Prokh, *E. pamirica* Prokh, *E. hirta* L., *E. clarkeana* Hook.f., *E. prostrate* Ait., *E. cauducifolia* Haines, *E. dracunculoides* Lam., *Phyllanthus fraternus* Webster

Fig. 1. Scanning micrographs: *Chrozophora oblongifolia*: A, Polar view, B, Exine pattern. *Andrachne cordifolia*: C, Equatorial view, D, Exine pattern. *Andrachne telephioides*: E, Equatorial view, F, Exine pattern
Scale bar = A, C & E = 10; B, D & F = 1 μ m.

Fig. 2. Scanning micrographs: *Euphorbia grossheimii*: A, Polar view, B, Equatorial view; C, Exine pattern. *E. heterophylla*: D, Equatorial view, E, Polar view, F, Exine surface.
Scale bar = A, B, D & E = 10; C & F= 1 μ m.

Key to the species and species groups

- 1 + Pollen sub-prolate or prolate-spheroidal or prolate subtype
 - *Euphorbia hispida*, *Andrachne telephioides* L., *A. cordifolia* (Wall ex Decn.) Muell., *Dalechampia scandens* L., *E. indica* L., and *E. hypericifolia* Less., ex Kar. Kir., *Euphorbia hispida* Boiss., *E. thymifolia* L., *E. heterophylla* L., *E. aserbajdzanica* Bordzk., *E. densa* Schrenk., *E. osyridea* Boiss., *E. multifurcata* Rech. Aellen & Estand, *E. grossheimii* Prokh., *E. tibetica* Boiss., *E. cornigera* Boiss., *E. wallichii* Hook. F., *E. falcata* L., *E. microsciadia* Boiss., *E. prolifera* Buch.-Ham., *E. hirta* L., *E. clarkeana* Hook.f., *E. prostrata* Ait., *E. dracunculoides* Lam., *Phyllanthus fraternus* Webster
- Pollen grain oblate-spheroidal sub type -
E. helioscopia, *Euphorbia caeladenia* Boiss., *E. helioscopia* L., *E. maddenii* Boiss., *E. talaina* A.Radeliffe-Smith, *E. cyrtophylla* Prokh., *E. pamirica* Prokh., *E. cauducifolia* Haines.

IV: *Mallotus philippensis* – type

Pollen class: 3-colporate, 3-zonocolporate.

P/E ratio: 0.93.

Shape: Oblate-spheroidal.

Aperture: Ectoaperture-colpus not sunken, long margin irregular, end acute
 Endoaperture: circular.

Exine: Sexine thick as nexine.

Ornamentation: Tectum verrucate.

Outline: Equatorial view elliptic, polar view trilobed, 3-lobed.

Measurements: Polar axis (P) 15.5 (17.9.25 ± 1.25) 20.2 µm, and colpus length 17.25 (19.2 ± 0.31) 20.25 µm long. Colpal membrane granulated. Mesocolpium 5 (6.89 ± 1.61) 10.5 µm. Apocolpium 5.0 (5.9 ± 1.43) 7.5 µm. Exine 1.0 (1.24 ± 1.11) 2.2 µm. P.A.I. 1.30

Species included: *Mallotus philippensis* (Lam.) Muell. Arg.

V: *Phyllanthus urinaria* - type (Fig. 3 A-F).

Pollen class: 3-colporate, 3-zonocolporate rarely pantocolporate.

P/E ratio: 0.9-1.22.

Apertures: Ectoapertures-colpus long, sunken, narrow, margins, sub-psilate end acute.
 Endoaperture circular

Exine: Sexine thicker or thinner than nexine.

Ornamentation: Tectum reticulate - rugulate or reticulate - foveolate.

Outline: Equatorial view elliptic. Polar view trilobed with aperture on the angles of the outline of the grains in polar view.

Measurements: Polar axis (P) 16 (23.5 ± 0.22) 31.7 µm. Equatorial diameter 12.4 (23.5 ± 0.22) 17.12 µm. Colpus length 12.5 (17.4 ± 0.11) 22.5 µm. Mesocolpium 10 (22.5 ± 0.11) 22.5 µm. Apocolpium 0.25-2.55 µm. Exine 0.75 (1.22 ± 0.11) 2.75 µm thick.

Species included: *Euphorbia micractina* Boiss., *E. sororia* Schrenk., *Phyllanthus urinaria* L., *P. amarus* Schum & Thonn., *P. rotundifolius* Kleine ex Willd., *P. virgatus* Forst.

Fig. 3. Scanning micrographs: *Phyllanthus rotundifolius*: A, Polar view, B, Exine pattern. *P. amarus*.: C, Equatorial view, D, Exine pattern. *P. virgatus*: E, Equatorial view, F, Exine Patten
Scale bar = A, C & E = 10; B, D & F= 1 μ m.

Key to the species and groups

- 1 + Pollen grains oblate-spheroidal *Euphorbia micractina*-group
(*Euphorbia micractina*, *E. sororia*)
- Pollen grains prolate-spheroidal to sub prolate or prolate 2
- 2 + Pollen prolate-spheroidal *Phyllanthus virgatus*
- Pollen sub-prolate or prolate *P. amarus*- group
(*Phyllanthus urinaria*, *P. amarus*, *P. rotundifolius*)

Discussion

Euphorbiaceae is an eurypalynous family (Erdtman, 1952). Pollen grains are usually radially symmetrical, isopolar, prolate - spheroidal to sub-prolate or prolate rarely oblate - spheroidal. Usually tricolporate (copli 3) rarely 6-8 colporate., colpal membrane finely - coarsely granulated or sub-psilate. Tectum is mostly reticulate (coarse-fine). In addition to this, various grades of rugulate-reticulate, reticulate-rugulate often verrucate or striate tectum are also found. However, tricolporate pollen with reticulate tectum are more commonly found within the family. Most striking variation is found in the shape class, apertural types and tectal surface. Pollen morphology of the family is significantly helpful at the generic, specific level and subfamilial level. On the basis of shape, apertures and tectum types, 5 distinct pollen types are recognized viz., *Andrachne aspera* -type, *Chrozophora oblongifolia* - type, *Euphorbia hirta* - type, *Mallotus philippensis* - type, *Phyllanthus urinaria* - type

Pollen type-I: *Andrachne aspera* - type is characterized by its striate tectum. Only single species is included in this pollen type (*Andrachne aspera*). Pollen type - II: *Chrozophora oblongifolia*-type is recognized by its 6-8-colporate pollen with coarsely reticulate tectum. It comprises of 2 species (see key to the species). Pollen type-III is easily delimited by having tri-colporate pollen with prolate-spheroidal to sub-prolate or prolate rarely oblate-spheroidal pollen. It comprises of 33 species, distributed in 3 genera. Although, the species of this pollen type are fairly uniform in their pollen character but on the basis of pollen shape these species can be divided into two subtypes viz., *Euphorbia hispida* - subtype (Prolate - type pollen) and *Euphorbia helioscopia* - subtype (oblate-spheroidal pollen) (see Account of pollen types).

Pollen type - IV: *Phyllanthus urinaria* is characterized by reticulate - rugulate tectum. Pollen of 5 species are included, belonging to two genera viz., *Euphorbia* and *Phyllanthus*. However, genera and species of this pollen type are easily separated on the basis of pollen shape class.

Pollen type - VI: *Mallotus philippensis* - type is recognized by its verrucate tectum . only a single species is included in this pollen type - *Mallotus philippensis* (Lam.) Muell. Webster (1994) divided the family Euphorbiaceae into 5 subfamilies viz., Phyllanthoideae, Oldfieldoideae, Acalyphoideae, Crotonoideae and Euphorbioideae. Present pollen data do not correlates with the sub familial classification of Webster (1994). Such as in the pollen type: *Phyllanthus urinaria* , species of *Euphorbia* are also found. Although, it belongs to the subfamily Phyllanthoideae. Similarly remaining three pollen type i.e., *Chrozophora oblongifolia*-type, *Andrachne aspera* - type and *Mallotus*

philippensis-type, are found in the subfamily Acalyphoideae. According to Punt (1962,1987), the subfamily Phyllanthoideae has two distinct related pollen lines, one is 3-colporate, prolate and mostly reticulate tectum, where as other has without much ornamentation and distinctly coarsely reticulate and more or less oblate pollen. According to Nowicke (1994) the pollen data of Euphorbiaceae is perplexing:

Oldfieldoideae, Crotonoideae and Euphorbioideae each have a basic pollen type. But specialized in Oldfieldoideae, Crotonoideae and generalized in Euphorbioideae, whereas in the Phyllanthoideae and Acalyphoideae have diverse pollen types. In Oldfieldoideae pollen are brevicolporate with spinulose tectum. Crotonoideae pollen has coroton structure and inaperturate. Pollen of Euphorbioideae has 3-colporate and tectate perforate. Moreover, pollen morphology suggested that these three subfamilies are natural assemblages. The remarkable diversity in the genus *Phyllanthus* is difficult to explain or interpret. However, in the genus *Polygonum* of the family Polygonaceae has also show great pollen diversity.

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