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Pollen Flora of Pakistan -XV Geraniaceae

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Abstract: The pollen morphology of 13 species belonging to the 3 genera of the family *Geraniaceae* was investigated with a light microscope and scanning microscope. It is eurypalynous in nature. Pollen grains mostly oblate-spheroidal, rarely prolate-spheroidal or spheroidal, often sub-oblate. Tectum reticulate with dense beculae or gammate muri, or striate. On the basis of exine ornamentation and apertural types, 3 distinct pollen types were recognized viz., *Erodium cicutarium*-type, *Geranium himalayense*-type and *Monsonia senegalensis*-type.

Key Words: Pollen morphology, Geraniaceae, Pakistan

Pakistan'ın Polen Florası -XV Geraniaceae

Özet: *Geraniaceae* familyasının 3 cinsine ait 13 türün polen morfolojisi ışık ve taramalı elektron mikroskobu kullanılarak incelenmiştir. Polen morfolojileri öripalinoz yapıdadır. Polenler çoğunlukla oblat-sferoyidal ya da sub-prolat, nadiren prolat-sferoyidal ya da sferoyidaldır. Tektum sık bakulalı veya gammat dikenli retikulat veya sitriyat. Ekzin süslenmesi ve apertür tiplerine dayalı olarak 3 polen tipi tanımlanmıştır. Bunlar *Erodium cicutarium*-tip, *Geranium himalayense*-tip ve *Monsonia senegalensis*-tipdir.

Anahtar Sözcükler: Polen morfolojisi, Geraniaceae, Pakistan.

Introduction

Geraniaceae is represented by 5 genera and c. 750 species, is cosmopolitan in distribution, but is mostly in temperate areas [1, 2]. In Pakistan it is represented by 4 genera and c. 26 native species [3]. The family is divided into two tribes i.e., *Geranieae* (*Geranium* L., *Erodium* L., *Monsonia* L. and *Sarcocole*) and *Pelargonieae* (*Palargonium* L. Herit ex Aiton) by Hutchinson [4]. Bortenschlager [5] studied the pollen morphology of the family *Geraniaceae* in relation to taxonomy. Oltmann [6] described the pollen morphology of the order *Geraniales*. El-Oqlah [7] examined the pollen grains of the genus *Erodium* L. from Middle East. Similarly, Verhoeven & Venter [8] studied the pollen morphology of the genus *Erodium* L. from south Africa.

The pollen morphology of the family has been studied by many researchers such as Selling [9], Heusser [10], Erdtman [11], Kuprianova and Alyoshina [12], and Moore and Webb [13]. There are no reports on the pollen morphology of the family *Geraniaceae* from Pakistan. In the present paper, the pollen morphology of 3 genera distributed in 16 species of the family *Geraniaceae* was examined with a light and scanning electron microscope.

Materials and Method

Pollen samples were obtained from Karachi University Herbarium (KUH) or collected from the field. The list of voucher specimens is deposited in KUH. The pollen grains were prepared for light (LM) and scanning microscopy (SEM) by the standard methods described by Erdtman [11]. 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), with a 10x eye piece. For SEM studies, pollen grains were suspended in a drop of water and directly transferred with a fine pipette to a metallic stub using double-sided cello tape 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 were based on 15-20 readings from each specimen. Pollen diameter, polar axis (P) and equatorial diameter (E), colpi length, apocolpium, mesocolpium and exine thickness were measured (Tables 1-2).

The terminology used is in accordance with Erdtman [11]; Kremp [14]; Faegri and Iversen [15] and Walker and Doyle [16].

Table 1. General pollen characters of species found in pollen type *Geranium himalayense*

Name of taxa	Shape	Aperture	Polar length	Equatorial diameter	Colpus length	Mesocolpium in	Apocolpium in	Exine thickness
Tectum		No.	(P) in μm	(E) in μm	in μm	μm	μm	in μm
<i>Geranium lucidum</i>	Ob-sph		51.83 (58.01±0.72)		59.12(63.83±1.10)		14.8(16.6±1.23)	
44.8(46.8±0.67)		14.3(19.71±0.11)		7.18(7.22±0.09)	Cr.bac			
L			61.02	68.21	21.58	47.8	-	7.53
<i>G. robertianum</i> L.	Ob-sph		64.61(70.9±1.80)	71.81(78.18±1.58)		14.35(17.26±0.72)		53.8(58.9±0.36)
21.5(28.9±1.01)		7.18(7.32±0.04)	Cr/G					
			75.71	82.5	21.5	81.0	35.9	8.97
<i>G. ocellatum</i>	Ob-sph		53.21(56.51±1.49)		51.91(60.70±0.51)		19.98(26.61±0.14)	
36.63(42.6±0.83)		19.98(25.34±0.89)		4.99(5.94±0.84)	Cr/G			
Camb.			59.9	33.31	53.3	46.62	29.97	6.66
<i>G. rotundifolium</i>	Ob-sph		53.91(57.2±1.07)	53.81(64.4±0.90)	10.7(16.3±0.28)	43.08(44.3±0.42)	17.9(18.2±0.28)	
5.38(7.03±0.026)			Cr/G					
Lindf			61.02	68.2	17.9	46.6	21.8	7.18
<i>G. nepalense</i>	Ob-sph		53.80(57.41±1.07)		53.8(63.21±1.52)		17.99(3.57±0.15)	
14.5(21.51±1.61)		14.5(21.71±1.01)		6.82(7.64±0.05)	R/G			
Sweet			61.64	68.23	68.2	25.17	25.17	9.18
<i>G. wallichianum</i> D. Don.	Ob-sph		93.2(94.09±0.67)	99.9(69.09±33.42.17)		ca. 16.6	49.95(69.09±3.93)	
23.31(32.31±0.11)		c. 6.66	Cr/G					

Table 2. General pollen characters of species found in pollen type *Erodium malacoides*

Name of taxa	Shape	Aperture	Polar length	Equatorial diameter	Colpus length	Apocolpium in	Mesocolpium in	Exine thickness
Tectum		No.	(P) in μm	(E) in μm	in μm	μm	μm	in μm
<i>Erodium oxycrhyynchum</i>	Ob-sph		71.31(78.02±0.72)		75.31(82.51±3.10)		c. 35.9	21.5(24.8±1.95)
35.91(55.9±1.29)		5.31(7.20±0.36)	St-R					
<i>M. Bieb. ssp oxycrhyynchum</i>			89.71	89.71	21.58	35.9	68.2	10.71
<i>E. oxycrhyynchum</i> L.	Ob-sph		43.01(58.8±4.36)	43.4(23.91±1.58)	17.9(23.91±0.72)	17.9(20.9±0.50)	43.61(47.98±1.96)	
6.82(7.09±0.04)			Cst					
<i>M. Bieb. ssp bryonifolium</i>				63.12	75.31	28.9	21.51	53.80
(Boiss.) Bch.- Tam								17.18
<i>E. malacoides</i>	Sub-ob		46.6(52.91±1.67)	50.2(60.20±1.08)	21.51(30.91±1.89)		17.91(20.91±0.59)	
48.01(47.58±1.46)		6.87(7.09±0.09)	Cst					
L Herit ex Aiton			61.01	75.31	35.91	21.51	53.81	7.18
<i>E. laciniatum</i>	Ob-sph		43.08(50.01±1.83)		49.91(54.56±1.07)		10.7(23.61±0.49)	c. 21.5
39.84(44.21±1.33)		5.38(6.66±0.0.15)		Cst				

Abbreviations: Ob-sph= Oblate-spheroidal, Sub-ob= sub-oblite, Cr= coarsely, G= gammate, R= reticulate, bac= baculate, st= striate, cst= coarsely striate.

Observations

General pollen characters of the family Geraniaceae

Pollen grains usually radially symmetrical, isopolar, generally oblate-spheroidal, rarely sub-oblite, trilobed, fossaperturate, tricolporate, colpi short, sexine thicker than nexine. Tectum reticulate with densely baculate or gemmate muri or striate. On the basis of exine ornamentation and apertural types 3 distinct pollen types are recognized viz. *Geranium himalayense* - type,

Erodium cicutarium - type, *Monsonia senegalensis* - type
Pollen type -I; *Erodium cicutarium* -type (Fig. 1 A-E; Fig. " C and D).

Pollen class : Tricolporate

P/E ratio : Subtransverse, rarely semi-transverse.

Shape : Oblate-spheroidal, rarely sub-oblite.

Apertures : Ectoaperture-colpi small, or large and circular.

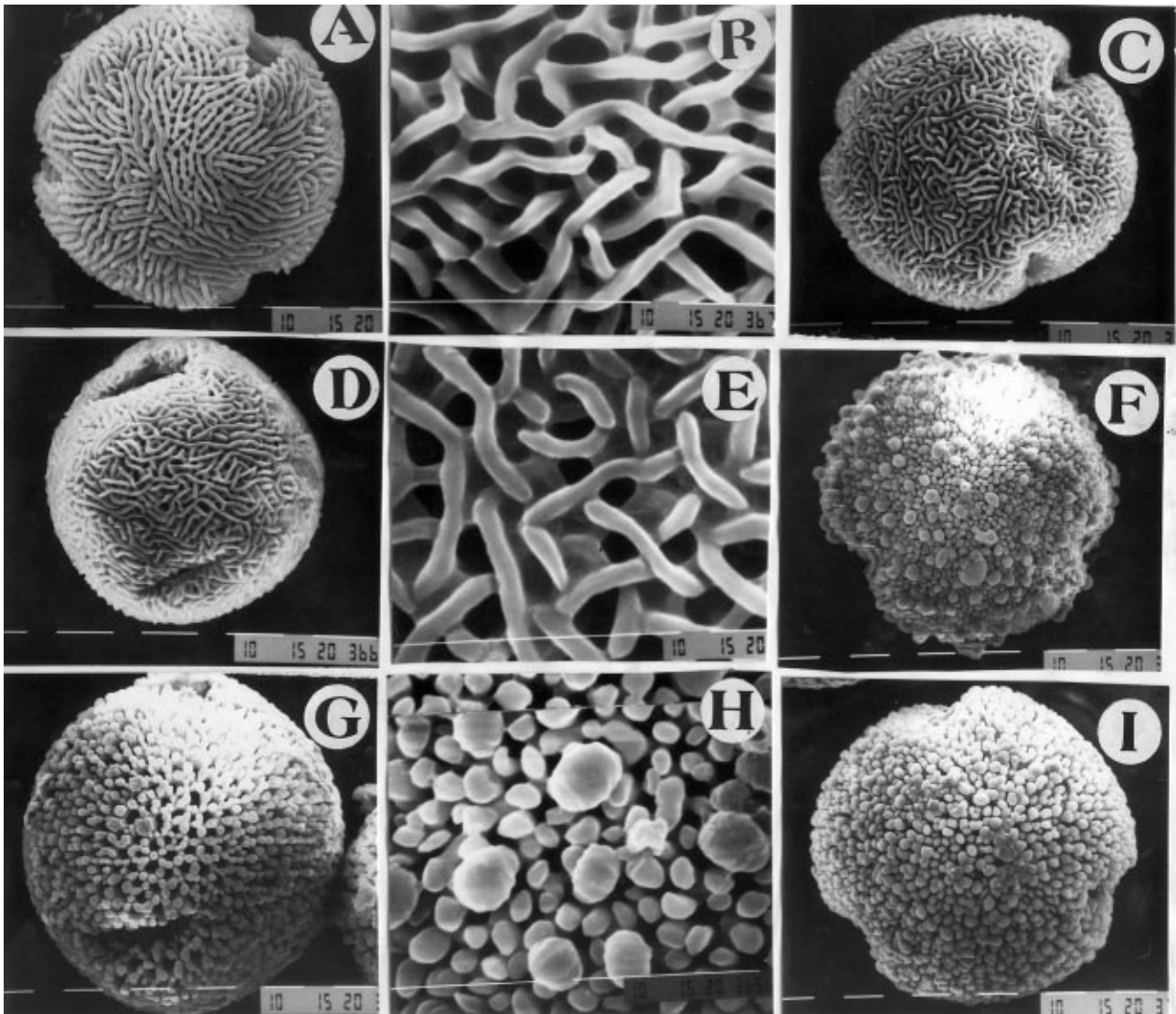


Figure 1. Scanning Electron micrographs of pollen grains. *Erodium cicutarium*: A, polar view; B, Exine pattern. *E. malacoides*: C, polar view; D, Equatorial view. *E. laciniatum* E, Exine pattern. *Geranium collinum*: F, polar view; G, Equatorial view; H, Exine pattern. *G. himalayense* I, polar view. Scale bar = A-I = 10 μ m.

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

Ornamentation : Tectum coarsely reticulate with baculate or gemmate muri, muri with striation.

Measurements : Polar length (P) 43.7 (29.4 \pm 0.13) 89.4 μ m, Equatorial diameter (E) 43.81 (29.75 \pm 1.41) 89.40 μ m, colpi 10.18 (5.35 \pm 1.94) 35.9 μ m in diameter. Mesocolpium 35.9 (18.54 \pm 0.22) 68.21 μ m. Apocolpium 17.9 (18.54 \pm 0.36) 35.21 μ m. Exine 5.31 (1.57 \pm 0.19) 10.71 μ m thick.

Species included:

Erodium oxyrrhynchum M. Bieb. ssp. *oxyrrhynchum*,
E. oxyrrhynchum M. Bieb. subsp. *bryoniifolium*
 (Boiss.) Sch. -Tem., *E. malacoides* (L.) L'Herit ex Aiton.,
E. laciniatum (Cav.) Willd ssp. *pulverulentum* (Cav.) Burt & Lewis,
E. cicutarium (L.) L'Herit ex Aiton.

Key to the species and species groups

+ Pollen grains sub-oblato.....

Erodium oxyrrhynchum M. Bieb. ssp. *oxyrrhynchum*,

- Pollen grains oblate-spheroidal..... *E. malacoides*-
 group (*Erodium oxyrrhynchum* M. Bieb. subsp.

bryoniifolium (Boiss.) Sch. -Tem., *E. malacoides* (L.) L'Herit ex Aiton., *E. laciniatum* (Cav. Willd ssp. *pulverulentum* (cav.) Burt & Lewis. *E. cicutarium* (L.) L'Herit ex Aiton).

Pollen type-II: *Geranium himalayense*-type (Fig. 1 F-I; Fig. 2 A-E; Fig. 3 A and B)

Pollen class: Tricolporate

P/E ratio: Subtransverse, rarely semi-transverse.

Shape: Prolate-spheroidal to oblate-spheroidal, rarely spheroidal.

Apertures: Ectoaperture-colpi small, or large and circular.

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

Ornamentation: Tectum coarsely reticulate with baculate or gemmate muri, muri with striation.

Measurements: Polar length (P) 43.7 (29.4±0.13) 118.4 µm, Equatorial diameter (E) 51.81 (29.75±1.41) 125.0 µm, colpi 7.18 (5.35±1.94) 39.4 µm in diameter. Mesocolpium 14.5 (18.54±0.22) 81.5 µm. Apocolpium 14.51 (18.54±0.36) 50.21 µm. Exine 4.99

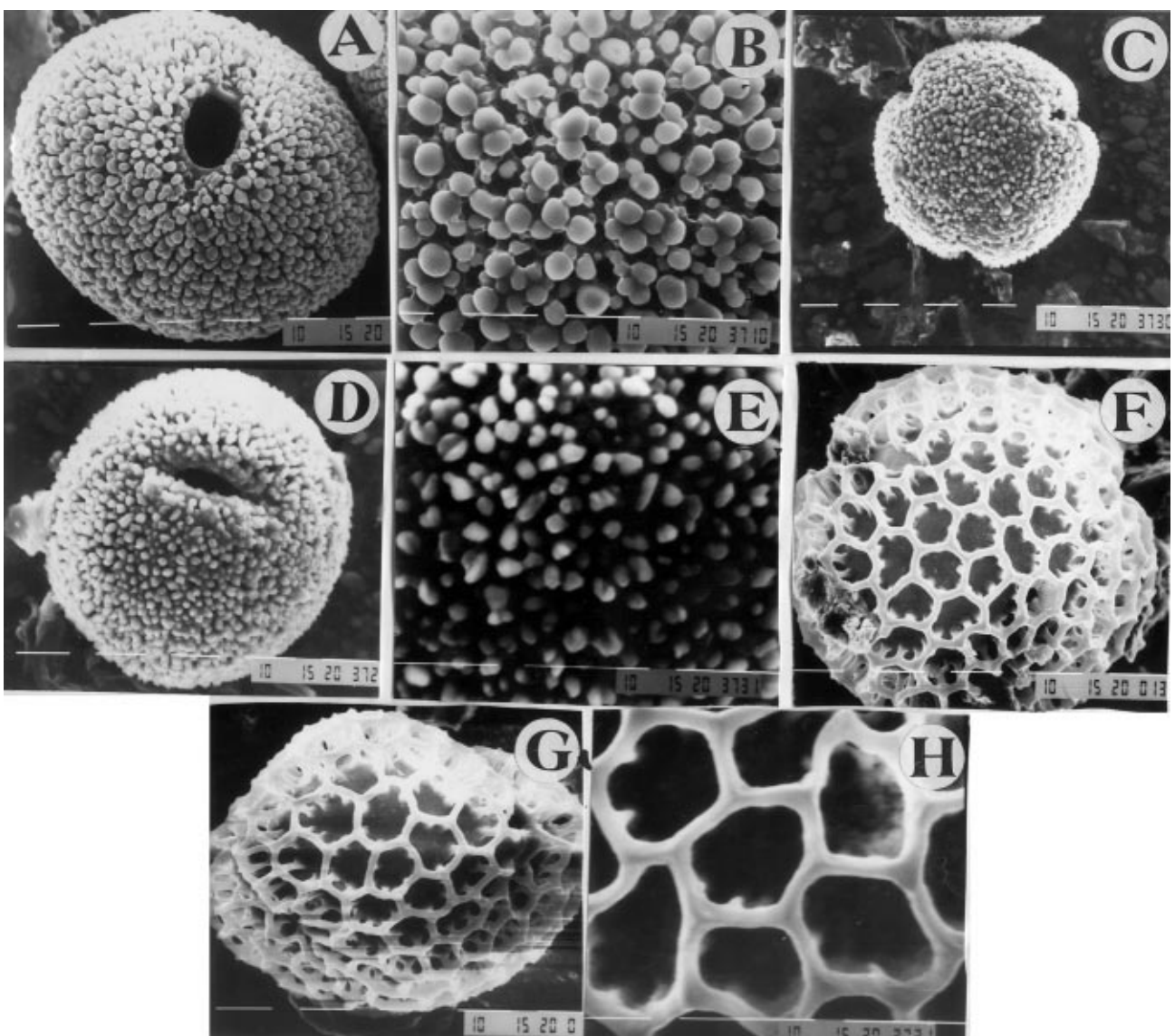


Figure 2. Scanning Electron micrographs of pollen grains. *Geranium himalayense*: A, Equatorial view; B, Exine pattern. *G. nepalense*: C, Polar view; D, Equatorial view; E, Exine pattern. *Monsonia senegalensis*: F, polar view; G, Equatorial view; H, Exine pattern. Scale bar = A-H=10 µm.

(1.57±0.19) 10.71 µm thick.

Species included:

Geranium lucidum L., *G. robertianum* L., *G. ocellatum* Camb., *G. rotundifolium* Lindl., *G. nepalense* Sweet, *G. wallichianum* D. Don ex Sweet, *G. himalayense* Kl., *G. collinum* Steph ex Willd., *G. swatense* Schonbeck-Temesy,

Key to the species and species group

1. + Pollen grains 104-118 µm...*Geranium himalayense*

- Pollen grains 43.8-94.41 µm 2

2. + Pollen grains sub-ovate.... *G. collinum*

- Pollen grains oblate-spheroidal 3

3 + Equatorial diameter 99-103....*G. wallichianum*

- Equatorial diameter 51-82.5 µm 4

4. + Mesocolpium 14.31-25.41 µm...*G. nepalense*

- Mesocolpium 36-53.1 µm 5

5. + Tectum coarsely reticulate with bacula... *G. lucidum*

- Tectum coarsely reticulate with gemmae....*G. ocellatum*-group *Geranium robertianum* L., *G. ocellatum* Camb., *G. rotundifolium* Lindl., *G. swatense* Schonbeck-Temesy,

Pollen type-III: *Monsonia senegalensis*-type (Fig. 2 F-H; Fig. 3 E and F).

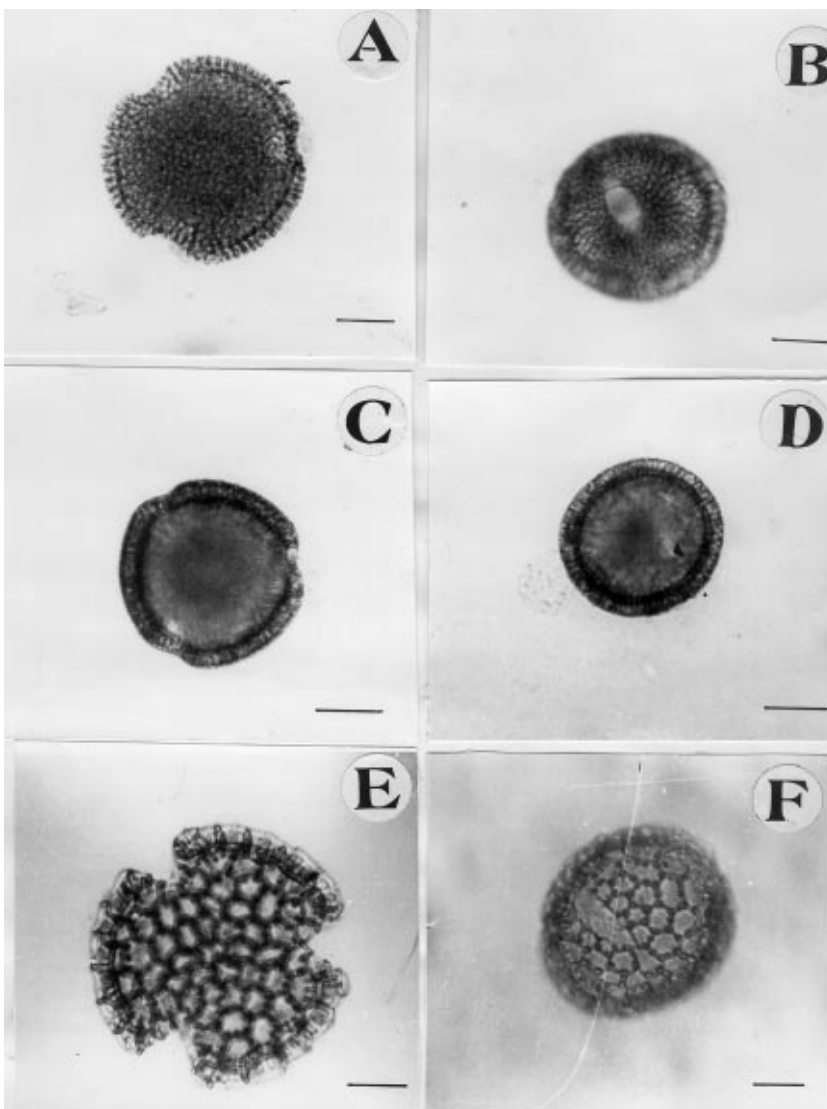


Figure 3. Light micrographs of pollen grains. *Geranium swatense*: A, polar view; B, Equatorial view. *Erodium laciniatum*: C, polar view; D, Equatorial view. *Monsonia senegalensis*: E, polar view; F, Equatorial view. Scale bar=A-F=20

Pollen class: Tricolpate

P/E ratio: Subtransverse.

Shape: Oblate-spheroidal.

Apertures: Ectoaperture-colpi small.

Exine: Baculate, sexine thicker than nexine.

Ornamentation: Tectum very coarsely reticulate with regular pattern of muri, lumina±hexagonal in shape, 6-6-8.6 µm in diameter.

Measurements: Polar axis P (71.80-) 82.92+1.81 (-89.75) µm, C.V. 6.90, and equatorial diameter E (71.80-) 82.39+1.61 (-89.75) µm, P/E ratio: 1.01., colpi (21.54-) 25.13+1.46 (-28.72) µm long, C.V. 11.61 Mesocolpium (53.85-) 63.54+1.69 (-71.81) µm, C.V. 8.44. Apocolpium (21.54-) 26.92+0.92 (-32.31) µm, C.V. 10.82. Exine (7.18-) 8.32+0.46 (-10.77) µm thick.

Species included: *Monsonia senegalensis* Guill.&Perr.

Discussion

Geraniaceae is a eurypalynous family [11]. The pollen morphology of the family is significantly useful at the generic level.

The pollen grains are usually radially symmetrical, isopolar, generally oblate-spheroidal, rarely sub-oblate, trilobed, tricolporate, rarely colpate, colpi short, sexine thicker than nexine. Tectum reticulate with densely baculate or gemmate muri or striate. The palynology of three genera i.e., *Monsonia* L., *Erodium* L. and *Geranium* L., was examined. Taxonomically these genera are closely related (separated on the basis of number of fertile stamens, leaf type and stylar axis). Palynological data also correlates to the above taxonomical interpretation of the family and each genus has more or less its own characteristic pollen type.

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On the basis of exine ornamentation and apertural type 3 distinct pollen types were recognized viz. *Geranium himalayense* -type, *Erodium cicutarium* -type, *Monsonia senegalensis* -type.

Pollen type-I is characterized by a simple striate tectum. Verhoeven and Venter [8] reported a similar pollen type in *Erodium* L. (except *Erodium oxycorynchum* ssp. *oxycorynchum* striate-reticulate tectum with gemmate and baculate muri). Bortenschlager [5] examined 33 *Erodium* L. species and recognized two basic types namely, *Geranium multiflorum* and *Erodium* L. El-Oqlah [7] also identified the two basic pollen types in *Erodium* L. The shape and size and apertural type of the grain do not show much variation, throughout the pollen type.

Pollen type-II is readily distinguished by a reticulate-striate tectum which is heavily ornamented with bacula and gemmae. Erdtman [11] described similar a type of pollen in the genus *Geranium* L., 9 species viz., *Geranium lucidum* L., *G. robertianum* L., *G. ocellatum* Camb., *G. rotundifolium* Lindl., *G. nepalense* Sweet *G. wallichianum* D. Don ex Sweet, *G. himalayense* Kl., *G. collinum* Steph ex Willd., *G. swatense* Schonbeck-Temesy, have been studied from this genus. However, species of *Geranium* L., show little variation in their shape, size, mesocolpium and exine ornamentation which are significantly helpful for characterizing the species into one group viz., *Geranium ocellatum* -group and five species *Geranium lucidum* L., *G. nepalense* Sweet *G. wallichianum* D. Don ex Sweet, *G. himalayense* Kl., *G. collinum* Steph ex Willd. (see the key to the species and species group).

Pollen type-III is easily recognized by its colpate pollen with very coarsely reticulate tectum. Only a single species *Monsonia senegalensis* Guill. & Perr., is included in this pollen type. Venter [17] also reported a similar type of pollen in the genus *Monsonia* L.

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