A. M. HAYRAPETYAN

POLLEN OF TREES AND SHRUBS OF ARMENIA (ANGIOSPERMAE. XI. *Rosaceae.* Genus *Pyrus*)

Pollen morphology of 18 species of Armenian trees from the genus *Pyrus* L. (family *Rosaceae* Juss.) was studied using light microscopy (LM) and scanning electron microscopy (SEM).

Pollen morphology, trees, LM, SEM

Հայրապետյան Ա. Մ. Հայաստանի ծառերի և թփերի ներկայացուցիչների ծաղկափոշու ուսումնասիրությունը (Angiospermae. XI. *Rosaceae*. *Pyrus* ցեղը): Լուսային (ԼՄ) և սկաներային էլեկտրոնային (ՍԷՄ) մանրադիտակների օգնությամբ ուսումնասիրվել է Հայաստանի դենդրոֆլորայի *Pyrus* L. (*Rosaceae* Juss. ընտ.) ցեղին պատկանող 18 տեսակների ծաղկափոշու մորֆոլոգիան:

Ծաղկափոշու մորֆոլոգիա, դենդրոֆլորա, ԼՄ, ՍԷՄ

Айрапетян А. М. Морфология пыльцы деревьев и кустарников Армении (Angiospermae. XI. *Rosaceae.* Род *Pyrus*). С помощью светового (СМ) и сканирующего электронного (СЭМ) микроскопов изучены особенности морфологии пыльцы 18 видов рода *Pyrus* L. флоры Армении (сем. *Rosaceae* Juss.).

Морфология пыльцы, деревья, СМ, СЭМ

The results of investigation of pollen morphology of 18 representatives of the genus *Pyrus* L. (family *Rosaceae* Juss.) of Armenian flora are presented.

MATERIAL AND METHODS

The material studied was obtained from the herbarium of the Institute of Botany after A. Takhtajyan NAS Republic of Armenia, Yerevan (ERE), Botanical Institute, St.-Petersbueg, Russia (LE), Herbarium of cultivated plants and their wild relatives and weeds of N. I. Vavilov All-Russian Research Institute of Plant Industry (WIR), as well as from living plants from the collection of the "Flora and Vegetation of Armenia" exposition plot of the Institute of Botany after A. Takhtajyan NAS RA

The descriptions of the pollen grains with the help of the light microscope are based on the grains stained with basic fuchsine (Smoljaninova, Golubkova, 1950), and also on the simplified acetolysis method (Avetisyan, 1950). Pollen grains for scanning electron microscopes (Jeol, JSM-35; Jeol, JSM-6390) were vacuum sputter-coated with gold and investigated in the laboratory of electronic microscopy of Botanical Institute, St.- Petersburg, Russia.

The palynological terminology used in our study mainly follows Erdtman (1952), Kuprianova and Alyoshina (1967, 1972), Punt et al. (2007) and Hesse et al. (2009).

Ten pollen grains were examined and measured for each investigated specimen.

Specimens examined (species names are given in accordance with The Plant List): *Pyrus caucasica* Fed.: АрмССР, Апаранский район, село Бужакан х монастырь Тегеняц. Leg. Я. Мулкиджанян [Armenian SSR, Aparan region, Buzhakan village x Tegenyats monastery. Leg. J. Mulkidzhanyan] (ERE, 87256); АрмССР, Кафанский район, Шишкерт. Leg. Ц. Давтян [ArmSSR, Kafan region, Shishkert. Leg. Ts. Davtyan] (ERE, 93829); Армения, Ереванский Ботанический сад, участок "Армянской флоры". Leg. Ж. Акопян (личные сборы) [Armenia, Yerevan Botanical Garden, plot of the "Armenian flora". Leg. J. Akopian (personal collections); Daračičag. Leg. Kusmin (ERE, 21054]; *P. communis* L.: Армения, Ереван, в саду. Leg. E. Gabrielyian [Armenia, Yerevan, in the garden. Leg. E. Gabrielyian] (ERE, 165682); Кавказ, Большой Кавказский хребет, город Железноводск, в буково-грабовом лесу по склону горы Железной, N 70 [Caucasus, Greater Caucasus Range, Zheleznovodsk city, in a beech-hornbeam forest on the slope of the Mount Zheleznaya, N 70] (LE); *P. x daralagezi* Mulk.: Armenia, Vayots dzor, Herher river gorge. Leg. H. Ter-Voskanyan, J. Akopian. 29.04.2012. N M12-35. (ERE); *P. elata* Rubtzov: Армения, Мегринский район, село Личк, 1900 м н.у.м. Leg. Рубцов [Armenia, Meghri region, Lichk village, 1900 m above sea level. Leg. Rubtsov] (ВИР); *P. fedorovii* Kuth.; Карабахлярский район, южный макросклон горы Еранос, 1500 м н.у.м. Leg. А. Ахвердов, Н. Мирзоева [Karabakhlyar region, southern macro slope of Mount Eranos,

1500 m above sea level. Leg. A. Akhverdov, N. Mirzoeva] (ERE, 185796); *P. georgica* Kuth.: Армения, Ереванский Ботанический сад, участок ”Армянской флоры“. Leg. Ж. Акопян (личные сборы) [Armenia, Yerevan Botanical Garden, plot of the “Armenian flora”. Leg. J. Akopian (personal collections)]; АрмССР, Ноемберянский район, окрестности станции Айрум, правый борт реки Дебет, дубово-грабовый лес. Leg. Р. Карапетян, Ш. Асланян [ArmSSR, Noyemberyan region, vicinity of the Ayrum station, right side of Debet river, oak-hornbeam forest. Leg. R. Karapetyan, Sh. Aslanyan] (ERE, 66594); *P. gergerana* Gladkova: Армения, по старой дороге к Джермуку. Leg. H. Ter-Voskanyan, J. Akopian. 29.04.2012. N M12-26 [Armenia, along the old road to Jermuk. N M12-26. Leg. H. Ter-Voskanyan, J. Akopian. 04.29.2012. N M12-26] (ERE); *P. hajastana* Mulk.: АрмССР, Котайкский район, окрестности монастыря Гегерад, правый берег реки Азат. Leg. А. Тахтаджян, Э. Габриэлян, В. Аветисян [ArmSSR, Kotayk region, environs of Gegerad monastery, right bank of the Azat river. Leg. A. Takhtajyan, E. Gabrielyan, V. Avetisyan] (ERE, 72842); АрмССР, ущелье реки Азат, правый борт, близ монастыря Гегард, южный каменистый склон. Leg. J. Mulkijanian [ArmSSR, gorge of the river Azat, right side, near Geghard monastery, southern rocky slope. Leg. J. Mulkijanian] (ERE, 144620); *P. medvedevii* Rubtzov: Армения, Ереванский Ботанический сад, участок ”Армянской флоры“. Leg. Ж. Акопян (личные сборы) [Armenia, Yerevan Botanical Garden, plot of the “Armenian flora”. Leg. J. Akopian (personal collections)]; *P. oxyprion* Woronow: Daralaghez, Чайкенд, пояс арчевого редколесья. Leg. A. Takhtadzian [Daralaghez, Chaykend, juniper forest belt. Leg. A. Takhtadzian] (ERE, 22402); *P. raddeana* Woronow: АрмССР, село Неркин Анд, лес в окрестностях села. Leg. Ц. Давтян [Armenian SSR, Nerkin Andes village, forest in the vicinity of the village. Leg. Ts. Davtyan] (ERE, 89681); АрмССР, село Неркин Анд, лес в окрестностях села. Leg. Ц. Давтян [Armenian SSR, Nerkin Andes village, forest in the vicinity of the village. Leg. Ts. Davtyan] (ERE, 89682); *P. salicifolia* Pall.: Армения, Ереванский Ботанический сад, участок ”Армянской флоры“. 13.04.2001. Leg. A. Айрапетян (личные сборы) [Armenia, Yerevan Botanical Garden, plot of the “Armenian flora”. 13.04.2001. Leg. A. Hayrapetyan (personal collections)]; Армения, Ереванский Ботанический сад, участок “Армянской флоры”. 23.04.2014. Leg. Ж. Акопян (личные сборы)) [Armenia, Yerevan Botanical Garden, plot of the “Armenian flora”. 23.04.2014. Leg. J. Akopian (personal collections)]; АрмССР, массив горы Еранос, ущелье. Leg. Э. Габриэлян, В. Манакян [Armenian SSR, Mount Yeranos massif, gorge. Leg. E. Gabrielyan, V. Manakyan] (ERE, 104713); *P. sosnovskyi* Fed.: АрмССР, Ереван, Ботанический сад, экспозиция растений отдела Флоры. Leg. Я. Мулкиджанян [Armenian SSR, Yerevan, Botanical Garden, plants exposition of the Flora Department. Leg. J. Mulkidzhanyan] (ERE, 103049); Армения, Ереванский Ботанический сад, участок “Армянской флоры”. Leg. Ж. Акопян (личные сборы)) [Armenia, Yerevan Botanical Garden, plot of the “Armenian flora”. Leg. J. Akopian (personal collections)]; Armenia, Yerevan, Bot. garden, “Flora and vegetation of Armenia”. Leg. J. Akopian (ERE 177374); *P. syriaca* Boiss.: АрмССР, к ю.-з. от села Гущи. Leg. Ш. Асланян, Р. Карапетян [ArmSSR, south-west from the village Gushchi. Leg. Sh. Aslanyan, R. Karapetyan] (ERE, 35119); *P. tamamschiannae* Fed.: Армения, Ереванский Ботанический сад, участок “Армянской флоры”. 23.04.2014г. Leg. Ж. Акопян (личные сборы) [Armenia, Yerevan Botanical Garden, plot of the “Armenian flora”. Leg. J. Akopian (personal collections)]; *P. theodorovii* Mulk.: АрмССР, Абовянский район, Гохт х Гегард, ближе к Гехарту, по тропе, южный склон. Leg. Я. Мулкиджанян [ArmSSR, Abovyan region, Goght x Geghard, closer to Geghart, along the trail, southern slope. Leg. Y. Mulkidzhanyan] (ERE, 75730); АрмССР, Веди х Гелайсор, полынные полупустыни. Leg. Я. Мулкиджанян [ArmSSR, Vedi x Gelaysor, wormwood semideserts. Leg. J. Mulkidzhanyan] (ERE, 91871); Armenia, Kotayk, between Narek and Gelaysor. Leg. H. Ter-Voskanyan, J. Akopian. 12.04.2013. N 13-08 (ERE); *P. voronovii* Rubtzov: Армения, Мегринский район, селение Таштун, 1950 м н.у.м. Leg. Рубцов [Armenia, Meghri region, Tashtun village, 1950 m above sea level. Leg. Rubtsov] (WIR); *P. zangezura* Maleev: АрмССР, Мегринский район, восточные склоны горы Союх, 2300 м н.у.м. Leg. А. Долуханов [ArmSSR, Meghri region, eastern slopes of Sojukh mountain,

2300 m above sea level. Leg. A. Dolukhanov] (ERE, 66615); АрмССР, Зангезур, Кафанский район, Шишкерт, дубово-грабовый лес. Leg. Ц. Давтян [ArmSSR, Zangezur, Kafan region, Shishkert, oak-hornbeam forest. Leg. Ts. Davtyan] (ERE, 89698).

RESULTS

Pyrus L.

Avetisyan, Manukyan, 1958; Kuprianova, Alyoshina, 1978; Westwood, Challice, 1978; Kocon Muszynski, 1982; Valdes et al., 1987; Fang, Yi-Xuan, 1990; Jones et al., 1995; Tokarev; 2004; Chakass et al., 2008; Zamani et al., 2010; Karpovich et al., 2015; Antkowiak et al., 2016; Ghosh, Saha, 2017; Karimi et al., 2019 (plate 1, phototables I-VIII)

Trees or shrubs.The number of species in Armenia – 32 (Akopian, 2007).

Pollen grains 3(4)-zonocolp-poroidate (porate), from oblong to oblate, outline in polar view rounded-3(4)-angular or rounded-3(4)-lobed; polar axis 12,8-27,8 μm, equatorial diameter 12,5-25,1 μm. Colpi sometimes geniculate, from wide to narrow, sometimes almost slit-like, long, usually with evenly thickened edges and with rounded or pointed, sometimes with anastomosing ends, i. e. synaperturate (*P. caucasica* Fed., *P. communis* L., *P. x daralagezi* Mulk., *P. theodorovii* Mulk.) or spiraperturate *(P. communis*); colpus membrane ornamentation from almost smooth to densely granular; apocolpium diameter 2,5-8,3 μm, mesocolpium width 11,7-20,3 μm. Due to the presence of the geniculum or the convergence of the colpi edges in the equator, pores as a rule are weakly expressed, often with uneven edges. Exine 1,25-1,9 μm, columellae thin, separate, with rounded ends. Exine ornamentation is represented with variations of striate sculpture, sometimes finely plicate or scabrate (LM), exine ornamentation is represented with variations of striate sculpture (SEM).

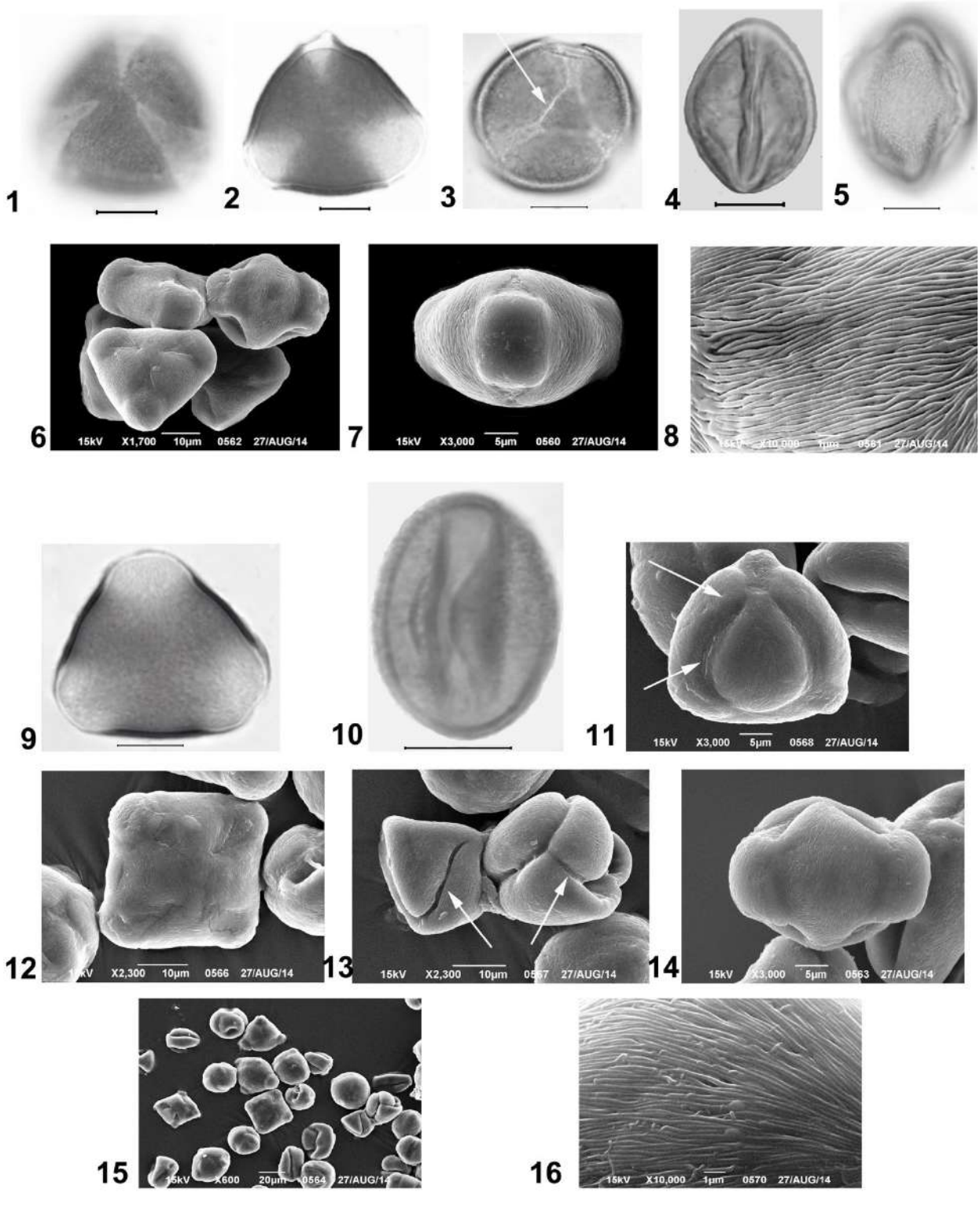
Plate 1. Palynomorphological characteristics of some species of the genus *Pyrus* L.

Species	Pollen grain size (P x E)[1] (μm)	Colpus		Exine ornamentation	
		apocolpium diameter (μm)	mesocolpium width (μm)	LM	SEM
Pyrus caucasica Fed.	18,2-24,4 x 17,8-24,2	5,3-8,2 (sometimes synaperturate)	16,7-20,3	finely striate, striae branched	finely striate, striae branched
P. communis L.	18,1-20,5 x 15,5-24,1	7,5-8,3 (sometimes synaperturate or spiraperturate)	14,5-20,2	finely striate	finely striate
P. x daralagezi Mulk.	18,3-23,5 x 15,3-19,2	2,5-5,6 (sometimes synaperturate)	12,5-14,3	scabrate	sinuously striate
P. elata Rubtzov	24,1-27,1 x 18,1-21,7	5,5-6,2	15,3-17,2	striate, striae short	striate, striae short, often gathered in groups

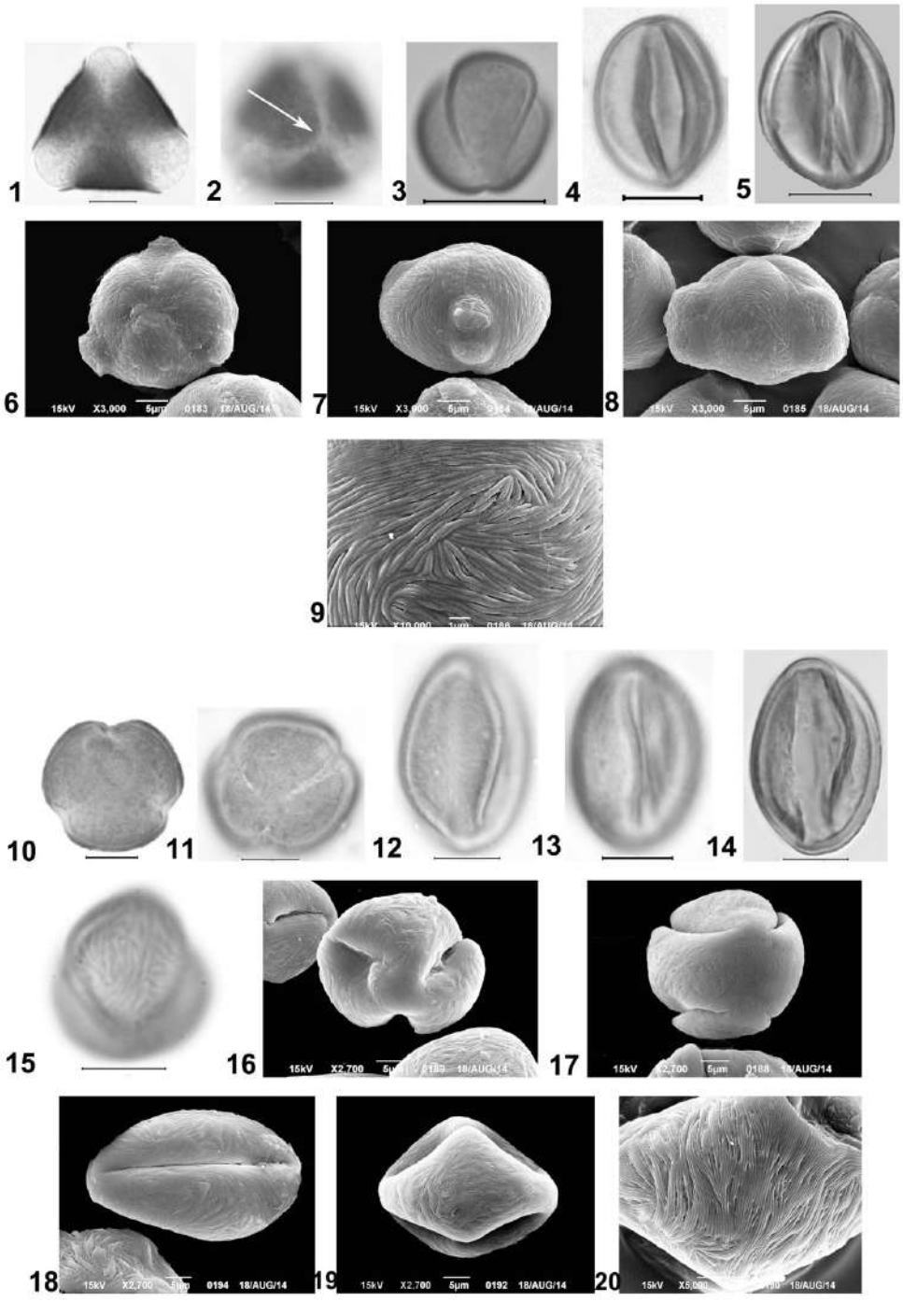
1 P – polar axis, E – equatorial diameter

Plate 1 (continuation)

P. fedorovii Kuth.	15,8-22,7 x 12,8-17,8	2,8-3,5	11,7-15,1	plicate-striate	striate, striae short
P. georgica Kuth.	14,1-22,1 x 12,5-17,2	4,2-5,4	12,8-14,3	striate, striae short	perforate-sinuously striate
P. gergerana Gladkova	12,8-18,9 x 17,4-21,0	4,7-5,1	14,4-15,5	reticulate-striate	sinuously striate, striae short
P. hajastana Mulk.	18,5-23,3 x 17,9-22,5	4,5-5,1	12,8-15,6	reticulate-striate	striate, striae, often branched
P. medvedevii Rubtzov	17,8-24,3 x 17,4-23,7	6,5-7,3	14,1-18,9	striate, reticulate-striate	sinuously striate, striae short
P. oxyprion Woronow	22,2-24,9 x 16,5-17,1	4,5-5,4	12,3-14,1	striate, striae short	finely striate, reticulate-striate
P. raddeana Woronow	18,2-27,1 x 22,5-24,5	4,4-5,6	12,8-16,1	finely plicate	perforate -finely striate
P. salicifolia Pall.	20,4-23,2 x 19,1-20,2	5,7-7,2	17,7-19,4	reticulate-striate	perforate-finely striate
P. sosnovskyi Fed.	23,4-27,8 x 17,4-25,1	4,2-5,0	15,5-18,2	striate, striae short	sinuously finely striate
P. syriaca Boiss.	23,1-24,7 x 17,4-23,2	7,5-8,2	14,5-15,2	reticulate-striate	perforate-finely striate
P. tamamschiannae Fed.	17,6-13,4 x 18,5-22,5	4,6-5,1	12,8-18,2	reticulate-striate	sinuously striate, striae short
P. theodorovii Mulk.	15,9-23,8 x 16,1-20,4	4,5-5,0 (sometimes synaperturate)	12,2-12,9	reticulate-striate	perforate - finely striate
P. voronovii Rubtzov	18,2-21,4 x 18,7-23,8	4,5-5,3	12,9-15,3	finely striate	sinuously finely striate
P. zangezura Maleev	21,2-27,4 x 17,2-23,5	3,5-5,1	12,8-14,9	finely striate	plicate - finely striate

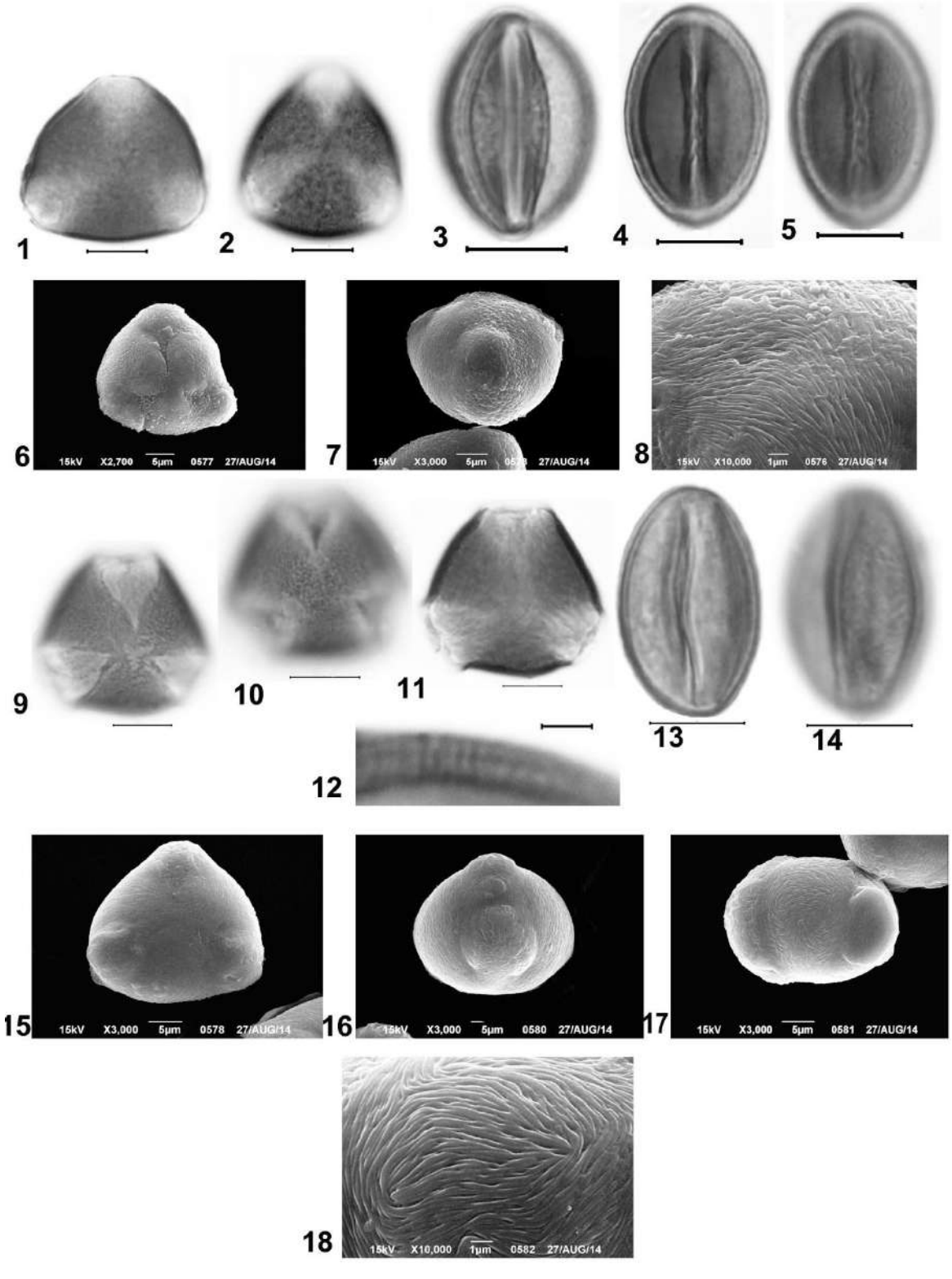


Phototable I. Pollen grains of some species of the genus *Pyrus* L.
1-8 – *Pyrus caucasica* Fed.: 1-3 – pollen grains from polar view (3 – synaperturate, marked by arrow), 4-5 – pollen grains from equatorial view (3 – aperture, 4 – mesocolpium) (LM), 6 – pollen grains from polar and equatorial view, 7 – pollen grain from equatorial view (aperture), 8 – exine ornamentation (SEM); 9-16 – *P. communis* L.: 9 – pollen grain from polar view, 10 – pollen grain from equatorial view (LM), 11 – pollen grain from polar view (synaperturate, marked by arrows), 12 – 4-aperturate pollen grain from polar view, 13 – spiraperturate pollen grains (marked by arrows), 14 – pollen grain from equatorial view (mesocolpium), 15 – pollen group, 16 – exine ornamentation (SEM) (scale bar: 1-5, 9-10 – 10 µm)

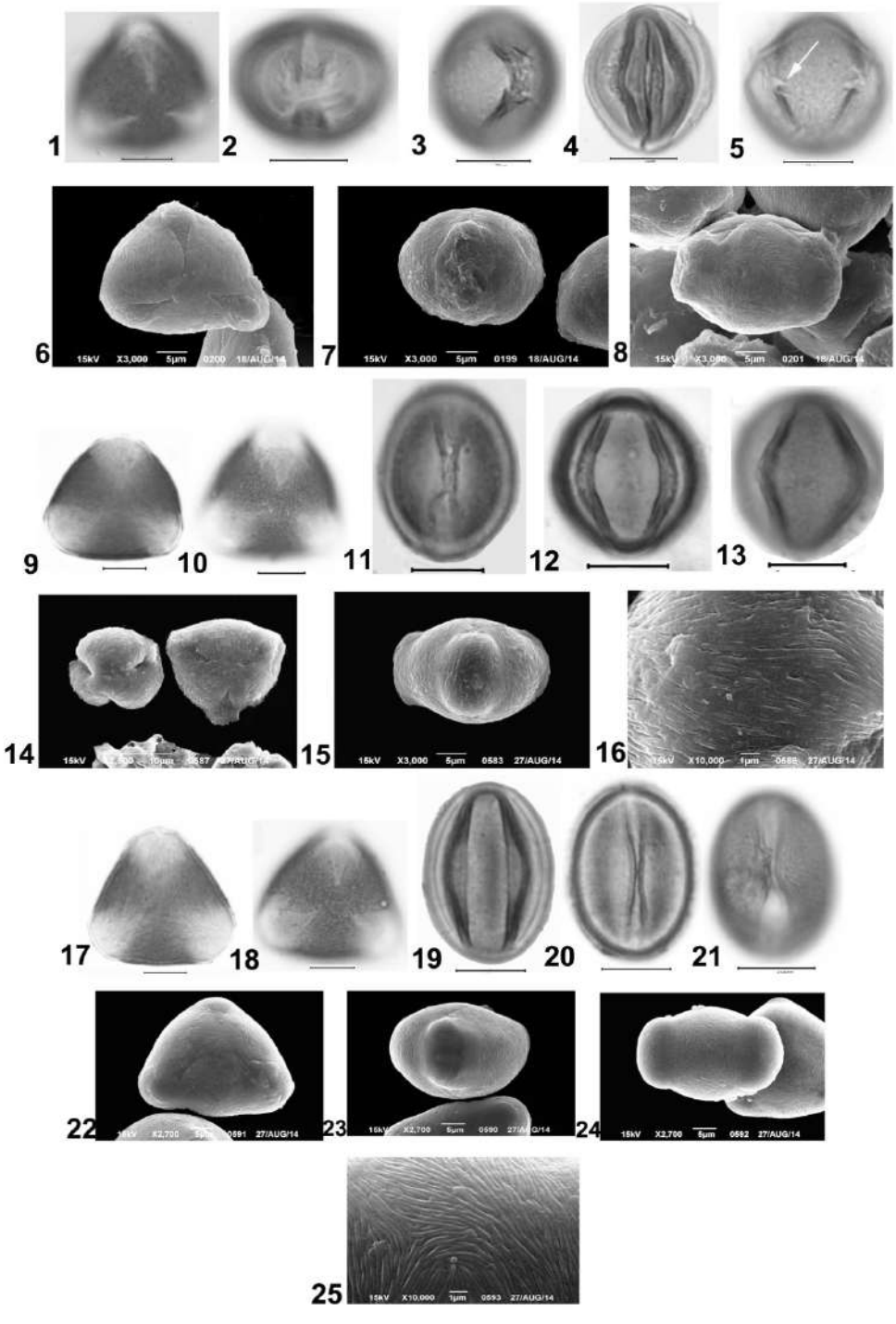


Phototable II. Pollen grains of some species of the genus *Pyrus* L.

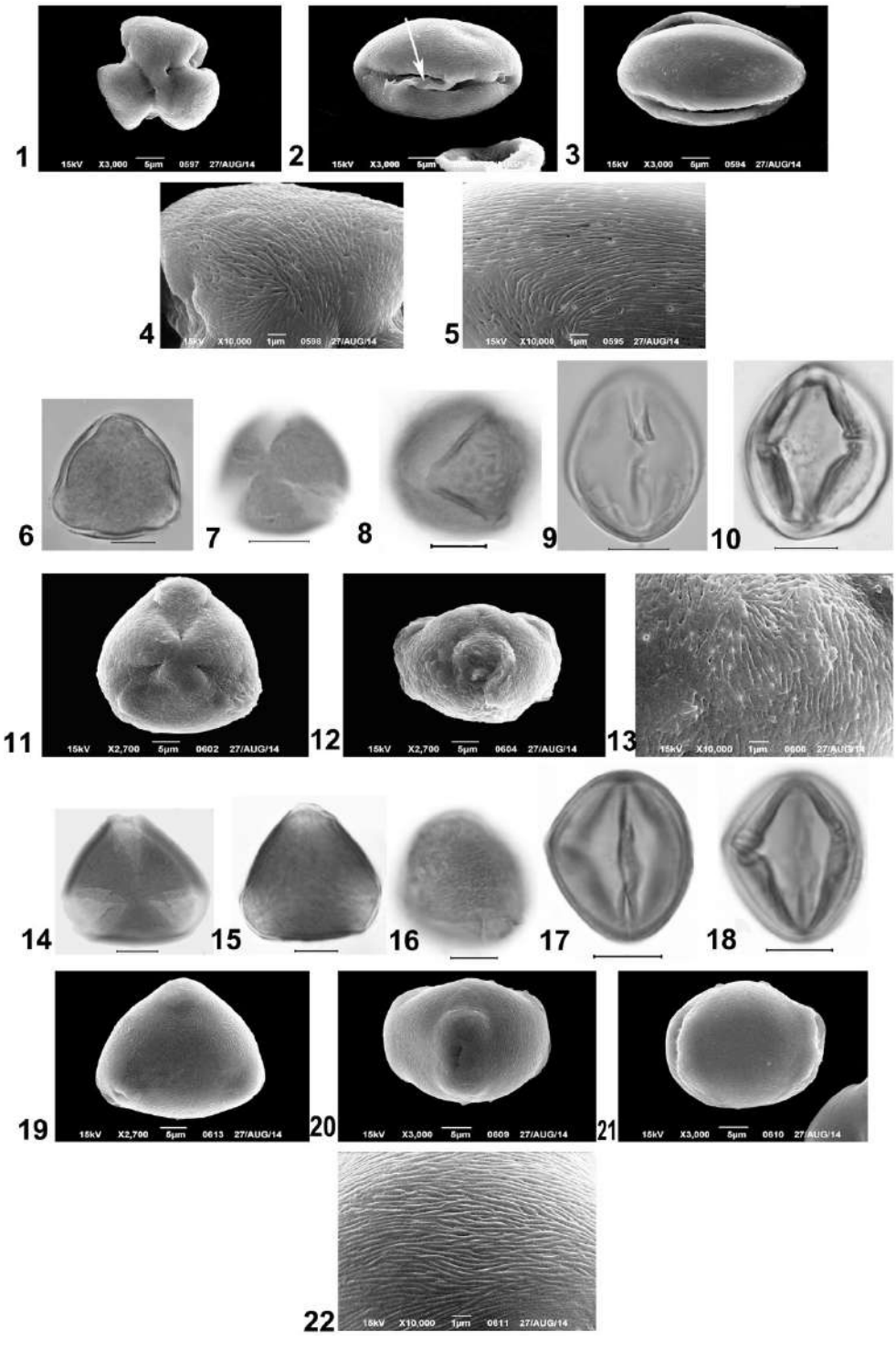
1-9 – *P. x daralagezi* Mulk.: 1-2 – pollen grains from polar view (2 – synaperturate, marked by arrow), 3 – pollen grain from semipolar view, 4-5 – pollen grain from equatorial view (aperture) (LM), 6 – pollen grain from polar view, 7-8 – pollen grains from equatorial view (7 – aperture, 8 – mesocolpium), 9 – exine ornamentation (SEM); 10-20 – *P. elata* Rubtzov: 10-11 – pollen grains from polar view, 12-14 – pollen grains from equatorial view (12, 14 – mesocolpium, 13 – aperture), 15 – pollen grain from semipolar view (ornamentation) (LM), 16-17 – pollen grains from polar view (16 – 3-aperturate, 17 – 4-aperturate), 18-19 – pollen grains from equatorial view (18 – aperture, 19 – mesocolpium), 20 – exine ornamentation (SEM) (scale bar: 1-5, 10-15 – 10 μm)



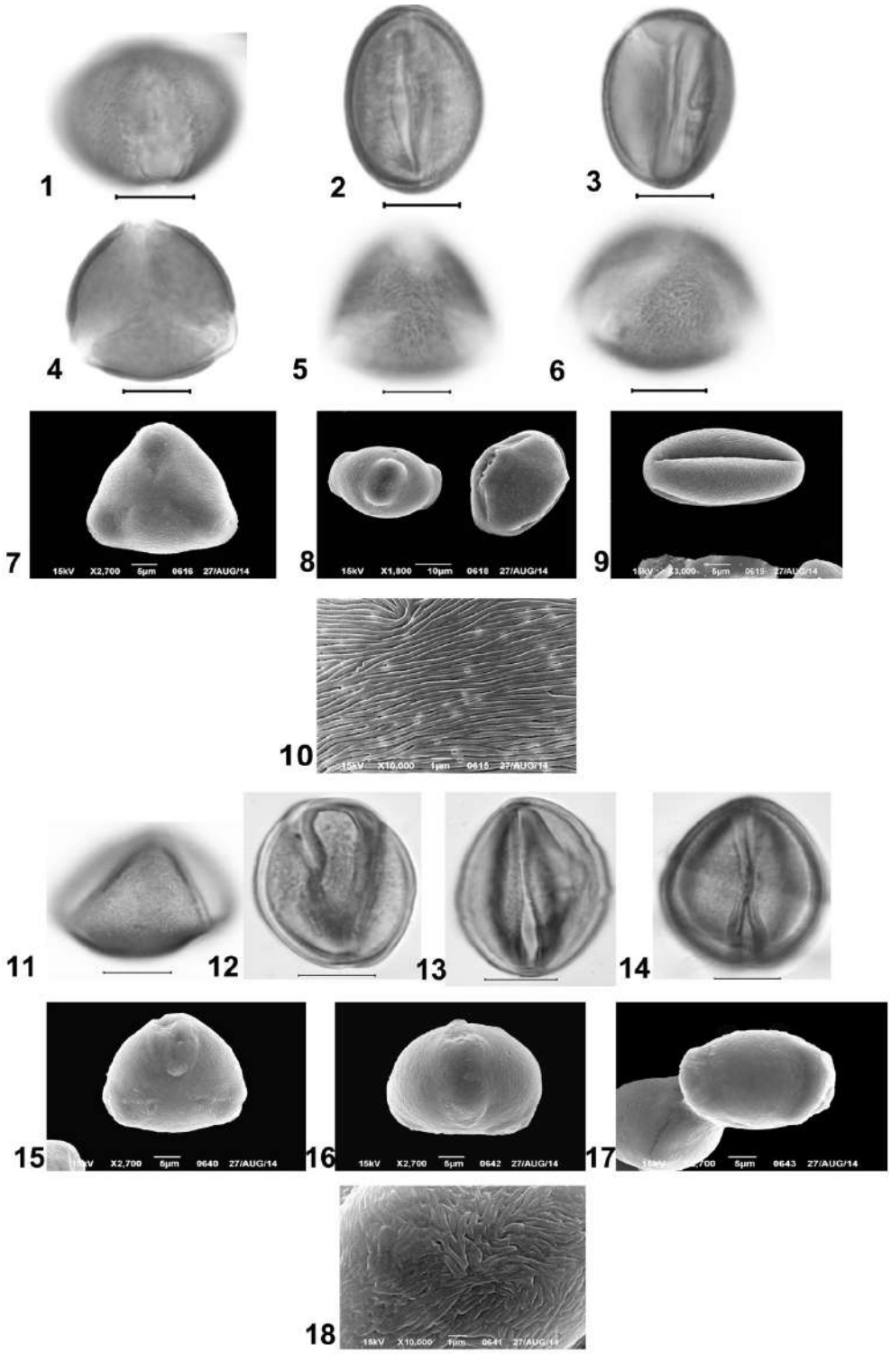
Phototable III. Pollen grains of some species of the genus *Pyrus* L.
1-8 – *P. fedorovii* Kuth.: 1-2 – pollen grains from polar view, 3-5 – pollen grains from equatorial view (aperture) (LM), 6 – pollen grain from polar view, 7 – pollen grain from equatorial view (aperture), 8 – exine ornamentation (SEM); 9-18 – *P. georgica* Kuth.: 9-11 – pollen grains from polar view, 12 – exine, 13-14 – pollen grains from equatorial view (aperture) (LM), 15 – pollen grain from polar view, 16-17 – pollen grains from equatorial view (16 – aperture, 17 – mesocolpium), 18 – exine ornamentation (SEM) (scale bar: 1-5, 9-11, 13-14 – 10 µm, 12 – 3 µm)



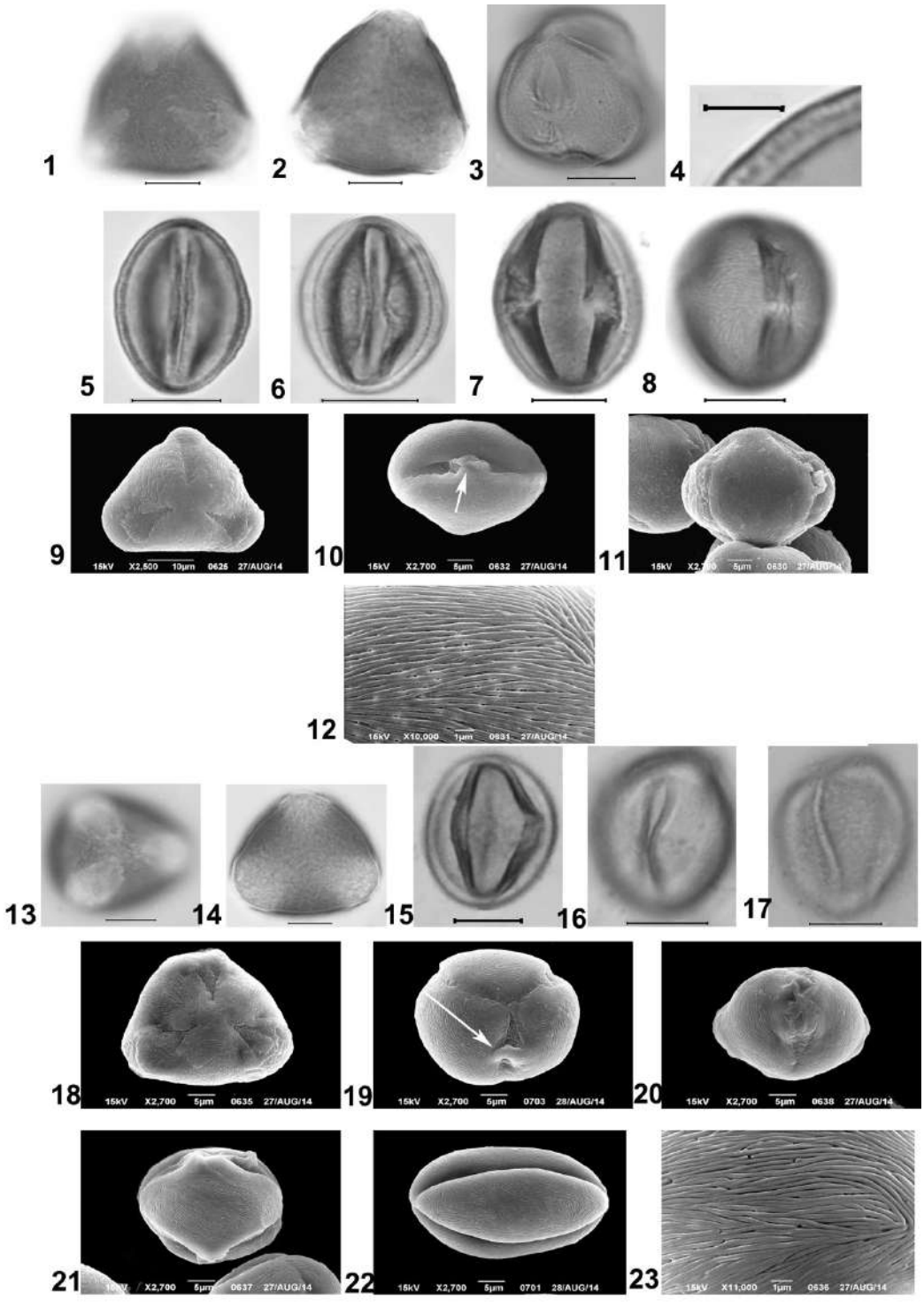
Phototable IV. Pollen grains of some species of the genus *Pyrus* L.
1-8 – *P. gergerana* Gladkova: 1 – pollen grain from polar view, 2-5 – pollen grains from equatorial view (2-4 – aperture, 5– mesocolpium & pore, marked by arrow) (LM), 6 – pollen grain from polar view, 7-8 – pollen grains from equatorial view (7 – aperture, 8 – mesocolpium) (SEM); 9-16 – *P. hajastana* Mulk.: 9-10 – pollen grains from polar view, 11-13 – pollen grains from equatorial view (11 – aperture, 12-13 – mesocolpium) (LM); 14 – pollen grains from polar view, 15 – pollen grain from equatorial view (aperture), 16 – exine ornamentation (SEM); 17-25 – *P. medvedevii* Rubtzov: 17-18 – pollen grains from polar view, 19-21 – pollen grains from equatorial view (19 – mesocolpium, 20-21 – aperture) (LM), 22 – pollen grain from polar view, 23-24 – pollen grains from equatorial view (23 – aperture, 24 – mesocolpium), 25 – exine ornamentation (SEM) (scale bar: 1-5, 9-11, 9-13, 17-21 – 10 μm)



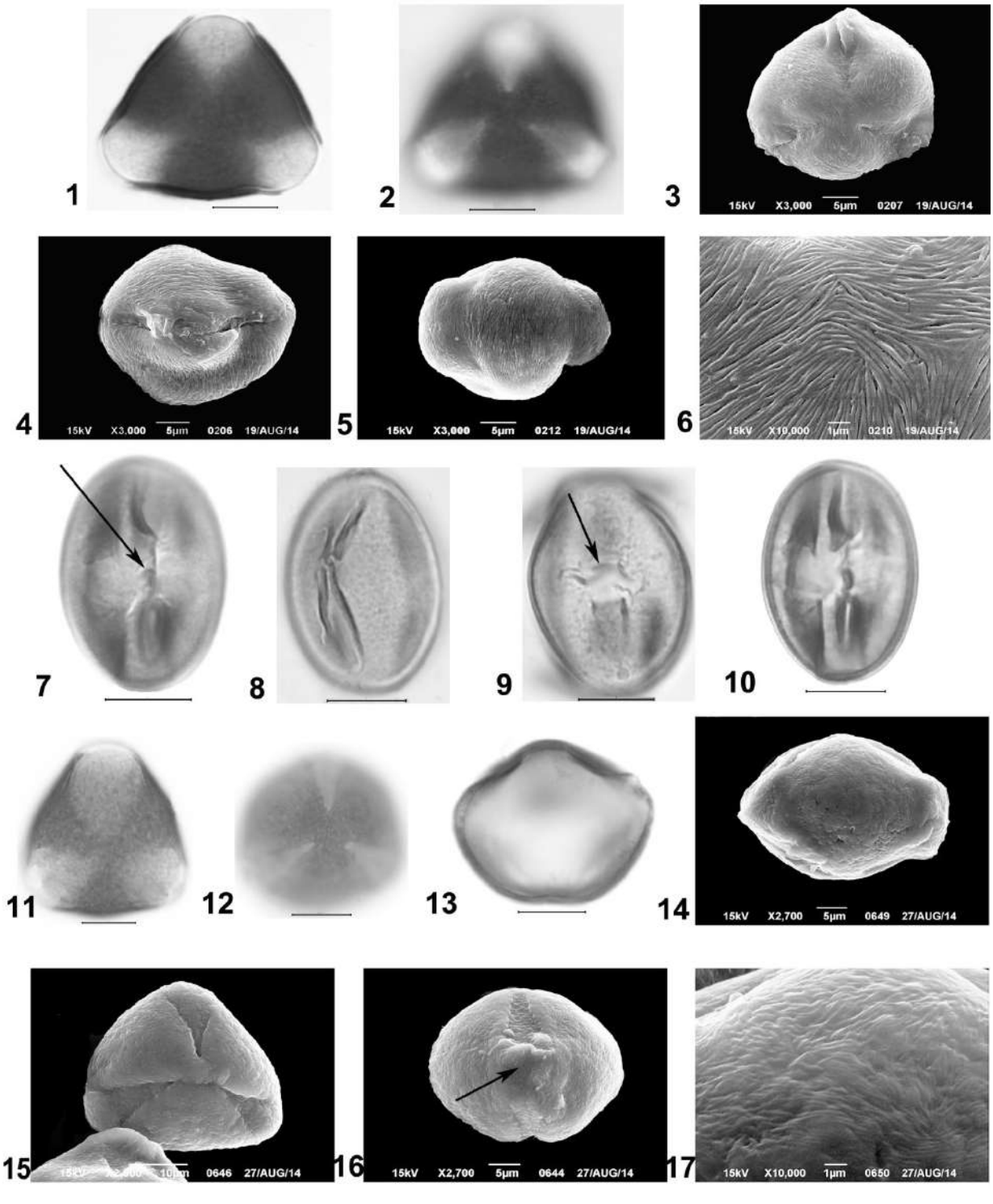
Phototable V. Pollen grains of some species of the genus *Pyrus* L.
1-5 – *P. oxyprion* Woronow: 1 – pollen grain from polar view, 2-3 – pollen grains from equatorial view (2 – aperture, colpus with geniculum, marked by arrow, 3 – mesocolpium), 4-5 – exine ornamentation (SEM); 6-13 – *P. raddeana* Woronow: 6-7 – pollen grains from polar view, 8 – pollen grain from semipolar view (ornamentation), 9-10 – pollen grains from equatorial view (9 – aperture, 10 – mesocolpium) (LM), 11 – pollen grain from polar view, 12 – pollen grain from equatorial view (aperture), 13 – exine ornamentation (SEM); 14-22 – *P. salicifolia* Pall.: 14-15 – pollen grains from polar view, 16 – pollen grain from semipolar view, 17-18 – pollen grains from equatorial view (LM), 19 – pollen grain from polar view, 20-21 – pollen grains from equatorial view (20 – aperture, 21 – mesocolpium), 22 – exine ornamentation (SEM)
(scale bar: 6-10, 14-18 – 10 μm)



Phototable VI. Pollen grains of some species of the genus *Pyrus* L.
1-10 – *P. sosnovskyi* Fed.: 1, 6 – pollen grains from semiequatorial view (1 – aperture, 6 – exine ornamentation), 2-3 – pollen grains from equatorial view, 4-5 – pollen grains from polar view (LM), 7 – pollen grain from polar view, 8-9 – pollen grains from equatorial view (aperture, mesocolpium), 10 – exine ornamentation (SEM); 11-18 – *P. tamamschiannae* Fed.: 11-14 – pollen grains from equatorial view (11 – mesocolpium, 12-14 – aperture) (LM), 15 – pollen grain from polar view,
16-17 – pollen grains from equatorial view (16 – aperture, 17 – mesocolpium), 18 – exine ornamentation (SEM) (scale bar: 1-6, 11-14 – 10 μm)



Phototable VII. Pollen grains of some species of the genus *Pyrus* L.
1-12 – *P. syriaca* Boiss.: 1-2 – pollen grains from polar view, 3 – pollen grain from semipolar view, 4 – exine, 5-8 – pollen grains from equatorial view (5-6 – aperture, 7-8 – mesocolpium) (LM), 9 – pollen grain from polar view, 10-11 – pollen grains from equatorial view (10 – aperture, colpus with geniculum, marked by arrow, 11 – mesocolpium), 12 – exine ornamentation (SEM); 13-23 – *P. theodorovii* Mulk.: 13-14 – pollen grains from polar view, 15-17 – pollen grains from equatorial view (15, 17– mesocolpium, 16 – aperture) (LM), 18-19 – pollen grains from polar view (19 – synaperturate, colpus with geniculum, marked by arrow), 20-22 – pollen grains from equatorial view (20 – aperture, 21-22 – mesocolpium), 23 – exine ornamentation (SEM)
(scale bar: 1-3, 5-8, 13-17 – 10 µm, 4 – 3 µm)



Phototable VIII. Pollen grains of some species of the genus *Pyrus* L.
1-6 – *P. voronovii* Rubtzov: 1-2 – pollen grains from polar view (LM), 3 – pollen grain from polar view, 4-5 – pollen grains from equatorial view (4 – aperture, 5 – mesocolpium), 6 – exine ornamentation (SEM); 7-17 – *P. zangezura* Maleev: 7-10, 13 – pollen grains from equatorial view (7 – geniculum, 9 – pore, marked by arrows), 11-12 – pollen grains from polar view (LM), 14, 16 – pollen grains from equatorial view (14 – mesocolpium, 16 – aperture, colpus with geniculum, marked by arrow), 15 – pollen grain from polar view, 17 – exine ornamentation (SEM)
(scale bar: 1-2, 7-13 – 10 µm)

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REFERENCES

Akopian J. A. 2007. On the *Pyrus* L. (*Rosaceae*) species in Armenia // Flora, vegetation and plant resources of Armenia, 16: 15-26 (in Russ.) (Акопян Ж. А. О видах рода *Pyrus* L. (*Rosaceae*) в Армении // Фл., растит., раст. рес. Армении, 16: 15-26).

Antkowiak W., Maciejewska-Rutkowska I., Jędrzejczyk I., Wojciechowski A. 2016. Morphological, anatomical and cytological characteristics of spontaneous hybrid *Pyrus x myloslavensis* // Dendrobiology, 75: 23-30.

Avetisyan E. M. 1950. Simplified acetolysed method of the pollen grains treatment // Bot. Zhurn., 35 (4): 385-387 (in Russ.) (Аветисян Е. М. 1950. Упрощенный ацетолизный метод обработки пыльцы // Бот. журн., 35 (4): 385-387).

Avetisyan E. M., Manukyan L. K. 1958. Description of the pollen of *Buxaceae, Grossulariaceae, Platanaceae, Rosaceae* // Flora of Armenia, 3 (ed. Takhtajan A. L.). Yerevan. 387 p. (in Russ.) (Аветисян Е. М., Манукян Л. К. 1958. Описание пыльцевых зерен сем. *Buxaceae, Grossulariaceae, Platanaceae, Rosaceae* // Флора Армении, 3. Ереван. 387 с.).

Chakass M. A., Boussioud-Corbières F., J.-P. Reduron & A.-M. Verhille. 2008. Contribution à une étude palynologique de trois espèces de Rosacées (tribu des Pyrées) indigènes au Liban: *Pyrus syriaca* Boiss., *Crataegus azarolus* L., *C. monogyna* Jacq. // Acta Bot. Gallica, 155 (4): 521-529.

Erdtman G. 1952. Pollen morphology and plant taxonomy. 1. Angiosperms. The Chronica Botanica Co.: Waltham, Mass., USA, Almqvist and Wiksell, Stockholm. 539 p.

Fang X., Yi-Xuan Y. 1990. Observation on pollen morphology and exine ultrastructure of *Pyrus* in China // Chin. J. Bot., 3 (1): 33-41.

Ghosh A., Saha I. 2017. Pollen morphological study of some selected Indian taxa of *Rosaceae* // Indian J. Applied & Pure Bio., 32 (2): 121-130.

Hesse M., Halbritter H., Zetter R., Weber M., Buchner R., Frosch-Radivo A., Ulrich S. 2009. Pollen Terminology - An Illustrated Handbook. Springer Wien, New York. 264 pp.

Jones, G. D., Bryant, V. M., Jr., Lieux, M. H., Jones, S. D., Lingren, P. D. 1995. Pollen of the southeastern United States: with emphasis on melissopalynology and entomopalynology. Dallas, TX: Am. Assoc. Stratigr. Palynol. Found., 30. 76 p.

Karimi H., Eslami B., Dehpouri A. A., Rad A. Sh. 2019. Quantitative and qualitative analyses of genus *Pyrus* L. (Pear tree) in West Azerbaijan Province, Iran // Iran. J. Sci. Technol. A., 43: 715–724.

Karpovich I. V., Drebezgina Ye. S., Elovikova E. A, Legotkina G. I., Zubova E. N., Kuzyaev R. Z., Khismatullin R. G. 2015. Atlas of pollen grains. The Ural worker: Yekaterinburg. 318 p. (+ 288 plates) (in Russ.) (Карпович И. В., Дребезгина Е. С., Еловикова Е. А., Леготкина Г. И., Зубова Е. Н., Кузяев Р. З., Хисматуллин Р. Г. 2015. Атлас пыльцевых зерен (Pollen atlas). Уральский рабочий: Екатеринбург. 318 с. (+ 288 илл.)).

Kocon J., Muszynski S. 1982. Ultrastructure of pollen grain sculpturing in several species of the *Rosaceae* family // Acta Soc. Bot. Pol., 51(3-4): 341-344.

Kuprianova L. A., Alyoshina L. A. 1967. Palynological terminology of angiosperms. "Nauka", Leningrad. 84 p. (in Russ.) (Куприянова Л. А., Алешина Л. А. 1967. Палинологическая терминология покрытосеменных растений. "Наука", Ленинград. 84 с.).

Kuprianova L. A., Alyoshina L. A. 1972. Pollen and spores of plants from the flora of European part of the USSR. "Nauka", Leningrad. 171 p. (Куприянова Л. А., Алешина Л. А. 1972. Пыльца и споры растений флоры европейской части СССР. I. "Наука", Ленинград. 171 с.).

Kuprianova L. A., Alyoshina L. A. 1978. Pollen and spores of plants from the flora of European part of the USSR. 2. *Lamiaceae-Zygophyllaceae*. "Nauka", Leningrad. 184 p. (in Russ.) (Куприянова Л. А., Алешина Л. А. 1978. Пыльца двудольных растений

флоры Европейской части СССР. “Наука”, Ленинград. 183 с.).

Punt, W., Hoen, P. P., Blackmore, S., Nilsson, S., Le Thomas, A., 2007. Glossary of pollen and spore terminology // Rev. Palaeobot. Palynol., 143 (1-2): 1-81.

Smoljaninova L. A., Golubkova V. F. 1950. To the method of the pollen investigation // Dokl. AN USSR, 75 (1): 125-126 (in Russ.) (Смольянинова Л. А., Голубкова В. Ф. 1950. К методике исследования пыльцы // Докл. АН СССР, 75 (1): 125-126).

The Plant List: http://www.theplantlist.org/tpl1.1/search?q=Pyrus

Tokarev P. I. 2004. Palynology of woody plants, growing on the territory of Russia. Synopsis of Doc. of Sci. thesis (Biology). Moscow. 55 p. (in Russ.) (Токарев П. И. 2004. Палинология древесных растений, произрастающих на территории России. Автореф. дисс. … докт. биол. наук. Москва. 55 с.).

Valdes B., Diez M. J. & Fernandes I. 1987. Atlas polinico de Andalucia Occidental. Universidad de Sevilla. 451p.

Westwood M., Challice J. S. 1978. Morphology and surface topography of pollen and anthers of *Pyrus* species // J. Amer. Soc. Hort. Sc., 103 (1): 28-37.

Zamani A., Attar F., Maroofi H. 2010. Pollen morphology of the genus *Pyrus* (*Rosaceae*) in Iran // Acta Biol. Szeged., 54 (1): 51-56.

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