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## Taxonomical investigation on some species of genus *Allium* based on the pollen morphology grain micromorphology

### ABSTRACT

**Aims:** The main aim of this research was to investigate the micromorphological characteristics of the pollen grains in seven species from genus *Allium* belong to three subgenera including *Melanocrommyum*, *Polyprason* and *Cepa* (seven sections).

**Methodology:** The pollen grains were examined by using Light Microscopy (LM), Scanning Electron Microscopy (SEM) and the pollen grains of one species under TEM (Transmission Electron Microscopy).

**Results:** The pollen grains were oblate and medium in shape and size. The pollen ornamentation of exine surface, exine ornamentation on sulcus edge, number of exine surface lumina and the state of pollen grain apex in the examined species were different. Semitectate and columellate ectexine with discontinuous endexine were seen in the pollen wall structure (sporoderm).

**Conclusion:** The dendrogram obtained from the pollen characters in SEM observations by using the numerical taxonomy system (NTSYS) software confirmed phylogram of the studied species obtained from recent phylogenetic research. Our palynological dendrogram can be used for segregation the sections and subgenera taxonomical levels in the studied species of genus *Allium*.

**Keywords:** *Allium*, Amaryllidaceae, Monocotyledons, Palynology, Phylogeny, Taxonomy

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## 1. INTRODUCTION

The genus *Allium* is one of the largest Monocotyledons with a wide dispersion in central and south-east Asia, where the species of this genus constitutes a great part of herbaceous societies [1, 2]. Approximately, fifty species of this genus are planted extensively or in local level that economically have great importance. Some of the wild species of this genus are used as edible, medicinal and even decorative plants. Moreover, the wild species of this genus have valuable potential for supplying of human consuming [3].

The taxonomical position of *Allium* as the polymorph genus is sophisticated [4, 5]. Lately, the phylogenetical and biogeographical examination on this genus has been ~~done been~~ done on the endemic species on China [1] and confirmed monophyly in *Allium* by using the phylogenetic analysis of molecular data (ITS nuclear marker and *rps16* chloroplast marker); but, the obtained phylogram from the phylogenetic analysis wasn't confirmed for some subgenera. In their research, three main monophyletic groups were specified: the first clade includes subgenera *Nectaroscordum*, *Amerallium* and *Microscordum*; the second clade includes subgenera *Caloscordum*, *Anguinum*, *Vvedenskya*, *Porphyroprason* and *Melanocrommyum* and the third clade includes subgenera *Butomissa*, *Cyathophora*, *Rhizirideum*, *Allium*, *Reticulatobulbosa* and *Polyprason* [1].

The palynological study of genus *Allium* is sophisticated but driven characteristics from some researches are able to classify taxonomical level on this genus. Majority of these studies were investigated the following characters: exine ornamentation to specify position of the tribe *Allieae* [6, 7], being single sulcus and having extensive sulcus as a predominant morphological pollen character in the genus *Allium* is determined [8]. [9] examined the

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37 species belong to sections *Codonoprasum* and *Allium* and specified the homogeneity of  
38 sulcus and pollen grain ornamentation in the genus *Allium*. Moreover, they indicated that  
39 some morphological characters of the pollen grain such as sulcus and presence or lack of  
40 operculum that have taxonomic importance in the section level. [2] examined the pollen  
41 grain morphology in some species of *Allium* (six sections including *Molium*, *Scorodon*,  
42 *Brevispatha*, *Codonoprasum*, *Allium* and *Melanocrommyum*) and characterized the shape  
43 of pollen grains was prolate and subprolate. Also, in all species extensive sulcus and the  
44 smallest and largest pollen grains are belonged to *A. guttatum* (section *Allium*) and *A.*  
45 *roseum* (section *Molium*), respectively. Pollen grains from 30 *Allium* taxa belonging to 15  
46 sections were recognized in Iran [10]. In this research, the pollens were heteropolar,  
47 peroblate to suboblate shape, rugulate to microrugulate, perforate to striate in subgenus  
48 *Melanocrommyum* and striate exine ornamentation [10].

49 According to result of [11], the morphological character of sulcus in investigated species in  
50 Iran was observed in genus *Allium*, and section *Allium* that this character wasn't observed  
51 about in the other sections. [12] observed an extensive sulcus from the beginning to the end  
52 of the pollen grains in all taxa in sections of *Rhizirideum*, *Codonoprasum* and *Allium*. In  
53 ultrastructure wall of the pollen grains, the exine semitectate and simplicolumellate were  
54 observed in all investigated sections. In addition, the exine ornamentation in these sections  
55 and related species were heterogeneous and weren't synchronize in classification of these  
56 sections and three exine ornamentation including striate-perforate, striate-rugulate-  
57 perforate and rugulate-perforate were observed in these species. They also stated that  
58 availability of operculum as an apomorphic character and narrow endexine layer as a  
59 taxonomic character in the genus *Allium* determined in the sections of *Rhizirideum*,  
60 *Codonoprasum* and *Allium* [12]. [15] separated *A. ursinum* in subspecies level based on

**Comment [f2]:** How many species are there in each section? Show the relevance of studying only few species of them.

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61 the exine ornamentation and stated that this character is an appropriate taxonomic  
62 character (granulate-rugulate, rugulate-striate ornamentation in the subspecies *Ucrainicum*  
63 and perforate-rugulate ornamentation in the subspecies *Ursinum*). [14] examined three  
64 types of pollen grains in seven subgenera and thirteen sections of *Allium* in Pakistan that  
65 weren't in agreement with the mentioned classifications and determined the types of *A.*  
66 *fedtschenkoanum* (reticulate ornamentation), *A. grifithianum* (rugulate-foveolate  
67 ornamentation) and *A. roylei* (subpsilate ornamentation). [15] demonstrated characteristics  
68 of the pollen grains including qualitative and quantitative characters of some European  
69 species of genus *Allium* including three subgenera (*Allium*, *Amerallium* and *Rhizirideum*)  
70 and five sections that explicitly being synchronize with the sections classification.

71  
72 The main aim of our research was to evaluate the pollen ~~grain micromorphological~~  
73 ~~characters~~ and its ~~comparison with implications on~~ the taxonomy and phylogeny of ~~some~~  
74 ~~species of the~~ genus *Allium* ~~including seven species belong to seven different sections. The~~  
75 ~~pollen grain characters were reported in some species for the first time. In addition,~~  
76 ~~compared with the previous researches, more pollen grain micromorphological characters~~  
77 ~~were evaluated.~~

## 78 2. MATERIAL AND METHODS

79  
80 The pollen grains were provided from the collected samples of Main Botanical Garden of  
81 Russian Academy of Sciences (MHA), Moscow, Russia. ~~The specimens~~ Samples were  
82 collected since May and June 2003 and identified by E. Kalikov (Table 1). Also, taxonomic  
83 relationships among the studied species in this research showed in Table 1 [1]. For light  
84 microscopy analysis (LM) ~~observations~~, the pollen grains were acetolyzed based on  
85

**Comment [f6]:** How is close *Allium* pollen of other genera in family? Look for other authors who did LM and SEM in their studies for comparisons!  
See:  
<http://dx.doi.org/10.1590/S0102-33062007000400021>

**Comment [f7]:** You can reduce the text, and show main pollen character of the groups.

**Comment [f8]:** Who is?

86 Erdtman's method [16]. Then, mounted ~~preparations with~~ glycerine jelly ~~glass slides~~.  
87 Thirty pollen grains were measured by Leitz Light Microscopy (HM-LUX3) from each  
88 studied species and images were taken by Dino camera (AM-423).

89 For ~~scanning electron microscopy analysis (SEM) observations~~, non-acetolyzed pollen  
90 grains were put on metal ~~legs stubs~~ and transferred to the EMITECH sputter coater for  
91 coating by gold-paladium (K450X). Finally, the obtained micrographs were taken by VEGA-  
92 TESCAN Scanning Electron Microscopy. Terminology for LM and SEM observations were  
93 explored according to the following references [17, 18, 19].

94 For construction the dendrogram, the obtained characters by SEM observations from the  
95 pollen grains were coded (Table 4). Finally, the NTSYS Software [20] was used along  
96 based on Single Linkage method and UN1 similarity coefficient (binary coefficient) (Table  
97 5). For TEM preparation, the pollen grains were fixed by 2% osmium tetroxide and stained  
98 by uranylacetate solution [21]. Then, dehydrated in ethanol series and were put in acetone.  
99 Finally, embedded in Epon mixture (Epon 812, Epon Harter DDSA, Epon Harter MNA)  
100 according to the standard method of [22]. Ultrathin sections of the pollen grains were  
101 obtained by an ultramicrotome (LKB 8800), then stained with lead citrate (LKB 8800,  
102 Ultratome III) [21]. The micrographs were made by using a JEOL-JEM-100B Transmission  
103 Electron Microscopy.

### 104 3. RESULTS AND DISCUSSION

105 ~~Based on the LM observations,~~ the pollen grains in the studied species were observed  
106 **oblate** in shape and medium in size (Table 2 and Fig. 1). In SEM micrographs, the pollen  
107 grain characters were different in these species (Table 3, Figs. 2 and 3). The exine  
108 ornamentation on surface and the exine ornamentation on **sulcus edge** were different and  
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Begin with general charactes (size and shape), then describe apertures (size and membrane, or edge here), and exine (thickness and ornamentation). Organize point to point, because it is easier for reader get your information.  
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111 these characters for each species are expressed as follows: striate exine ornamentation on  
112 surface and sulcus edge for *A. altissimum*, perforate-striate exine ornamentation on surface  
113 and perforate on sulcus edge for *A. fetisowii*, striate-perforate exine ornamentation on  
114 surface and striate on sulcus edge for *A. backhousianum*, exine ornamentation on surface  
115 and sulcus edge of macrostriate for *A. karataviense*, striate-psilate exine ornamentation on  
116 surface and psilate-striate exine ornamentation on sulcus edge for *A. obliquum*, perforate-  
117 striate exine ornamentation on surface and psilate exine ornamentation on sulcus edge for  
118 *A. rosenbachianum*, perforate-microstriate exine ornamentation on surface and sulcus  
119 edge for *A. schoenoprasum* (Table 3). The pollen grains of *A. fetisowii* and *A.*  
120 *schoenoprasum* species were acute in the end and in the other species were obtuse (Table  
121 3). The size of lumina and muri in the studied species also was different. The scope of  
122 changes in lumina's size in surface of the pollen grain almost was observed similar in *A.*  
123 *altissimum*, *A. backhousianum* and *A. karataviense* (0.06- 0.13  $\mu\text{m}$ ) (Table 3). The number  
124 of exine surface lumina, was the least (4 lumina at  $2 \mu\text{m}^2$ ) for *A. altissimum* and the most  
125 (30 and 31 lumina at  $2 \mu\text{m}^2$ ) for *A. fetisowii* and *A. backhousianum* species, respectively  
126 (Table 3).

127  
128 The results of *A. schoenoprasum* TEM micrographs belongs to section *Schoenoprasum*  
129 and subgenus *Cepa* revealed that the ectexine is semitectate, infratectum is  
130 simplicolumellate, foot-layer is discontinuous and endexine layer is very thin and  
131 discontinuous (Fig. 4).

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133 This research indicated that there were less differences about the LM observations (shape  
134 and size); but, the dendrogram of pollen micromorphological characters from SEM

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135 observations provided useful valuable taxonomical characters on the subgenera and  
136 sections classifications (Table 4 & 5, Fig. 5).

137  
138 Various shapes of pollen grains were observed in ~~this genus~~*Allium spp.* on previous  
139 investigations and the ~~dominant-main~~ shape of the pollen grains in this genus is oblate  
140 shape. Medium pollen type was observed in the most species ~~studied here of this genus~~  
141 ~~during this research~~ and previous research [2, 9, 10, 11, 13, 14, 15].

142  
143 ~~Exine ornamentation was varied in genus Allium [2, 9, 10, 11, 13, 14, 15]. Our results show~~  
144 ~~that varied exine ornamentation with the other characters on SEM observation as useful~~  
145 ~~taxonomic characters in section level.~~

146  
147 Our research on the genus *Allium* confirms previous palynological research on pollen wall  
148 structure on *Codonoprasum*, *Allium* and *Rhizirideum* sections [9, 12].

149  
150 The perforate-striate exine surface ornamentation for two species including *A. fetisowii* and  
151 *A. rosenbachianum* belong to the subgenus *Melanocrommyum* was alike; but, these two  
152 species were different in the exine ornamentation on sulcus edge, the number of exine  
153 surface lumina, the state of pollen grain apex and the size of lumina and muri.

154 The variations of exine ornamentation on the surface and sulcus edge for the other species  
155 were in agreement with the performed sections classification. Moreover, the number of  
156 exine surface lumina for each species was also different and the least and the most  
157 number of lumina was counted in the subgenus *Melanocrommyum*. Our results also  
158 indicated that *A. obliquum* belong to section *Oreiprason* and subgenus *Polyprason* had no

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159 lumina in the exine surface. In the studied species in Iran, the exine surface ornamentation  
160 without lumina was observed in the subgenus *Reticulatobulbosa* in section *Campanulata*  
161 and also in the subgenus *Polyprason* in section *Falcatifolia* [11]. Therefore, the exine  
162 surface ornamentation without lumina can be defined as a useful micromorphological  
163 character in the subgenus *Polyprason* and its related sections. In flora of Pakistan *A.*  
164 *rosenbachianum* on section *Megaloprasum*, *A. schoenoprasum* belongs to section  
165 *Schoenoprasum* and *A. roylei* in section *Oreiprasum* were placed on *A. roylei* types based  
166 on the pollen grain morphology [14].

167  
168 The dendrogram of the [palynological-pollen](#) characters analysis was in agreement with the  
169 taxonomical ranking and previous phylogram by [1] on these taxa in subgenus and section  
170 levels. The phylogram of the studied species were distinguished based on [1]-[research](#). [4]  
171 [These authors](#) had done the extensive phylogenetic analysis by molecular data (ITS  
172 nuclear marker and *rps16* chloroplast marker) on *Allium* genus. The final dendrogram of  
173 our palynological investigation was in agreement with the obtained phylogram by [1]  
174 [research](#). According to the pollen [grain](#)-dendrogram obtained from analysis by SEM  
175 observations in subgenus *Melanocrommyum*, *A. fetisowii* introduced as a sister group with  
176 the other species in this subgenus. In clade *Melanocrommyum*, *A. fetisowii* in section  
177 *Longibidentata* determined as the sister group of the remaining species of the subgenus  
178 *Melanocrommyum* based on the phylogenetic information of molecular markers [1]. *A.*  
179 *schoenoprasum* belongs to subgenus *Cepa* and section *Schoenoprasum* was different from  
180 the other species in SEM observation, although in the state of pollen grain apex was similar  
181 to *A. fetisowii*. The results also indicated that *A. altissimum*, *A. backhousianum* and *A.*  
182 *karataviense* species with similar size in lumina were placed in the subgenus

183 *Melanocrommyum*. The palynological dendrogram in this study put the species *A.*  
184 *altissimum* and *A. backhousianum* from subgenus *Melanocrommyum* and in sections  
185 *Procerallium* and *Acmeperala* together. Moreover, according to the molecular studies,  
186 these two sections were put together [1].

#### 187 **4. CONCLUSION**

188 The dendrogram of palynological analysis data in the related species was in parallel with  
189 the divisions of sections and subgenera taxonomical rank and the phylogram of  
190 phylogenetic studies. Also, our research on the genus *Allium* confirms some previous  
191 palynological research.

#### 192 **COMPETING INTERESTS**

193 The authors of this manuscript declare that they have no competing interests.

#### 194 **REFERENCES**

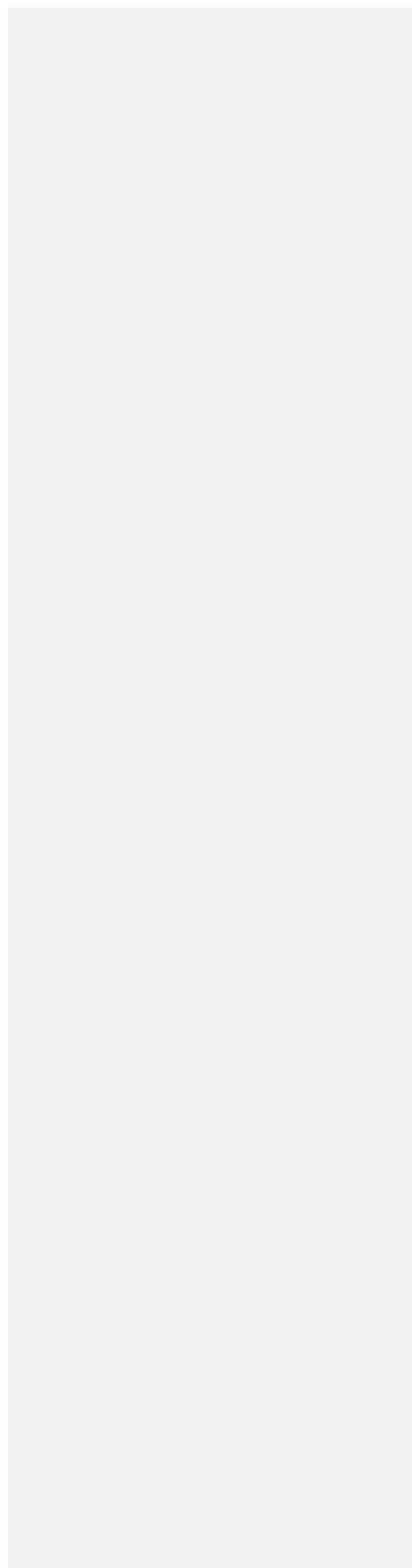
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256 | **Table 1. Taxonomic relationships and collecting data from the studied species of *Allium* (Amaryllidaceae). [1].**

Taxon	Section	Subgenus	Collector and date of collecting
<i>Allium altissimum</i> Regel.	<i>Procerallium</i>	<i>Melanocrommyum</i>	E. Kalikov, 30.5.2003, gathering from MHA
<i>Allium fetisowii</i> Regel.	<i>Longibidentata</i>	<i>Melanocrommyum</i>	E. Kalikov, 30.5.2003, gathering from MHA
<i>Allium backhousianum</i> Regel.	<i>Acmeperata</i>	<i>Melanocrommyum</i>	E. Kalikov, 10.6.2003, gathering from MHA
<i>Allium karataviense</i> Regel.	<i>Miniprasum</i>	<i>Melanocrommyum</i>	E. Kalikov, 30.5.2003, gathering from MHA
<i>Allium obliquum</i> L.	<i>Oreiprasum</i>	<i>Polyprason</i>	E. Kalikov, 30.5.2003, gathering from MHA
<i>Allium rosenbachianum</i> Regel.	<i>Megaloprasum</i>	<i>Melanocrommyum</i>	E. Kalikov, 30.5.2003, gathering from MHA
<i>Allium schoenoprasum</i> L.	<i>Schoenoprasum</i>	<i>Cepa</i>	E. Kalikov, 30.5.2003, gathering from MHA

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**Table 2. The obtained pollen data from the Light Microscopy studies Pollen measurements of the studied species of Allium (Amaryllidaceae).**

Taxon	Pollen size	Polar axis (µm)	Equatorial axis (µm)	P.E	Pollen	Pollen
	(µm)	Min-Mean±SD-Max	Min-Mean±SD-Max		shape	typesize
<i>A. altissimum</i>	35.18±6.52	17.00-18.28±1.24-21.00	27.50-35.18±6.52-46.00	0.5	Oblate	Medium
<i>A. fetisowii</i>	30.74±5.13	15.00-16.16±1.51-20.00	22.50-30.74±5.13-37.50	0.5	Oblate	Medium
<i>A. backhousianum</i>	29.97±2.34	12.00-16.22±1.79-17.50	27.50-29.97±2.34-35.00	0.5	Oblate	Medium
<i>A. karataviense</i>	31.39±4.92	12.00-16.84±2.03-20.00	22.50-31.39±4.92-41.00	0.5	Oblate	Medium
<i>A. obliquum</i>	31.56±6.09	12.50-16.16±1.60-20.00	25.00-31.56±6.09-41.00	0.5	Oblate	Medium
<i>A. rosenbachianum</i>	33.70±1.92	14.00-19.60±3.63-25.00	30.00-33.70±1.92-37.50	0.6	Oblate	Medium
<i>A. schoenoprasum</i> var. <i>sibiricum</i>	30.82±5.08	15.00-16.46±2.24-20.00	25.00-30.82±5.08-39.00	0.5	Oblate	Medium

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Comment [f17]: Smaller or bigger?

Comment [f16]: Pollen size is the greater value of a diameter (equat or polar one). In case of monolocate pollen, there are 2 equatorial diameters (a smaller and a bigger) and one pollen diameter. So, I don't know what POLLEN SIZE means here!

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Comment [f19]: The same

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291 **Table 3. The obtained pollen data from the Scanning Electron Microscopy from Pollen data of the studied species of**  
292 **Allium (Amaryllidaceae).**

Taxon	Exorn	Sd	S	L	M	P
<i>A. altissimum</i>	Striate	Striate	Obtuse	0.06-0.13	0.13-3.46	4
<i>A. fetisowii</i>	Perforate-striate	Perforate	Acute	0.06-0.20	0.13-0.86	30
<i>A. backhousianum</i>	Striate-perforate	Striate	Obtuse	0.06-0.13	0.13-0.40	31
<i>A. karataviense</i>	Macrostriate	Macrostriate	Obtuse	0.06-0.13	0.06-0.40	12
<i>A. obliquum</i>	Striate-psilate	Psilate-striate	Obtuse	-	-	-
<i>A. rosenbachianum</i>	Perforate-striate	Psilate	Obtuse	0.06-0.26	0.06-1.20	27

**Comment [f20]:** But if it is MACROSTRATE, it hasn't lumina!

*A. schoenoprasum* var. *sibiricum* Perforate-microstriate Perforate-microstriate Acute 0.06-0.40 0.06-1.60 22

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Exorn: Exine ornamentation, Sd: Sulcus edge ornamentation, S: The state of pollen grain apex, L: Lumina size, M: Margin size, P: The number of exine surface lumina. 295

**Comment [f21]:** Do you mean sulcus membrane ornamentation? Or margin?

**Comment [f22]:** Width?

**Comment [f23]:** Number, how? Do you mean density? Lumina by area? I can't understand!

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309 **Table 4. The pollen traits from Scanning Electron Microscopy and coding of these characters by the analysis with**

310 **NTSYS software.**

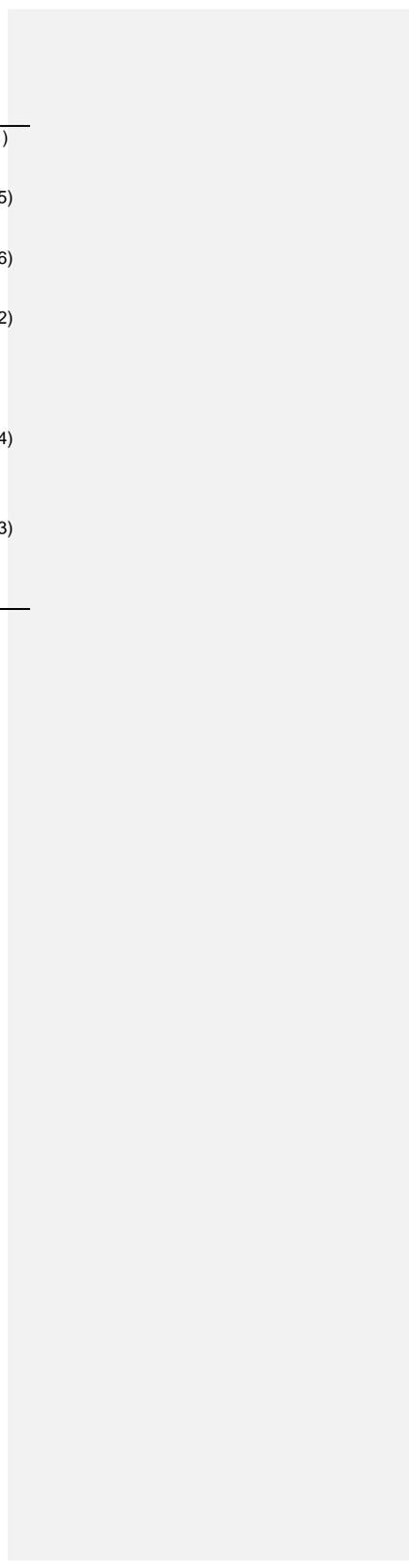
**Comment [f24]:** The same of table 3! You must change.

Taxon	Exorn (code)	Sd (code)	S (code)	L (code)	M (code)	P (code)
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<i>A. altissimum</i>	Striate (1)	Striate (1)	Obtuse (1)	0.06 (1)-0.13 (1)	0.13 (1)-3.46 (5)	4 (1)
<i>A. fetisowii</i>	Perforate-striate (2)	Perforate (2)	Acute (2)	0.06 (1)-0.20 (2)	0.13 (1)-0.86 (2)	30 (5)
<i>A. backhousianum</i>	Striate-perforate (3)	Striate (1)	Obtuse (1)	0.06 (1)-0.13 (1)	0.13 (1)-0.40 (1)	31 (6)
<i>A. karataviense</i>	Macrostriate (4)	Macrostriate (3)	Obtuse (1)	0.06 (1)-0.13 (1)	0.06 (2)-0.40 (1)	12 (2)
<i>A. obliquum</i>	Striate-psilate (5)	Psilate-striate (4)	Obtuse (1)	(0)	0	0
<i>A. rosenbachianum</i>	Perforate-striate (2)	Psilate (5)	Obtuse (1)	0.06 (1)-0.26 (3)	0.06 (2)-1.20 (3)	27 (4)
<i>A. schoenoprasum</i> var. <i>sibiricum</i>	Perforate-microstriate (6)	Perforate-microstriate (6)	Acute (2)	0.06 (1)-0.40 (4)	0.06 (2)-1.60 (4)	22 (3)

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Table 5. The similarity coefficients of the studied species of Allium (Amaryllidaceae) compared with the others by using the

NTSYS software.

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Taxon	a	b	c	d	e	f	g
a	1.00						
b	0.40	1.000					
c	0.76	0.40	1.00				
d	0.54	0.222	0.66	1.00			
e	0.22	0.00	0.22	0.22	1.00		
f	0.40	0.400	0.40	0.54	0.22	1.00	
g	0.22	0.40	0.22	0.40	0.00	0.40	1.00

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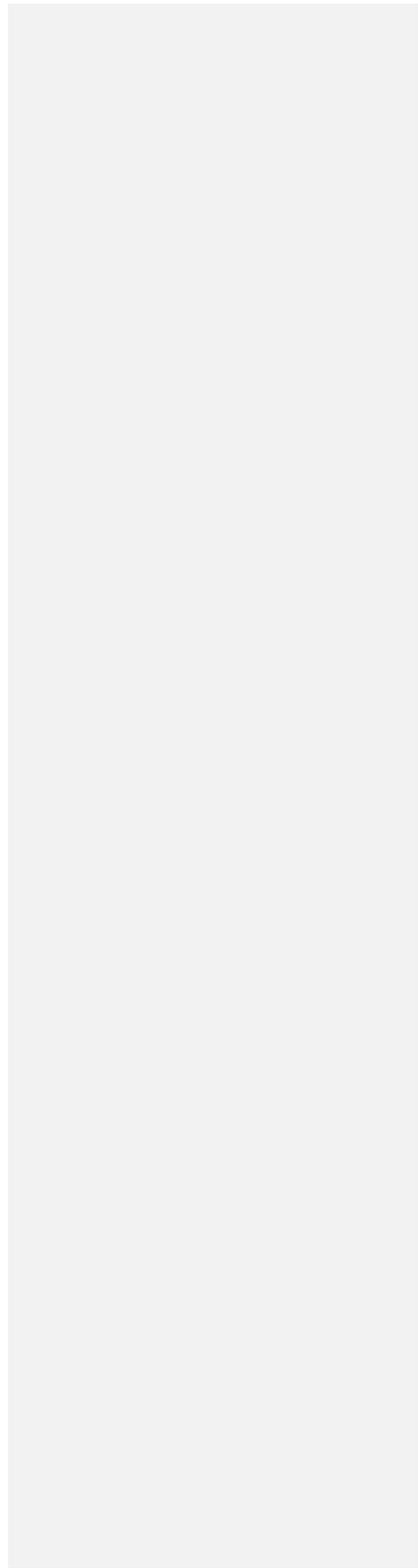
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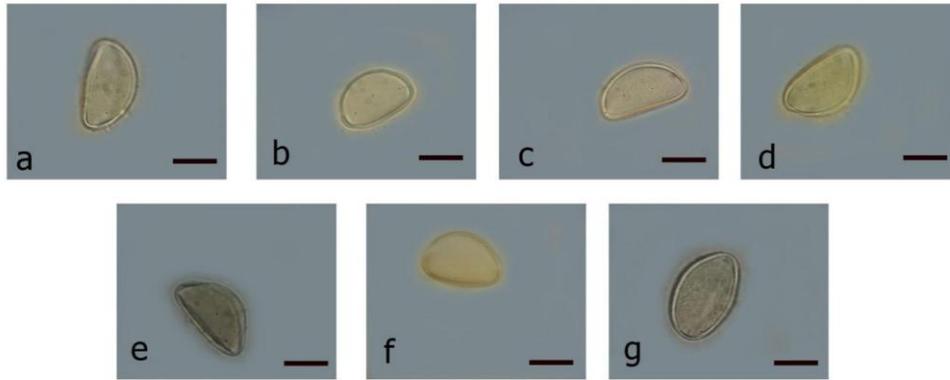
a. *A. altissimum*, b. *A. fetisowii*, c. *A. backhousianum*, d. *A. karataviense*, e. *A. obliquum*, f. *A. rosenbachianum*, g. *A. schoenoprasum* var. *sibiricum*.

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367 | Fig. 1. [Light microscopy photographs](#)Pollen grains of the studied species of *Allium* (Amaryllidaceae), seen on  
368 | [LM](#). a. *A. altissimum*, b. *A. fetisowii*, c. *A. backhousianum*, d. *A. karataviense*, e. *A. obliquum*, f. *A.*  
369 | *rosenbachianum*, g. *A. schoenoprasum* var. *sibiricum*. (Light Microscopy, 1000X, scale: 10  $\mu$ m)

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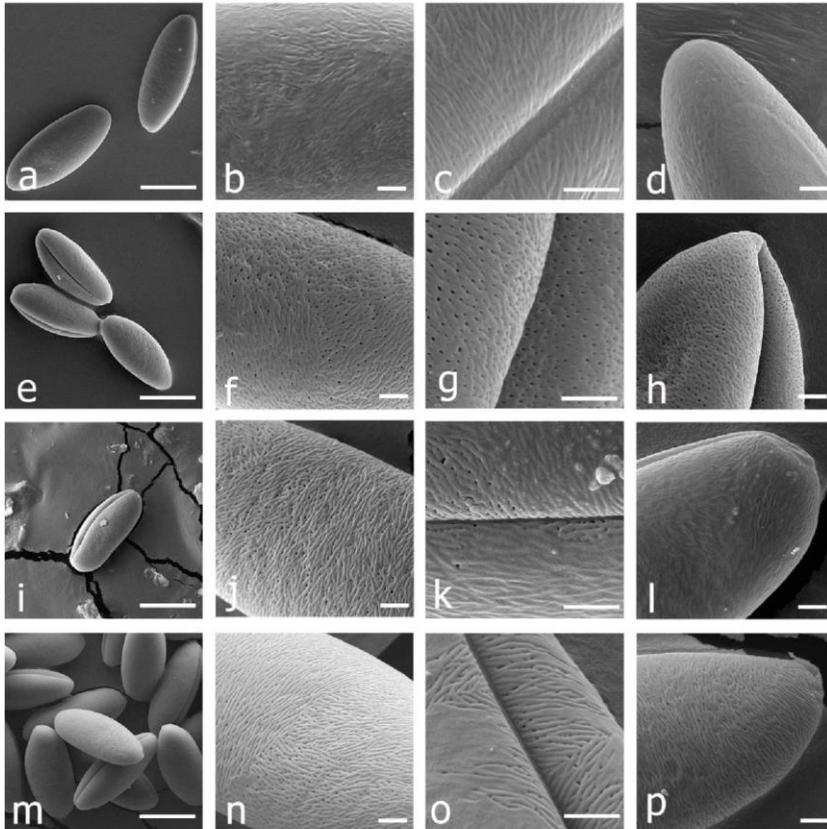
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389 Fig. 2. The Scanning Electron Microscopy micrographs of Pollen grains of the studied species of Allium  
390 (Amaryllidaceae), on SEM: (for each species, the equatorial view of pollen grain, exine ornamentation, sulcus  
391 edge exine ornamentation and the state of pollen grain apex have been determined, respectively). *A. altissimum*  
392 (a–d), *A. fetisowii* (e–h), *A. backhousianum* (i–l) and *A. karataviense* (m–p). (Scale bar: 20  $\mu$ m for a, e, i & m., scale  
393 bar: 2  $\mu$ m for b, c, d, f, g, h, j, k, l, n, o & p.)

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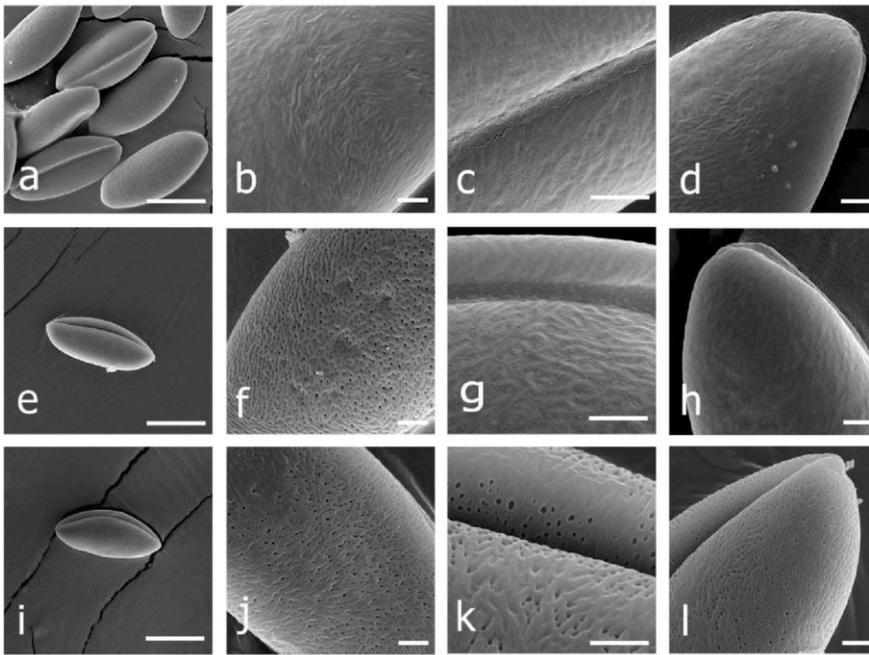
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401 Fig. 3. ~~The Scanning Electron Microscopy micrographs~~ Pollen grains of the studied species of Allium  
402 (Amaryllidaceae), on SEM: (for each species, the equatorial view of pollen grain, exine ornamentation, sulcus  
403 edge exine ornamentation and the state of pollen grain apex have been determined, respectively). *A. obliquum*  
404 (a-d), *A. rosenbachianum* (e-h) and *A. schoenoprasum* var. *sibiricum* (i-l). (Scale bar: 20  $\mu$ m for a, e & i., scale  
405 bar: 2  $\mu$ m for b, c, d, f, g, h, j, k & l)

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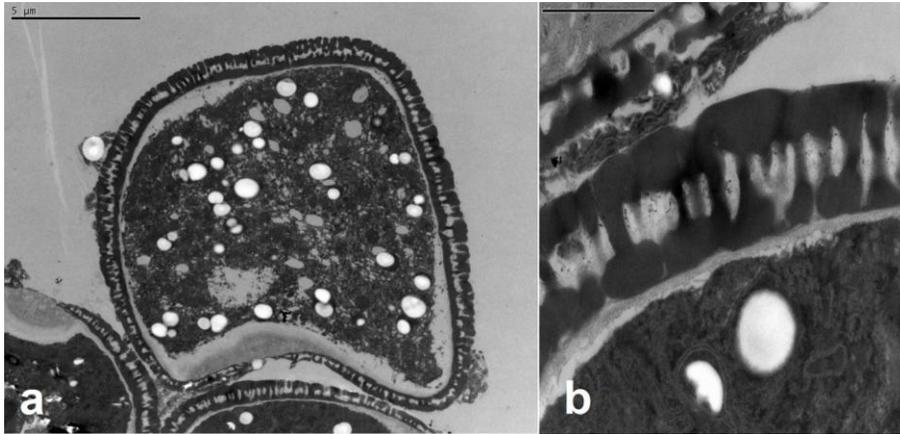
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Fig. 4. The Transmission Electron Microscopy micrographs Ultra-thin section on pollen grain of *A. schoenoprasum* var. *sibiricum* (Amaryllidaceae): a. Cross section of pollen grain (Scale bar: 5 µm), b: Cross section of pollen wall structure (Scale bar: 1 µm).

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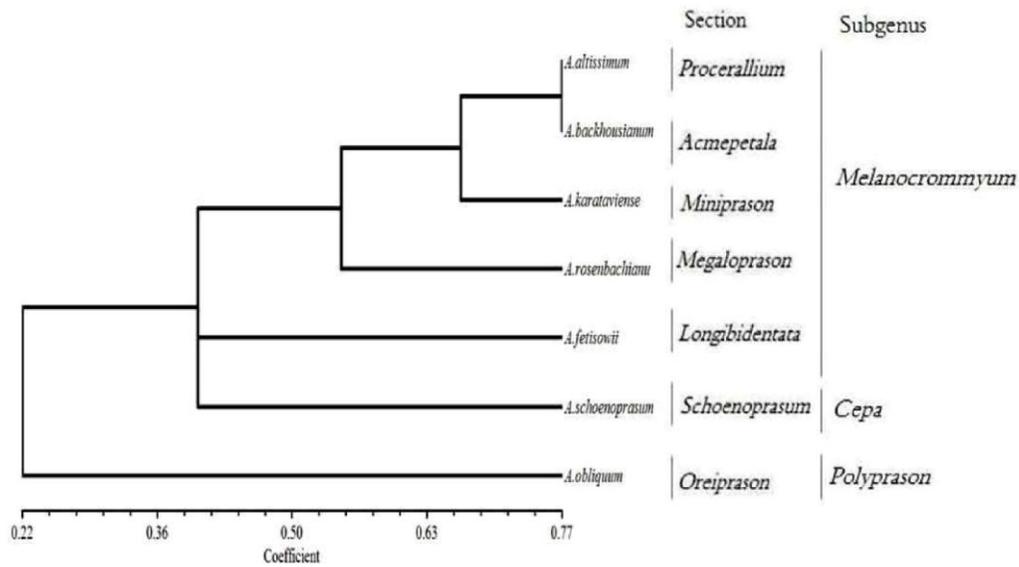
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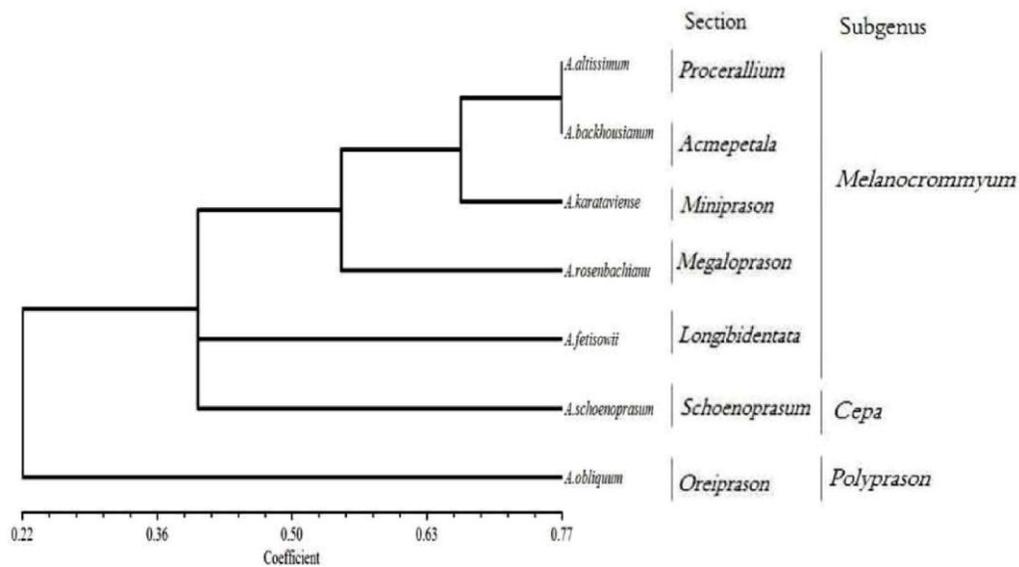
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Fig. 5. Dendrogram obtained from [implication the analysis of pollen data morphology on](#) and taxonomic relationships of the studied species [of \*Allium\* \(Amaryllidaceae\)](#).

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