Pollination morphology of Allium species (Liliaceae) in European Turkey and around Istanbul

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Abstract. Pollen morphology of 23 Allium species in European Turkey and around Istanbul, belonging to the sections Molium, Scorodon, Brevispatha, Codonoprasum, Allium, and Melanocrommyum, were investigated under LM (light microscopy) and by SEM (scanning electron microscopy). The pollen grains of genus Allium are monosulcate. The pollen shapes (based on LA / SA) are prolate and subprolate. The sulcus extends from distal to proximal in all taxa. The smallest pollen grain belong to A. guttatum subsp. guttatum (25.75 × 19.22 μm), the largest one to A. roseum (51.19 × 2.30 μm).

Key words: Allium, Liliaceae, LM, morphology, pollen, SEM

Introduction

The genus Allium is one of the most diverse and taxonomically difficult groups of the monocots. Formerly regarded as member of the Liliaceae s.l., in modern systems of Flowering Plants it is the largest genus of Alliaceae (order Asparagales) (Angiosperm Phylogeny Group 2003), comprising about 750-800 species. Most species occur naturally in the northern hemisphere, with a main centre of diversity in the mountains of Southwest to Central Asia and a second but smaller centre of diversity in western North America. The genus Allium in the Flora of Turkey is represented by 174 species (Özhatay 1983, 1984a, b; Kollmann 1984; Davis & al. 1988; Güner & al. 2000; Özhatay & Kultur 2006; Özhatay & al. 2009).

The Liliaceae pollen grains are usually monocolpate. The colpus generally extends fully to the end of the grain, it may be very wide or may have an operculum, which may be ornamented (e.g. reticulate), or thin and scabrate (Dane 1999; Karaca & al. 2007; Özler & Pehlivan 2007).

Material and methods

The investigated 23 Allium specimens were collected from European Turkey and around Istanbul (Fig. 1; Annex I). Data for the pollen morphology illustrations of Allium species were given by Mohl (1834) and
Annex I. Specimens investigated (deposited in ISTE):

**Sect. Molium**

**Sect. Brevispatha**

**Sect. Scorodon**

**Sect. Codonoprasum**

**Sect. Allium**

**Sect. Melanocrommyum**

Wunderlich (1936). Furthermore, the detailed pollen morphology of Allium was investigated by Koç (2001), Özler (2001) and Güler & Pehlivan (2006).

The specimens were compared with those in the Herbarium of Kew (K) and Herbarium of the British Museum (BM) and kept in the Herbarium of the Faculty of Pharmacy of Istanbul University (ISTE).

Our object was to examine the pollen morphology of 23 of the Turkish Allium taxa which occur in European Turkey and around Istanbul by using data obtained from LM and SEM observations.

Pollen grains of specimens for LM investigations were prepared according to the methods of Wodehouse (1935) and Erdtman (1960) at Istanbul University, Faculty of Forestry, and Department of Forest Botany.

Pollen shapes and ornamentation were identified according to Halbritter & al. (2007). Pollen dimensions of all species were measured on Zeiss-Winkel 278943 Light Microscope (1 ocular area = 1.45 μm). The following parameters were registered: long axis (LA) and short axis (SA). Pollen photographs were taken on SEM in Jodrell Laboratory (England), and on LM in ISTE Laboratory. Preparations are kept in ISTE.

The formula of pollen dimensions:
\[ M = n + a \cdot \frac{1}{n} \sum xy \]
\[ \sigma = a \cdot \sqrt{\frac{1}{n} \sum x^2y - u^2} \]
\[ u = \frac{1}{n} \sum xy \]
\[ n = \text{measurement counts} \]
\[ a = \text{differences between classes} \]
\[ \sigma = \text{standard deviation} \]
\[ M = \text{mean value} \]
Results and discussions

The main palynological features of the examined Allium specimens are summarized in Table 1. According to SEM (Plate I, II, III, IV) and LM (Plate V, VI) investigations, the pollen grains are monosulcate. The monosulcate pollen grains, which are regarded as primitive among seed plants, occur widely among the monocotyledons (Furness & Rudall 2001; Özler & Pehlivan 2007; Dönmez Oybak & İşık 2008). The pollen shapes (based on LA/SA ratio) are prolate, subprolate and ellipsoid in distal view, and circular in polar view. The sulcus extends from distal to proximal in sect. Codonoprasum, Molium, Brevispatha, Scorodon and Melanocrommyum. The sulcus clearly extends both from distal and proximal only in sect. Allium. The sulcus membrane is provided with a fragmented operculum only in the sect. Codonoprasum (Figs 6, 7, 10, 12, 13, 14, 17).

These results correspond to the earlier studies (Güler & Pehlivan 2006). The sulcus ends are narrowed and rounded only in sect. Molium (Figs 11, 18). The sulcus ends are broad and rounded in sect. Brevispatha and Scorodon (Figs 9, 15). The sulcus ends are rounded in sect. Melanocrommyum (Figs 3, 5, 56). The exine is semitectate, rugulate perforate (Figs 25, 26, 27, 30, 31, 32, 37, 38, 40, 42), psilate (Figs 28), shadowy rugulate (Figs 34, 35, 36, 39, 43), or rugulate (Figs 23, 24, 29, 33, 41, 44) ornamentation can be distinguished in the investigated Allium species. These results show that there are several pollen characters of taxonomic significance in the genus Allium. The main palynological differences have been registered at the section level. These results are similar to the earlier studies (Koç 2001 & Özler 2001; Güler & Pehlivan 2006; Bogdanović & al. 2008; Nesli & al. 2009).

Table 1. Palynological features of the examined Allium species (Wodhouse).

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Pollen shapes (LA/SA)</th>
<th>Dimensions</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Long axis (LA) M SD Variation</td>
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<tr>
<td></td>
<td></td>
<td>Short axis (SA) M SD Variation</td>
</tr>
<tr>
<td>Allium roseum</td>
<td>Prolate (1.58)</td>
<td>51.2 ±2.52 44.95–56.55</td>
</tr>
<tr>
<td>A. neapolitanum</td>
<td>Prolate (1.44)</td>
<td>51 ±1.39 47.85–53.65</td>
</tr>
<tr>
<td>A. moschatum</td>
<td>Subprolate (1.31)</td>
<td>27.3 ±1.56 23.20–29</td>
</tr>
<tr>
<td>A. peroninianum</td>
<td>Prolate (1.43)</td>
<td>27.4 ±1.97 24.65–31.90</td>
</tr>
<tr>
<td>A. paniculatum subsp. paniculatum</td>
<td>Prolate (1.41)</td>
<td>30.9 ±1 29–33.35</td>
</tr>
<tr>
<td>A. paniculatum subsp. fuscum</td>
<td>Prolate (1.39)</td>
<td>31.1 ±1.78 27.55–36.25</td>
</tr>
<tr>
<td>A. rhodopaeum</td>
<td>Subprolate (1.26)</td>
<td>28.5 ±1.11 26.10–31.90</td>
</tr>
<tr>
<td>A. pallens subsp. pallens</td>
<td>Prolate (1.54)</td>
<td>34.8 ±1.58 30.45–37.70</td>
</tr>
<tr>
<td>A. flavum</td>
<td>Prolate (1.61)</td>
<td>35.6 ±1.75 30.45–37.70</td>
</tr>
<tr>
<td>A. myrianthum</td>
<td>Prolate (1.56)</td>
<td>28 ±0.65 27.55–29</td>
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<tr>
<td>A. ampeloprasum</td>
<td>Prolate (1.47)</td>
<td>30.6 ±1.33 27.55–34.80</td>
</tr>
<tr>
<td>A. atroviolaceum</td>
<td>Prolate (1.53)</td>
<td>29.4 ±0.91 27.55–30.45</td>
</tr>
<tr>
<td>A. scorodoprasum subsp. scorodoprasum</td>
<td>Prolate (1.44)</td>
<td>27 ±2.24 23.20–34.80</td>
</tr>
<tr>
<td>A. scorodoprasum subsp. rotundum</td>
<td>Prolate (1.58)</td>
<td>36.9 ±1.21 34.80–31.15</td>
</tr>
<tr>
<td>A. sphaerocephalon</td>
<td>Prolate (1.62)</td>
<td>31.8 ±0.95 29–33.35</td>
</tr>
<tr>
<td>A. proponticum</td>
<td>Prolate (1.80)</td>
<td>32.9 ±0.84 31.90–34.80</td>
</tr>
<tr>
<td>A. vineale</td>
<td>Prolate (1.40)</td>
<td>30.6 ±0.91 29–33.35</td>
</tr>
<tr>
<td>A. amethystinum</td>
<td>Prolate (1.38)</td>
<td>25.8 ±0.82 24.65–27.55</td>
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<tr>
<td>A. guttatum</td>
<td>Prolate (1.47)</td>
<td>25.8 ±1.13 23.20–27.55</td>
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<tr>
<td>A. atropurpureum</td>
<td>Prolate (1.68)</td>
<td>36.6 ±1.43 33.35–39.15</td>
</tr>
<tr>
<td>A. nigrum</td>
<td>Prolate (1.47)</td>
<td>31.9 ±2.01 29–36.25</td>
</tr>
<tr>
<td>A. cyrrilli</td>
<td>Prolate (1.79)</td>
<td>34.4 ±1.34 30.45–37.70</td>
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</table>

Legend: M – Mean value; SD – Standard deviation.
Plate I

Figs 1–8. Pollen grains of *Allium* species (a: SEM photographs; b: drawings):
Plate II

Figs 9–16. Pollen grains of *Allium* species (a: SEM photographs; b: drawings):
9, *A. moschatum* (SEM 2500x); 10, *A. myrianthum* (SEM 2500x); 11, *A. neopolitanum* (SEM 2500x); 12, *A. pallens* subsp. *pallens* (SEM 2500x); 13, *A. paniculatum* subsp. *fuscum* (SEM 2500x); 14, *A. paniculatum* subsp. *paniculatum* (SEM 2500x); 15, *A. peroninianum* (SEM 2500x); 16, *A. proponticum* (SEM 2500x). Scale bar – 10 μm.
Plate III

Figs 17–22. Pollen grains of *Allium* species (a: SEM photographs; b: drawings):

17, *A. rhodopeum* (SEM 3000x); 18, *A. roseum* (SEM 1500x); 19, *A. scorodoprasum* subsp. *rotundum* (SEM 2500x); 20, *A. scorodoprasum* subsp. *scorodoprasum* (SEM 2500x); 21, *A. sphaerocephalon* (SEM 2500x); 22, *A. vineale* (SEM 2500x). Scale bar – 10 μm.
Plate IV

Figs 23–44. SEM photographs of the pollen surfaces of *Allium* species:
23, *A. amethystinum* (SEM 3000x); 24, *A. ampeloprasum* (SEM 2500); 25, *A. atropurpureum* (SEM 2500x); 26, *A. atrovioletaceum* (SEM 2500x); 27, *A. cyrilli* (SEM 2500x); 28, *A. flavum* subsp. *flavum* (SEM 2500x); 29, *A. flavum* subsp. *tauricum* (SEM 2500x); 30, *A. guttatum* subsp. *guttatum* (SEM 3000x); 31, *A. moschatum* (SEM 3000x); 32, *A. myrianthum* (SEM 2500x); 33, *A. neapolitanum* (SEM 3000x); 34, *A. pallens* subsp. *pallens* (SEM 3000x); 35, *A. paniculatum* subsp. *fuscum* (SEM 3000x); 36, *A. paniculatum* subsp. *paniculatum* (SEM 2500x); 37, *A. peroninianum* (SEM 2500x); 38, *A. proponticum* (SEM 2500x); 39, *A. rhodopeum* (SEM 3000x); 40, *A. roseum* (SEM 1500x); 41, *A. scorodoprasum* subsp. *rotundum* (SEM 2500x); 42, *A. scorodoprasum* subsp. *scorodoprasum* (SEM 2500x); 43, *A. sphaerocephalon* (SEM 2500x); 44, *A. vineale* (SEM 2500x). Scale bar – 10 μm.
Plate V

Figs 45–59. LM photographs of the pollen of *Allium* species, according to the method of Wodhouse (W) and Erdtman (E):
45, *A. amethystinum* (LM 100x, W); 46, *A. ampeleopsis* (LM 100x, W); 47, *A. atropurpureum* (LM 100x, W); 48, *A. atroviolaceum* (LM 100x, W); 49, *A. cyrilli* (LM 100x, W); 50, *A. flavum* subsp. *flavum* (LM 100x, E); 51, *A. flavum* subsp. *tauricum* (LM 100x, W); 52, *A. guttatum* subsp. *guttatum* (LM 100x, E); 53, *A. moschatum* (LM 100x, W); 54, *A. myrianthum* (LM 100x, W); 55, *A. neopolitanum* (LM 100x, W); 56, *A. nigrem* (LM 100x, W); 57, *A. pallens* subsp. *pallens* (LM 100x, E); 58, *A. paniculatum* subsp. *fuscum* (LM 100x, E); 59, *A. paniculatum* subsp. *paniculatum* (LM 100x, W). Scale bar – 10 μm.
Plate VI

Figs 60–67. LM photographs of the pollen of *Allium* species:
60, *A. peroninianum* (LM 100x, W);
61, *A. proponticum* (LM 100x, W);
62, *A. rhodopeum* (LM 100x, W);
63, *A. roseum* (LM 100x, W);
64, *A. scorodoprasum* subsp. *rotundum* (LM 100x, W);
65, *A. scorodoprasum* subsp. *scorodoprasum* (LM 100x, W);
66, *A. sphaerocephalon* (LM 100x, E);
67, *A. vineale* (LM 100x, W).

Scale bar – 10 μm.

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