

Pollen Atlas of the Flora of Egypt.

2. Species of Polygonaceae*

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Pollen grains of 20 species belonging to 7 genera of Polygonaceae represented in the Flora were studied using Light and Scanning Electron Microscope. Pollen characters, including those of size, shape, exine sculpture and structure of the aperture allowed the recognition of five pollen types: *Atraphaxis*, *Calligonum-Oxygonum*, *Persicaria*, *Polygonum* and *Rumex-Emex* types. A key for the separation of the different types is provided and the pollen morphology in relation to taxonomy of the investigated taxa is briefly discussed.

Key words: Flora of Egypt, Pollen atlas, Polygonaceae.

Introduction

Polygonaceae is a well-defined cosmopolitan family containing more than 40 genera and 300 species of herbs, shrubs and trees; mainly known from the north temperate regions.

The classification of Polygonaceae has remained a major challenge for taxonomists at the generic and tribal levels (Meissener, 1857; Gross, 1913; Jaretzky, 1928; Hedberg, 1946; Graham & Wood, 1964; Roberry & Vautier, 1964; Hara, 1966; Haraldson, 1978 and Ronse-Decraene, 1988). The early classifications of the Polygonaceae were based mainly on gross morphological characters (Meissener, 1826; Bentham and Hooker, 1880). Recently, other criteria have been used in the classification of this family including anatomy (Vautier, 1949; Haraldson, 1978), chromosome number (Löve and Löve, 1956), and chemical constituents (Jaretzky, 1928).

According to Täckholm (1974: 58-68) Polygonaceae is represented by 28 species. A less number of 24–26 species which belong to seven–eight genera were reported by El-Hadidi (1997:24-26) and Boulos (1999:21-34); while El-Husseini and El-Hadidi (2000: 64-82) reported the presence of seven genera and 24 species.

* Continued from *Täckholmia* 20(2):173-179.

Table (1): Collection data of the investigated taxa.

Code number	Species	Locality
19.22.45	<i>Atraphaxis spinosa</i>	On the step way to Gebel Musa, Sinai, 10.5.1965; <i>El-Hadidi</i> (CAI) – Gebel Catherine, Sinai, April 1940; <i>M. Hassib</i> (CAI).
19.23.46	<i>Calligonum comosum</i>	Bahariya depression, 65 km s. Bawiti, 23.3.1968; <i>Romé</i> (CAI) – Alexandria desert road, 4-7 km from pyramids, 26.12.1952; <i>Boulos</i> (CAI) – Cairo – Assiut desert road, 30 km S. Assiut, 30.3.1998; <i>El-Naggar</i> (AST).
19.24.47	<i>Emex spinosus</i>	In the fields around Iking Mariut, 7.4.1967; <i>V. Täckholm et al.</i> (CAI) – El-Minia, in the fields, 22.3.1998; <i>El-Naggar</i> (AST).
19.25.48	<i>Oxygonum sinuatum</i>	Gebel Elba, January 14 th Feb. 6 th 1933; <i>Fahmy & Hassib</i> (CAI) – Gebel Elba, January 23-27 th 1929; <i>G. Täckholm</i> (CAI).
19.25.51	<i>Polygonum plebeium</i>	El-Minia, 15.10.1971; <i>Boulos et al.</i> (CAI), Arab Mutaer, 10.1.1998; <i>El-Naggar</i> (AST).
19.26.54	<i>P. patulum</i>	Tahrir province, 8.6.1973; <i>Ibrahim et al.</i> (CAI) – Dakhla Oasis, 2.5.1969; <i>Osborn & Helmy</i> .
19.26.55	<i>P. equisetiforme</i>	Sallum town, 24.5.1963; <i>V. Täckholm et al.</i> (CAI) – 120 km west of Mersa Matruh, 28.9.1963; <i>Boulos</i> (CAI).
19.27.56	<i>Persicaria lapathifolia</i>	El-Mallawi, 18.10.1971; <i>Boulos et al.</i> (CAI) – Mahmoudia, Miniut El Sdid, 14.8.1970; <i>Imam et al.</i> (CAI).
19.27.57	<i>P. decipiens</i>	Ras El Barr, 2.7.1976; <i>El Gazzar et al.</i> (CAI) – Along the canals at Masraf El Gosh, N. Inshas, 28.8.1959; <i>V. Täckholm</i> (CAI).
19.27.58	<i>P. senegalensis</i>	On the way to Beilbeis along Ismailia canal, 27.3.1968; <i>V. Täckholm et al.</i> (CAI) – Sendabis, Al-Qanater El-Khairia, 18.8.1971; <i>Imam et al.</i> (CAI).
19.27.59	<i>P. lanigera</i>	Assiut, El-Salakhana, 10.3.1983; <i>Zareh</i> (AST).
19.27.60	<i>P. attenuata</i>	Faraskur, 27.10.1967; <i>V. Täckholm et al.</i> (CAI) – Between Ras El Bar and Damietta, 13.9.1929; <i>Hefnawy</i> (CAI).
19.28.61	<i>Rumex pictus</i>	Rosetta, 20.4.1973; <i>Ibrahim et al.</i> (CAI) – Sidi Abdel Rahman, 8.3.1978; <i>Soliman</i> (CAI).
19.28.62	<i>R. cyprius</i>	Wadi Aber, Gebel Ataqa, Suez road, 8.4.1967; <i>V. Täckholm</i> (CAI) – Wadi along 60 km S. of Suez, 25.2.1964; <i>Kassas</i> (CAI).
19.28.63	<i>R. vesicarius</i>	Wadi Angabya, Suez road, 23.1.1956; <i>El-Hadidi</i> (CAI) – Burg El-Arab, 1.4.1960; <i>El-Batanony</i> (CAI).
19.28.64	<i>R. simpliciflorus</i>	Gebel Hamata, Red Sea Coast, 7.2.1961; <i>V. Täckholm</i> (CAI) – Khor Wadi Yahameib, Gebel Elba, 22.1.1962; <i>V. Täckholm et al.</i> (CAI).
19.28.66	<i>R. crispus</i>	Shebin Al-Qanatir, Arab El Hosne, 18.6.1983; <i>El-Fayoumi</i> (CAI).
19.28.67	<i>R. pulcher</i>	Kobry El Serafy, Id fina – Alexandria road, 16.3.1984; <i>El-Garf & El-Fayoumi</i> (CAI).
19.28.68	<i>R. dentatus</i>	Fayium, stop at a field, 12.2.1952; <i>El-Hadidi</i> (CAI) – El-Minia, in the fields, 22.3.1998; <i>El Naggar</i> (AST).

Polygonaceae is considered to be one of the europalynous families among the dicotyledons (Wodehouse, 1931; Erdtman, 1960). Its pollen morphology and taxonomy has been the subject of several studies among which may be mentioned: Gross (1913), Wodehouse (1931), Hedberg (1946), Erdtman (1960), Nowicke and Skvarla (1977) and Van Leeuwen *et al.* (1988).

The present account deals with the pollen morphology of 20 species belonging to seven genera of Polygonaceae. It aims to assess the significance of the pollen characters in the species delimitation.

Material and Methods

This study is based on mature pollen grains of 20 species of the Polygonaceae (El-Husseini & El-Hadidi: 64-82, 2000). The code number preceding each species is that used for the computer data base of the Vascular plants represented in the Flora of Egypt. Samples of pollen grains of each species were collected from their natural habitats as shown in Table (1) or from herbarium specimens. Voucher specimens for each studied species are kept in the herbarium of Cairo University (CAI, Holmgren *et al.* 1990) and the herbarium of Botany Department, Faculty of Science, Assiut University (AST, proposed abbreviation).

Materials for light microscopy were boiled for about 30 seconds in an aqueous 5% NaOH, washed several times with distilled water, spread on a clean slide in a drop of lactic acid and gently heated until the boiling point. The pollen grains were examined using a Nikon 140 Research microscope.

Materials for SEM were prepared by mounting acetolyzed pollen grains onto clean stubs using double sided cellotape. Untreated dry pollen grains were mounted directly onto other stubs. Some acetolyzed pollen grains were mounted onto clean stubs and with clean cover slips were forced against to fractionate them to study the wall. Some others were immersed in liquid nitrogen to frozen and then ruptured with hammer. These stubs were coated with gold in a JEOL JFC 1100 Eion. sputtering device. Pollen grains were then examined in a JEOL JSM 5400 LV Scanning Electron Microscope operated at accelerated voltage of 15 KV., at Electron Microscopy Unit, Assiut University. The terminology used here for pollen description followed Erdtman (1952) and Ristima (1970).

Results

Table (2) presents the pollen morphological features of the investigated species; belonging to five pollen types that can be distinguished through the following key:

- | | | |
|------|---|-----------------------------------|
| 1.a. | Pollen grains pantopolyporate | <i>Persicaria</i> type |
| b. | Pollen grains 3 – 4 – colporate | 2 |
| 2.a. | Pollen grains oblate – spheroidal | <i>Rumex – Emex</i> type |
| b. | Pollen grains prolate to perprolate | 3 |
| 3.a. | Tectum scabrate granulate or microechinate | <i>Polygonum</i> type |
| b. | Tectum foveolate – reticulate or striate – reticulate | 4 |
| 4.a. | Tectum striate – reticulate | <i>Atraphaxis</i> type |
| b. | Tectum foveolate – microreticulate | <i>Calligonum – Oxygonum</i> type |

Table (2). Summary of palynological data of the investigated taxa, all measurements in μm .

Number	Species	Dimensions			Shape	Aperture characters	Exine sculpture
		P	E	P/E			
19.22.45	<i>Atraphaxis spinosa</i>	30-35	25-27	1.25	prolate	Tricolporate	striate – reticulate
19.23.46	<i>Calligonum comosum</i>	27-35	22-30	1.19	prolate	Tricolporate	reticulate – microreticulate
19.24.47	<i>Emex spinosa</i>	20-26	20-26	1	spheroidal	Tricolporate	microreticulate - foveolate
19.25.48	<i>Oxygonum sinuatum</i>	47-50	35-40	1.30	prolate	Tricolporate	reticulate – microreticulate
19.26.51	<i>Polygonum plebeium</i>	25-27.5	20-25	1.16	prolate	Tricolporate	scabrate punctate
19.26.54	<i>P. patulum</i>	20-25	15-20	1.30	prolate	Tricolporate	scabrate punctate
19.26.55	<i>P. equisetiforme</i>	22.5-30	15-20	1.50	prolate	Tricolporate	scabrate punctate
19.27.56	<i>Persicaria lapathifolia</i>	42.5	42.5	1	spheroidal	Pantoporate	coarse reticulate
19.27.57	<i>P. decipiens</i>	47.5-52.5	47.5-52.5	1	spheroidal	Pantoporate	coarse reticulate
19.27.58	<i>P. senegalensis</i>	40-50	40-50	1	spheroidal	Pantoporate	coarse reticulate
19.27.59	<i>P. lanigera</i>	32.5-37.5	32.5-37.5	1	spheroidal	Pantoporate	coarse reticulate
19.27.60	<i>P. attenuata</i>	48.5-56.5	48.5-56.5	1	spheroidal	Pantoporate	coarse reticulate
19.28.61	<i>Rumex pictus</i>	20-25	20-25	1	spheroidal	Tricolporate	microreticulate – foveolate
19.28.62	<i>R. cyprius</i>	25-27.5	25-27.5	1	spheroidal	Tricolporate	microreticulate – foveolate
19.28.63	<i>R. vesicarius</i>	22.5-25	22.5-25	1	spheroidal	Tricolporate	microreticulate – foveolate
19.28.64	<i>R. simpliciflorus</i>	20-27	20-27	1	spheroidal	Tricolporate	microreticulate – foveolate
19.28.66	<i>R. crispus</i>	22.5-25	22.5-25	1	spheroidal	Tricolporate	microreticulate – foveolate
19.28.67	<i>R. pulcher</i>	27.5-32.5	27.5-32.5	1	spheroidal	Tricolporate	microreticulate – foveolate
19.28.68	<i>R. dentatus</i>	20-25	20-25	1	spheroidal	Tricolporate	microreticulate – foveolate

1- *Atraphaxis* type

Pollen grains isopolar, radiosymmetric, tricolpate or tricolporate, 30 – 35 x 25 – 27 μm , prolate, striate-reticulate. Aperture: ectoaperture colpus long, slit-like, wide, distinctly sunken, margins distinct, ends acute to obtuse; endoaperture \pm porus. Exine thick, nexine thinner than sexine, sexine 1- columellate, columella indistinct; sexine 2- tectate, tectum foveolate with holes of different shape and size. Exine ornamentation composed of narrow ridges (muri), connected with each other in different ways and foveolate furrows (lumina); ridges and furrows running parallel to the colpus.

This pollen type characterizes *Atraphaxis spinosa* (Fig. 1a).

2- *Calligonum* – *Oxygonum* type

Pollen isopolar, radiosymmetric, tricolpate, 27-35 x 22-30 μm (*Calligonum*) 47-50 x 35-40 μm (*Oxygonum*), prolate to spheroid, reticulate to microreticulate. Aperture ectoaperture colpus, narrow, slit-like, long or very long (94% of the equatorial axis), sunken, margins distinct, irregular, ends acute, endoaperture colpus or porus, elongated, lalongate, sometimes slightly rhombic, margins distinct. Exine thick, sexine thicker than nexine, sexine one columellate, sexine two tectat semitectate, tectum reticulate, mural areas visible which represent fused apices of columella, lumina variable in outline \pm elongate or circular.

This type characterizes two species: *Calligonum comosum* L' Her. and *Oxygonum sinuatum* (Hochst. & Steud.) Dammer (Fig. 1b).

3- *Rumex* – *Emex* type

Pollen isopolar, radiosymmetric 3-4-colporate, 22-32 x 22-32 μm (*Rumex*) 20-26 x 20-26 μm (*Emex*), oblate to spheroid, microreticulate-foveolate. Aperture, ectoaperture colpus, narrow, slit like, long or very long (90% of the polar axis), usually sunken sometimes not or only slightly sunken, margin distinct, irregular, ends acute, endoaperture porus, circular, slightly lalongate or \pm lalongate. Exine thick, sexine thicker than nexine, sexine one columellate, columella low either distinct or indistinct, uniform in thickness, sexine two tectate, sexine three scabrate; muri simple columellate, often irregular in surface view, always beset with granular scabrate, lumina irregular in outline, usually \pm circular, sometimes indistinct columellae circular in cross section.

Emex spinosus (L.) Campdera, *Rumex pictus* Forssk., *R. cyprius* Murb., *R. vesicarius* L., *R. simpliciflorus* Murb., *R. crispus* L., *R. pulcher* L. and *R. dentatus* (Fig. 1c).

4- *Persicaria* type

Pollen isopolar, radiosymmetric, pantoporate, 32-50 x 33-55 μm , oblate-spheroid; coarse reticulate. Aperture, ectoaperture porus circular, situated in a single lumen of the reticulum, not sunken, margins not particularly distinct, number of pori 12-27, endoaperture porus, distinct, irregular, exine thick, sexine much thicker than nexine, sexine one columellate in muri of reticulum and of spherical elements inside lumina, sexine two semitectate. Muri thin duplicolum-ellate, columellae usually opposite or some alternate, lumina variable in size, angular, usually forming 4-6 sided polygonal the side straight in fully expanded grains, slightly wavy in contracted grains, granules numerous inside lumina.

Persicaria lapathifolia (L.) S.F. Gray, *P. decipiens* (R.Br.) K.L. Wilson, *P. senegalensis* (Meisn.) Soják, *P. lanigera* (R.Br.) Soják and *P. attenuata* (R.Br.) Soják (Fig. 1d).

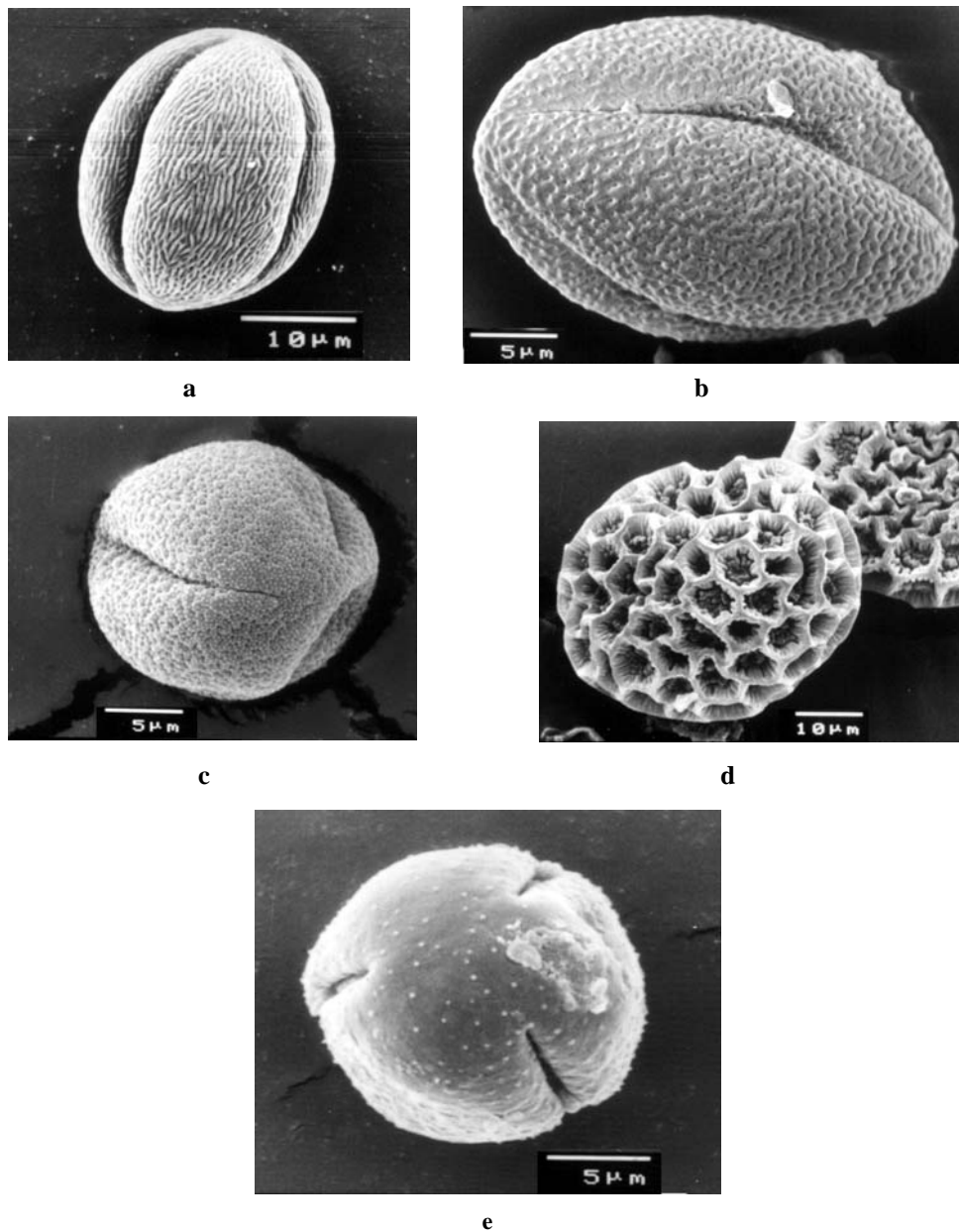


Fig. 1. SEM micrographs of pollen grains belonging to the five pollen types, bar = 5 or 10 µm.
a. *Atraphaxis* type, e.g. *Atraphaxis spinosa*, b. *Calligonum Oxygonum* type, e.g. *Calligonum comosum*, c. *Rumex-Emex* type, e.g. *Rumex vesicarius*, d. *Persicaria* type, e.g. *Persicaria lapathifolia*.

5- *Polygonum* type

Pollen isopolar, radiosymmetric, tricolporate, 22-30 x 15-20 μm , prolate, rectangular shaped, scabrate, or microechinate. Aperture, endoaperture colpus, long, slit-like, distinctly sunken, margins distinct, irregular, ends acute to slightly obtuse, endoaperture colpus lalongate, exine thick (1.2 μm), nexine much thinner than sexine, sexine one columellate, distinct, variable in length, much thicker at the base, sexine two tectate, sexine three scabrate microgranulate or microspinulate.

This type characterizes species: *Polygonum plebeium* R. Br., *P. patulum* M. Bieb. and *P. equisetiforme* Sm. (Fig. 1e).

Discussion

Polygonaceae is an europalynous family (Hedberg, 1946; Erdtman, 1960). Its pollen morphological characters have been successfully used in the classification of the family particularly at the generic level (Gross, 1913; Nowick and Skvarla, 1977; Van Leeuwen *et al.*, 1988).

The present results show that pollen shape, size and aperture characters as well as exine structure and sculpture are reliable to differentiate between the studied taxa.

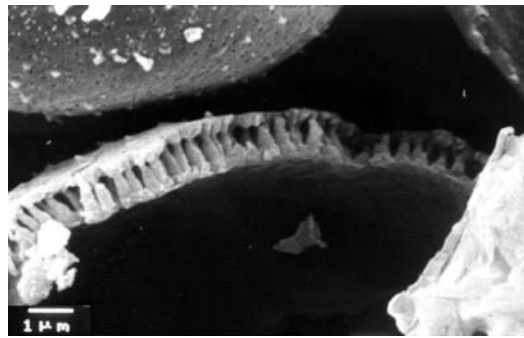
Pollen shape varies greatly among the studied taxa but it is constant at the generic level. It ranges from oblate to oblate – spheroidal in *Rumex*, *Emex* and *Persicaria*, to prolate – spheroidal and prolate in *Oxygonum*, *Calligonum* and *Atraphaxis* (Table 2). Among the prolate pollen grains of the investigated taxa, the polar area can be used to differentiate between *Oxygonum* and *Polygonum* (with broad pole) as well as *Atraphaxis* and *Calligonum* (with narrow pole).

Pollen size is also variable among the studied taxa at the generic and specific levels. The smallest pollen grains recorded were in *Emex*, *Rumex* and *Polygonum* and ranged between 23 x 23 μm and 30 x 25 μm , the largest pollen grains are those of *Oxygonum* and *Persicaria*, 48.5 x 37.5 μm and 42.5 x 42.5 μm respectively.

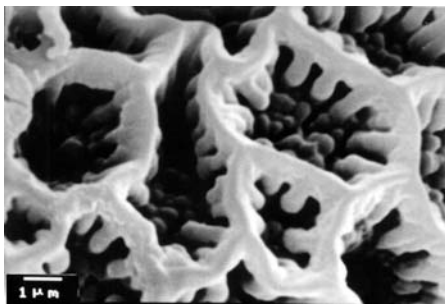
Among the examined taxa, apertures are porate or colporate. Porate apertures are usually ectoaperturate and characteristic to *Persicaria* species. Colporate apertures are endoaperturate and are characteristic to the species of other genera. The apertures vary in their number, position and structure among the studied taxa: these are 12-27 apertures in *Persicaria* or 3-4 apertures in the other taxa. Colpus length ranges from 66-85 % of the total polar length in *Oxygonum* and *Polygonum* to more than 95 % in *Atraphaxis*, *Calligonum*, *Rumex* and *Emex*. Apertures are rectangular in *Polygonum*, *Atraphaxis* and *Calligonum* or more or less circular in *Rumex* and *Emex*. Ectoaperturate opening are usually circular among the studied taxa of *Persicaria*.

Exine usually consists of sexine and nexine. Sexine can be differentiated into three layers: sexine one (Columella), sexine two (tectum or semitectum) and sometimes sexine three (microgemmae or microechinae). This stratification is clear in *Emex*, *Rumex*, *Polygonum* (Fig. 2a) and *Persicaria* but indistinct in *Calligonum*, *Oxygonum* and *Atraphaxis*.

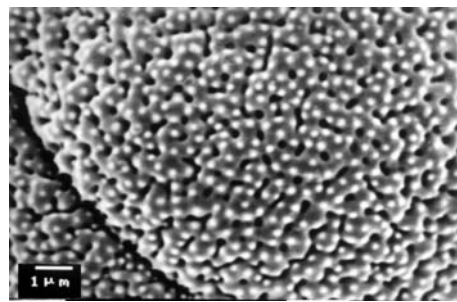
Tectum is coarse reticulate in *Persicaria*, perforate to microreticulate in *Rumex* and *Emex*, reticulate in *Calligonum* and *Oxygonum*. This is striate – reticulate in *Atraphaxis*. Sexine three in *Polygonum* is microgemmae or microgranulae (Fig. 2 b-e).



a



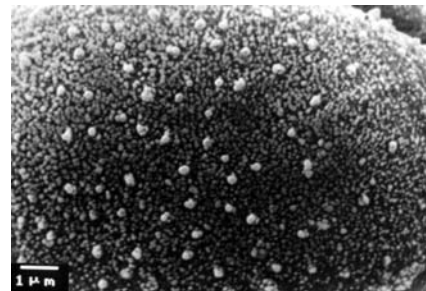
b



c



d



e

Fig. 2. SEM micrographs showing stratification and sculpture among the studied pollen types, bar = 1 µm.

a. Stratification in sexine of *Polygonum patulum* (i. columella, ii. tectum, iii. microgemmae), b. Sculpture coarse reticulate, e.g. *Prasicaria lapathifolia*, c. Sculpture perforate-microreticulate, e.g. *Rumex vesicarius*, d. Sculpture striate-reticulate, e.g. *Atraphaxis spinosa*, e. Sculpture microgemmate-microgranulate, e.g. *Polygonum patulum*.

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