

A Revision of *Alyssum* L. Section *Gamosepalum* (Hauskn.) Dudley (*Brassicaceae*), in Iran

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Abstract

Section *Gamosepalum* has been reported from Turkey for the first time by Dudley. In recent years, several species of this section were reported as new records for Iran. Four species of *Alyssum* section are transferred from sect. *Alyssum* to sect. *Gamosepalum* with considering of important characters in each section. These changes made two synonymies. Five species of *Gamosepalum* section including *A. lanceolatum*, *A. persicum*, *A. lepidoto-stellatum*, *A. mulleri* and *A. baumgartnerianum* are present in Iran. Identification key of accepted species and distribution map of them are given. All specimens examined in the present work are deposited at FUMH, G, TARI and W.

Key words: *Alyssum*; *Gamosepalum*; *Brassicaceae*; Iran; Revision

Introduction

The Brassicaceae comprise 49 tribes, 321 genera, and 3660 species. Of which, 20 genera and 34 species remain to be assigned to tribes (Al-Shehbaz, 2012). The genus *Alyssum* L. consists of about 170 – 195 species worldwide, native to Europe, Asia and northern Africa (Al-Shehbaz, 1987; Appel and Al-Shehbaz, 2003; Warwick *et al.*, 2006, Li *et al.*, 2014). Most of its species grow in rocky and arid regions. 28 species and 7 varieties, belong to 5 sections were introduced from Iran (Rechinger, 1968). Most of these species, especially those belong to *Alyssum*, section *Gamosepalum* (Hauskn.) Dudley has been known from Turkey, Iraq and Armenia. Rechinger (1968) in Flora Iranica reported *A. baumgartnerianum* from Persia without giving any exact location. Based on Dudley (1964) all species of the genus *Gamosepalum* Hauskn. were transferred to *Alyssum*. Dudley (1964) introduced *Alyssum* section *Gamosepalum* Dudl. with 10 species, namely *A. baumgartnerianum* Bornm., *A. niveum* Dudley, *A. harputicum* Dudley, *A.*

sulphureum Dudley and Hub., *A. tetrastemon* Boiss. and *A. corningii* Dudley. Later, *A. nezaketiae* by Duman and Aytac (2000) and *A. misirdalianum* by Orcan and Binzet (2006) were introduced from Turkey. Based on the synopsis of Dudley (1964) species in the genus *Alyssum*, section *Gamosepalum* are recognizable from the other species by dimorphic sepals with simple, furcated and stellate hairs on the inner surface. Kavousi *et al.* (2011) reported, *Alyssum tetrastemon* Boiss., *A. harputicum* T. R. Dudley, *A. lepidoto-stellatum* (Hauskn and Bornm.) T. R. Dudley, *A. paphlagonicum* (Hauskn.) T. R. Dudley, *A. niveum* T. R. Dudley, *A. sulphureum* T. R. Dudley and Hub.-Mor., *A. corningii* T. R. Dudley and *A. thymops* (Hub.-Mor. and Reese) T. R. Dudley from Khorassan province in NE Iran. Moreover Kavousi *et al.* (2014) introduced *A. hezarmasjedense* as a new species from Hezarmasjed (Khorasan, Iran) Iran that belongs to Section *Gamosepalum*. The aim of this study is to revise the taxonomy of the Section *Gamosepalum* (Hauskn.) Dudley of the genus of *Alyssum* in Iran.

Materials and Methods

Type specimens of species section *Gamosepalum* presented in Herbarium of Natural History Museum of Vienna (W), Herbarium of Boissier (G), Herbarium of Research Institute of Forests and Rangelands (TARI) and Herbarium of Ferdowsi University of Mashhad (FUMH) were studied. All of the species belong to the section *Gamosepalum* that were introduced as new records from Iran, were morphologically investigated.

The flowers of them were boiled and dissected. Sepals of types were selected for scanning by electronic microscope (SEM) and light microscope (LM). They were mounted and coated with gold-paladium. After coating specimens were viewed with a SU 3500 Electron microscope at 15 kv. Make a determination key for section *Gamosepalum* in Iran. The Examined specimens for all species of section *Gamosepalum* were illustrated in map (Fig.1).

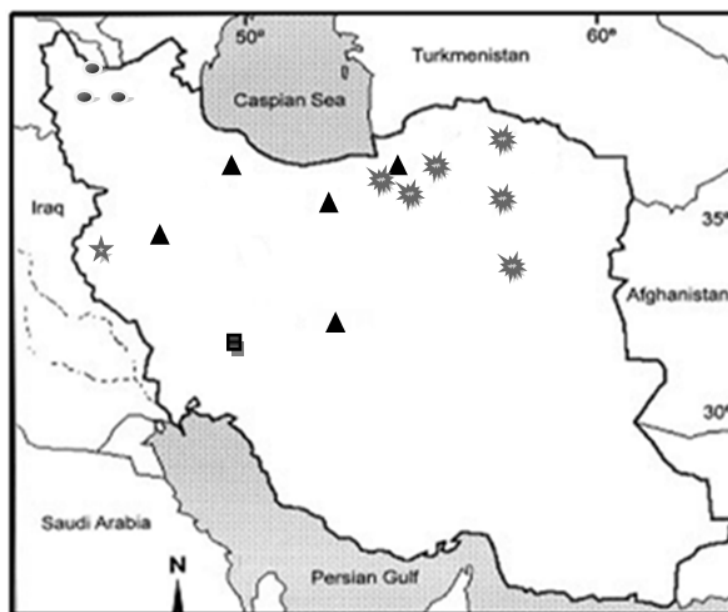


Fig. 1. Distribution map of *A. lanceolatum* (☼), *A. mulleri* (▲), *A. persicum* (■), *A. baumgartnerianum* (●) and *A. lepidoto-stellatum* (*).

Results

Taxonomic treatment

Alyssum sect. *Gamosepalum* (Hauskn.) Dudley (Dudley 1965).

Perennials, sepals dimorphic, often persistent and inflated in fruit, inner surface hairy. Petals

purple or yellow, spatulate, narrowed and then broadened at the middle of blade.

Key to the determination of accepted species of section *Gamosepalum* in Iran

1. Indumentums on upper part of plant consist of stellate hairs with equal and unequal rays... *A. lepidoto-stellatum*

1. Indumentums on upper part of plant consist of lepidote and stellate hairs with long unequal rays²

2. Petals retusa or emarginated, 5.5-7×1.5-2.5 mm..... *A. muelleri*

2. Petals integra.....3

3. Silicule elliptic, 4.5-6×2.5-4.5 mm.....*A. baumgartnerianum*

3. Silicule orbicular or sub orbicular..... 4

4. Plant silver-greenish, silicule 6-6.5×5-6 mm, truncate, style 3-4.5 mm., petals 5-8 × 2-2.5 mm, yellow or purple *A. lanceolatum*

4. Plant silvery, silicule 4-5.5×4-6 mm, subretusa, style 2-3.5, Petals 6-8 × 1.5-2.2 mm, yellow *A. persicum*

1. *A. lepidoto-stelatum* (Hauskn. and Bornm.) Dudley in J. Arn. Arb. 45(1): 70 (1964).

= *Gamosepalum lepidoto-stellatum* Hauskn. & Bornm. In Mitt. Thur. Bot. Ver. 11: 73 (1897).

Typus: In declivibus apricis inter Siwas et mt. Yyldisdagh, 1300-1400 m, 1880. Bornmuller 1671 G!

= *A. iranicum* Hauskn. ex Baumg. Jahresber. Kais.- Franz-Jos. –Oberrealschule Baden b. Wien 48: 9 (1911), **syn. nov.**

Typus: Kermanshah: Kuhe Tarikha, STR., W!

Gen. Dist. Iran, Turkey and Iraq.

Perennial herb, suffruticose, ca. 9- 17 cm tall. Indumentums silvery, densely stellate indumentum. Leaves oblanceolate, 6-11 × 1.2-1.5 mm. Sepals indumentums consist of few rayed, branched, stellate hairs, in the inner surface with long sericeous hairs (Fig. 2a). Petals 7 × 2 mm, retuse, yellow, spatulate, with sparse stellate trichome. Fruits ovate or obovate, obtuse or truncate, 4-6 × 3-5 mm. Styles 2-3.5 mm.

2. *A. muelleri* Boiss. and Buhse, in Nouv. Mem. Soc. Nat. Mosc. 12: 16 (1860).

Typus: In the monte Yazd, Buhse, 1358 W!

Gen. Dist. Iran and Iraq.

Perennial herb, suffruticose, ca. 14- 19 cm tall, with erect or ascending stems; indumentum silvery. dimorphic on the upper part of plant. Leaves oblanceolate or lanceolate, 9-27 × 2- 2.5 mm. Sepal's indumentum of lepidote and stellate hairs, in the inner surface with stellate and simple hairs (Fig. 3). Petals 5.5-7×1.5-2.5 mm,

retuse or emarginate, yellow, spatulate, with sparse stellate trichome. Fruits elliptic or obovate, obtuse or truncate, 4-5 × 4-5 mm, with dense canescent –silvery indumentums of leptidote or sublepidote hairs. Styles 2.5 -4.5 mm. long.

Examined specimens: **Mazandaran:** ca. 30 km S. Ramsar between Khash-e Chal mountain and Miankuh, 3100 m., Assadi and Massoumi 51249 (TARI); S. of Ramsar, Siemam mt. 3620m. Runemark and Massoumi 21818 (TARI). **Yazd:** S. of Deh-Bala, Shirkuh Mountain, 3000 m. Foroughi and Assadi 17999 (TARI); Shirkuh, from Deh-Bala and Sheikh Alishahr and Lagerda valleys, 2400-3400m. Mozaffarian 77648 (TARI); Deh-Bala, Shirkuh mountain, 3700-4000 m. Foroughi and Assadi 17955 (TARI). **Hamedan:** Agh Bolagh, Pabot 207 (TARI). **Khorassan:** NE of Cheneran, 31km. Boghmej to Hazarmasjed, 2506m. Zangooei and Nazari 39876a (FUMH); N of Chaneran, 5km. to Boghmej, 2008m. Zangooei & Joharchi 39876b (FUMH); Chaneran, Boghmej to Hazarmasjed, after Shohadaye Ashayer, 2500m. Nazari 39394 (FUMH). **Semnan:** ca 20 km N. W. of Shahrud, above Nekarman, Kuh-e Shahvar, near the top, 3600-3900m. Assadi & Mozaffarian 50894 (TARI). **Tehran:** Firuzkuh, Goodvin 9197; Kalar Khan km 39 S. E., Firuzkuh, 2500m. Bazargan and Arazm 6663 (TARI).

Note: *A. niveum* was introduced as a new record from Khorassan province (Kavousi, 2011). The specimens (39876 a, b and 39394- FUMH) was studied. The petals are retuse (not entire), 5.5× 2 mm. (not 6.5 × 3.5 mm), the length of style is 3.5 mm. (not 2-2.5). These characters fit to *A. muelleri* (not *A. niveum*). Although one of the important characters in section *Gamosepalum* is persistence sepals, sepals of *A. mulleri* are deciduous. It is because of presence of sparse and simple hairs than the stellate hairs, therefore sepals are not interlocked by the indumentums as done by the members of the sect. *Gamosepalum*.

3. *A. baumgartnerianum* Bornm. in Baumg., Jahresber. Kais. –Franz-Jos.-Oberrealschule Baden B. Eien 48: 6 (1911).

Typus: Libanon. Dschebel Baruk, Bornm. 11405 W!

Gen. Dist. Iran, Turkey, Russia and Iraq.

Suffrutescent, up to 15 cm. Leaves obtuse, obovate, spatulate, oblanceolate. Indumentum dimorphic on the upper parts of plant. Petals 5.5-9 × 1.5-2.5 mm, entire, yellow, with dense, canescent-silvery indumentums of lepidote or sublepidote hairs. Silicule elliptic, 4.5-6 × 2.5-4.5 mm, styles 2.5-4 mm., hairy at the base.

Examined specimens: **Azerbaijan:** 15km S. of Marand, Mishu-Dagh mt., 1800-2250 m. Assadi & Mozaffarian 29843 (TARI); 20 km to Tehran-Tabriz road on the road from Ahar, 1450 m, Wendelbo and Assadi 28002 (TARI); 20 km to Siahrud on the road from Kharvana, 900 m. Assadi 86744 (TARI).

Note: The specimens that have collected by Assadi (Assadi 86744-TARI), which look likes the figure in Fl. Of Armenia (Takhtajan, 1966), 5: 193 (fig.LXXXIV), as *A. muelleri* is in fact *A. Baumgartnerianum*, therefore the record of *A. muelleri* in Armenia might be *A. Baumgartnerianum*.

4. A. laceolatum Baumg., Jahresber. Kais.-Franz-Jos.-Oberrealschule Baden b. Wien 48: 11 (1911).

Typus: Turcomania, Kulan Mountain, pr jouran, 700 m. 28.5.1898. Litwania 569 W!

= *A. persicum* auct. Fl. Turcoman. et Afghan. nec Boiss. and Buhse (1860).

= *A. iranicum* Czernjak., Not. Syst. Herb. Hort. Bot. Rep. Ross. 5: 34 (1924) et Feddes Repert. 27: 272 (1930) nec Hausskn. ex Baumg. (1907).

= *A. czernjakowskiae* Rech. f., Phytion 3: 54 (1951).

= *A. hezarmasjedense* Kavousi and Nazary, Novon vol. 23, no.1 (2014), **syn. nov.** (Typus: Iran. Khorassan: NE Chenaran, ca., 31 km from Boghmech to Hezarmasjed Mtn 2344 m, 22 May 2008, Z. Nazary and H. Zangoii 39391 (holotype, FUMH!; isotypes, FUMH !)

Gen. Dist. Iran, Afghanistan, Turcomania.

Perennial herb, suffruticose, silver-greenish, ca. 7-10 cm tall, stem erect or ascending. Indumentum silvery, of many rays, on the upper part of plant dimorphic of lepidote and stellate

hairs with long divergent rays. Leaves lanceolate or oblanceolate, 8-17 × 0.1- 0.2 mm. Sepals indumentums of few rayed and branched stellate hairs; inner surface with stellate hairs (Fig. 2b). Petals 5-8 × 2-2.5 mm, entire, yellow or purple, spatulate, with sparse trichomes. Fruits ovate or obovate, 6-6.5 × 5-6 mm, truncate at the apex, Styles 3-4.5 mm. long.

A. lanceolatum bears persistent sepals, indumentum on the inner surface of sepals and lepidote trichomes and therefore is transferred from Section *Alyssum* to Section *Gamosepalum*.

Type specimen of *A. hezarmasjedense* was studied. All given data on *A. lanceolatum* was totally matched with those of *A. hezarmasjedense* and therefore they are regarded as synonyms.

A. coringii, *A. sulphureum*, *A. tetrastemon*, *A. harputicum* and *A. thympos* were introduced as new records from Iran by Kavousi *et al.* (2011). The specimens of these species were studied and none of them are proved. They all are variations of *A. lanceolatum*.

The specimen named *A. coringii* has a style of 4-4.5 mm. long and petals are retuse with 2.5 mm. wide similar to that of *A. lanceolatum* while in *A. coringii* style is 1.5-2.5 mm. long and petals are bilobed with 0.5-1 mm. wide. *A. sulphureum* has bilobed petals and pilose style. while in the specimen named *A. sulphureum* petals are entire and style is glabrous. The specimen named *A. tetrastemon* is not in flowering stage, but the other characters of the specimen are closer to *A. lanceolatum* than *A. tetrastemon*. The seeds in the specimens are winged similar to that of *A. lanceolatum* than wingless seeds of *A. tetrastemon*, also, the length of style is 3-4.5 mm as in *A. lanceolatum* (not 2-3 mm as in *A. tetrastemon*) In *A. thympos* the length of style is 1-5-2 mm. and petals are emarginate (not 4-4.5 long and entire) The specimen that named as *A. harputicum* have dimorphic indumentums on upper part of plant, similar to *A. lanceolatum* (in *A. harputicum* indumentums on the upper part of plant is monomorphic of lepidote hairs), also the other characters are characters of *A. lanceolatum*.

It is necessary to mention that the distribution of all these records is in the distribution of *A. lanceolatum* and far away from the true distribution of the species in Turkey.

Examined specimens: **Khorassan**: 42 km to Birjand, on the road from Ghayen, 2000 m. Assadi & Amirabadi 84741 (TARI); ca. 50 km. NNE. Kashmar, Kuhe Bezgh, 2900 m. Assadi and Mozaffarian 35764 (TARI); between Ghoochan and Darreh Gaz, Tandooreh National Park, Shekarab. 2300m. Assadi and Maassoumi 50576 (TARI); Mashhad, Zooshk, 1550m., Foroughi 4494 (TARI); 50 km. NNE Kashmar, Kuh-e Bezgh, 1900-2500 m. Assadi and Mozaffarian 35756 (TARI); Sabzevar, between Sarough and Nazar Soltan mt., 2482m. Nazari 42719(FUMH); 95 km to Mashhad, S.W. Marashk, Hezarmasjed, 2500m. Faghiahnia & Zangooei 27570 (FUMH); S. of Mashhad, Moghan, Moghan cave, 2000m. Joharchi & Zangooei 42684 (FUMH); NE of Chaneran, 31km. Boghmej to Hezarmasjed, 2506m. Zangooei & Nazari 39872 (FUMH); NE of Chaneran, 31km. Boghmej to Hezarmasjed, 2506m. Zangooei and Nazari 39871 (FUMH); 30 km. S. of Gonabad, Kalat mt., 1700m. Joharchi & Zangooei 11951(FUMH); 75 km. of old road of Mashhad, Torbat-e Heidaryeh, before Asadabad, Rezaei and Zangooei 10908 (FUMH); S. of Mashhad, Moghan, Moghan cave, 2000m. Joharchi and Zangooei 42681 (FUMH); NE of Cheneran, 31km. Boghmej to Hezarmasjed, after Shohadaye Ashayer, 2200m. Nazari 39402 (FUMH); BandarGaz, Tandoreh National Park, Shekarab mt., Nazari 39397 (FUMH). **Semnan**: Shahrud-Bastam (Turan Protected Area), in montibus Cale, NE Qaleh bala, 1500m. Rechinger 50424 (TARI); 35km SE of Shahrud on road to Biarjomand, 1700m. Freitag & Mozaffarian 28363 (TARI); Touran Protected Area. Kuh-e Mulhadow, N part, 1200-1300m. Freitag and Mozaffarian 28892 (TARI);

5. *A. persicum* Boiss. Ann. Scienc. Nat. Ser. 2, 17: 152 (1842).

Typus: Esfahan, Aucher, 4089W!

Gen. Dist. Endemic.

Perennial herb, suffruticose, silvery, ca. 14- 19 cm tall, with erect or ascending stems. Indumentum silvery, dimorphic on the upper parts of plant.

Leaves oblanceolate or lanceolate, 9-27 × 2- 2.5 mm. Sepals indumentums many rayed, in the inner surface with stellate hairs (Fig. 3c) . Petals 6-8 × 1.5-2.2 mm, entire, yellow, spatulate, with sparse stellate trichome. Fruits orbicular or suborbicular, subretuse, 4-5.5×4-6 mm, with dense canescent –silvery indumentums of leptidote or sublepidote hairs. Styles 2-3.5 mm.

Examined specimens: Chaharmahal-e Bakhtiari: Lordegan, N. slope Kuh-e Rig from the village Chaman Bid, 2100-2900m. Mozaffarian 57570 (TARI).

Discussion

Alyssum muelleri, *A. persicum*, *A. lanceolatum* and *A. iranicum* due to the presence of indumentums on the inner surface of sepals are transferred to section *Gamosepalum* (Fig 2, 3). The members of the sect. *Gamosepalum* in fruiting stage with the lack of sepals are very similar to sect. *Alyssum*.

Townsend & Guest (1980) in Flora of Iraq pointed out that the sepals in *A. muelleri* have hairs on the inner surface of sepals but did not change its section from *Alyssum* to *Gamosepalum*.

These studies improve necessity of rank changes from one section to the other. The results also show that in Khorassan province only one species of section *Gamosepalum* occur while the other species i. e. *A. mulleri*, *A. persicum*, and *A. iranicum* occur in the other parts of Iran (Rechinger, 1968). The result of this study fills the gap between the main distribution center of the section in Turkey and Khorassan province.

The specimen of *A. paphlagonicum* that reported by Kavousi *et al.* (2011) from Iran is not accessible, due to the incomplete description, unavailable materials and not giving exact locality, presence of this species in Iran remains doubtful.

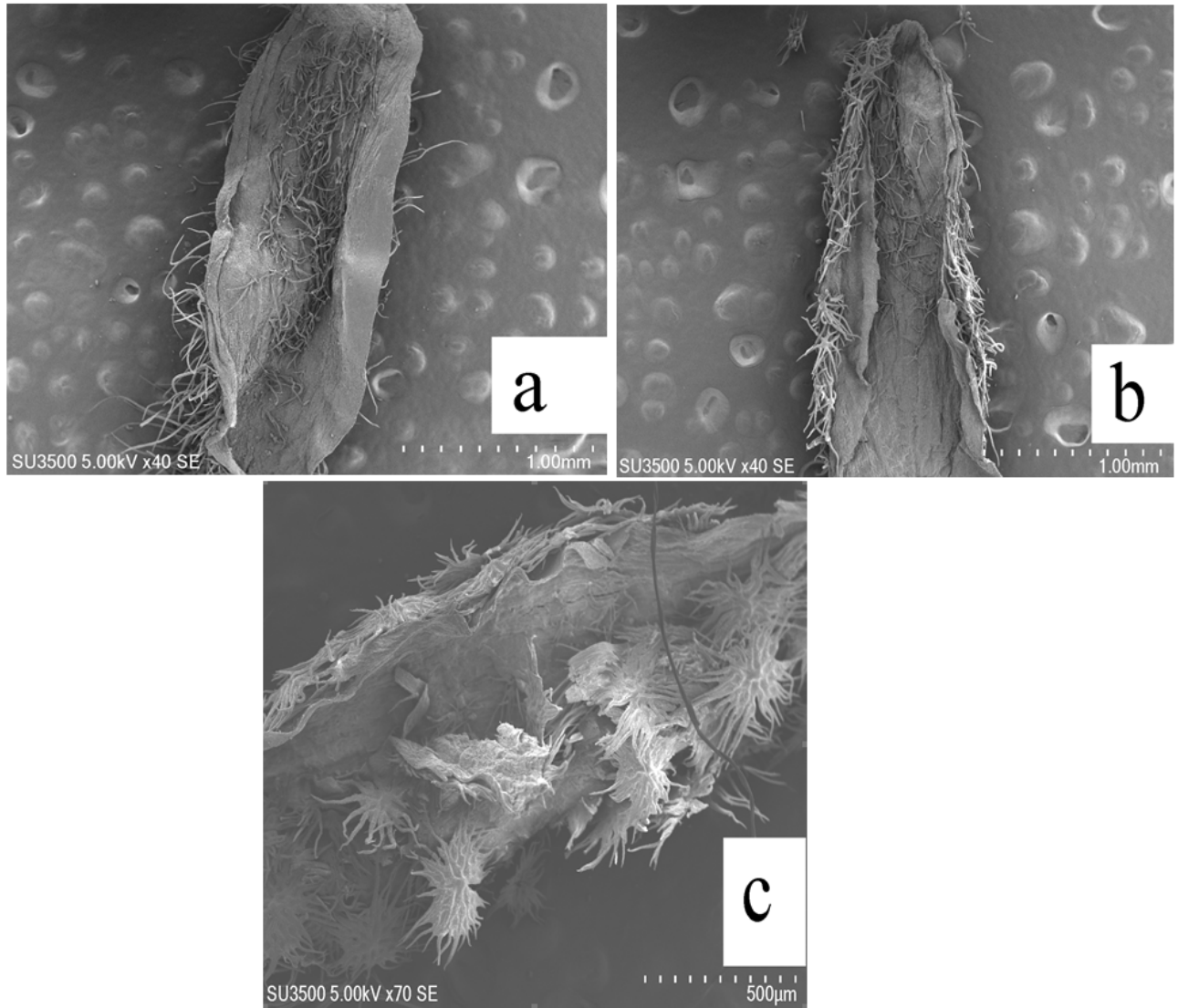


Fig. 2. SEM photo of sepals on the inner surface in type specimens of *Alyssum iranicum* (A); *A. lanceolatum* (B); *A. persicum* (C).

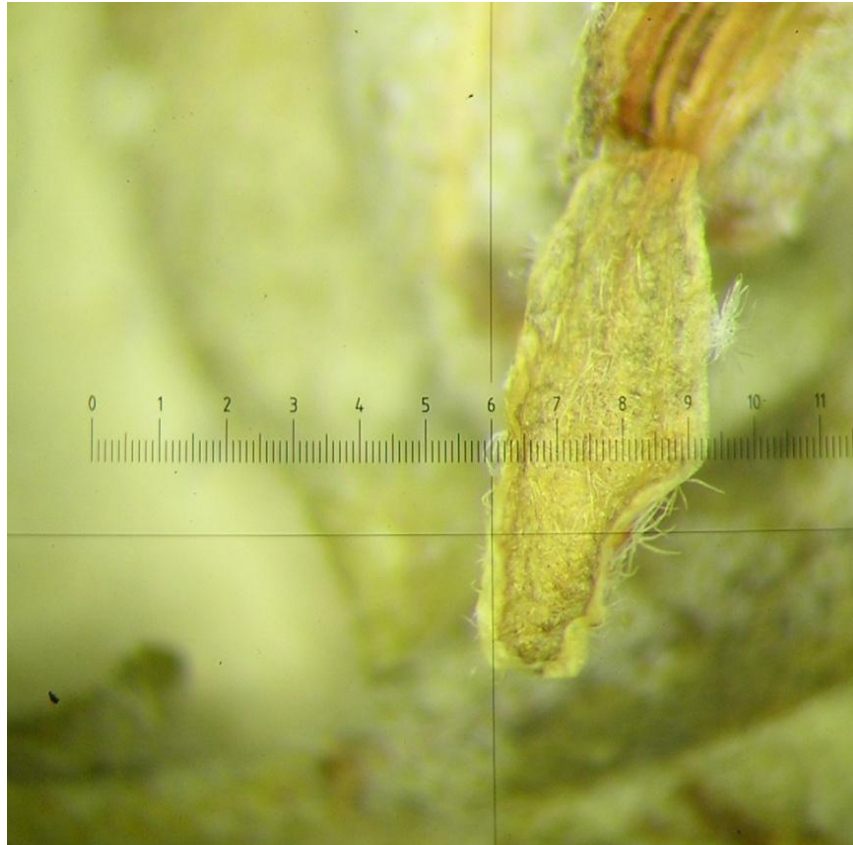


Fig. 3. Inner surface of sepal in type specimen of *A. muelleri* by LM.

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References

- Al-Shehbaz IA. 1987. The genera of *Alyseae* (*Cruciferae*; *Brassicaceae*) in the Southeastern United States. *J Arnold Arboretum* 68: 185-240.
- Al-Shehbaz IA. 2012. A generic and tribal synopsis of the *Brassicaceae* (*Cruciferae*). *Taxon* 61: 931-954.
- Appel O, Al-Shehbaz IA. 2003. *Cruciferae*. In: Kubitzki K, Bayer C. eds. *The families and genera of vascular plants*. Berlin: Springer. 5:75 -174.
- Dudley TR. 1964. Synopsis of the genus *Alyssum*. *J Arnold Arboretum* 45: 358-372.
- Dudley TR. 1965. *Alyssum* in *Flora of Turkey*. Davis PH. ed, Great Britain 1: 362-409.
- Duman H, Aytac Z. 2000. *Alyssum nezaketiae* new species from central Anatolica. *Israel J Plant Sci* 48: 317-319.
- Kavousi K, Dumain H, Nazari Z, Jouharchi MR. 2011. The genus *Alyssum* Section *Gamosepalum* in Iran. *Acta Botanica Hungarica* 53: 145-149.
- Kavousi K, Nazari Z, Ghahramani Nejad F. 2014. A new species of *Alyssum* (*Brassicaceae*) from north eastern Iran. *Novon* 23: 59-61.
- Li Y, Kong Y, Zhang Z, Yin Y, Liu B, Lv G, Wang X. 2014. Phylogeny and biogeography

- of *Alyssum* (Brassicaceae) based on nuclear ribosomal ITS DNA sequences. *J Genet* 93: 313-323.
- Orcan N, Binzet R. 2006. A new record for the Flora of Turkey, *Alyssum idaeum* Boiss. & Heldr. *Pakistan J Bot* 38: 931-933.
- Rechinger KH. 1968. *Alyssum* in: Flora Iranica. Cruciferae. Graze, Austria. 57: 146-170.
- Reetnik I, Satovic Z, Schneeweiss GM, Liber Z. 2013. Phylogenetic relationships in *Brassicaceae* tribe *Alysseae* inferred from nuclear ribosomal and chloroplast DNA sequence data. *Mol Phylogenet Evol* 69:772-786.
- Takhtajan A. 1966. *Alyssum* in: *Flora of Armenia*. Akademiya nauk Armyanskoy SSR, Erevan. [In Russian] 5: 193.
- Townsend C, Guest E. 1980. *Alyssum* in: *Flora of Iraq*, Townsend C, Guest E. (eds), Ministry of Agriculture & Agrian reform Republic of Iraq 4: 959-988.
- Warwick SI, Francis A, Al-Shehbaz IA. 2006. *Brassicaceae*: Species checklist and database on CDROM. *Plant Syst Evol* 259: 249-258.