

## POLLEN FLORA OF PAKISTAN – LXIV: SAXIFRAGACEAE

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### Abstract

Pollen morphology of 13 species of the family Saxifragaceae belonging to 2 genera viz., *Bergenia* Moench., and *Saxifraga* L., has been investigated using light and scanning electron microscope. Pollen grains are usually radially symmetrical, isopolar, sub-prolate to prolate-spheroidal rarely prolate or oblate-spheroidal, tricolporate. Tectum reticulate-rugulate or striaspinulose rarely punctate. On the basis of exine ornamentation 5 distinct pollen types have been recognized viz., *Bergenia ciliata*-type, *Bergenia stracheyi*-type, *Saxifraga asarifolia*-type, *Saxifraga hirculus*-type and *Saxifraga oppositifolia*-type. However, exine ornamentation and pollen shape are important pollen characters. Within the family pollen diversity is significant enough for delimiting the species.

### Introduction

The family Saxifragaceae is a fairly larger family, represented by 30 genera and c. 580 species mostly distributed in cold and temperate regions (Mabberley, 1987). It is represented in Pakistan by 3 genera and 22 species (Ghazanfar, 1977). The family is characterized by perennial herbs, alternate leaves, without stipules, flowers five merous, perigynous and fruit capsule. The family Saxifragaceae is of little economic importance except for rock garden or perennial ornamentals. *Astilbe* is frequently cultivated as a garden ornamental and various species of *Saxifraga* are grown in rock garden.

Pollen morphology of the family Saxifragaceae has been studied by a number of workers. Erdtman (1952), Faegri & Iverson (1964) and Saxena (1973) have studied the pollen of few members of the family Saxifragaceae. All these studies clearly indicate that the family is eurypalynous. However, the data was not employed in the taxonomy of the family. Ferguson & Webb (1970) published a comprehensive paper on the pollen morphology of 105 species of the genus *Saxifraga* and recognized four pollen types. The data was also co-related with the infrageneric classification of the genus. Pastre & Pons (1970), Wakabayashi (1970) Hideux (1974), Hideux & Ferguson (1976), Verbeek-Reuvers (1977) also studied the pollen morphology and tried to correlate their findings with the taxonomy of the family. However, all these studies include every few species occurring in our area. There are no information on the pollen morphology of most of the species occurring in Pakistan. The present palynological investigations are based on the study of 2 genera representing 13 species.

### Materials and Methods

Polleniferous material was obtained from Karachi University Herbarium (KUH) and National Herbarium, Islamabad (RAW) or collected from the field. The list of voucher specimens is deposited in KUH. The pollen grains were prepared for light (LM) by the

standard methods described by Erdtman (1952) and scanning microscopy (SEM). For light microscopy, the pollen grains were mounted in unstained glycerin 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 cello tape and coated with gold in a sputtering chamber (Ion-sputter JFC-1100). Coating was restricted to 150 A. The S.E.M examination was carried out on a Jeol microscope JSM-2. The measurements are based on 15-20 readings from each specimen. Polar axis (P) and equatorial diameter (E), aperture size, apocolpium, mesocolpium and exine thickness were measured (Tables 1-3).

The terminology used is in accordance with Erdtman (1952), Kremp (1965), Faegri & Iversen (1964) and Walker & Doyle (1975).

### General pollen characters of the family Saxifragaceae

Pollen grains usually radially symmetrical, isopolar, sub-prolate rarely prolate-spheroidal to oblate-spheroidal often prolate sexine thicker or thinner than nexine, colpal membrane granulate to spinulose. Tectum is mostly striate-punctate with spinulose, striae coarse to fine. In addition to this, reticulate-rugulate or punctate-reticulate tectum are also found.

### Key to the pollen types

1. + Tectum reticulate-rugulate or punctate-reticulate ..... 2  
 - Tectum spinulose-punctate or striate-spinulose ..... 3
2. + Tectum reticulate-rugulate ..... *Bergenia ciliata*-type  
 - Tectum punctate-reticulate ..... *Bergenia stracheyi*-type
3. + Tectum spinulose-punctate ..... *Saxifraga hirculus*-type  
 - Tectum not as above ..... 4
4. + Tectum striate ..... *Saxifraga oppositifolia*-type  
 - Tectum striate-spinulose ..... *Saxifraga asarifolia*-type

**Pollen type:** *Bergenia ciliata*-type (Fig. 1 A & B).

**Pollen class:** Tricolporate

**P/E ratio:** 1.20.

**Shape:** Sub-prolate

**Apertures:** Colpus long sunken with acute ends.

**Exine:** Sexine thinner than nexine.

**Ornamentation:** Reticulate-rugulate, lumina granulated, variable in size and shape.

**Measurements:** Size: (27.5-)  $30.31 \pm 0.81$  (-33.75)  $\mu\text{m}$ . Colpi (25.61-)  $27.31 \pm 0.60$  (-30.11)  $\mu\text{m}$  long,  $\pm$  triangular in polar view and elliptic in equatorial view, 3-colporate, Mesocolpium 25  $\mu\text{m}$ . Exine (1.75-)  $2.0 \pm 0.61$  (-2.5)  $\mu\text{m}$  thick, sexine thinner than nexine. Tectum reticulate-rugulate, lumina granulated, variable in size and shape. P.A.I: 0.96.

**Species included:** *Bergenia ciliata* (Ham.) Sternb.

Table 1. General characters of pollen grains found in pollen type-Saxifraga asarifolia-type.

Name of species	Shape	Polar length in $\mu\text{m}$	Equatorial diameter $\mu\text{m}$	Colpus length in $\mu\text{m}$	Mesocolpium $\mu\text{m}$	Apocolpium $\mu\text{m}$	Exine thickness $\mu\text{m}$
<i>Saxifraga asarifolia</i> Stemb.	Sub Pr.	20.11(27.66 $\pm$ 1.09) 30.12	16.20 (20.75) 24.51	25.10(25.70 $\pm$ 0.56) 27.5	17.50(18.7 $\pm$ 0.73) 20.11	c. 2.5	2.11(2.26) 2.50
<i>Saxifraga meeboldii</i> Engl. & Irm.	Sub Pr.	15.81 (16.25 $\pm$ 29.7) 17.11	13.10(14.1.7 $\pm$ 0.85) 15.10	c. 15.10	c. 14.10	c. 1.81	c. 1.8
<i>Saxifraga parnassifolia</i> D. Don.	Sub-pr	24.0(25.12) 26.0	18.60(22.8 $\pm$ 0.09) 20.00	23.40	23.0(24.19 $\pm$ 0.21) 125.0	c. 0.8	c. 0.5
<i>Saxifraga sibirica</i> L.	Sub-Pr	15.01 (16.21) 17.22	c.18.23	17.50(17.66 $\pm$ 0.40) 18.22	12.5(15.76 $\pm$ 0.2) 16.50	0.9	1.25(1.5 $\pm$ 0.10) 0.61

Table 2. General characters of pollen grains found in pollen type-Saxifraga hirculus.

Name of species	Shape	Polar length in $\mu\text{m}$	Equatorial diameter $\mu\text{m}$	Colpus length in $\mu\text{m}$	Mesocolpium $\mu\text{m}$	Apocolpium $\mu\text{m}$	Exine thickness $\mu\text{m}$
<i>Saxifraga flagellaris</i> Willd. ex Stemb.	Ob-sp	16.20(17.66 $\pm$ 1.09) 18.20	17.20(17.75) 18.31	14.10-15.20	c. 14.2	c.1.8	1.6-1.8
<i>Saxifraga filicanlis</i> Wall. ex Stemb.	Sub-pr	16.81(19.2 $\pm$ 19.7) 20.11	16.10(17.1.7 $\pm$ 0.85) 18.10	16.10(16.22) 17.10	16.22(16.11) 15.11	c. 2.9	c. 1.8
<i>Saxifraga hirculus</i> L.	Pr.	25.0(28.12) 31.75	23.11(23.7 $\pm$ 0.09) 27.00	22.50(42.0) 28.70	16.2(18.1) 28.70	c.2.5	2.40(2.60) 2.60
<i>Saxifraga moorcraftiana</i> (Ser.) Stemb.	Sub-pr	25.01(22.60) 26.22	15.90(16.20) 17.10	17.50(21.11 $\pm$ 0.4) 22.22	12.5(18.76 $\pm$ 0.2) 16.50	c.4.5	c.1.5
<i>Saxifraga jacquemontiana</i> Decne.	Ob-Sp	c. 15.0	c. 17.1	c. 14.0	c. 16.0	c. 1.7	c. 1.5

Table 3. General characters of pollen grains found in pollen type-Saxifraga oppositifolia.

Name of species	Shape	Polar length in $\mu\text{m}$	Equatorial diameter $\mu\text{m}$	Colpus length in $\mu\text{m}$	Mesocolpium $\mu\text{m}$	Apocolpium $\mu\text{m}$	Exine thickness $\mu\text{m}$
<i>Saxifraga oppositifolia</i> L.	Sub Pr.	19.08(20.4 $\pm$ 1.08) 20.41	16.11(17.81) 18.20	17.21(18.7 $\pm$ 0.06)	9.40(10.9 $\pm$ 0.73) 11.10	1.2(1.9 $\pm$ 0.59)	3.1
<i>Saxifraga pseudo-pallida</i> Engl. & Irm.	Sub Pr.	11.10(11.99 $\pm$ 06.70) 12.10	20.32(21.47 $\pm$ 0.85) 21.70	9.00 (9.17 $\pm$ 0.58) 10.0	6.11(7.59 $\pm$ 6.73) 7.90	c. 0.2	c. 0.5

Sub-Pr = Sub-prolate, Pr-Sp = Prolate spheroidal, Ob-Sp = Oblate-spheroidal, Pr = Prolate

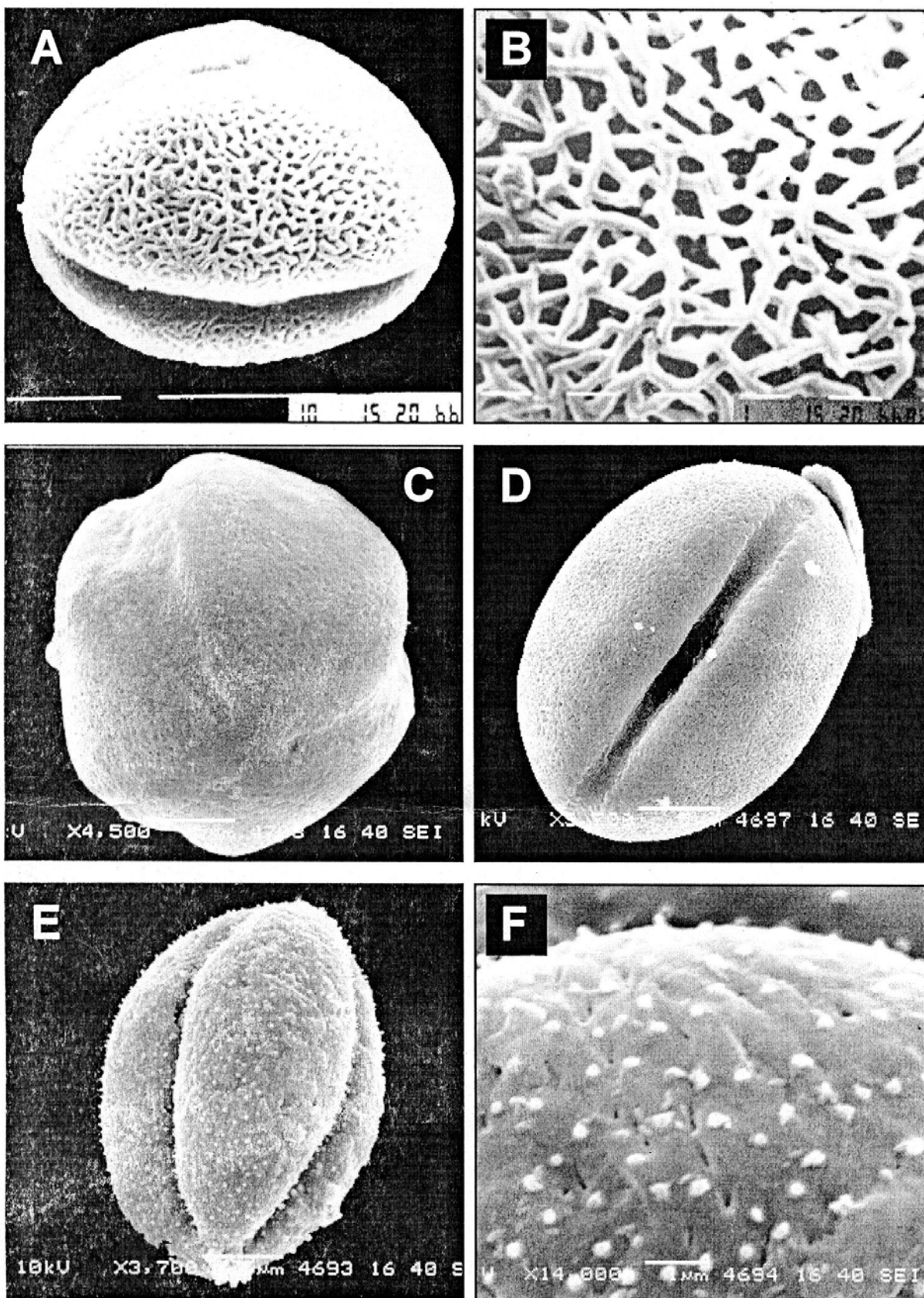


Fig. 1. Scanning Electron micrographs of pollen grains: *Bergenia ciliata*: A, Equatorial view, B, Exine pattern. *Bergenia stracheyi*: C, Polar view; D, Equatorial view; *Saxifraga jacquemontiana*: E, Equatorial view, F, Exine pattern.

Scale bar: A = 10  $\mu$ m; B & F = 1  $\mu$ m; C, D & E = 5  $\mu$ m

**Pollen type:** *Bergenia stracheyi*-type (Fig. 1C & D)

**Pollen class:** Tricolporate

**P/E ratio:** 1.07.

**Shape:** Prolate-spheroidal

**Apertures:** Colpus long sunken with acute ends.

**Exine:** Sexine thicker than nexine.

**Ornamentation:** Punctate-reticulate.

**Measurements:** Size: Polar length (25.11-)  $26.25 \pm 0.471$  (-27.5)  $\mu\text{m}$  and equatorial diameter E(17.5)  $21.35 \pm 3.54$  (-25.25)  $\mu\text{m}$ , colpi (20.11-)  $23.80 \pm 0.89$  (-27.7)  $\mu\text{m}$  long. Mesocolpium (12.5-)  $16.85 \pm 1.03$  (-20)  $\mu\text{m}$ . Apocolpium (2.25-)  $2.51 \pm 0.06$  (-2.75)  $\mu\text{m}$ . Exine (2.25-)  $2.33 \pm 0.166$  (1.5)  $\mu\text{m}$  thick, sexine thicker than nexine. Tectum punctuate-reticulate.

**Species included:** *Bergenia stracheyi* (Hook.f. & Thoms.) Engl.

**Pollen type:** *Saxifraga asarifolia*-type (Fig. 2A-C).

**Pollen class:** Tricolporate

**P/E ratio:** 1.20-1.32.

**Shape:** Sub-prolate

**Apertures:** Colpus long sunken with acute ends.

**Exine:** Sexine thicker than nexine.

**Ornamentation:** Striate with spinulated lirae.

**Measurements:**Size. Polar length P (15.01-)  $23.61 \pm 1.36$  (-31.12)  $\mu\text{m}$  and equatorial diameter E (13.15-)  $18.25 \pm 1.84$  (-24.50)  $\mu\text{m}$ . Colpi (15.51-)  $21.65 \pm 0.8$  (-27.8)  $\mu\text{m}$  long, trilobed, tricolporate. Mesocolpium (12.5-)  $20.30 \pm 0.47$  (-25.11)  $\mu\text{m}$ . Apocolpium 0.9-2.5  $\mu\text{m}$ . Exine (0.5)  $1.5 \pm 0.28$  (1.5)  $\mu\text{m}$  thick, sexine thicker than nexine. Tectum striate with spinules lirae.

**Species included:** *Saxifraga asarifolia* Sternb., *S. parnassifolia* D. Don., *S. meeboldii* Engl. & Irm., and *S. sibirica* L.

#### Key to the species

1. + Exine 0.5  $\mu\text{m}$  thick ..... *Saxifraga parnassifolia*  
 - Exine 1.8-3  $\mu\text{m}$  thick ..... 2
2. + Polar length of pollen 15.2-17  $\mu\text{m}$  ..... 3  
 - Polar length of pollen 20-30  $\mu\text{m}$  ..... *Saxifraga asarifolia*
3. + Colpi 15.1  $\mu\text{m}$  ..... *Saxifraga meeboldii*  
 - Colpi 18.22  $\mu\text{m}$  ..... *Saxifraga sibirica*

**Pollen type:** *Saxifraga hirculus*-type (Fig. 1E-F).

**Pollen class:** Tricolporate

**P/E ratio:** 1.20-1.32.

**Shape:** Sub-prolate

**Apertures:** Colpus long sunken with acute ends.

**Exine:** Sexine thicker than nexine.

**Ornamentation:** Spinulose-punctate

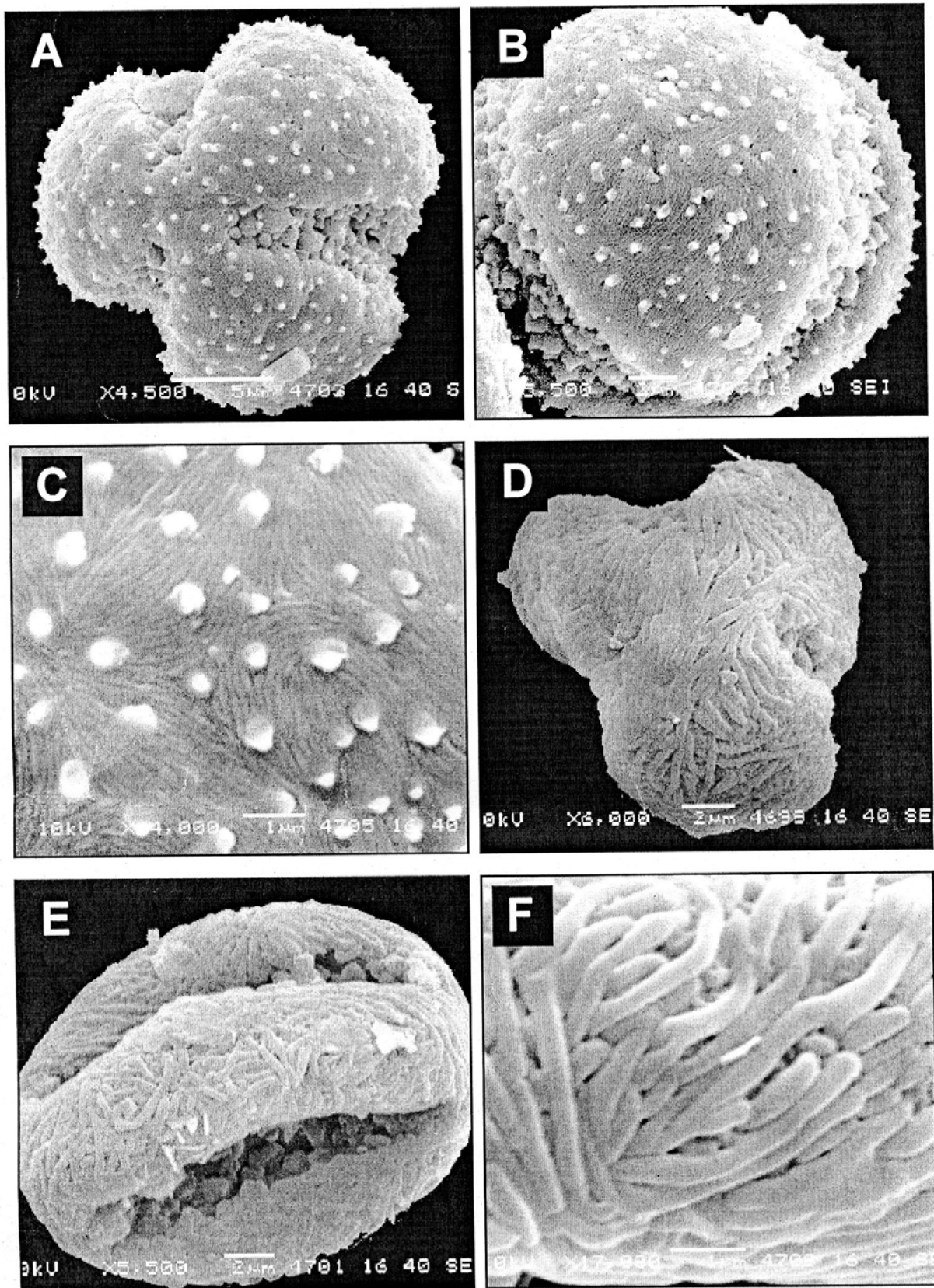


Fig. 2. Scanning Electron micrographs of pollen grains: *Saxifraga parnassifolia*: A, Polar view; B, Equatorial view, C, Exine pattern. *Saxifraga oppositifolia*: D, Polar view; E, Equatorial view; F, Exine pattern.

Scale bar: A = 5  $\mu$ m; C & F = 1  $\mu$ m; B, D & E = 2  $\mu$ m

**Measurements:** Size: Polar length P (16.21-)  $23.61 \pm 1.36$  (-31.12)  $\mu\text{m}$  and equatorial diameter E (16.25-)  $21.90 \pm 7.84$  (-27.55)  $\mu\text{m}$ . Colpi (14.51-)  $21.65 \pm 0.8$  (-28.8)  $\mu\text{m}$  long, trilobed, tricolporate. Mesocolpium (14.2-)  $21.15 \pm 0.47$  (-28.11)  $\mu\text{m}$ . Apocolpium 1.8-4.5  $\mu\text{m}$ . Exine (2.11-)  $2.80 \pm 0.28$  (-2.5)  $\mu\text{m}$  thick, sexine thicker than nexine. Tectum spinulose-punctate.

**Species included:** *Saxifraga hirculus* L., *S. flagellaris* Vild. ex Sternb. subsp. *crassiflagellata* Hulten, *S. flagellaris* Vild. ex Sternb. subsp. *stenophylla* (Royle) Hulten, *S. filicaulis* Wall. ex Ser., *S. moorcroftiana* (Ser.) Sternb and *S. jacquemontiana* Decne.

### Key to the species

1. + Pollen oblate-spheroidal ..... Group-1  
(*Saxifraga flagellaris* subsp. *crassiflagellata*, *Saxifraga flagellaris* subsp., *stenophylla*, *S. jacquemontiana*,)  
- Pollen sub-prolate to prolate ..... 2
2. + Pollen prolate ..... *Saxifraga hirculus*  
- Pollen sub-prolate ..... 3
3. + Polar length of pollen grains 25-31.26  $\mu\text{m}$  ..... *Saxifraga moorcroftiana*  
- Polar length of pollen grains 16-20  $\mu\text{m}$  ..... *Saxifraga filicaulis*

**Pollen type:** *Saxifraga oppositifolia*- type (Fig. 2D-F).

**Pollen class:** Tricolporate

**P/E ratio:** 1.20-1.32.

**Shape:** Sub-prolate

**Apertures:** Colpus long sunken with acute ends.

**Exine:** Sexine thicker than nexine.

**Ornamentation:** Coarsely striate

**Measurements:** Size: Polar length P (11.2 1-)  $15.51 \pm 1.26$  (-19.8)  $\mu\text{m}$  and equatorial diameter E (16.25-)  $18.75 \pm 1.24$  (-21.25)  $\mu\text{m}$ . Colpi (9.11-)  $13.62 \pm 0.6$  (-18.1.4)  $\mu\text{m}$  long, trilobed, tricolporate. Mesocolpium (9.12-)  $9.61 \pm 0.45$  (-10.11)  $\mu\text{m}$ . Apocolpium c. 0.2-1.9  $\mu\text{m}$ . Exine (0.52-)  $1.81 \pm 1.24$  (-3.1)  $\mu\text{m}$  thick, sexine thicker than nexine. Tectum coarsely striate.

**Species included:** *Saxifraga oppositifolia* L., and *S. pseudo-pallida* Engle. & Irm.

### Key to the species

1. + Pollen grains 11  $\mu\text{m}$  in polar length ..... *Saxifraga pseudo-pallida*  
- Pollen grains 19-20.4  $\mu\text{m}$  in polar length ..... *Saxifraga oppositifolia*

### Discussion

The pollen morphology of the family Saxifragaceae shows a considerable variation particularly in the exine pattern and shape. On the basis of exine ornamentation five different pollen types are recognized. Two of the pollen types belong to the genus *Bergenia* viz., *Bergenia ciliata*-type and *Bergenia stracheyi*-type. The former type is characterized by

punctate-reticulate tectum and the latter has reticulate-rugulate tectum. Both the types have one species each. The three types recognized in the genus *Saxifraga* are *Saxifraga asarifolia*-type, *Saxifraga hirculus*-type and *Saxifraga oppositifolia*-type. *Saxifraga asarifolia*-type is recognized by its striate with spinulose tectum. According to Ferguson & Webb (1970) pollen having striate tectum is most common and wide spread in the *Saxifraga* species. In the present type this type includes 4 species. These four species belong to 3 different sections of the genus *Saxifraga*. *Saxifraga asarifolia* and *Saxifraga sibirica* belong to the section Mesogyne Sternberg. *Saxifraga meeboldi* falls in the section Porphyron Tausch and *Saxifraga parnassifolia* belongs to the section Ciliatae Haworth. The second pollen type, *Saxifraga hirculus*-type which is characterized by having spinulose-punctate tectum and includes five species viz., *S. hirculus*, *S. flagellaris*, *S. filicaulis*, *S. jacquemontiana* and *S. moorcroftiana*. All these five species belong to the section Ciliatae. Thus the pollen morphology is supporting the infrageneric classification in this case. However, these species can be identified on the basis of exine thickness and polar and colpi length. Similarly, in the third pollen type i.e., *Saxifraga oppositifolia*-type two species are included but both the species are distributed in two different section of the genus *Saxifraga* viz., *Saxifraga oppositifolia* belongs to the section Porphyron Tausch, and *Saxifraga pseudopallida* falls in the section Micranthes (Haworth) D. Don. Thus the pollen morphology supports the infrageneric classification partially.

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