



POLLEN MORPHOLOGY OF SOME *COLCHICUM* L. TAXA (COLCHICACEAE) FROM MEDITERRANEAN REGION IN TURKEY

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ABSTRACT: In this study, pollen grains of twenty taxa of the genus *Colchicum* L. distributed in Turkey were investigated under LM (light microscope) and SEM (scanning electron microscope). Using scanning electron microscope (SEM) investigations on the pollen grains of *Colchicum* taxa are reported for the first time in Turkey. All *Colchicum* taxa, eight of which are endemic to Turkey, were collected from Mediterranean region in Turkey. Detailed pollen morphological characteristics are given for each taxa. Pollen grains are shed as monad. They are diporate, mostly oblate (rarely peroblate), isopolar and bilateral symmetry. Pores are ectoaperture and almost circular. The characteristic structures of pollen ornamentation, which were observed in SEM micrographs, are rugulate, reticulate, perforate-rugulate, rugulate-reticulate and microreticulate.

Key words: *Colchicum*, light microscopy, pollen morphology, SEM, taxonomy

INTRODUCTION

Colchicum L. is a taxonomically very difficult genus of the family Colchicaceae. Colchicaceae is a family within Liliales. Colchicaceae have a largely southern hemisphere distribution in Africa, Madagascar, Malesia, New Guinea, Australia, and New Zealand, but notably excluding South America; Colchicaceae also include several species in North America and Eurasia [34]. The high frequencies of species and of endemics in Turkey and the Balkans indicate these regions as major centers of diversity and speciation [21].

Colchicaceae was first described in 1805 by De Candolle in the Flora Française [6]. He included six genera: *Bulbocodium*, *Colchicum* and *Merendera*, which are still members of the family and *Erythronium*, *Tofieldia* and *Veratrum* today assigned to Liliaceae, Tofieldiaceae and Melanthiaceae respectively [35].

Stefanoff [30] was the first to include *Bulbocodium* and *Merendera* in *Colchicum*, and many contemporary authors follow this treatment, including all four genera within the circumscription of *Colchicum* [16]. Recently, the subgeneric taxa of the genus *Colchicum* (including *Bulbocodium*, *Fouha*, *Merendera*, *Monocaryum* and *Synsiphon*) are listed with accepted synonyms by Persson [25] and chromosome data are studied all taxa of the genus *Colchicum* by Persson [26]. *Colchicum* L. is a confused and problematic genus. The problems arise partly from that in many instance these species have been described from flowering material alone, partly from the scarcity of collected material that is complete, i.e. comprising both flowering material and leaves known with certainly to have come from the same species and population [20]. The genus *Colchicum* L. (± 90 spp.) is a moderately large genus of acaulescent, often hysteroanthous geophytes distributed from Portugal and North Africa eastwards through Europe and Asia as far as the Himalayas. It is centred in the Mediterranean basin [16]. According to Flora of Turkey and the East Aegean Islands and related articles, the genus *Colchicum* is represented by 49 taxa (46 species), of which 22 are endemic in Turkey [2, 3, 22, 23, 24, 25, 26]. The high frequencies of species and of endemics in Turkey and the Balkans indicate these regions as major centers of diversity and speciation [21].

Numerous detailed pollen morphological studies on monocotyledone family have been done by different researchers [1, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 19, 28, 29, 31, 32, 33, 37] However, so far there have been no detailed palynologic studies on all *Colchicum* taxa which are distributed from Mediterranean region in Turkey.

In this research, we aimed the pollen morphology of the *Colchicum* taxa, which are members of a very difficult genus of the family Colchicaceae. So, detailed pollen morphological studies of 20 taxa of the genus *Colchicum* have been investigated from Mediterranean Region in Turkey. Twenty taxa of the genus *Colchicum* are for the first time reported here with reference to palynological diversity by light microscopy (LM) and scanning electron microscopy (SEM).

MATERIAL AND METHODS

Plant samples were collected from the Mediterranean region in Turkey between 2000-2010. *Colchicum* specimens were dried according to standard herbarium techniques and preserved in the Pamukkale University herbarium (PAMUH) and Akdeniz University herbarium (AKDU).

Pollen materials were removed from herbarium specimens in the laboratories. Pollen of 20 taxa of the genus *Colchicum* was studied by LM (light microscope) and SEM (scanning electron microscope). For light microscopy, the pollen was first treated with 70% alcohol to remove oily substances, then embedded in glycerine jelly stained with basic fuchsin, following the method of Wodehouse [36]. The photomicrographs were made with a Nikon microscope mounted Coolpix 5500 camera. Pollens dimensions of all taxa were measured in such amounts that the resulting data followed Gaussian curves. These measurements are given Table 1, in which the morphological parameters of the investigated *Colchicum* taxa are shown. There the taxa appear in systematical order, together with the polar axis (P), equatorial axis (E), P/E rate, pore length (Plg), pore width (Plt), Plg/plt rate, exine thickness, intine thickness and pollen shape. To examine the exine sculpture in detail, scanning electron microscopy (SEM) was also used. For SEM investigations, the pollen was first treated with 70% alcohol, then dried before mounting on stubs with gold, and then the pollen grains were transferred directly to double-sided tape affixed stubs and sputter-coated with gold plate. The photomicrographs were taken with a Zeiss-Leo 14320 electron microscope at the University of Akdeniz, Faculty of Medicine, Department of Histology and Embryology. The palynological terminology mainly follows Punt *et al.* [27].

Table 1. Pollen morphological parameters of the investigated *Colchicum* taxa.

Taxa	P (µm) M±SD	E (µm) M±SD	P/E	Plg (µm) M±SD	Plt (µm) M±SD	Plg/Plt	Exine (µm) M±SD	Intine (µm) M±SD	Pollen shape
<i>C. boissieri</i>	23.03±1.21	42.76±1.75	0.53	7.53±0.76	6.60±0.84	1.14	1.03±0.05	0.97±0.07	Oblate
<i>C. baytopiorum</i>	29.47±1.38	47.41±2.04	0.61	9.58±0.89	8.40±1.18	1.14	1.36±0.36	1.15±0.10	Oblate
<i>C. minutum</i>	28.76±1.95	49.17±4.59	0.58	10.76±0.52	10.19±0.62	1.05	1.12±0.13	1.00±0.08	Oblate
<i>C. stevenii</i>	22.36±1.18	41.57±2.38	0.53	9.42±0.91	8.35±0.89	1.13	1.28±0.28	1.09±0.08	Oblate
<i>C. serpentinum</i>	22.60±1.26	42.80±2.03	0.52	6.91±0.93	6.04±0.80	1.14	1.03±0.08	0.97±0.09	Oblate
<i>C. szovitsii</i>	25.99±1.93	51.07±2.63	0.50	10.81±0.77	9.99±0.65	1.08	1.23±0.32	1.00±0.09	Oblate
<i>C. triphyllum</i>	48.40±4.47	66.50±5.65	0.72	10.96±0.82	9.99±0.80	1.09	1.16±0.18	1.05±0.09	Oblate
<i>C. burtii</i>	24.00±1.03	39.54±1.67	0.60	9.73±0.52	9.12±0.73	1.06	1.01±0.06	0.94±0.09	Oblate
<i>C. kotschyi</i>	38.74±1.88	69.39±3.93	0.55	12.19±1.32	11.32±1.26	1.07	1.46±0.29	1.21±0.14	Oblate
<i>C. heldrechii</i>	40.01±2.79	68.44±3.80	0.58	11.11±0.14	10.45±0.14	1.06	1.20±0.28	1.10±0.07	Oblate
<i>C. decaisnei</i>	31.05±2.24	57.29±2.74	0.53	11.88±1.42	10.50±1.10	1.12	1.61±0.34	1.14±0.10	Oblate
<i>C. balansae</i>	45.94±2.68	69.01±3.58	0.65	15.16±1.95	13.93±1.67	1.08	1.39±0.34	1.07±0.07	Oblate
<i>C. variegatum</i>	30.37±1.38	81.68±3.32	0.36	10.60±0.83	9.88±1.01	1.07	1.70±0.31	1.15±0.11	Peroblate
<i>C. cilicicum</i>	33.81±2.79	57.25±2.96	0.60	13.88±1.46	12.65±1.56	1.09	1.20±0.25	1.08±0.06	Oblate
<i>C. sanguicolle</i>	28.88±1.70	63.21±2.91	0.45	11.17±0.80	10.50±0.80	1.06	1.13±0.13	1.02±0.08	Peroblate
<i>C. davisii</i>	36.61±2.05	67.21±3.56	0.54	11.42±1.01	10.60±0.68	1.07	1.11±0.09	1.02±0.07	Oblate
<i>C. dolichantherum</i>	31.96±4.01	57.62±9.04	0.55	13.73±1.50	12.34±1.30	1.11	1.26±0.18	1.07±0.07	Oblate
<i>C. imperatoris-friderici</i>	37.60±2.10	67.75±3.23	0.54	13.62±1.69	12.96±1.73	1.05	1.14±0.13	1.01±0.06	Oblate
<i>C. inundatum</i>	34.66±1.65	63.89±3.10	0.54	15.32±1.86	14.50±1.88	1.05	1.23±0.20	1.06±0.08	Oblate
<i>C. polyphyllum</i>	30.15±1.03	57.64±2.61	0.51	10.45±0.41	9.88±0.60	1.05	1.02±0.08	0.97±0.08	Oblate

Abbreviations: P (Polar axis); E (Equatorial axis); Plg (Pore length); Plt (Pore width)

RESULTS

Colchicum boissieri Orph. (Figure 1, 1A & 1B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) 23.03±1.21 µm (20.50-25.62 µm), equatorial axis 42.76±1.75 µm (38.95-46.12 µm). P/E ratio is 0.53 µm. Pore ectoaperture, almost circular. Pore length (Plg) 7.53±0.76 µm (6.15-9.22 µm), pore width (Plt) 6.60±0.84 µm (5.12-8.20 µm). Plg/Plt ratio is 1.14 µm. Exine 1.03±0.05 µm (0.92-1.13 µm) thick, tectate. Exine surface perforate-rugulate. Intine 0.97±0.07 µm (0.82-1.02 µm) thick.

Colchicum baytopiorum C.D.Brickell (Figure 1, 2A & 2B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $29.47 \pm 1.38 \mu\text{m}$ (26.65-31.77 μm), equatorial axis (E) $47.41 \pm 2.04 \mu\text{m}$ (43.05-51.25 μm). P/E ratio is 0.61 μm . Pore ectoaperture, almost circular. Pore length (Plg) $9.58 \pm 0.89 \mu\text{m}$ (8.20-11.27 μm), pore width (Plt) $8.40 \pm 1.18 \mu\text{m}$ (7.17-10.25 μm). Plg/Plt ratio is 1.14 μm . Exine $1.36 \pm 0.36 \mu\text{m}$ (1.02-2.05 μm) thick, tectate. Exine surface rugulate. Intine $1.15 \pm 0.10 \mu\text{m}$ (1.02-1.33 μm) thick.

Colchicum minutum K.M.Perss. (Figure 1, 3A & 3B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $28.76 \pm 1.95 \mu\text{m}$ (25.64-33.33 μm), equatorial axis (E) $49.17 \pm 4.59 \mu\text{m}$ (35.89-53.84 μm). P/E ratio is 0.58 μm . Pore ectoaperture, almost circular. Pore length (Plg) $10.76 \pm 0.52 \mu\text{m}$ (10.25-11.27 μm), pore width (Plt) $10.19 \pm 0.62 \mu\text{m}$ (9.22-11.27 μm). Plg/Plt ratio is 1.05 μm . Exine $1.12 \pm 0.13 \mu\text{m}$ (1.02-1.54 μm) thick, tectate. Exine surface rugulate-reticulate. Intine $1.00 \pm 0.08 \mu\text{m}$ (0.82-1.13 μm) thick.

Colchicum stevenii Kunth (Figure 1, 4A & 4B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $22.36 \pm 1.18 \mu\text{m}$ (20.50-24.60 μm), equatorial axis (E) $41.57 \pm 2.38 \mu\text{m}$ (35.87-46.12 μm). P/E ratio is 0.53 μm . Pore ectoaperture, almost circular. Pore length (Plg) $9.42 \pm 0.91 \mu\text{m}$ (8.20-11.27 μm), pore width (Plt) $8.35 \pm 0.89 \mu\text{m}$ (7.17-10.25 μm). Plg/Plt ratio is 1.13 μm . Exine $1.28 \pm 0.28 \mu\text{m}$ (1.02-2.05 μm) thick, tectate. Exine surface rugulate-reticulate. Intine $1.09 \pm 0.08 \mu\text{m}$ (1.02-1.23 μm) thick.

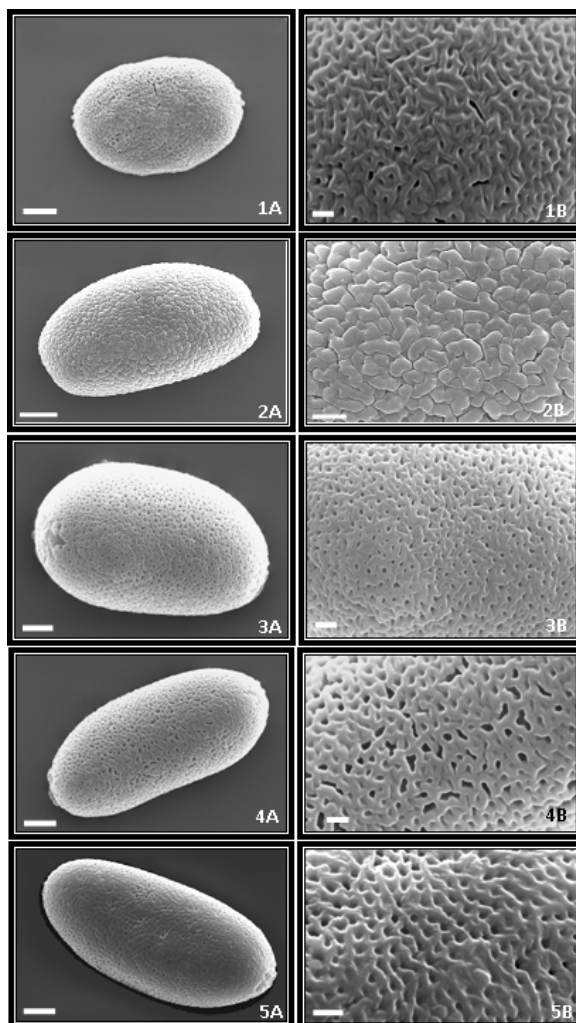


Figure 1. Scanning electron microscope (SEM) micrographs of pollen grains of *Colchicum* species. 1. *C. boissieri*: (A) Polar view, (B) Exine sculpturing (Scales: A = 8 μm , B = 2 μm). 2. *C. baytopiorum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 7 μm , B = 4 μm). 3. *C. minutum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 6 μm , B = 4 μm). 4. *C. stevenii*: (A) Polar view, (B) Exine sculpturing (Scales: A = 5 μm , B = 2 μm). 5. *C. serpentinum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 5 μm , B = 1 μm).

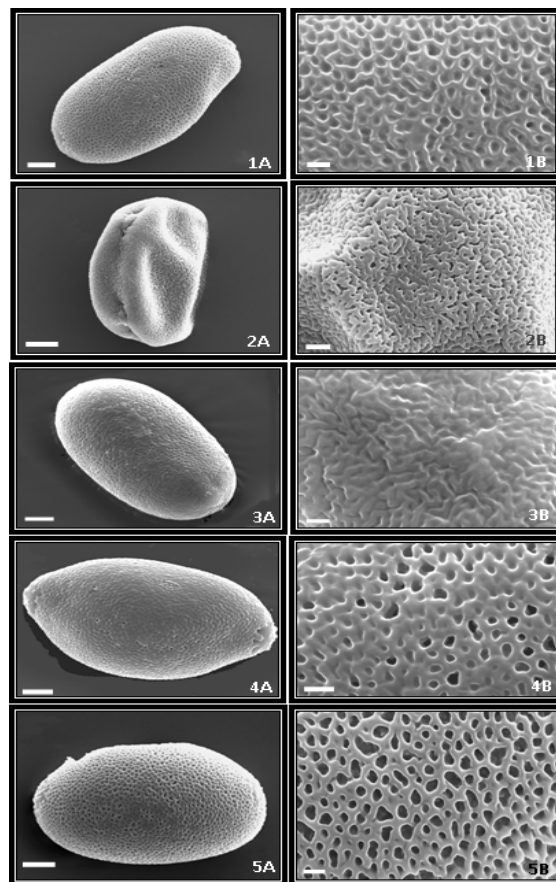


Figure 2. Scanning electron microscope (SEM) micrographs of pollen grains of *Colchicum* species. 1. *C. szovitsii*: (A) Polar view, (B) Exine sculpturing (Scales: A = 6 μm , B = 2 μm). 2. *C. triphyllum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 9 μm , B = 4 μm). 3. *C. burtii*: (A) Polar view, (B) Exine sculpturing (Scales: A = 6 μm , B = 2 μm). 4. *C. kotschyi*: (A) Polar view, (B) Exine sculpturing (Scales: A = 8 μm , B = 3 μm). 5. *C. heldreichii*: (A) Polar view, (B) Exine sculpturing (Scales: A = 9 μm , B = 2 μm).

Colchicum serpentinum Woron. ex Misch. (Figure 1, 5A & 5B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $22.60 \pm 1.26 \mu\text{m}$ (20.50-25.62 μm), equatorial axis (E) $42.80 \pm 2.03 \mu\text{m}$ (39.97-48.17 μm). P/E ratio is 0.52 μm . Pore ectoaperture, almost circular. Pore length (Plg) $6.91 \pm 0.93 \mu\text{m}$ (5.12-8.20 μm), pore width (Plt) $6.04 \pm 0.80 \mu\text{m}$ (5.12-8.20 μm). Plg/Plt ratio is 1.14 μm . Exine $1.03 \pm 0.08 \mu\text{m}$ (0.82-1.23 μm) thick, tectate. Exine surface perforate-rugulate. Intine $0.97 \pm 0.09 \mu\text{m}$ (0.82-1.13 μm) thick.

Colchicum szovitsii Fisch. & C.A.Mey. subsp. *szovitsii* (Figure 2, 1A & 1B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $25.99 \pm 1.93 \mu\text{m}$ (23.07-30.76 μm), equatorial axis (E) $51.07 \pm 2.63 \mu\text{m}$ (43.58-56.40 μm). P/E ratio is 0.50 μm . Pore ectoaperture, almost circular. Pore length (Plg) $10.81 \pm 0.77 \mu\text{m}$ (9.22-12.30 μm), pore width (Plt) $9.99 \pm 0.65 \mu\text{m}$ (9.22-11.27 μm). Plg/Plt ratio is 1.08 μm . Exine $1.23 \pm 0.32 \mu\text{m}$ (1.02-1.94 μm) thick, tectate. Exine surface reticulate. Intine $1.00 \pm 0.09 \mu\text{m}$ (0.82-1.13 μm) thick.

Colchicum triphyllum Kunze (Figure 2, 2A & 2B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $48.40 \pm 4.47 \mu\text{m}$ (41.02-64.10 μm), equatorial axis (E) $66.50 \pm 5.65 \mu\text{m}$ (51.28-76.92 μm). P/E ratio is 0.72 μm . Pore ectoaperture, almost circular. Pore length (Plg) $10.96 \pm 0.82 \mu\text{m}$ (9.22-12.30 μm), pore width (Plt) $9.99 \pm 0.80 \mu\text{m}$ (8.20-11.27 μm). Plg/Plt ratio is 1.09 μm . Exine $1.16 \pm 0.18 \mu\text{m}$ (1.02-1.74 μm) thick, tectate. Exine surface rugulate-reticulate. Intine $1.05 \pm 0.09 \mu\text{m}$ (0.92-1.23 μm) thick.

Colchicum burtii Meikle (Figure 2, 3A & 3B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $24.00 \pm 1.03 \mu\text{m}$ (21.52-25.62 μm), equatorial axis (E) $39.54 \pm 1.67 \mu\text{m}$ (35.87-43.05 μm). P/E ratio is 0.60 μm . Pore ectoaperture, almost circular. Pore length (Plg) $9.73 \pm 0.52 \mu\text{m}$ (9.22-10.25 μm), pore width (Plt) $9.12 \pm 0.73 \mu\text{m}$ (8.20-10.25 μm). Plg/Plt ratio is 1.06 μm . Exine $1.01 \pm 0.06 \mu\text{m}$ (0.92-1.13 μm) thick, tectate. Exine surface perforate-rugulate. Intine $0.94 \pm 0.09 \mu\text{m}$ (0.71-1.02 μm) thick.

Colchicum kotschyi Boiss. (Figure 2, 4A & 4B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $38.74 \pm 1.88 \mu\text{m}$ (35.87-44.07 μm), equatorial axis (E) $69.39 \pm 3.93 \mu\text{m}$ (61.50-75.85 μm). P/E ratio is 0.55 μm . Pore ectoaperture, almost circular. Pore length (Plg) $12.19 \pm 1.32 \mu\text{m}$ (10.25-15.37 μm), pore width (Plt) $11.32 \pm 1.26 \mu\text{m}$ (10.25-14.35 μm). Plg/Plt ratio is 1.07 μm . Exine $1.46 \pm 0.29 \mu\text{m}$ (1.02-2.05 μm) thick, tectate. Exine surface reticulate. Intine $1.21 \pm 0.14 \mu\text{m}$ (1.02-1.53 μm) thick.

Colchicum heldreichii K.M.Perss. (Figure 2, 5A & 5B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $40.01 \pm 2.79 \mu\text{m}$ (32.80-44.07 μm), equatorial axis (E) $68.44 \pm 3.80 \mu\text{m}$ (59.45-74.82 μm). P/E ratio is 0.58 μm . Pore ectoaperture, almost circular. Pore length (Plg) $11.11 \pm 0.14 \mu\text{m}$, pore width (Plt) $10.45 \pm 0.14 \mu\text{m}$. Plg/Plt ratio is 1.06 μm . Exine $1.20 \pm 0.28 \mu\text{m}$ (1.02-2.05 μm) thick, tectate. Exine surface reticulate. Intine $1.10 \pm 0.07 \mu\text{m}$ (1.02-1.23 μm) thick.

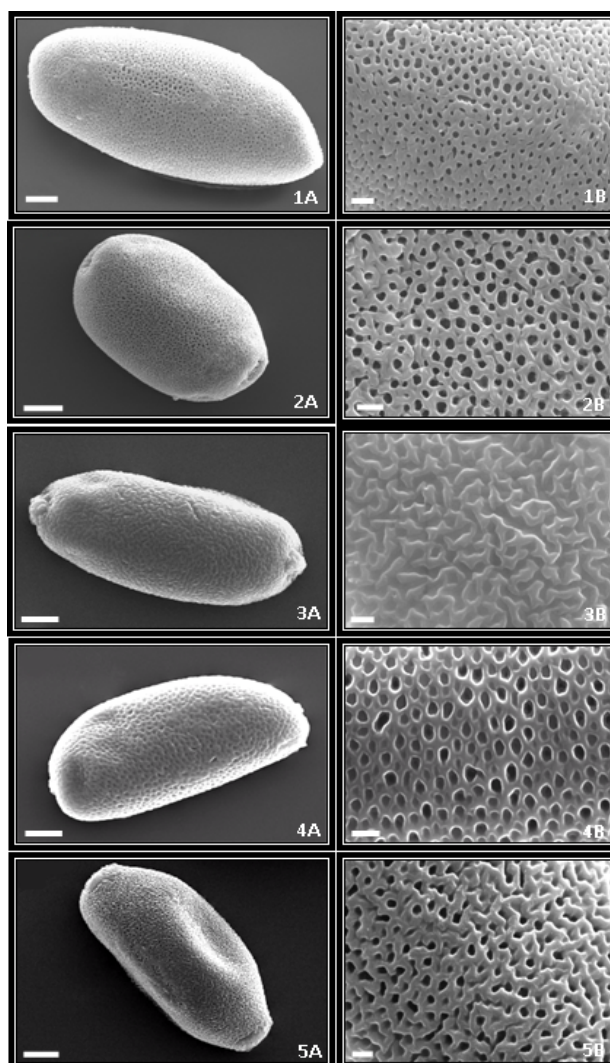


Figure 3. Scanning electron microscope (SEM) micrographs of pollen grains of *Colchicum* species. 1. *C. decaisnei*: (A) Polar view, (B) Exine sculpturing (Scales: A = 5 μm , B = 2 μm). 2. *C. balansae*: (A) Polar view, (B) Exine sculpturing (Scales: A = 10 μm , B = 5 μm). 3. *C. variegatum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 10 μm , B = 2 μm). 4. *C. cilicicum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 8 μm , B = 2 μm). 5. *C. sanguicolle*: (A) Polar view, (B) Exine sculpturing (Scales: A = 6 μm , B = 2 μm).

Colchicum decaisnei Boiss. (Figure 3, 1A & 1B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $31.05 \pm 2.24 \mu\text{m}$ (26.65-35.87 μm), equatorial axis (E) $57.29 \pm 2.74 \mu\text{m}$ (48.17-61.50 μm). P/E ratio is 0.53 μm . Pore ectoaperture, almost circular. Pore length (Plg) $11.88 \pm 1.42 \mu\text{m}$ (10.25-15.37 μm), pore width (Plt) $10.50 \pm 1.10 \mu\text{m}$ (9.22-13.35 μm). Plg/Plt ratio is 1.12 μm . Exine $1.61 \pm 0.34 \mu\text{m}$ (1.13-2.05 μm) thick, tectate. Exine surface microreticulate. Intine $1.14 \pm 0.10 \mu\text{m}$ (1.02-1.33 μm) thick.

Colchicum balansae Planch. (Figure 3, 2A & 2B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $45.94 \pm 2.68 \mu\text{m}$ (41.02-51.28 μm), equatorial axis (E) $57.29 \pm 2.74 \mu\text{m}$ (61.53-76.92 μm). P/E ratio is 0.65 μm . Pore ectoaperture, almost circular. Pore length (Plg) $15.16 \pm 1.95 \mu\text{m}$ (12.30-20.50 μm), pore width (Plt) $13.93 \pm 1.67 \mu\text{m}$ (11.27-18.45 μm). Plg/Plt ratio is 1.08 μm . Exine $1.39 \pm 0.34 \mu\text{m}$ (1.02-2.05 μm) thick, tectate. Exine surface reticulate. Intine $1.07 \pm 0.07 \mu\text{m}$ (0.92-1.23 μm) thick.

Colchicum variegatum L. (Figure 3, 3A & 3B): Pollen grains are isopolar, bilateral symmetrical, diporate, peroblate. Polar view circular. Polar axis (P) $30.37 \mu\text{m}$ (27.67-33.82 μm), equatorial axis (E) $81.68 \pm 3.32 \mu\text{m}$ (75.85-88.15 μm). P/E ratio is 0.36 μm . Pore ectoaperture, almost circular. Pore length (Plg) $10.60 \pm 0.83 \mu\text{m}$ (9.22-12.30 μm), pore width (Plt) $9.88 \pm 1.01 \mu\text{m}$ (9.22-12.30 μm). Plg/Plt ratio is 1.07 μm . Exine $1.70 \pm 0.31 \mu\text{m}$ (1.02-2.05 μm) thick, tectate. Exine surface reticulate. Intine $1.15 \pm 0.11 \mu\text{m}$ (1.02-1.33 μm) thick.

Colchicum cilicicum (Boiss.) Dammer (Figure 3, 4A & 4B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $33.81 \pm 2.79 \mu\text{m}$ (27.67-39.97 μm), equatorial axis (E) $57.25 \pm 2.96 \mu\text{m}$ (51.25-61.05 μm). P/E ratio is 0.60 μm . Pore ectoaperture, almost circular. Pore length (Plg) $13.88 \pm 1.46 \mu\text{m}$ (11.27-15.37 μm), pore width (Plt) $12.65 \pm 1.56 \mu\text{m}$ (10.25-15.37 μm). Plg/Plt ratio is 1.09 μm . Exine $1.20 \pm 0.25 \mu\text{m}$ (1.02-1.85 μm) thick, tectate. Exine surface reticulate. Intine $1.08 \pm 0.06 \mu\text{m}$ (1.02-1.23 μm) thick.

Colchicum sanguicolle K.M.Perss. (Figure 3, 5A & 5B): Pollen grains are isopolar, bilateral symmetrical, diporate, peroblate. Polar view circular. Polar axis (P) $28.88 \pm 1.70 \mu\text{m}$ (25.62-31.77 μm), equatorial axis (E) $63.21 \pm 2.91 \mu\text{m}$ (56.37-69.70 μm). P/E ratio is 0.45 μm . Pore ectoaperture, almost circular. Pore length (Plg) $11.17 \pm 0.80 \mu\text{m}$ (10.25-12.30 μm), pore width (Plt) $10.50 \pm 0.80 \mu\text{m}$ (9.22-12.30 μm). Plg/Plt ratio is 1.06 μm . Exine $1.13 \pm 0.13 \mu\text{m}$ (1.02-1.54 μm) thick, tectate. Exine surface reticulate. Intine $1.02 \pm 0.08 \mu\text{m}$ (0.92-1.23 μm) thick.

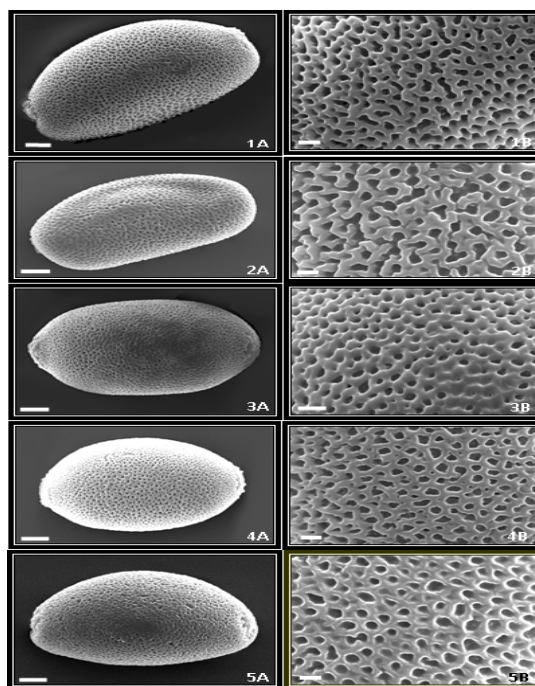


Figure 4. Scanning electron microscope (SEM) micrographs of pollen grains of *Colchicum* species. 1. *C. davisii*: (A) Polar view, (B) Exine sculpturing (Scales: A = 8 μm , B = 2 μm). 2. *C. dolichantherum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 8 μm , B = 2 μm). 3. *C. imperatoris-friderici*: (A) Polar view, (B) Exine sculpturing (Scales: A = 10 μm , B = 2 μm). 4. *C. inundatum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 8 μm , B = 2 μm). 5. *C. polyphyllum*: (A) Polar view, (B) Exine sculpturing (Scales: A = 8 μm , B = 2 μm).

Colchicum davisii C.D.Brickell (Figure 4, 1A & 1B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $36.61 \pm 2.05 \mu\text{m}$ (30.75-42.02 μm), equatorial axis (E) $67.21 \pm 3.56 \mu\text{m}$ (59.45-78.92 μm). P/E ratio is 0.54 μm . Pore ectoaperture, almost circular. Pore length (Plg) $11.42 \pm 1.01 \mu\text{m}$ (10.25-14.35 μm), pore width (Plt) $10.60 \pm 0.68 \mu\text{m}$ (9.22-12.30 μm). Plg/Plt ratio is 1.07 μm . Exine $1.11 \pm 0.09 \mu\text{m}$ (1.02-1.33 μm) thick, tectate. Exine surface reticulate. Intine $1.02 \pm 0.07 \mu\text{m}$ (0.92-1.13 μm) thick.

Colchicum dolichantherum K.M.Perss. (Figure 4, 2A & 2B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $31.96 \pm 4.01 \mu\text{m}$ (25.62-39.97 μm), equatorial axis (E) $57.62 \pm 9.04 \mu\text{m}$ (46.12-76.87 μm). P/E ratio is 0.55 μm . Pore ectoaperture, almost circular. Pore length (Plg) $13.73 \pm 1.50 \mu\text{m}$ (10.25-15.37 μm), pore width (Plt) $12.34 \pm 1.30 \mu\text{m}$ (9.22-12.30 μm). Plg/Plt ratio is 1.11 μm . Exine $1.26 \pm 0.18 \mu\text{m}$ (1.02-1.54 μm) thick, tectate. Exine surface reticulate. Intine $1.07 \pm 0.07 \mu\text{m}$ (1.02-1.23 μm) thick.

Colchicum imperatoris-friderici Siehe ex K.M.Perss. (Figure 4, 3A & 3B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $37.60 \pm 2.10 \mu\text{m}$ (30.75-41.00 μm), equatorial axis (E) $67.75 \pm 3.23 \mu\text{m}$ (61.50-76.87 μm). P/E ratio is 0.54 μm . Pore ectoaperture, almost circular. Pore length (Plg) $13.62 \pm 1.69 \mu\text{m}$ (11.27-16.40 μm), pore width (Plt) $12.96 \pm 1.73 \mu\text{m}$ (10.25-15.37 μm). Plg/Plt ratio is 1.05 μm . Exine $1.14 \pm 0.13 \mu\text{m}$ (1.02-1.54 μm) thick, tectate. Exine surface reticulate. Intine $1.01 \pm 0.06 \mu\text{m}$ (0.92-1.13 μm) thick.

Colchicum inundatum K.M.Perss. (Figure 4, 4A & 4B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $34.66 \pm 1.65 \mu\text{m}$ (30.76-38.46 μm), equatorial axis (E) $63.89 \pm 3.10 \mu\text{m}$ (56.40-69.22 μm). P/E ratio is 0.54 μm . Pore ectoaperture, almost circular. Pore length (Plg) $15.32 \pm 1.86 \mu\text{m}$ (11.27-18.45 μm), pore width (Plt) $14.50 \pm 1.88 \mu\text{m}$ (10.25-17.42 μm). Plg/Plt ratio is 1.05 μm . Exine $1.23 \pm 0.20 \mu\text{m}$ (1.02-1.74 μm) thick, tectate. Exine surface reticulate. Intine $1.06 \pm 0.08 \mu\text{m}$ (0.92-1.23 μm) thick.

Colchicum polyphyllum Boiss. & Heldr. (Figure 4, 5A & 5B): Pollen grains are isopolar, bilateral symmetrical, diporate, oblate. Polar view circular. Polar axis (P) $30.15 \pm 1.03 \mu\text{m}$ (27.67-32.80 μm), equatorial axis (E) $57.64 \pm 2.61 \mu\text{m}$ (51.25-61.50 μm). P/E ratio is 0.51 μm . Pore ectoaperture, almost circular. Pore length (Plg) $10.45 \pm 0.41 \mu\text{m}$ (10.25-11.27 μm), pore width (Plt) $10.45 \pm 0.41 \mu\text{m}$ (9.22-11.27 μm). Plg/Plt ratio is 1.05 μm . Exine $1.02 \pm 0.08 \mu\text{m}$ (0.92-1.23 μm) thick, tectate. Exine surface reticulate. Intine $0.97 \pm 0.08 \mu\text{m}$ (0.71-1.02 μm) thick.

DISCUSSION

Pollen morphology can be useful in supporting taxonomic suggestions. The role of pollen morphology is of significance in taxonomic debate for classification. Pollen grains have an important part in the modern issues of plant taxonomy [17]. Pollen and anther characters have frequently been regarded as systematically significant in monocotyledons, both above and below the family level [10]. The pollen of most members of Colchicaceae are monosulcate, exceptions include *Colchicum*, which usually has diporate pollen, and *Uvularia* where the pollen may be disulcate [13].

Colchicum L. has longish pollen grains with a pore at each end. This seems to be the result of a development from an anacolpate condition by partial regrowth of the colpus [8]. *Colchicum* is the only grain which normally has two pori, however it does not survive fossilization as the grains are very thin valled and exposed on wetting [18]. Although *Colchicum* has diporate pollen, infrequently the pollen of some *Colchicum* spp. may have a third aperture on the distal face. In both di- and triporate pollen the pores may be smallish, with discrete margos or larger with more diffuse margins as in *Colchicum* [13].

The main results are given Table 1, in which the morphological parameters of the investigated *Colchicum* taxa are shown. There the taxa appear in systematical order, together with the polar axis (P), equatorial axis (E), P/E rate, pore length (Plg), pore width (Plt), Plg/plt rate, exine, intine and pollen shape.

According to LM and SEM investigations, the pollen grains of *Colchicum* taxa from Mediterranean Region are shed as monad. They are diporate, isopolar and circular in polar view, mostly oblate or rarely peroblate and bilateral symmetry.

In our study, some remarkable dimensional differences were determined between pollen grains of *Colchicum* taxa. The pollen shape of studied taxa are mostly oblate, but *C. variegatum* and *C. sanguicolle* are peroblate. The biggest pollen size was found in *C. variegatum* (30.37 x 81.68 μm) and the smallest in *C. burtii* (24.00 x 39.54 μm). The longest length of the pore was measured in *C. inundatum* (Plg 15.32 μm), the shortest in *C. serpentinum* (Plg 6.91 μm). The widest pore was observed in *C. inundatum* (Plt 14.50 μm), the narrowest in *C. serpentinum* (Plt 6.04 μm) (Table 1). The exine structure is tectate. Muri usually solid, lumina are almost circular or irregular shape.

Pollen ornamentations are perforate-rugulate in *C. boissieri*, *C. serpentinum* and *C. burtii*, rugulate-reticulate ornamentations in *C. minutum*, *C. stevenii*, *C. triphyllum* and *C. variegatum*, reticulate ornamentations in *C. szovitsii*, *C. kotschyi*, *C. heldreichii*, *C. balansae*, *C. cilicum*, *C. davisii*, *C. dolichantherum*, *C. inundatum* and *C. polyphyllum*, microreticulate ornamentations have been seen in *C. decaisnei*, *C. sanguicolle* and *C. imperatoris-friderici*, and rugulate ornamentations only in *C. baytopiorum*.

These results show that there are several pollen characters of taxonomic significance in *Colchicum*. The main palynological differences have been found especially in the pollen size, shape and ornamentation.

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