

## SEED MORPHOLOGY AND TESTA SCULPTURES OF SOME *Allium* L. SPECIES (Alliaceae)

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### Abstract

The paper presents the results of the study on seed morphology of eight following *Allium* species: *A. pyrenaicum* Costa & Vayr., *A. rotundum* L., *A. sphaerocephalon* L., *A. vineale* L., *A. moly* L., *A. karataviense* Regel, *A. fistulosum* L. and *A. nutans* L. The study confirmed the substantial diversity in testa characters, especially curvature and relief of anticlinal walls as well as microsculpture of outer periclinal walls. The occurrence of raised anticlinal walls – an unusually rare feature in *Allium* seeds, previously observed only in a few species, was found in *A. karataviense*. It was also found that the testa type in *A. pyrenaicum* did not match the typical character combination, described before for subg. *Allium* sect. *Allium*.

**Key words:** Alliaceae, *Allium*, seeds, testa sculpture, SEM

### INTRODUCTION

*Allium* L. is a large, very diverse and taxonomically difficult genus of the monocots. The genus comprises about 800 species belonging to 15 subgenera and 56 sections (Friesen et al. 2006; Neshati and Fritsch, 2009). The most important subgenera are: *Allium*, *Amerallium*, *Cepa*, *Melanocrommyum*, and *Rhizirideum*. Most species occur naturally in the northern hemisphere with the main centre of diversity in Southwest and Central Asia. *Allium* includes many cultivated species – mostly ornamental plants but also economically important crop species and some with medicinal properties.

A high level of morphological diversity ascertained in the genus *Allium* concerns also seed testa characters whose details are well visible under the scanning electron microscope (SEM). A large number of different testa types have been described so far (e.g. Kruse, 1984, 1986, 1988, 1994; Fritsch et

al. 2006; Neshati and Fritsch, 2009). Most of them occur only in certain systematic groups reflecting taxonomic relations and evolutionary levels (Fritsch et al. 2006). The other seed characters, such as colour, size and shape, were considered to be taxonomically rather unimportant characters in the genus *Allium* (Neshati and Fritsch, 2009).

The aim of the presented work was to describe testa sculptures of some selected *Allium* species, not investigated so far: *A. pyrenaicum* Costa & Vayr., *A. rotundum* L., *A. sphaerocephalon* L., *A. vineale* L., *A. moly* L., *A. karataviense* Regel, *A. fistulosum* L., and *A. nutans* L. Micromorphological characters of seeds may be useful as additional taxonomic features in identification and distinguishing taxa within the genus *Allium*.

### MATERIALS AND METHODS

Seeds of eight *Allium* species representing the most important five subgenera were investigated. Seeds were collected in natural localities, in a collection of Poznań University of Life Sciences, and in the Botanical Garden of Adam Mickiewicz University in Poznań (Table 1). All examinations were carried out on fully developed dry seeds. The seeds were not specially prepared, but only cleaned. Size (length and width), shape, outline, and seed colour were determined from 30 seeds of each species using a stereoscope microscope, PZO type 131. Five seeds of each species were mounted on aluminium stubs with “Leit-Tabs” and coated with gold in an Agar sputter coater. Electron micrographs were obtained with a Zeiss EVO 40 scanning electron microscope at an accelerating voltage of 12 kV. The terminology describing the seed surface followed mainly Barthlott (1981, 1984).

## RESULTS

The main macro- and micro-morphological characters of the investigated seeds are summarized in Table 2, and the selected SEM microphotographs of the seed showing a general view and testa details are presented in Figs 1-8.

### General morphological characters

The seeds of all investigated species were black; matte in *A. karataviense*, and slightly shiny in the remaining species. The shape of seeds was generally angular; most often with four walls in *A. fistulosum*, three walls in *A. sphaerocephalon*, and two walls in the remaining species. The seed outline was very variable – elliptic, roundish, obovate, or wide ovate. The seeds of *A. fistulosum* were outstanding in this respect, because they were wider than longer. The average seed size ranged from 2.5 mm (*A. vineale*) to 3.1 mm (*A. karataviense*) in length and 1.4 mm (*A. vineale*) to 2.9 mm (*A. karataviense*) in width.

Thus, *A. vineale* had the smallest and *A. karataviense* the largest seeds.

### Shape and sculpturing of testa cells

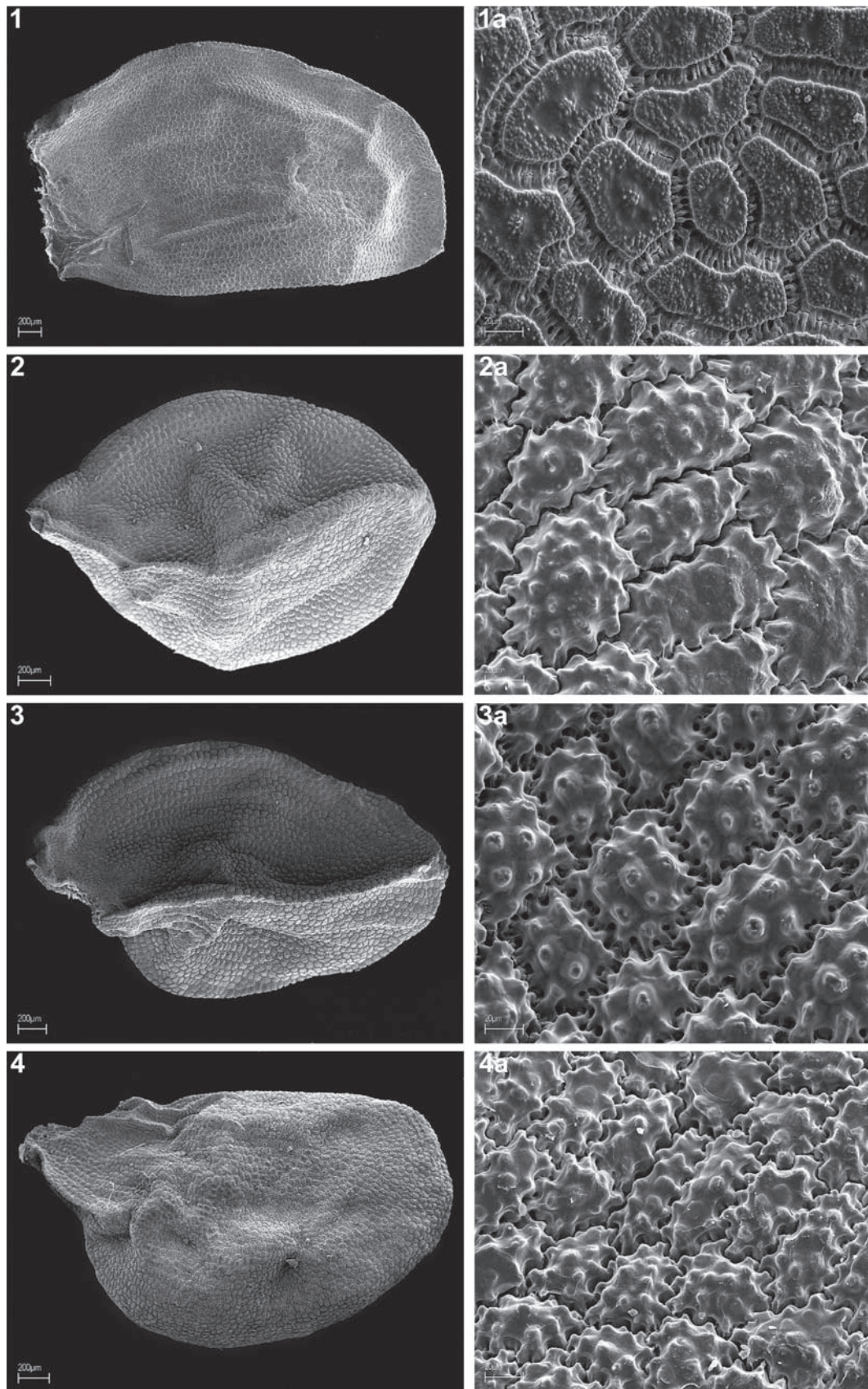
The shape of testa cells was very variable – from elliptic and circular to polygonal and irregular. The anticlinal walls were usually depressed, except the raised ones in *A. karataviense*. They were more or less straight, strip-like in *A. pyrenaicum* (Fig. 1a), *A. fistulosum* (Fig. 7a) and *A. nutans* (Fig. 8a), and S-like, U-like or Omega-like undulated in the remaining species. Sculpturing patterns of the periclinal walls were not very variable among the species investigated. Most common were convex, granulose walls bearing several verrucae. *A. pyrenaicum* (Fig. 1a) had flat, distinctly granulose walls with a central verruca. *A. moly* (Fig. 5a) showed flat, not granulated walls, most often with one central verruca. *A. fistulosum* (Fig. 7a) had densely granulose walls with no verrucae, and *A. nutans* (Fig. 8a) were distinctive of very densely granulose walls and hidden, indistinct central verruca.

Table 1.  
Origin of the material (taxonomic groups after Friesen et al. 2006)

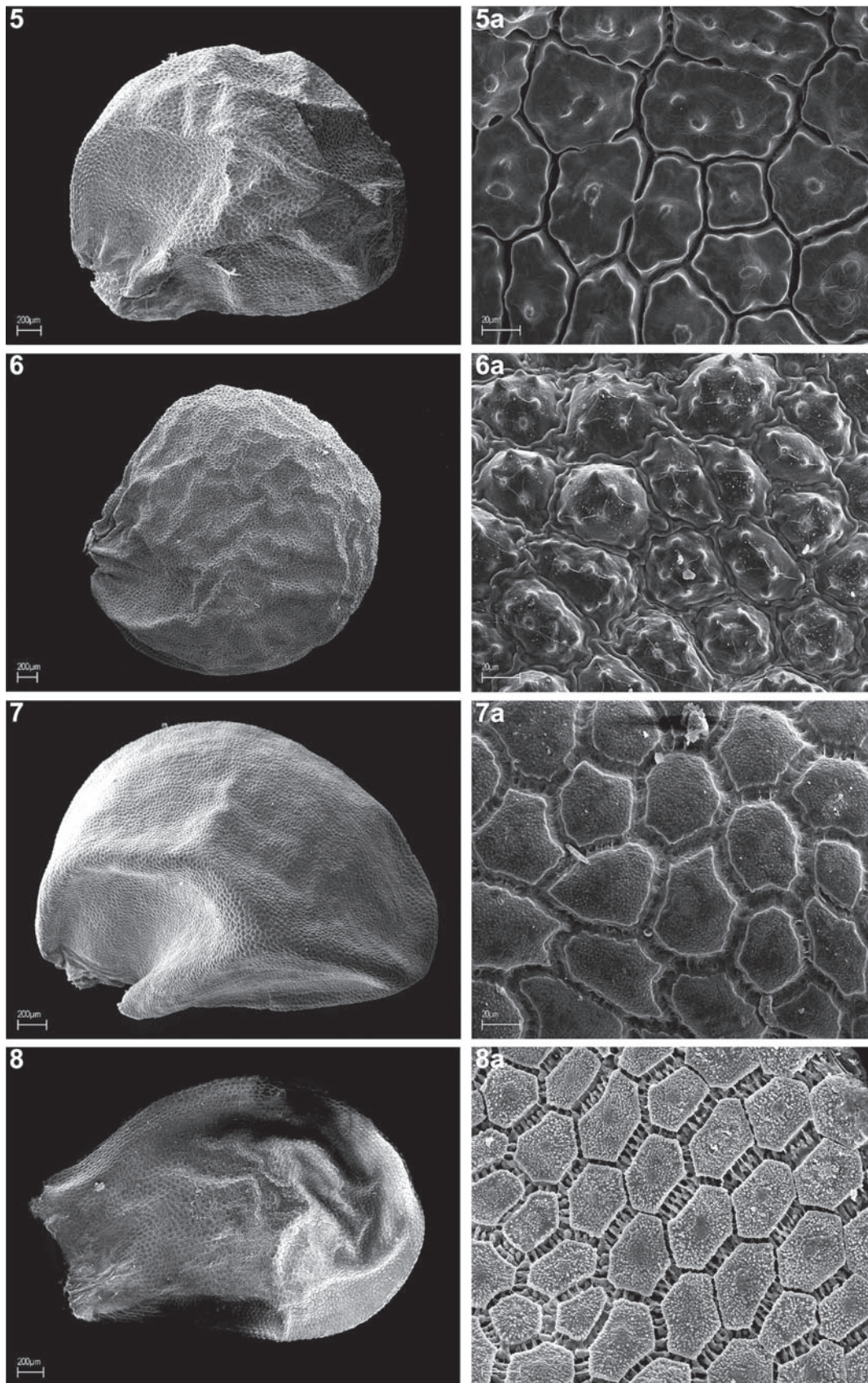
Taxonomic groups and species	Collection site
<b>subg. <i>Allium</i></b>	
sect. <i>Allium</i>	
<i>A. pyrenaicum</i> Costa & Vayr.	Poznań, collection of Poznań University of Life Sciences
<i>A. rotundum</i> L.	Konarskie, Greater Poland Voivodeship
<i>A. sphaerocephalon</i> L.	Poznań, collection of Poznań University of Life Sciences
<i>A. vineale</i> L.	Błażejowo, Greater Poland Voivodeship
<b>subg. <i>Amerallium</i></b>	
sect. <i>Molium</i>	
<i>A. moly</i> L.	Poznań, collection of Poznań University of Life Sciences
<b>subg. <i>Mellanocrommyum</i></b>	
sect. <i>Miniprason</i>	
<i>A. karataviense</i> Regel	Poznań, collection of Poznań University of Life Sciences
<b>subg. <i>Cepa</i></b>	
sect. <i>Cepa</i>	
<i>A. fistulosum</i> L.	Poznań, Botanical Garden of Adam Mickiewicz University
<b>subg. <i>Rhizirideum</i></b>	
sect. <i>Rhizirideum</i>	
<i>A. nutans</i> L.	Poznań, Botanical Garden of Adam Mickiewicz University

Table 2.  
Seed size and outline as well as characters of epidermal cells

Taxonomic groups and species	Average seed size – length x width [mm]	Dominant seed outline	Dominant shape of testa cells	Anticlinal walls: relief, undulation type	Periclinal walls: curvature, ornamentation
<b>subg. <i>Allium</i></b>					
sect. <i>Allium</i>					
<i>A. pyrenaicum</i>	3.6 x 1.9	elliptic	irregular	depressed, ± straight, strip-like	± plain, verrucate with central verruca, distinctly granulose
<i>A. rotundum</i>	2.6 x 1.6	elliptic, obovate	elliptic	depressed, S – to U – like undulation	convex, verrucate with many predominant verrucae, granulose
<i>A. sphaerocephalon</i>	2.8 x 1.7	obovate	elliptic, angularly round	depressed, omega-like undulation	convex, verrucate with many predominant verrucae, slightly granulose
<i>A. vineale</i>	2.5 x 1.4	elliptic	± elliptic	depressed, U – to omega-like undulation	convex, verrucate with many predominant verrucae, rarely granulose
<b>subg. <i>Amerallium</i></b>					
sect. <i>Molium</i>					
<i>A. moly</i>	2.7 x 2.4	roundish	irregular	depressed, channel-like S – like undulation	plain, verrucate, most often with central verruca, rarely with 2-4 verrucae
<b>subg. <i>Mellanocrommyum</i></b>					
sect. <i>Miniprason</i>					
<i>A. karataviense</i>	3.1 x 2.9	roundish	elliptic to round	raised, S – to U – like undulation	convex, verrucate with 4-10 prominent verrucae, granulose
<b>subg. <i>Cepa</i></b>					
sect. <i>Cepa</i>					
<i>A. fistulosum</i>	2.5 x 2.8	wide ovate	tetra- to hexagonal	depressed, ± straight, strip-like	convex, densely granulose
<b>subg. <i>Rhizirideum</i></b>					
sect. <i>Rhizirideum</i>					
<i>A. nutans</i>	2.7 x 1.8	roundish, elliptic	penta- to hexagonal	shallowly depressed, straight, strip-like	± convex, verrucate with central, hidden verruca, very densely granulose



Figs 1-4. Micromorphological comparison of *Allium* seeds – general view and testa sculptures: 1, 1a – *A. pyrenaicum*, 2, 2a – *A. rotundum*, 3, 3a – *A. sphaerocephalon*, 4, 4a – *A. vineale*.



Figs 2-8. Micromorphological comparison of *Allium* seeds – general view and testa sculptures: 5, 5a – *A. moly*, 6, 6a – *A. karataviense*, 7, 7a – *A. fistulosum*, 8, 8a – *A. nutans*.

## DISCUSSION

Former studies on seed morphology have shown that testa sculptures have been very diverse and at the same time taxonomically important characters in the genus *Allium*. So far, the seed coat patterns of more than 250 *Allium* species have been investigated using SEM and many species- or group-specific character combinations have been described (Fritsch et al. 2006; Neshati and Fritsch, 2009). In the present study, seeds of eight *Allium* species representing six subgenera were investigated.

The seed testa cells of most species representing subgen. *Allium* and *Mellanocrommyum* (investigated so far) are rather similar, showing convex periclinal walls with several large verrucae, combined with depressed, S- to Omega-like, undulated anticlinal walls (Fritsch et al. 2006 after Kruse, 1992). The three species of subgen. *Allium* sect. *Allium*, investigated in the present study, match this character combination, while *A. pyrenaicum* shows convex periclinal walls with one central verruca, combined with nearly straight, strip-like anticlinal walls. *A. karataviense*, belonging to subgen. *Mellanocrommyum*, also breaks away from the pattern by the occurrence of raised anticlinal walls. This is an unusually rare feature in *Allium* seeds, previously observed only in a few species, e.g. *A. ursinum* from subgen. *Amerallium* (Kruse, 1984). According to Kruse (1988), the species of sect. *Molium* are characterized by wide, depressed, channel-like anticlinal walls and specific verrucate testa patterns with a distinctly raised central verruca surrounded by small granules. *A. moly*, described in the present paper, has anticlinal walls typical for sect. *Molium* but periclinal walls, although of similar verrucate sculpture, are more flat and non-granulate. The investigated species of sect. *Cepa* (*A. fistulosum*) and sect. *Rhizirideum* (*A. nutans*) with densely granulate periclinal walls represent the testa type typical for these sections (Kruse, 1988, 1994).

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### Morfologia i skulptura powierzchni nasion wybranych gatunków rodzaju *Allium* L. (Alliaceae)

#### Streszczenie

W pracy przedstawiono wyniki badań nad morfologią nasion ośmiu następujących gatunków rodzaju *Allium*: *A. pyrenaicum* Costa & Vayr., *A. rotundum* L., *A. sphaerocephalon* L., *A. vineale* L., *A. moly* L., *A. karataviense* Regel, *A. fistulosum* L. i *A. nutans* L. Obserwacje wykonano z zastosowaniem elektronowego mikroskopu skaningowego (SEM) oraz mikroskopu stereoskopowego. Przeprowadzone badania potwierdziły znaczne zróżnicowanie cech powierzchni nasion czosnków, a w szczególności przebiegu i reliefu ścian antyklinalnych oraz mikro-urzeźbienia zewnętrznych ścian peryklinalnych komórek testy. U *A. karataviense* stwierdzono występowanie wypukłych ścian antyklinalnych komórek testy – cechy niezwykle rzadko spotykanej u czosnków, wcześniej zaobserwowanej zaledwie u kilku gatunków. Stwierdzono również, że typ skulptury nasion *A. pyrenaicum* nie odpowiada typowej kombinacji cech komórek testy, opisanej wcześniej u innych gatunków podrodzaju *Allium* sekcji *Allium*.