

## POLLEN MORPHOLOGY OF THE POLISH SPECIES OF THE GENUS *SORBUS* L.

LESZEK BEDNORZ<sup>1</sup>, IRMINA MACIEJEWSKA-RUTKOWSKA<sup>2</sup>,  
DOROTA WROŃSKA-PILAREK<sup>3</sup>, TOSHIYUKI FUJIKI<sup>4</sup>

<sup>1</sup> Department of Botany, August Cieszkowski Agricultural University  
Wojska Polskiego 71 C, 60-625 Poznań, Poland  
e-mail: lbednorz@au.poznan.pl

<sup>2,3</sup> Department of Forest Botany, August Cieszkowski Agricultural University  
Wojska Polskiego 71 D, 60-625 Poznań, Poland

<sup>4</sup> Nagoya University, Graduate School of Environmental Studies, School of Sciences  
Furo-cho, Chikusa-ku Nagoya City, 464-8601 Japan

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### ABSTRACT

This paper presents the results of the study on pollen morphology of five Polish species of the genus *Sorbus* L. (*S. aria* (L.) Crantz, *S. aucuparia* L. Emend. Hedl., *S. chamaespilus* (L.) Crantz, *S. intermedia* (Ehrh.) Pers. and *S. torminalis* (L.) Crantz). Observations were carried out with light and scanning microscopes. Investigated pollen grains were small or medium size, most often subprolate or prolate spheroidal in outline. Exine of medium thickness, consisted of two layers. Mainly 3-zonocolporate or sometimes 4-zonocolporate (*S. chamaespilus* and *S. torminalis*) grains were noted. Usually striatae type of sculpture was observed, except the grains of *S. intermedia*, which were characterized by intermediate type of sculpture, with the features both striate and regulate ornamentation.

Pollen morphology of the investigated *Sorbus* species corresponds with their systematic classification. It is relatively easy to separate pollen grains of the following subgenera: *Sorbus*, *Chamaespilus* and *Torminaria*. Only subgenus *Aria* includes grains of different morphology and therefore it is impossible to determine the diagnostic features of this subgenus. Pollen morphology does not confirm a close relationship between *S. aria* and *S. intermedia*.

It is possible to distinguished pollen grains of all the analysed native species. However, there are no important differences in pollen morphology between the subspecies of *Sorbus aucuparia*. The key for Polish *Sorbus* species, based on pollen grain characters is given too.

**KEY WORDS:** *Sorbus*, pollen morphology, palynotaxonomy, SEM, LM.

### INTRODUCTION

Studies on pollen morphology of European species of the genus *Sorbus* showed their considerable similarity to pollen grains of other taxa of the Rosaceae family, as *Crataegus*, *Malus*, *Pyrus*, *Dryas*, *Prunus* and *Aronia* (Teppner 1965; Reitsma 1966; Eide 1981; Moore et al. 1991, Faegri and Iversen 1992). All those mentioned species belong to the trizonocolporate class of pollen and the lack of operculum and costae colpi are considered to be the most important features, differentiating them from the other representatives of Rosaceae.

Older palynological investigations, carried out only with the use of LM, have proposed to include *Sorbus* grains into morphological type of *Crataegus* (Faegri and Iversen 1964; Reitsma 1966). However, according to Gabrielian (1978), it is possible to separate within this genus a num-

ber of pollen types, using exclusively LM. The cited author (l.c.) observing pollen of 40 species, originating from western Asia and of Himalayas, distinguished 17 morphological types of grains. She recognized shape and size of grains, number, structure and shape of apertures, exine thickness and sculpture type, as diagnostic features of the genus. Gabrielian (l.c.) also noticed that it was relatively easy to separate the so called 'good species', which usually were diploids and had got pollen of high vitality. On the other hand, within the genus *Sorbus*, the hybrids and polyploids produce pollen in high percentage sterile.

Moore and others (1991) have emphasized the very large differentiation of pollen morphology of the taxa of Rosaceae family, even among the populations within the same species. They thought the grain size to be the least reliable feature and they related it to the comparatively frequent occurrence of hybrid and polyploid species in this family.

In the key to pollen grains of north-west European species the cited authors divided taxa of Maloideae subfamily into two groups. *Sorbus aucuparia*, *S. rupicola* and *S. torminalis* (together with *Malus sylvestris* and *Pyrus pyraeaster*) comprise the first group, and *S. aria* and poliploids of the *Sorbus* (with *Crataegus monogyna* and *C. laevigata*) – the second.

Many palynological studies showed that the interpretation of exine ornamentation in *Sorbus* species was very difficult to carry out just with the use of light microscope. For instance Pragłowski (1962), observing pollen grains of *S. aucuparia* distinguished a striate type of ornamentation, with very gentle striae. According to Stachurska and others (1973), the sculpture in this species was faintly granular and slightly striatae. Instead, Boyd and Dickson (1986) described the exine sculpture of *S. aucuparia* as psilate, finely stippled and with slightly beaded striations.

Faultless qualification of sculpture character of pollen grains of particular *Sorbus* species is possible using scanning microscope, what illustrates Eide's work (1981). The author proved that striate ornamentation with distinct muri was a characteristic feature of pollen grains of four *Sorbus* species (*S. aranensis*, *S. aucuparia*, *S. hybrida* and *S. rupicola*). Eide (l.c.) thought exine ornamentation to be one of the most important diagnostic features, not only with re-

gard to the taxa of *Sorbus*, but also with regard to other genera within the Rosaceae family.

Within the area of Poland, till now pollen grains of four *Sorbus* species occurring in the wild: *S. aria*, *S. aucuparia*, *S. chamaemespilus* and *S. torminalis* and of one cultivated species: *S. domestica*, have been described by means of light microscope (Stachurska et al. 1973). From among those native species only pollen morphology of *S. aucuparia* was investigated in SEM (Eide 1981; Moore et al. 1991), but the analysed pollen samples originated from north-west Europe.

The main aim of the present work was to describe pollen morphology of the native species of genus *Sorbus*, both in SEM and LM. The authors also wanted to evaluate the utility of pollen features in identification of the examined species and in taxonomy of genus *Sorbus*.

## MATERIALS AND METHODS

Pollen grains of five *Sorbus* species naturally occurring in Poland were investigated. They represented four subgenera: two species of subgenus *Aria* – *S. aria* (L.) Crantz, *S. intermedia* (Ehrh.) Pers., one species of subgenus *Chamaemespilus* –

TABLE 1. Location of studied pollen samples of Polish *Sorbus* species. Division into subgenera according to Phipps and the others (1990).

Subgenera	No. of sample	Location	Longitude E	Latitude N	Collector, date of collection	
<b><i>Aria</i></b>	<b><i>S. aria</i> (L.) Crantz</b>					
	1	Prov. Małopolskie, Pieniny Mts.	20°24'	49°25'	Bodziarczyk J., 25.05.2003	
	2	Prov. Małopolskie, Tatra Mts. (GOB Zakopane)	19°58'	49°17'	Walusiak E., 27.05.2003	
	<b><i>S. intermedia</i> (Ehrh.) Pers.</b>					
	1	Prov. Pomorskie, 'Kępa Redłowska' reserve	18°33'	54°34'	Szramka J., 14.05.2002	
	2	Prov. Pomorskie, Kolbudy	18°28'	54°17'	Szramka J., 13.05.2002	
	3	Prov. Pomorskie, Wirty	18°22'	53°55'	Bednorz L., 23.05.2002	
	4	Prov. Wielkopolskie, Poznań (Dendrological Garden)	16°53'	52°25'	Bednorz L., 8.05.2002	
	<b><i>Sorbus</i></b>	<b><i>Sorbus aucuparia</i> subsp. <i>aucuparia</i></b>				
		1	Prov. Lubuskie, Stubice	14°35'	52°21'	Bednorz E., 16.05.2003
2		Prov. Pomorskie, Stowiński National Park	17°24'	54°44'	Antkowiak W., 1.06.2003	
3		Prov. Pomorskie, Kaliska	18°13'	53°55'	Bednorz L., 23.05.2002	
4		Prov. Kujawsko-pomorskie, Jamy	18°58'	53°31'	Tarnawski A., 20.05.2002	
5		Prov. Podlaskie, Białowieża	14°52'	52°42'	Korczyk A., 16.05.2002	
6		Prov. Wielkopolskie, Wielkopolski National Park	16°48'	52°16'	Bednorz L., 4.05.2002	
7		Prov. Wielkopolskie, Kątnik	16°55'	52°18'	Bednorz L., 5.05.2002	
8		Prov. Wielkopolskie, Tokary	18°25'	52°23'	Bednorz L., 16.05.2002	
9		Prov. Małopolskie, Babiogórski National Park	19°31'	49°36'	Bodziarczyk J., 31.05.2003	
<b><i>S. aucuparia</i> subsp. <i>glabrata</i> (Wimm. &amp; Grab.) Cajander</b>						
1		Prov. Małopolskie, Babia Góra	19°31'	49°35'	Bodziarczyk J., 14.06.2003	
2		Prov. Małopolskie, Tatra Mts.	19°50'	49°14'	Bednorz L., 7.07.2002	
<b><i>Chamaemespilus</i></b>	<b><i>S. chamaemespilus</i> (L.) Crantz</b>					
1	Prov. Małopolskie, Tatra Mts. (GOB Zakopane)	19°58'	49°17'	Walusiak E., 23.05.2003		
<b><i>Torminaria</i></b>	<b><i>S. torminalis</i> (L.) Crantz</b>					
	1	Prov. Pomorskie, Borzechowo	18°19'	53°54'	Bednorz L., 23.05.2002	
	2	Prov. Kujawsko-pomorskie, Jamy	18°58'	53°31'	Tarnawski A., 20.05.2002	
	3	Prov. Wielkopolskie, Goraj	16°31'	52°53'	Bednorz L., 28.05.2002	
	4	Prov. Wielkopolskie, 'Brzęki przy Starej Gajówce' reserve	16°28'	52°28'	Bednorz L., 8.05.2002	
	5	Prov. Wielkopolskie, 'Bytyńskie Brzęki' reserve	16°28'	52°28'	Bednorz L., 8.05.2002	
	6	Prov. Wielkopolskie, Wielkopolski National Park	16°48'	52°16'	Bednorz L., 14.05.2002	
7	Prov. Małopolskie, 'Białowodzka Góra' reserve	20°38'	49°41'	Chochliński K., 6.05.2002		

TABLE 2. Measurements of examined pollen grains in glycerine-jelly.

Species of <i>Sorbus</i>	Mean length of polar axis (P) and its range [µm]	Mean length of equatorial axis (E) and its range [µm]	P/E ratio and its range	Mean length of ectocolpi [µm]	Exine thickness [µm]	Pollen shape [%]					Pollen size	Pollen class
						subprolate	prolate spheroidal	prolate	spheroidal	oblate spheroidal		
<i>S. aria</i>	32.30 25.2-43.2	27.40 21.6-32.4	1.18 1.00-1.35	27.10	2.00	-	4.4	36.7	56.7	2.2	medium	3-colporate
<i>S. aucuparia</i> subsp. <i>aucuparia</i>	23.60 18.0-28.8	19.60 14.4-23.4	1.20 1.00-1.50	19.79	1.50-2.00	-	4.8	24.8	57.0	13.4	small (60%), medium (40%)	3-colporate
<i>S. aucuparia</i> subsp. <i>glabrata</i>	24.60 21.6-28.8	20.70 18.0-23.4	1.19 1.00-1.40	19.98	2.00	-	5.0	20.0	71.7	3.3	medium (60%), small (40%)	3-colporate
<i>S. chamaemespilus</i>	28.10 25.2-32.4	25.30 21.6-28.8	1.11 0.94-1.23	23.16	1.50-2.00	3.3	20.0	36.7	40.0	-	medium	3 (4)-colporate
<i>S. intermedia</i>	34.90 21.6-45.0	27.50 19.8-34.2	1.27 1.00-1.56	28.50	1.50-2.00	-	1.1	14.5	53.3	31.1	medium (97.8%), small (2.2%)	3-colporate
<i>S. torminalis</i>	32.10 27.0-39.6	26.50 21.6-32.4	1.21 1.00-1.54	26.14	1.50	-	2.4	20.0	63.2	14.4	medium	3 (4)-colporate

*S. chamaemespilus* (L.) Crantz, one species of subgenus *Sorbus* – *S. aucuparia* L. Emend. Hedl. and one species of subgenus *Torminaria* – *S. torminalis* (L.) Crantz. In accordance to *S. aucuparia* its division into two subspecies – *aucuparia* and *glabrata* (Wimm. & Grab.) Cajander was included.

Pollen from mature anthers was collected from natural localities and sporadically from cultivated plants. The number of examined species samples (1-9) depended on their distribution range and abundance. Detailed information about the collected material is given in Table 1.

Thirty pollen grains for each sample were investigated and 750 grains in all were observed. The following quantitative and qualitative pollen features were analysed: length of polar axis (P), length of equatorial axis (E), P/E ratio, thickness of exine, length of ectocolpi, shape and outline of grains and the type of pollen sculpture. The results of measurements are presented in Table 2.

All samples were acetolysed according to Erdtman's method (1952), with insignificant modifications (Wrońska-Pilarek 1998). The pollen terminology follows Erdtman (1952), Reitsma (1970) and Hoen (1999). The classes of thickness of exine were fixed on the basis of its characteristic feature for some species within Rosaceae family (Eide 1981). Basing on this scale the medium thick exine has 1.46-2.09 µm of thickness.

The observations and microphotographs were performed both with scanning electron microscope (JEOL JSM 6300) and light microscopes (BIOLAR 2308, Nikon HFX-DX). The pictures of investigated grains are presented in Figures 1-6. SEM allowed to investigate the details of exine sculpture and LM was mainly used to study the exine structure.

## RESULTS

Pollen grains of all investigated species were small or medium sized. On average, length of polar axis (P) was within the interval 23.6-34.9 µm (with the whole range 18.0-45.0 µm). Small grains were most often observed in samples of *Sorbus aucuparia* subsp. *aucuparia* (60% analysed grains of this taxon) and of *S. aucuparia* subsp. *glabrata* (40%) and only sporadically in samples of *S. intermedia* (2.2%). In turn, polar axes of *S. aria*, *S. chamaemespilus*, *S. intermedia* and *S. torminalis* were usually more than 28 µm long and their ranges of variability partly overlapped (Table 2).

According to the five analysed species, the P/E value most often oscillated from 1.11 to 1.27 (with minimum 0.94 in *S. chamaemespilus* sample and maximum 1.56 in *S. intermedia* one). At least 50% of pollen grains in samples of *S. aria*, *S. aucuparia*, *S. intermedia* and *S. torminalis* had subprolate shape. This form was also characteristic for 40% of grains of *S. chamaemespilus*. Almost the same percentage of *S. chamaemespilus* grains were prolate spheroidal and this shape class was also often noted in samples of the other taxa. Also grains of *S. chamaemespilus* had a relatively large number of spheroidal forms, and grains of *S. intermedia* were sometimes distinguished by prolate shape.

Irrespective of the *Sorbus* species, the outline in polar view was mostly circular, more rarely triangular with obtuse apices and convex sides and in equatorial view – mostly elliptic, more rarely circular or quinquangular with obtuse apices and concave sides.



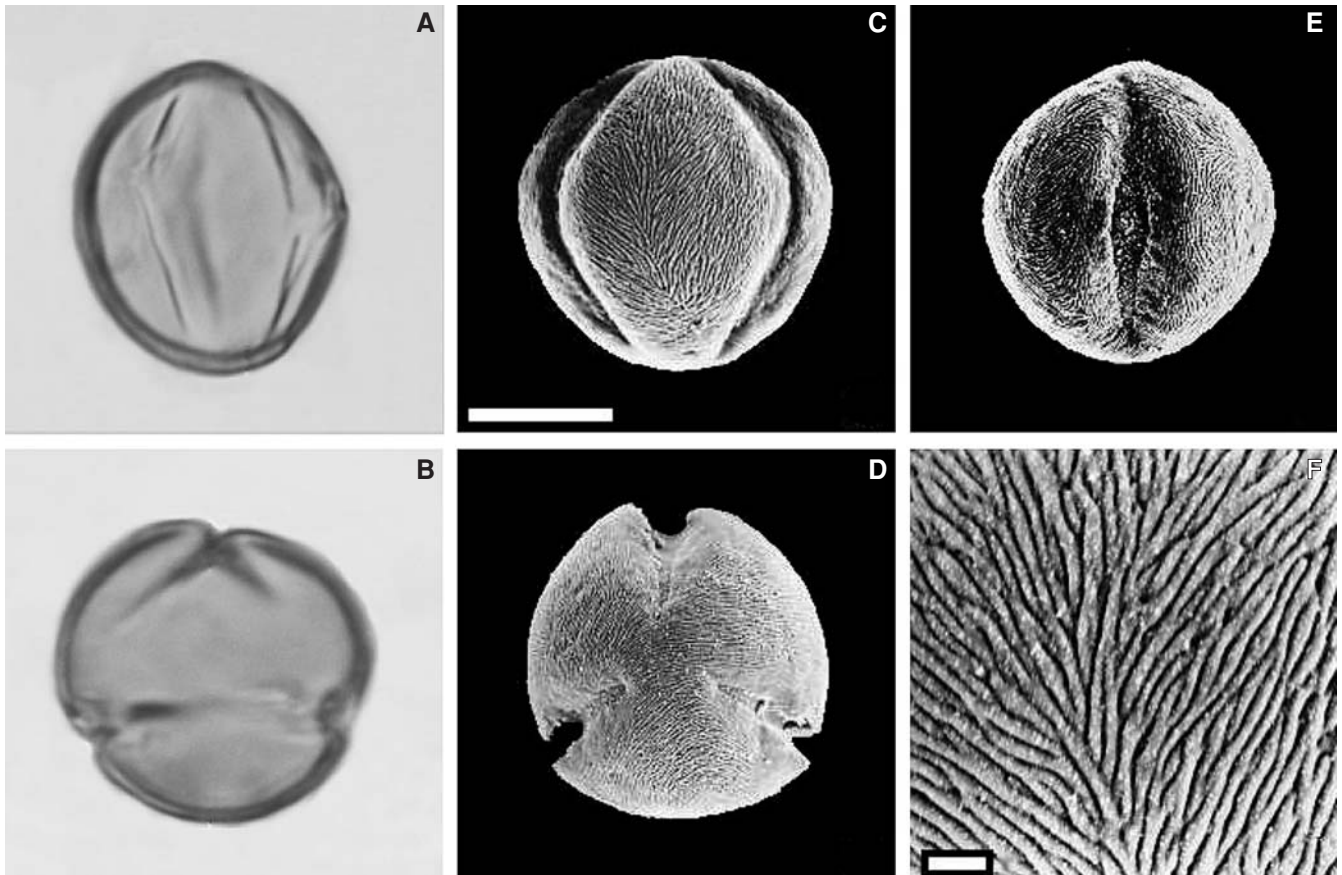
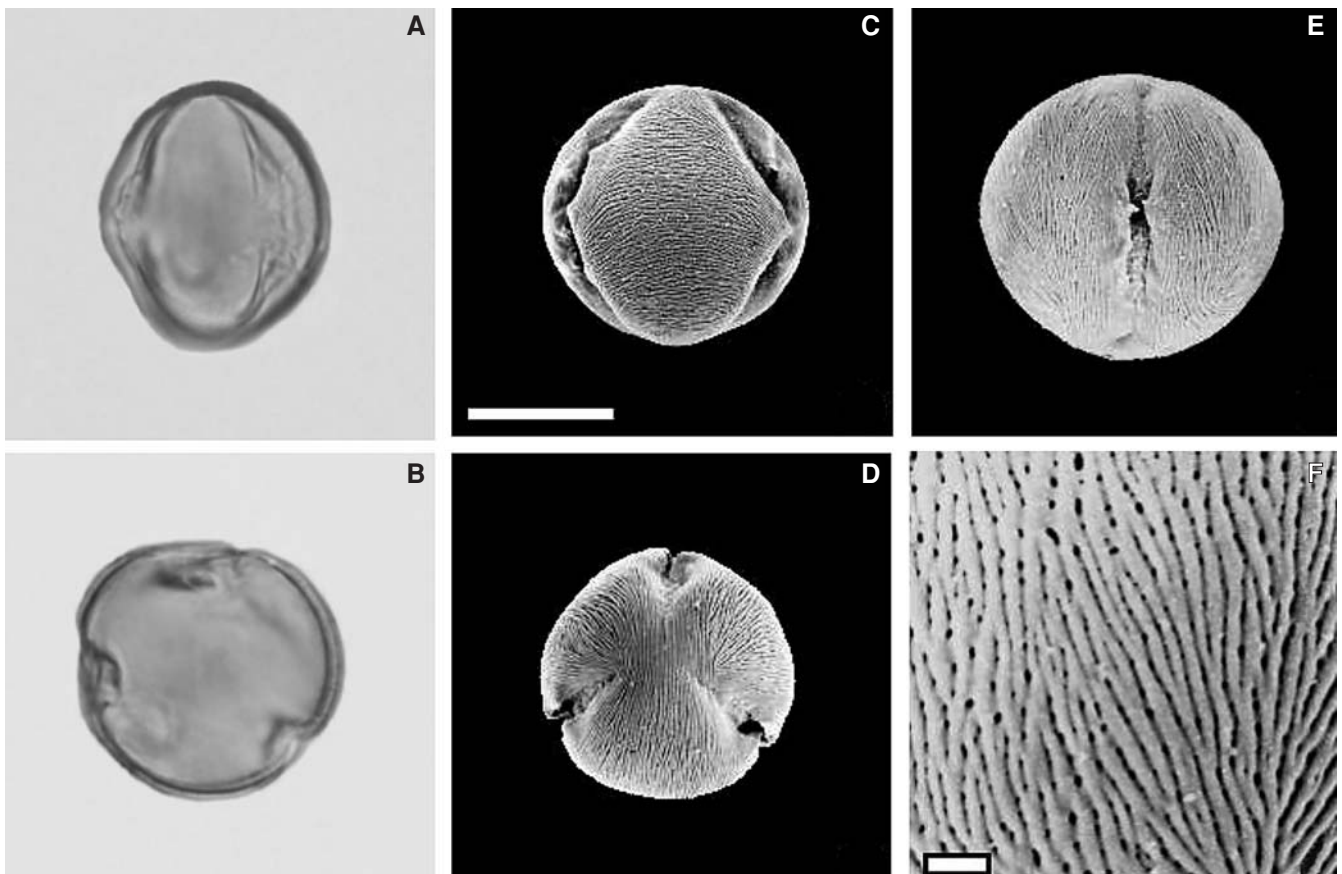


Fig. 1. *Sorbus aria*. A – (LM). Outline in equatorial view; 2 ectocolpi and exine structure visible ( $\times 1000$ ); B – (LM). Outline in polar view; exine structure, apocolpium and fragments of 3 ectocolpi visible ( $\times 1000$ ); white bare corresponds to  $10\ \mu\text{m}$ ; C – (SEM). Outline in equatorial view; 2 ectocolpi and striate sculpture of grain visible ( $\times 2000$ ); white bare corresponds to  $10\ \mu\text{m}$ ; D – (SEM). Outline in polar view; striate sculpture of grain, apocolpium and fragments of 3 ectocolpi visible ( $\times 2000$ ); E – (SEM). Outline in equatorial view; ectocolpus and striate sculpture of grain visible ( $\times 2000$ ); F – (SEM). Close-up of striate sculpture of grain; striae and muri visible ( $\times 8000$ ); white bare corresponds to  $1\ \mu\text{m}$ .



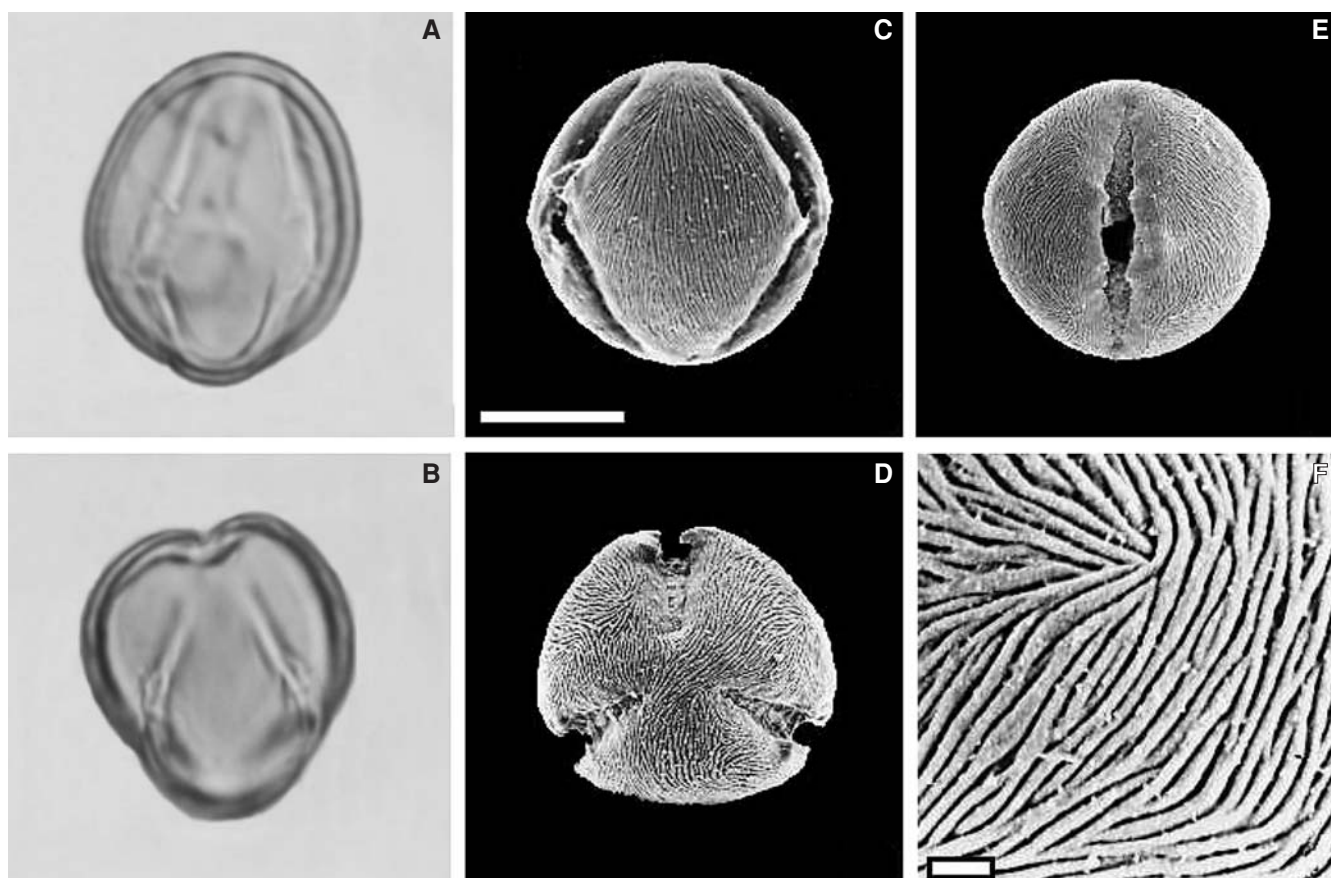


Fig. 3. *Sorbus aucuparia* subsp. *glabrata*. A – (LM). Outline in equatorial view; 2 ectocolpi and exine structure visible ( $\times 1000$ ); B – (LM). Outline in polar view; exine structure, apocolpium and fragments of 3 ectocolpi visible ( $\times 1000$ ); C – (SEM). Outline in equatorial view; 2 ectocolpi and striate sculpture of grain visible ( $\times 2000$ ); white bare corresponds to 10  $\mu\text{m}$ ; D – (SEM). Outline in polar view; striate sculpture of grain, apocolpium and fragments of 3 ectocolpi visible ( $\times 2000$ ); E – (SEM). Outline in equatorial view; ectocolpus and striate sculpture of grain visible ( $\times 2000$ ); F – (SEM). Close-up of striate sculpture of grain; striae, muri and perforations visible ( $\times 8000$ ); white bare corresponds to 1  $\mu\text{m}$ .

Three-zonocolporate pollen grains were observed in all investigated species. Besides, 4-zonocolporate grains were noted in the samples of *S. chamaemespilus* (relatively often) and of *S. torminalis* (rarely).

Ectocolpi had an elliptical outline and were usually relatively narrow and deeply sunken in exine, with acute ends. Ectoaperture length was more than 4/5 length of polar axis. Ectocolpus margin was irregular, slightly recurvate inwards. Membrana ectocolpi were rugulate or granulate. A bridge over ectocolpus in the equatorial region was present, well visible in LM as a central break. If there were three ectocolpi in the equatorial zone, then they were regularly arranged, the distance among them was  $\pm$  equal; if there were four ectoapertures – the distance among them was distinctly unequal. Endopori were placed in the central part of ectocolpi, circular or elliptical in outline, with irregular margins. A fastigium in the region of the endoporus was observed.

Exine always consisted of two layers, well visible in LM. Usually ectexine and endexine were of the same thickness,

only in *S. torminalis* samples ectexine was thicker than endexine. Exine of medium thickness – 1.5-2.0  $\mu\text{m}$  thick.

All grains with tectum perforatum. Usually striate type of sculpture was observed, except pollen grains of *S. intermedia*, which was characterized by intermediate type of sculpture, with the feature both striate and regulate ornamentation. In the striate surface relief muri were well marked, cylindrical,  $\pm$  bifurcately forked, parallel elongated to the polar axis, rarely perpendicularly, with an arrangement resembling leaf venation (*S. aucuparia* [type and subsp. *glabrata*], *S. aria*) or forming numerous curves (*S. chamaemespilus*, *S. torminalis*). Single muri were divided by well visible striae. Striae relatively narrow, with less or more marked perforations at their bottom. Perforations of different diameters. Ornamentation of apocolpi and mesocolpi were the same. Intermediate type of sculpture was distinguished by short muri, markedly flattened, wide, irregularly arranged. Striae relatively narrow and shallow, very short, with perforations of different diameters, rather poorly visible. Ornamentation of apocolpi and mesocolpi similar.

Fig. 2. *Sorbus aucuparia* subsp. *aucuparia*. A – (LM). Outline in equatorial view; 2 ectocolpi and exine structure visible ( $\times 1000$ ); B – (LM). Outline in polar view; exine structure, apocolpium and fragments of 3 ectocolpi visible ( $\times 1000$ ); C – (SEM). Outline in equatorial view; 2 ectocolpi and striate sculpture of grain visible ( $\times 2000$ ); white bare corresponds to 10  $\mu\text{m}$ ; D – (SEM). Outline in polar view; striate sculpture of grain, apocolpium and fragments of 3 ectocolpi visible ( $\times 2000$ ); E – (SEM). Outline in equatorial view; ectocolpus and striate sculpture of grain visible ( $\times 2000$ ); F – (SEM). Close-up of striate sculpture of grain; striae, muri and perforations visible ( $\times 8000$ ); white bare corresponds to 1  $\mu\text{m}$ .



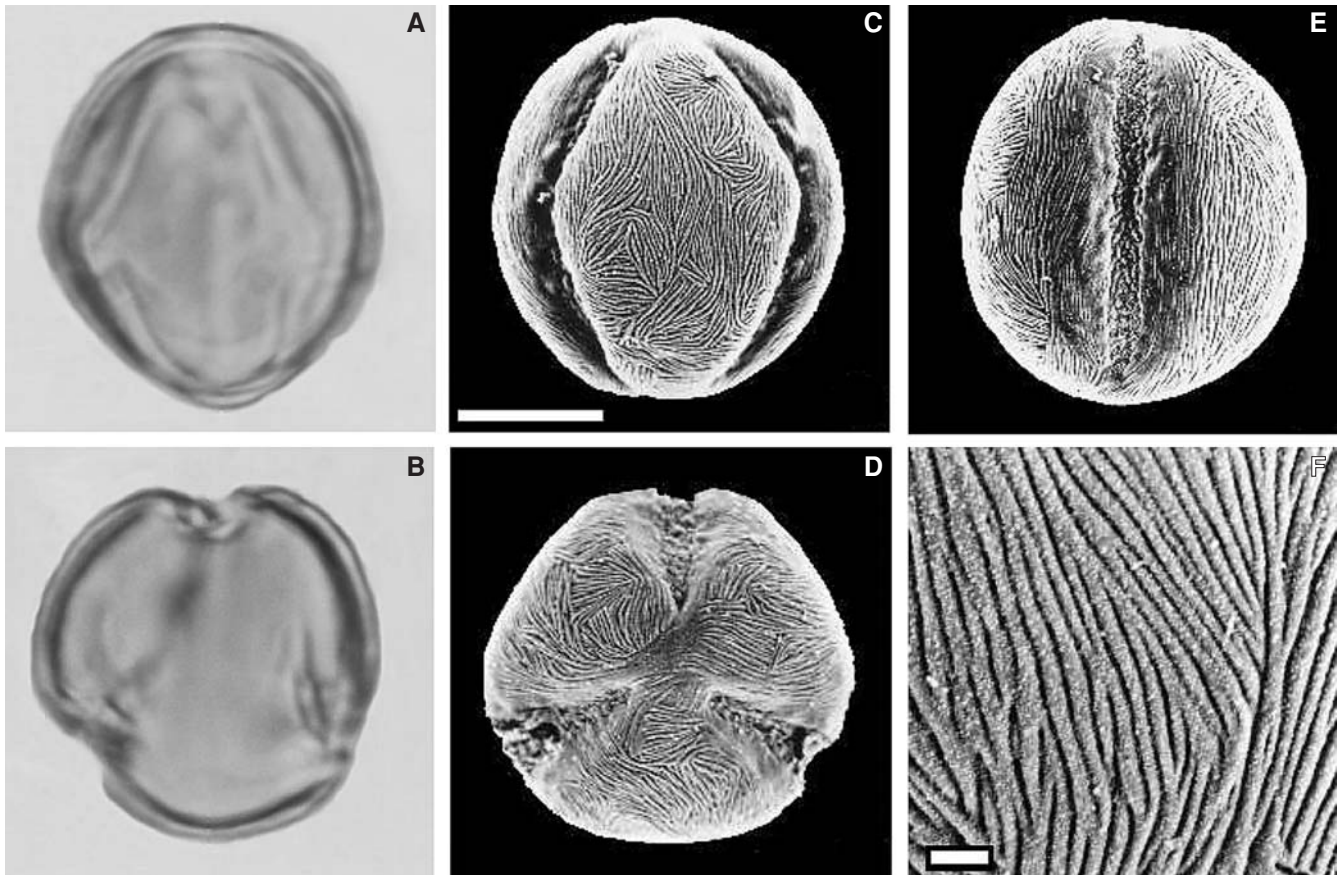
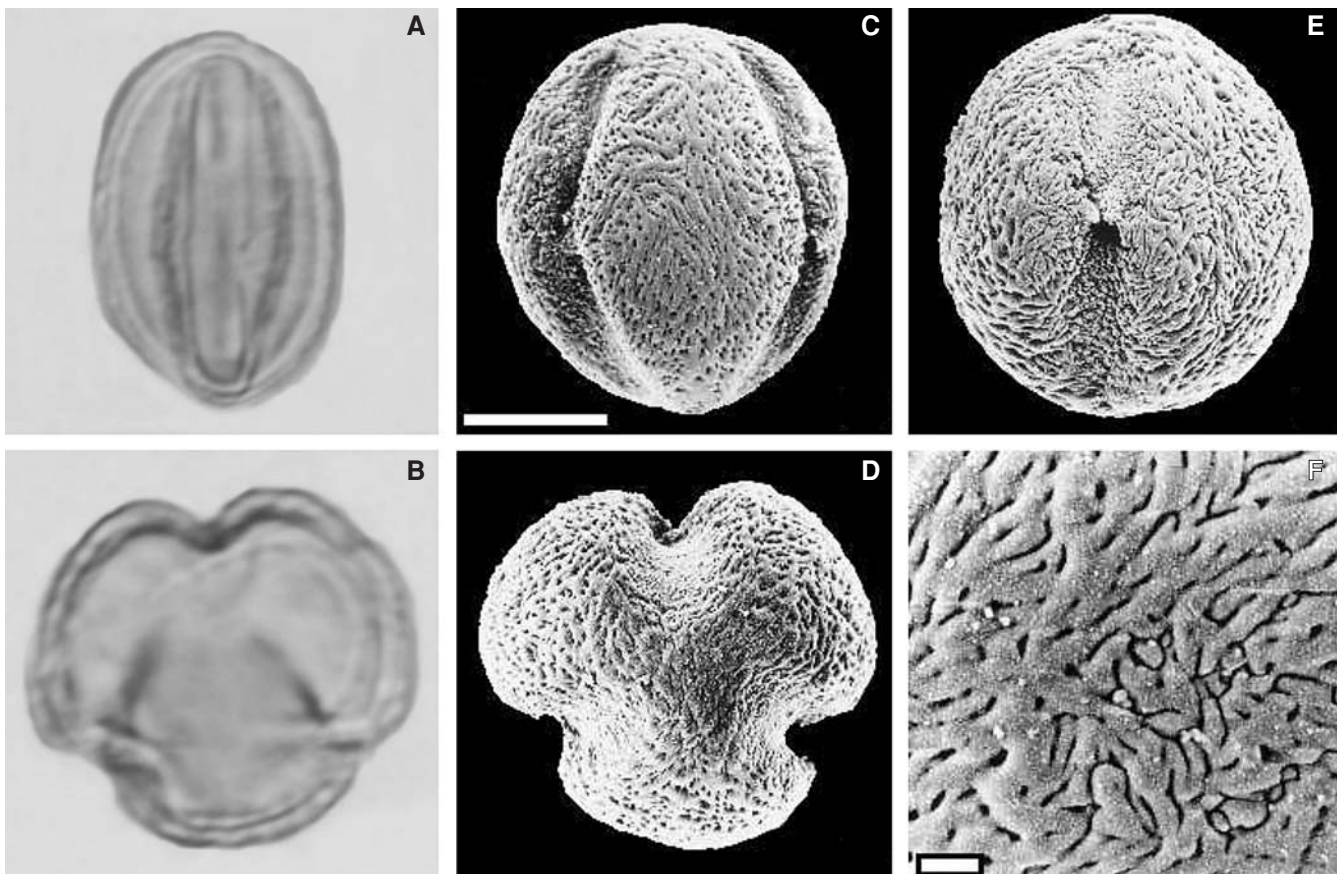


Fig. 4. *Sorbus chamaemespilus*. A – (LM). Outline in equatorial view; 2 ectocolpi and exine structure visible ( $\times 1000$ ); B – (LM). Outline in polar view; exine structure, apocolpium and fragments of 3 ectocolpi visible ( $\times 1000$ ); C – (SEM). Outline in equatorial view; 2 ectocolpi and striate sculpture of grain visible ( $\times 2000$ ); white bare corresponds to 10  $\mu\text{m}$ ; D – (SEM). Outline in polar view; striate sculpture of grain, apocolpium and fragments of 3 ectocolpi visible ( $\times 2000$ ); E – (SEM). Outline in equatorial view; ectocolpus and striate sculpture of grain visible ( $\times 2000$ ); F – (SEM). Close-up of striate sculpture of grain; striae, muri and perforations visible ( $\times 8000$ ); white bare corresponds to 1  $\mu\text{m}$ .



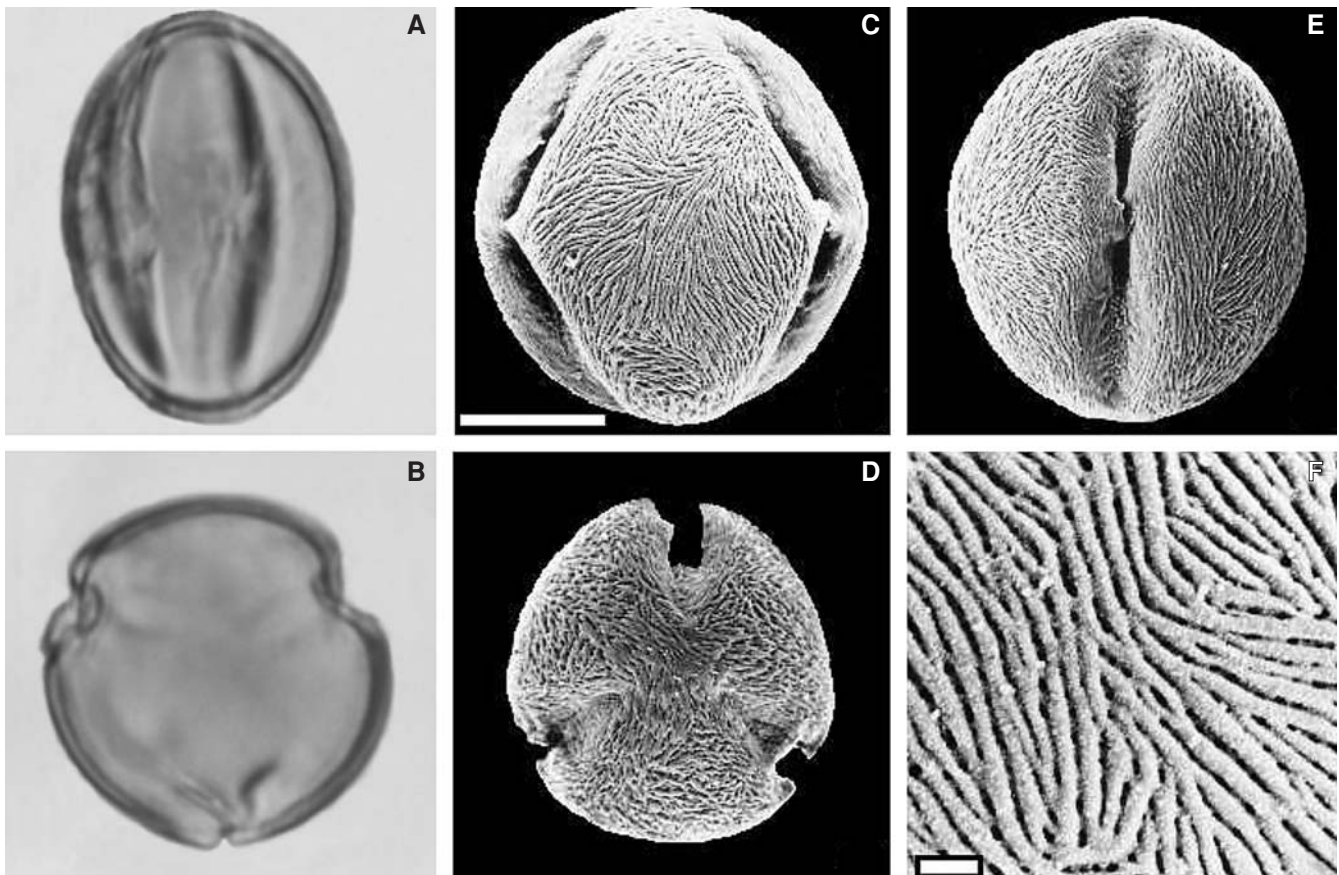


Fig. 6. *Sorbus torminalis*. A – (LM). Outline in equatorial view; 2 ectocolpi and exine structure visible ( $\times 1000$ ); B – (LM). Outline in polar view; exine structure, apocolpium and fragments of 3 ectocolpi visible ( $\times 1000$ ); C – (SEM). Outline in equatorial view; 2 ectocolpi and striate sculpture of grain visible ( $\times 2000$ ); white bare corresponds to 10  $\mu\text{m}$ ; D – (SEM). Outline in polar view; striate sculpture of grain, apocolpium and fragments of 3 ectocolpi visible ( $\times 2000$ ); E – (SEM). Outline in equatorial view; ectocolpus and striate sculpture of grain visible ( $\times 2000$ ); F – (SEM). Close-up of striate sculpture of grain; striae, muri and perforations visible ( $\times 8000$ ); white bare corresponds to 1  $\mu\text{m}$ .

#### KEY TO POLISH SPECIES OF *SORBUS*, BASED ON POLLEN MORPHOLOGY

1. Intermediate sculpture between striate and rugulate.  
Muri markedly flattened, wide, short irregularly arranged..... *S. intermedia*  
1\*. Striate sculpture. Muri cylindrical, narrow, elongated, regularly arranged ..... 2.
2. Grains small or medium size,  
usually polar axis (18.0-)23.6-24.6(-28.8)  $\mu\text{m}$  long;  
only 3-zonocolporate pollen grains..... *S. aucuparia*  
2\*. Grains of medium size, rarely small, usually polar axis (21.6-)28.1-32.3(-45.0)  $\mu\text{m}$ ;  
besides 3-zonocolporate pollen grains,  
sometimes 4-zonocolporate ones observed..... 3.
3. Muri  $\pm$  straight, most often bifurcately forked ..... *S. aria*  
3\*. Muri forming numerous curves..... 4.
4. Ectexine and endexine  
of equal thickness ..... *S. chamaespilus*  
4\*. Ectexine thicker than endexine ..... *S. torminalis*

#### DISCUSSION

Moore and others (1991), basing on endoaperture structure, sculpture, shape and size of grains, divided the investigated species of *Sorbus* (together with other representatives of Maloideae subfamily) into two groups. One of those among other taxa included *S. aucuparia* and *S. torminalis*, the second one – *S. aria* and poliploids of genus (with *S. intermedia* too). Present investigations have not confirmed correctness of such classification. However, striate sculpture is a common feature in *S. aucuparia* and *S. torminalis*, both species differ in structure details of this ornamentation. Exine surface of *S. aucuparia* with the  $\pm$  rectilinearly arranged muri rather resembles the sculpture of *S. aria*, than of ornamentation of *S. torminalis*, with curved muri.

In turn, in accordance with the systematic classification of Phipps and others (1990), *Sorbus aria* and *S. intermedia* belong to the *Aria* subgenus. The present study reveals completely different types of exine sculpture in those species: striatae type characteristic for grains of *S. aria*, as mentioned above with the features similar ornamentation

Fig. 5. *Sorbus intermedia*. A – (LM). Outline in equatorial view; 2 ectocolpi and exine structure visible ( $\times 1000$ ); B – (LM). Outline in polar view; exine structure, apocolpium and fragments of 3 ectocolpi visible ( $\times 1000$ ); C – (SEM). Outline in equatorial view; 2 ectocolpi and intermediate sculpture of grain visible ( $\times 2000$ ); white bare corresponds to 10  $\mu\text{m}$ ; D – (SEM). Outline in polar view; intermediate sculpture of grain, apocolpium and fragments of 3 ectocolpi visible ( $\times 2000$ ); E – (SEM). Outline in equatorial view; ectocolpus and intermediate sculpture of grain visible ( $\times 2000$ ); F – (SEM). Close-up of intermediate sculpture of grain; irregular striae and muri visible ( $\times 8000$ ); white bare corresponds to 1  $\mu\text{m}$ .



of *S. aucuparia* and intermediate type observed exclusively in grains of *S. intermedia*. Jankun (1993) ascertained *S. intermedia* to be a tetraploid hybrid, consisting of two genomes of *S. aria*, one of *S. aucuparia* and one of *S. torminalis*. Considering the character of exine ornamentation, no evidence of relationship among *S. intermedia* and three other species, from which it probably has been derived, has been found.

In the current study no significant differences in shape of grains among the analysed *Sorbus* species have been noted. All taxa had  $\pm$  elongated polar axis and only 1/5 pollen grains of *S. chamaemespilus* were spheroidal. Whereas, in accordance with Moore's and others observations (1991), *S. aucuparia* and *S. torminalis* were narrowly elliptic, unlike the group with *S. aria*, having only slightly longer than broad pollen grains. The authors of this paper have not confirmed Eide's observation (1981) either, who noted that pollen grains of *S. aucuparia* are more oblate than other *Sorbus* species. However, it is necessary to remember that the shape of grains considerably depends on the method of pollen preparation.

Generally, pollen size is thought to be a diagnostic feature of little reliability. Such an opinion results from the variability of pollen grains of Rosaceae (Moore et al. 1991) and from the method of acetolysis (Reitsma 1969). Nevertheless, comparing our results with the data from palynological literature, it is still possible to ascertain some regularities. Pollen grains of *S. intermedia* were usually larger than the grains of other observed species (from  $\pm 2$  to  $\pm 8$   $\mu\text{m}$ ). Similar value of grain dimensions of this taxon was noted by Pragłowski (1962). It confirms Moore's and others' observation (l.c.), that grains of polyploid species are used to be greater than those of diploids. In turn, pollen grains of *S. aucuparia* (both subsp. *aucuparia* and *glabrata*) were small, with the polar axis no longer than 25  $\mu\text{m}$ . Almost the same results for this species were obtained by Eide (1981), Boyd and Dickson (1986) and Moore and others (l. c.). Length of polar axis (P) of grains of this taxon noted by Pragłowski (1962) and Stachurska and others (1973), was  $\pm 2$   $\mu\text{m}$  greater.

The aperture structure of pollen grains of the described species may be a controversial question too. For example the authors of the current study did not observe star-shaped endoapertures, according to Moore and others (1991), being characteristic features of grains of *S. aucuparia* and *S. torminalis*. Such a type of endoaperture has not been mentioned in any other palynological elaboration of genus *Sorbus*.

## CONCLUSIONS

Pollen morphology of the investigated species of *Sorbus* corresponds with their systematic classification. It is relatively easy to separate pollen grains of the following subgenera: *Sorbus*, *Chamaemespilus* and *Torminaria*. Only subgenus *Aria* includes grains of different morphology, and therefore it is impossible to determine the diagnostic features of this subgenus. Pollen morphology does not confirm a close relationship between *S. aria* and *S. intermedia*.

The presented study allowed to determine some diagnostic features of pollen grains of each investigated species. Type of sculpture, length of polar axis, number of ectocolpi, ratio of ectexine to endexine thickness are the most im-

portant ones. It is possible to distinguish the pollen grains of all the analysed native species, but only using SEM. However, there are no important differences in pollen morphology between the subspecies of *Sorbus aucuparia*.

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