

A BIOSYSTEMATIC STUDY ON THE FOUR VARIETIES OF *ALYSSUM MINUS* (BRASSICACEAE) IN IRAN

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Alyssum minus (L.) Rothm. var. *minus* is recorded for the first time from Iran. *Alyssum minus* (L.) Rothm. var. *mazandaranicum* Pakravan & Bolourian is described as a new taxon from the North and West of Iran. The four varieties of *Alyssum minus* in Iran (*A. minus* (L.) Rothm. var. *minus*, -var. *strigosum* (Banks & Sol.) Zohary, -var. *micranthum* (C.A.Mey.) Dudley and - var. *mazandaranicum* Pakravan & Bolourian) based on their morphological, palynological and anatomical characters were studied and compared with *A. desertorum* Stapf and *A. szowitsianum* Fisch. & Mey., from the same section. Although a great similarity observed in morphological characters and many intermediate specimens especially between the varieties of *A. minus* var *minus* and -var. *micranthum* (C. A. Mey.) Dudley was found, due to anatomical differentiation in sclerenchymatous cells and palynological differences in pollen size and shape, the varieties of *Alyssum minus* (L.) Rothm. were distinguishable.

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مطالعه بیوسیستماتیکی چهار واریته *Alyssum minus* (Brassicaceae) در ایران

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واریته *Alyssum minus* (L.) Rothm. var. *minus* برای اولین بار از ایران گزارش می‌شود. واریته‌ای جدید (*Alyssum minus* var. *mazandaranicum* Pakravan & Bolourian) از شمال و غرب علاوه بر واریته‌های موجود در ایران (*A. minus* (L.) Rothm. var. *minus*, -var. *strigosum* (Banks & Sol.) Zohary, -var. *micranthum* (C.A.Mey.) Dudley) معرفی می‌شود و صفات ریخت-شناسی، گرده‌شناسی و تشریحی جهت یافتن ویژگی‌های جداکننده یا مترادف‌کننده این چهار واریته بررسی و با دو گونه دیگر از همان بخشه یعنی *A. desertorum* Stapf و *A. szowitsianum* Fisch. et C. A. Mey. مقایسه می‌شوند. شباهت قابل توجهی در صفات ریخت-شناسی وجود داشت و افراد حدواسط زیادی به ویژه در بین دو واریته *A. minus* var. *minus* و *A. minus* var. *micranthum* (C. A. Mey.) مشاهده گردید. با این حال به دلیل اختلافات موجود در شکل و اندازه دانه‌گرده و تفاوت‌های تشریحی در سلول‌های اسکله‌رانشیمی، می‌توان واریته‌های *Alyssum minus* (L.) Rothm. را از یکدیگر تشخیص داد.

INTRODUCTION

The Brassicaceae (Cruciferae) is one of the largest angiosperm families, comprising approximately 340 genera and more than 3350 species in some poorly defined tribes, distributed throughout the world, chiefly in temperate regions of the Northern Hemisphere (Al-

Shehbaz 1984). In terms of generic content, the situation of tribes is two monotypic tribes, five oligotypic ones and six giant tribes. *Alyssum* is one of the six genera belonging to Brassicaceae with endemic species in Irano-Turanian, Mediterranean and Saharo-Sindian regions (Hedge 1976).

Table 1. List of investigated *Alyssum* taxa kept in the ALUH herbarium.

Taxa	Locality	Collector & herb. no.
<i>A. minus</i> (L.) Rothm. var. <i>minus</i>	Tehran, Lavasan to Afje, 1800m Tehran, Shahrestanak	Bolourian 5030-ALUH Gholami 5062-ALUH
<i>A. minus</i> var. <i>mazandaranicum</i> Pakravan et Bolourian	Mazandaran, Galugah, Sorkh Geriveh village, 1917m Kermanshah, Kouhestan park	Nataj 5058- ALUH Jahandideh 5038- ALUH
<i>A. minus</i> var. <i>strigosum</i> (Banks & Sol.) Zohary	Gillan, 12km after Rudсар, after Rahim abad, Garmabdasht village, 700m Mazandaran, Sari road, Kiasar 50km	Bolourian, Hariri, Noghianian 5000- ALUH Nataj 5057-ALUH
<i>A. minus</i> var. <i>micranthum</i> (C. A. Mey.) Dudley	Tehran, Darabad, 1800m Tehran, Lavasan, Naran road, 1780m Tehran, Lavasan, 1800m Tehran, Lavasan to Afje, 1800m Tehran, Abe-ali, 2140m Hamadan, Agh bolagh Mazandaran, Espili road, Rudсар Tehran, 16km after Ziaran to Taleghan, 2100m	Bolourian 5023-ALUH Bolourian 5028-ALUH Bolourian 5031-ALUH Bolourian 5032-ALUH Bolourian 5037-ALUH Pakravan 5055-ALUH Nataj 5059-ALUH Falaturi 5060-ALUH
<i>A. desertorum</i> Stapf	Tehran, Shahre Jadide Pardis, 1600m Tehran, Lavasan to Afje, 1900m Qom, Qom road to Arak, after Imamzadeh Jafar, 1740m Tehran, Darabad, 1800m Tehran, Lavasan, Naran, 1780m Tehran, Lavasan to Afje, 1800 Tehran, Kan, 2116m 50. 57. 03 E, 35. 56. 02 N Kermanshah, Sanandaj road, Mahmoud abad village Tehran, Haraz road, After Pardis, Kamard, 1460m Tehran, Mahdasht road, Eshtehard, 1400m Tehran, 15km before Abe-Ali Mazandaran, Galugah, 9km after Sorkh Geriveh village	Bolourian 5003- ALUH Bolourian 5004- ALUH Bolourian 5016- ALUH Bolourian 5027- ALUH Bolourian 5029- ALUH Bolourian 5033- ALUH Keshavarzi 5041- ALUH Jahandideh 5042- ALUH Falaturi 5043-ALUH Falaturi 5052-ALUH Falaturi 5053-ALUH Nataj 5054-ALUH
<i>A. szowitsianum</i> Fisch. & C. A. Mey.	Tehran, Tehran-Qom road, before Hasan abad, 1260m Qom, Qom road to Arak, after Imamzadeh Jafar, 1740m Qom, Qom-Arak road, after Dizijan, Besharat abad, 1780m	Bolourian 5012-ALUH Bolourian 5018- ALUH Bolourian 5020- ALUH

The aims of the current study are to evaluate the possibility of combining the current varieties of *A. minus* defined in Flora Iranica as var. *minus* and var. *micranthum* (C. A. Mey.) Dudley (Rechinger 1968) including *A. strigosum* Banks & Soland. a species decreased to a variety of *Alyssum minus* (L.) Rothm. by Zohary (1966), to describe a new variety based on their morphological, anatomical and palynological characters, and to study two close species from the same section.

MATERIALS AND METHODS

The present study is based on herbarium specimens that were collected from many localities in Iran and fresh material in the field, voucher specimens are preserved in the ALUH herbarium (Table 1). Specimens were examined using a Dino-Lite digital microscope AM413T model.

For light microscopy observations, dried flowers were taken. Pollen grains from mature anthers were mounted using a fine needle and Carmen was used to stain grains. Measurements were taken from LM photography. At least 20 grains from a minimum of five specimens in two populations of each species or varieties were examined. The ratio between the mean polar axis (P) and the mean equatorial diameter (E) were used in order to determine the shape of pollen grains following Erdtman (1943).

The stem of specimens used in anatomical studies was cut in the mid section and soaked in boiling water and glycerol. Transverse sections of stem were prepared by hand cutting. Sections were cleared with sodium hypochlorite diluted, acetic acid and stained in safranin and methyl green solutions to distinguish the tissues in microscopic examinations, then sections were mounted in glycerine. All microscopic observations took place using an Olympus B×51 light microscope.

RESULTS

Morphological properties

The fruit shape in *A. minus* and *A. desertorum* were spheroid but in *A. szowitsianum* was wider below the equatorial axis. In *A. desertorum* fruit was glabrous, whilst *A. minus* var. *micranthum* and some other specimens of *A. minus* (No. 5030-ALUH and 5062-ALUH that henceforth will be named taxon A) had monomorphic indumentums, whereas *A. minus* var. *strigosum* and *A. szowitsianum* had a dimorphic indumentum. Also, we found dimorphic hairs in fruit of two specimens from Azerbaijan (no. 5058) and Kermanshah (no. 5038) that were very similar to *A. minus*. These specimens henceforth will be named taxon B. Taxon A and *A. minus* var. *micranthum* had small stellate hairs and larger stellate hair with divergent, spreading unequal rays. Taxon B differed from *A. minus* var. *strigosum* in bifurcate hairs that had extremely small rays at their base compared to bifurcate hairs in the latter. *A. szowitsianum* had intermediate and compound stellate hairs (Fig. 1).

Petals in *A. minus* were extremely similar in the varieties with bilobed tips and constrictions in the middle area (Fig. 2). Petals in *A. desertorum* were similar to *A. minus* but had emarginated tips. In *A. szowitsianum* petals were gradually attenuated towards the base and had bilobed tips.

The hairs on the style of taxon B and *A. minus* var. *strigosum* was sparse compared to taxon A and *A. minus* var. *micranthum* (Fig. 1). Style length was similar in different varieties. *A. desertorum* had no hairs on the style but *A. szowitsianum* had hairs on the style base.

Filaments were similar in all *A. minus* varieties, including taxon A and B, and showed variation from simple and toothed filaments to winged. *A. desertorum* specimens had toothed and winged filaments. *A. szowitsianum* specimens had both simple and winged filaments.

Palynological properties

Pollen grains were tricolpate and varied considerably in size and shape between species and in the *A. minus* varieties (Table 2). The longest and shortest equatorial diameter of 33.89 μ m and 20.97 μ m were seen in *A. minus* var. *micranthum* and taxon B respectively. The polar axis with a maximum and minimum length of 47.73 μ m and 26.61 μ m were observed in *A. minus* var. *micranthum* and *A. desertorum* respectively. In the studied taxa the smallest grains (Taxon B) had a polar axis of 33.18 μ m and an equatorial diameter of 20.97 μ m. The largest grains (*A. minus* var. *micranthum*) had a polar axis of 47.73 μ m and an equatorial diameter of 33.89 μ m.

Subprolate and prolate shapes were seen in *A. minus*, while *A. desertorum* and *A. szowitsianum* were subprolate and prolate-spheroidal respectively.

Anatomical characters of stem

In all specimens examined, epidermis was covered with a cuticle layer. Endodermis was below the cortex parenchyma. Sclerenchymatous cells were found above the phloem. These sclerenchymatous cells were constant in the species and variety level. They showed some differences in the studied species, existing as a few scattered cells in *A. minus* var. *strigosum*, or one layer in taxon A, *A. minus* var. *micranthum* and more than one layer in taxon B. Sclerenchymatous cells were also seen in one layer in *A. desertorum*, but were absent in *A. szowitsianum*. The xylem was in the shape of a ring parallel to the outside. The number of vascular bundles was 10-13 in taxon A, *A. minus* var. *micranthum* and more than one layer in taxon B. Sclerenchymatous cells were also seen in one layer in *A. desertorum*, but were absent in *A. szowitsianum*. The xylem was in the shape of a ring parallel to the outside. The number of vascular bundles was 10-13 in taxon A, 9-15 in *A. minus* var. *micranthum*, 15 in taxon B, 11-13 in *A. minus* var. *strigosum*, 9-12 in *A. desertorum* and 10-12 in *A. szowitsianum* (Table 3). The pith was composed of parenchyma cells, which were smaller close to the xylem and grew in size towards the middle of the pith zone (Fig. 3).

DISCUSSION

New record

Alyssum minus (L.) Rothm. var. *minus*

Studied specimens. Tehran, Lavasan to Afje, 1800m, Bolourian (5030 - ALUH); Tehran, Shahrestanak, Gholami (5062 - ALUH).

After studying the morphological, anatomical and palynological characters of the taxon B and other varieties of *A. minus* we found that they could be varieties of the same species. While comparing the descriptions of the other taxa of *Alyssum* proved that taxon A has all characters of *A. minus* var. *minus*.

A. minus var. *minus* is reported for the first time from two localities in Iran. This variety has been separated from var. *micranthum* by its style length (0.7-1.3 mm in var. *minus* compared to 1-2 mm in var. *micranthum*) and equal rayed fruit hairs (in var. *minus*) compared to unequal rays in var. *micranthum*) (Rechinger 1968). It has previously been found in Crimea, Turkey, Caucasus, parts of Europe and N. Africa (Townsend 1980).

Table 2. Morphological data of pollen grains in *A. minus* varieties, *A. desertorum* and *A. szowitsianum*. P: polar axis; E: equatorial diameter; P/E: the ratio between the polar and equatorial; Ps: pollen shape

Taxon	Equatorial diameter (E μ m)			Polar axis (P μ m)			P/E	Pollen shape (Ps)
	min	mean	max	min	mean	max		
<i>Taxon A</i>	30.58	32.50	35.39	36.95	39.46	43.61	1.21	subprolate
<i>Taxon B</i>	19.90	20.97	22	30.83	33.18	37.70	1.58	prolate
<i>A. minus</i> var. <i>micranthum</i>	22.14	33.89	48.50	40.81	47.73	50.66	1.4	prolate
<i>A. minus</i> var. <i>strigosum</i>	23.54	27.64	30.94	30.10	35.65	40.69	1.28	subprolate
<i>A. desertorum</i>	18.88	22.74	24.77	24.87	26.61	29.42	1.17	subprolate
<i>A. szowitsianum</i>	20.56	30.32	36.97	31.77	33.97	36.15	1.12	prolate-spheroidal

Table 3. Comparison between distinguishable anatomical characters of stem TS in *Allysum minus* varieties, *A. desertorum* and *A. szowitsianum*.

Taxon	Cortex thickness (μ m)	Number of vascular bundles	Sclerenchyma
taxon A	80-100	10-13	one layer
taxon B	80-100	15	more than one layer
<i>A. minus</i> var. <i>micranthum</i>	80-100	9-15	one layer
<i>A. minus</i> var. <i>strigosum</i>	80-100	11-13	scattered cells
<i>A. desertorum</i>	80-100	9-12	one layer
<i>A. szowitsianum</i>	80-100	10-12	-

New taxon

***Alyssum minus* (L.) Rothm. var. *mazandaranicum* Pakravan & Bolourian, var. nov.**

Typus. Mazandaran, Galugah, Sorkh Geriveh village, 1917m, 09.05.2008, Nataj 5058 (holotypus ALUH, Alzahra University herbarium). –Paratypus. Kermanshah, Kouhestan Park, 2008, Jahandideh (5038-ALUH).

Annuum, usque ad 15 cm altum. Caules simplices vel ramosi, ramis divergentibus vel ascendentibus. Folia oblanceolata vel obovato-spathulata. Racemi 5-10 cm longi. Sepala decidua. Siliculae 3-5 mm longae et latae; indumentum dimorphum, pilis bifurcatis basim radiis tuberculatis et minutis praesentibus, pilis stellatis majusculis vel parvis cum radiis aequantibus vel inaequantibus; valvae \pm inaequaliter inflatae. Styli rigidi, 0.5-1 mm longi, glabri vel sparse pilosi.

Annuals, up to 15 cm high. Stem if present, divergent or ascending. Leaves oblanceolate or obovate-

spathulate. Racemes 5-10 cm long. Sepals deciduous. Silicules 3-5 mm long and broad; indumentum dimorphic with bifurcate hairs having slightly tuberculate short rays at their base in addition with large or small equal or unequal rayed stellate indumentum. Valves \pm unequally inflated. Style rigid, 0.5-1 mm long, glabrous or sparsely hairy.

Based on dimorphic and monomorphic indumentums of the silicule, type of scleranchymatus cells in the stem, pollen size and shape that have observed in taxon B, we recognized it as a new variety of *A. minus*.

The new variety differs from other varieties in its silicule indumentum and style shape and indumentum. var. *minus*, var. *micranthum* and var. *collinum* have monomorphic indumentums while var. *mazandaranicum* has a dimorphic indumentum. The hair on the style is sparse compared to var. *minus* & var. *micranthum*. The new variety also differs from var. *strigosum*, in bifurcate hairs that have small rays at their base.

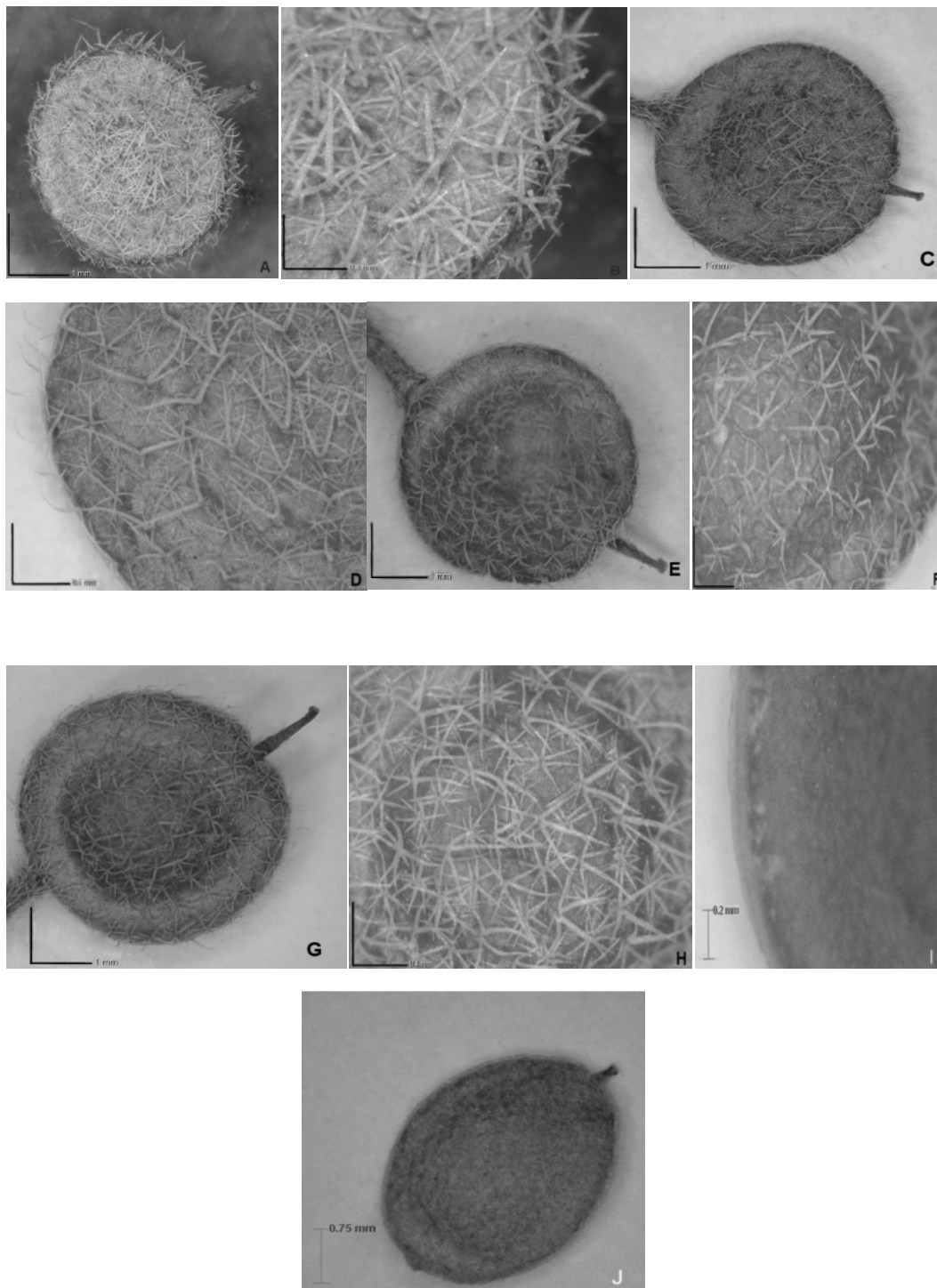


Fig. 1. Fruit indumentum. *Alyssum minus* var. *mazandaranicum* (A) silicule and style, (B) stellate and bifurcate hairs with small rays at their base. -var. *strigosum* (C) silicule and style, (D) stellate and bifurcate hairs. -var. *minus* (E) silicule and style, (F) equal monomorphic stellate hairs. -var. *micranthum* (G) silicule and style, (H) equal monomorphic stellate hairs. (I) *A. desertorum*, (J) *A. szowitsianum*.

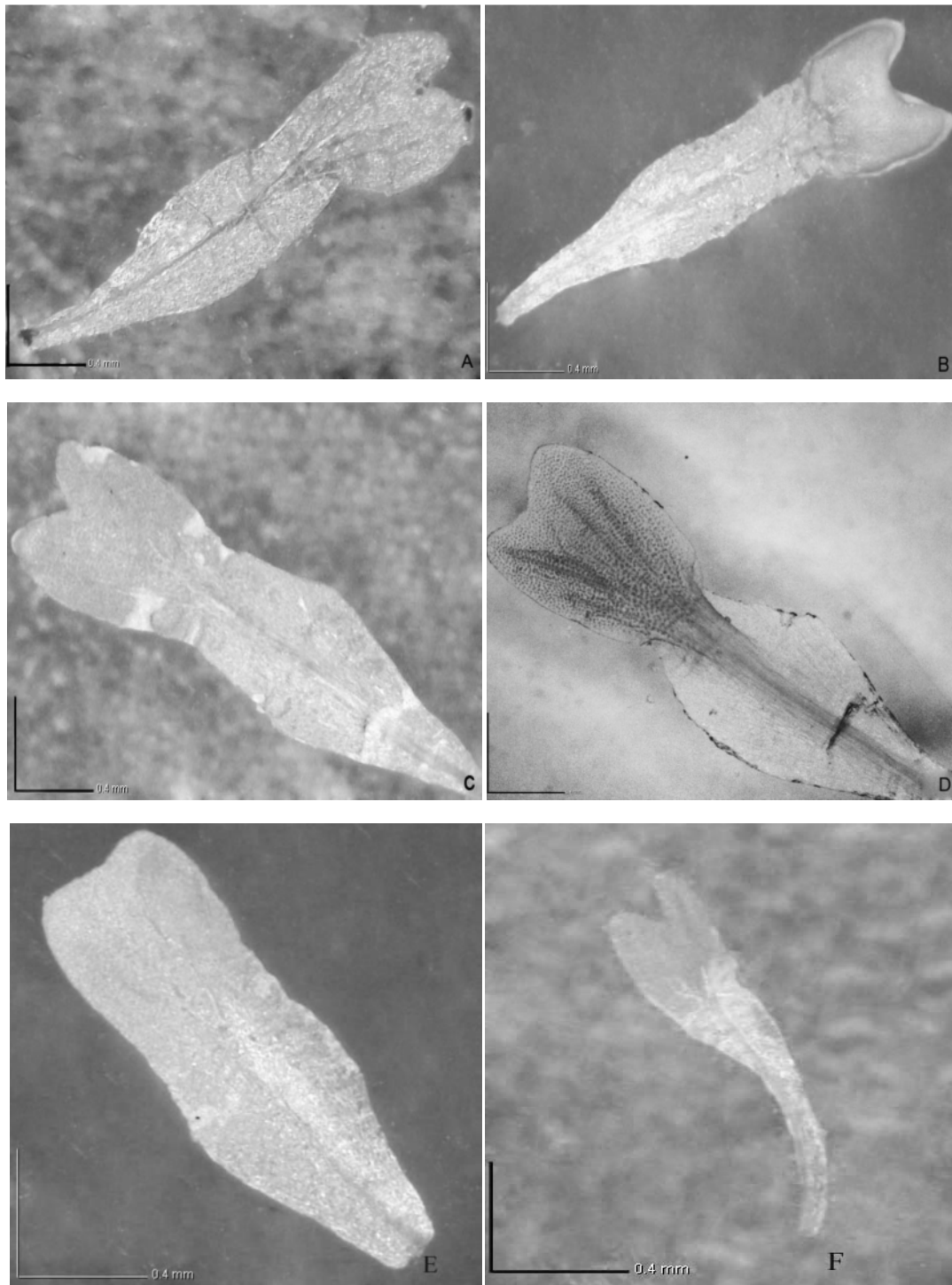


Fig. 2. Petal. (A) *Alyssum minus* var. *mazandaranicum*, (B) *A. minus* var. *strigosum*, (C) *A. minus* var. *minus*, (D) *A. minus* var. *micranthum*, (E) *A. desertorum*, (F) *A. szowitsianum*.

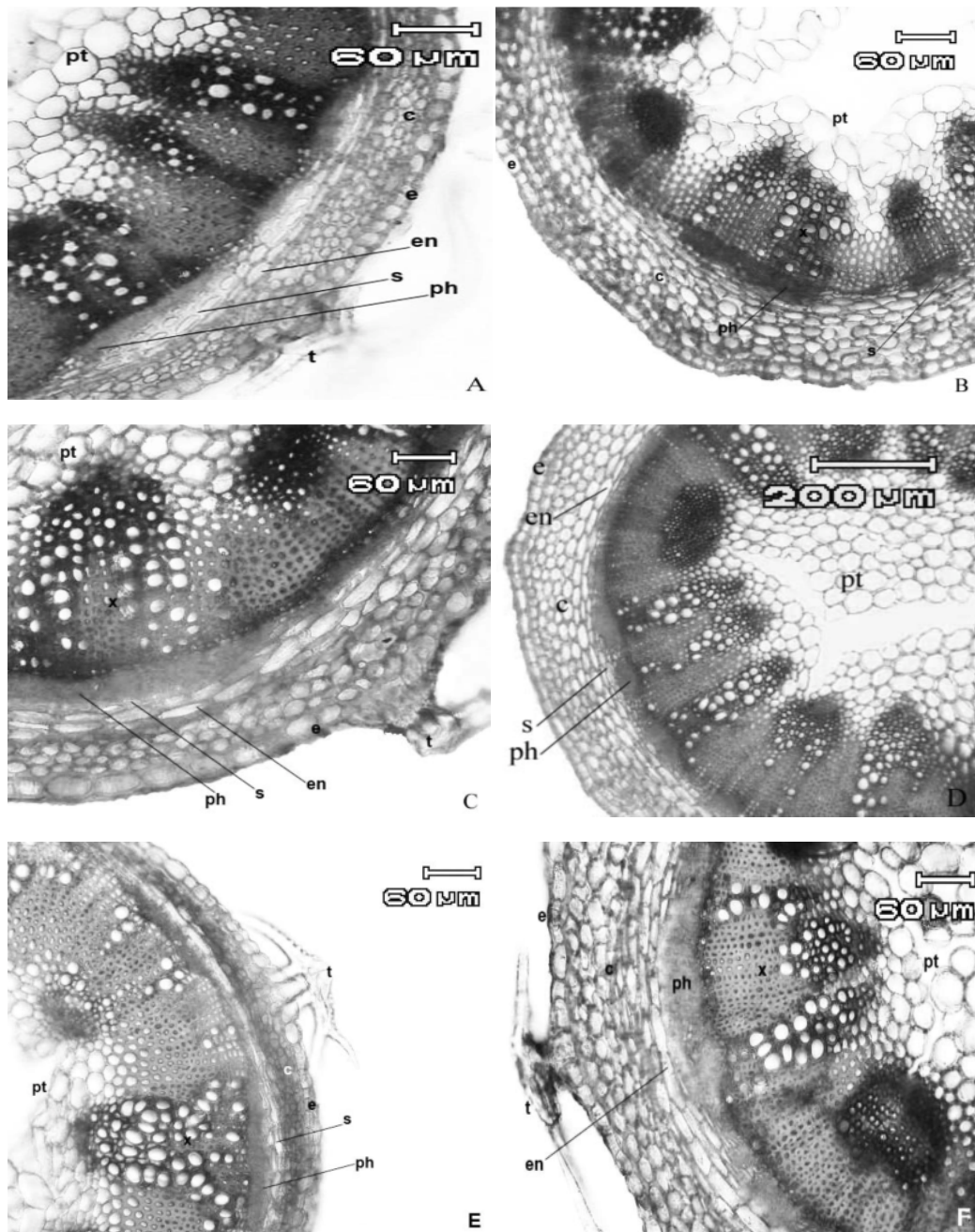


Fig. 3. Stem TS. (A) *Alyssum minus* var. *mazandaranicum*, (B) -var. *strigosum*, (C) -var. *minus*, (D) -var. *micranthum*, (E) *A. desertorum*, (F) *A. szowitsianum*, t: trichome, e: epiderm, c: cortex, en: endoderm, s: sclerenchyma, ph: phloem, x: xylem, pt: pith.

Pollen grains in var *mazandaranicum* were prolate and differed from var. *micranthum* (also prolate) in size. The presence of more than one layer of sclerenchymatous cells was another specific character that was able to distinguish the new variety from the other already existing *A. minus* varieties.

Based on the combination of anatomical differentiation in sclerenchymatous cells and palynological differences in pollen size and shape it is possible to separate the annual species of *A. minus*, *A. desertorum* and *A. szowitsianum* in addition to separating the four varieties of *A. minus*.

In addition, the studied petals of *Alyssum minus* varieties showed great similarity and unlike previous studies (Persson 1971) the shape of petals were not considered a reliable character. Appendages of shorter stamens used by Persson (1971) were also unstable because they varied in different specimens and flowers of the same specimen. Rechinger (1968) used style length to distinguish the taxa, however they were variable in the specimens and there are many intermediate specimens so it was not a distinguishable character for separating the taxa.

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