

Astragalus bartinense (Fabaceae), a new species from Turkey

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Abstract – *Astragalus bartinense* is described as a new species from Bartın Province in Northern Anatolia, Turkey. The new species is close to *A. depressus* L. and *A. froedinii* Murb., but distinctly differs from *A. froedinii* in having hairy fruit, long stipules (10–12 mm) and peduncle (10–25 mm). It also differs from *A. depressus* in having long stipules and a stipitate and glabrous ovary. Taxonomic descriptions, micromorphology of pollen and seed and geographical distribution are presented.

Keywords: *Astragalus*, Leguminosae, micromorphology, sect. *Tapinodes*, taxonomy, Turkey

Introduction

The genus *Astragalus* L. (Fabaceae) is represented by 2,398 taxa in the Old World, which are classified into 10 subgenera and 136 sections (Maassoumi 1998, Podlech and Zarre 2013). In Turkey, the genus is represented by 476 taxa in 63 sections with 51% endemism (Maassoumi 1998, Aytaç 2000, Aytaç et al. 2012, Ekici et al. 2015, Dönmez and Aydın 2018).

In the Old World 86 taxa are annual within 21 sections, and 2297 taxa within 115 sections are perennial, 97 sections are simple and 39 sections are bifurcate or bifid hairy (Podlech and Zarre 2013). In Turkey, 18 taxa are annual within 9 sections and 458 taxa perennial within 54 sections; 34 sections are simple hairy and 29 sections medifixed or bifid hairy (Aytaç et al. 2012).

Astragalus is the biggest genus in the world in terms of number of species and is dominant in the steppes, in Central Asia, Iran (Ghahremaninejad 2015) and Turkey (Irano-Turanian Region), which are suggested to be centers of diversification of the genus (Maassoumi 1998). Recently, the morphologically based classification of the genus has been shown to be artificial and does not correspond with the phylogenetically recovered clades (Azani et al. 2017, 2019).

The section *Tapinodes* is represented by three species in the Old World, *A. depressus*, *A. tetuanensis* and *A. froedinii* (Podlech and Zarre 2013).

The specimen collected from Bartın was compared with *A. depressus* and *A. froedinii* (sect. *Tapinodes*) and we decided to describe it as a new species.

Materials and methods

Flowering and fruiting materials of the new species were collected in June 2016 at an elevation of 550 m in limestone rocky areas above Abdurrahman village in the Küre Mountains National Park in Ulus County, Bartın Province. The location of the new species in Bartın Province falls within the A4 grid square (Davis 1965).

The types and images for *Astragalus depressus*, *A. froedinii* and *A. tetuanensis* were examined from different herbaria, such as E, K, M, MSB, P, RAB and W. On the other hand, many specimens of *A. depressus* were investigated in the ANK, GAZI and HUB herbaria.

Pollen slides were prepared using the technique of Wodehouse (1935). Light microscope (LM) studies were made using a Leica ICC50 HD microscope. Measurements were based on 30 or more pollen grains for *A. bartinense* and *A. depressus*. For scanning electron microscope (SEM), dry pollen grains were mounted on stubs and coated with gold. Morphological observations were made with a JSM 6060 electron microscope. The terminology used is mainly that of

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Faegri and Iversen (1992), and Punt et al. (2007). The pollen shape class based on the polar axis to equatorial axis (P/E) was identified using Erdtman's system (Erdtman 1969).

Research materials were collected during the flowering and fruiting periods.

Macromorphological observations of the seeds were carried out using a stereoscope microscope. Axis parameters were measured with the aid of an ocular micrometer. For SEM, dry seeds were directly mounted on stubs using double-sided adhesive tape.

The leaflets were investigated with the same methodology as the seeds using a stereo microscope and SEM.

The SEM photomicrographs were taken with the JEOL JSM 6060 SEM at the Gazi University Electron Microscopy Unit.

Based on this information, and using the relevant literature (i.e., Chamberlain and Matthews 1970, Podlech and Zarre 2013, Ekici et al. 2015) we decided that this specimen is new and have described it as a new taxon.

The specimens were deposited in the GAZI herbarium. The plant names mentioned here follow the International Plant Names Index (IPNI 2020).

Results

Astragalus bartinense Aytaç, Tunçkol et N. Aksoy sp. nov., sect. *Tapinodes* Bunge (Fig. 1).

Type: Turkey. A4 Bartın, Uluş, Küre Mountains National Park, above Abdurrahman village, 550 m a.s.l., limestone rocky areas, 11 June 2016, Tunçkol 2271. (Holotype: GAZI!; Isotypes: ANK!, DUOF!).

Diagnosis: The new species is very similar to *A. froedii* and *A. depressus*, however, it is different from *A. froedii*, with hairy fruit, recurved pedicel, 10–12 mm long stipules (not 2–5 mm), 10–25 mm long peduncle (not 2–5 cm) and 5–7 mm long bracts (not 1–1.5 mm). Also, it is distinguished from *A. depressus* by 10–12 mm long stipules (not 2–10 mm), distinctly hairy stem and 10–25 cm long peduncle (not 0.3–8 cm) and a stipitate and glabrous ovary (not sessile and short hairy). The other distinctive character is the pale pink corolla (not whitish or yellow).

Description: Plants 15–30 cm long, shortly to distinctly caulescent and caespitose, covered with white, also black hairs in the inflorescence. Stems 5–15 cm long, glabrous at base, sparsely hirsute towards tip. Stipules 10–12 mm; free from stem and covering the internodes, lanceolate-acuminate, sparsely hairy below, ± glabrous upper

side, ciliate at margin. Leaves 10–20 cm long; petiole at least 1/3 times longer than lamina and sparsely hirsute. Leaflets 5–15 × 3–10 mm long, 8–14 pairs, oblong to obovate, glabrous on upper side, sparsely hairy on underside and long ciliate at margins. Peduncles 10–25 cm long, shorter or longer than leaves and densely spreading hairy. Raceme 5–10 cm long, cylindrical, 10–30-flowered. Bracts 5–7 mm long, white membranous, triangular to linear, acuminate at apex, completely black hairy. Bracteoles 1–2 mm long, narrowly triangular to linear, covered with black spreading hairs. Pedicel 0.5–1 mm long, recurved, covered with spreading black hairs. Calyx 3–4 mm long, campanulate, covered with spreading black hairs outside; teeth 2–2.5 mm long and linear. Petals pale violet bluish pink; standard ca. 12 mm long, rounded at apex; wings 8–9 mm long, whitish – pink. Staminal tube slightly obliquely at apex. Ovary stipitate, glabrous. Legume 15–16 mm long, nodding, linear, slightly falcate, with short (2–3 mm) curved beak at tip, bilocular, white simple hairy, 3–5-seeded. Seeds, 2–3 × 1–1.5 mm long, reniform reddish brown, rugulose.

Flowering and fruiting: June.

Pollen structure: Polar axis (P) varies from 28.8 to 32.6 µm, while equatorial axis

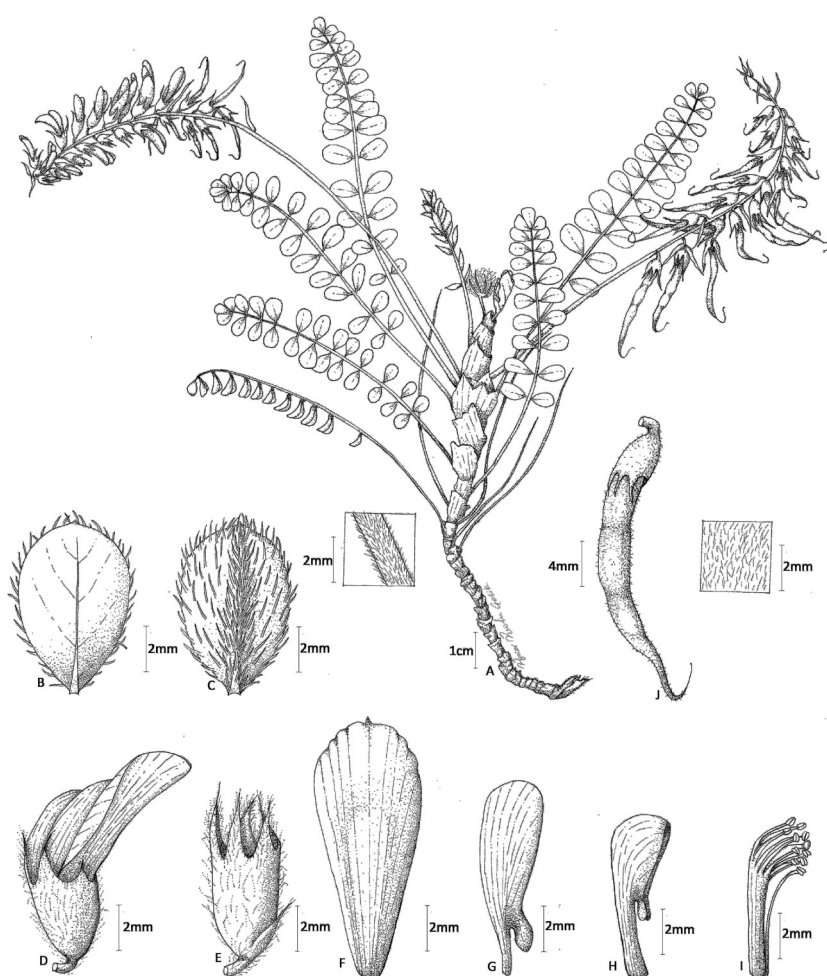


Fig. 1. *Astragalus bartinense*, A – habit, B – upper surface of leaflet, C – lower surface of leaflet, D – flowers, E – calyx, F – standard, G – wing, H – keel, I – stamens, J – fruit (Illustration: Hacer Muslu Çelik).

Tab. 1. Pollen structure of *Astragalus bartinense* and *A. depressus* in Turkey. Clg – colpus latitude (width), Clt – colpus longitude (length), P/E – polar/equatorial axis, P/E – polar/equatorial axis, Plt – pore longitude (length), Plt – pore latitude (width), Min. – minimum value, Max. – maximum value, Mean – average value ± standard deviation (SD), n = 30.

Taxon	Polar axis (P, μm)			Equatorial axis (E, μm)			P/E and shape		Aperture type	Ornamentation	Colpus (μm)		Pore (μm)		Exine thickness (μm)	Intine thickness (μm)
	Min.	Max.	Mean±SD	Min.	Max.	Mean±SD	Subprolate	Prostrate			Clg	Clt	Plg	Plt		
<i>A. bartinense</i>	28.8	32.6	30.7±1.2	22.1	25.7	23.5±1.0	1.30	subprolate	Tricolporate	Microreticulate-perforate	21.5±1.6	1.9±0.2	7.1±1.0	9.8±1.1	1.0±0.2	0.6±0.1
<i>A. depressus</i>	32.6	38.5	34.3±0.9	21.1	25.2	23.1±1.1	1.48	prolate	Tricolporate	Microreticulate-perforate	21.6±1.2	1.8±0.1	6.1±0.5	5.8±0.5	0.9±0.1	0.6±0.1

(E) varies from 22.1 to 25.7 μm in *A. bartinense* (Tab. 1). The shapes of the pollen grains are subprolate and tricolporate. Exine sculpturing (ornamentation is microreticulate-perforate in *A. bartinense*).

The polar axis (P) varies from 32.6 to 38.5 μm, while the equatorial axis (E) varies from 21.1 μm to 25.2 μm in *A. depressus* (Tab. 1). The pollen grains are prolate tricolporate. Exine sculpturing (ornamentation) is microreticulate-perforate in *A. depressus*.

Exine thicknesses are very close to each other and range from 0.7 to 1.4 μm (Tab. 1). The exine is 0.7–1.4 μm in *A. bartinense* and 0.72–1.2 μm in *A. depressus* (GAZI H. Duman 4462). The intine thickness average is 0.6 μm in both taxa (Fig. 2).

Leaflet structure: 5–15 × 3–10 mm, oblong to obovate, glabrous on upper side, sparsely simple hairy on underside and ciliate at margin. The hairs on the lower surface and sides of the leaflets are 1–2-celled and simple. Epidermal cells have bifurcated hair-like (epicular wax) protrusions bending the membrane structures. Stomas are amphistomatic (Fig. 3).

Etymology: The name is derived from name of the city where plant was collected. The Turkish name of this new species has been proposed as “Bartın geveni” (in English: Bartın milkvetch).

Distribution and ecology: *A. bartinense* is only known from the type location. It is endemic to the northwestern Black Sea Region of Turkey and belongs to the Euxine element. It grows in open limestone rocky areas with the following taxa: *Fritillaria pontica*

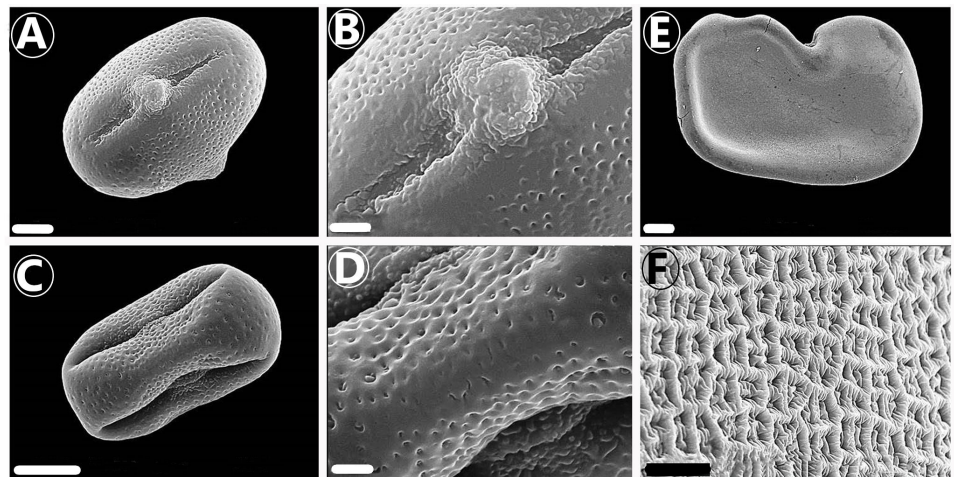


Fig. 2. Pollen and seed structure. Pollen of *Astragalus bartinense* (A, B), *A. depressus* (C, D), and seed of *A. bartinense* (E, F). Scale bars: 2 μm (B, D), 5 μm (A), 10 μm (C, F), 200 μm (E).

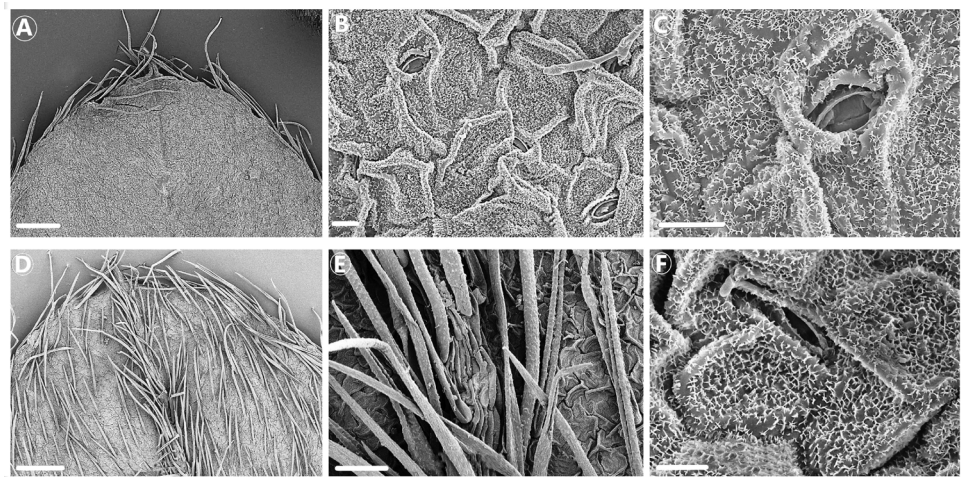


Fig. 3. The leaflets of *Astragalus bartinense*: A-C – upper surface, B and C – stomata and cuticle crease, D-F – flower surface, E and F – stomata and cuticle crease. Scale bars: 10 μm (C, F), 100 μm (B, E), 500 μm (A, D).

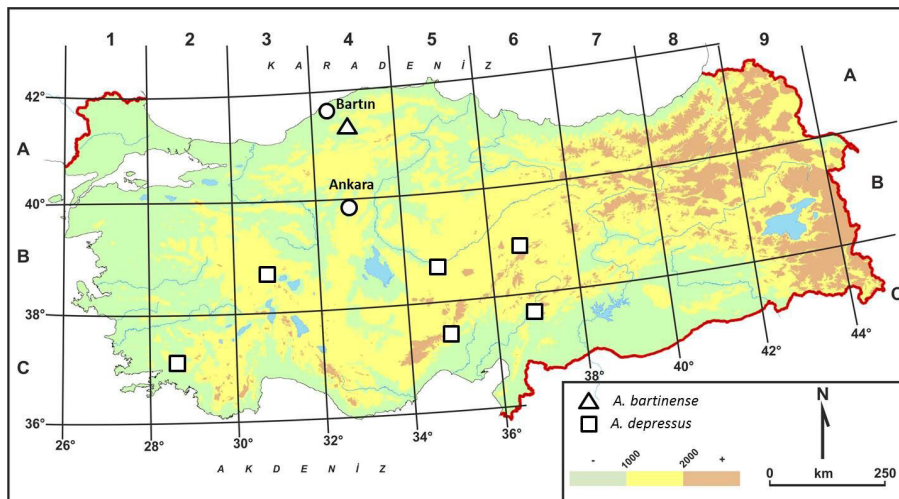


Fig. 4. Distribution of *Astragalus bartinense* and *A. depressus* in Turkey.

Wahlenb., *Lathyrus setifolius* L., *Aristolochia pallida* Willd., *Tripleurospermum oreades* (Boiss.) Rechf., *Sedum pallidum* M. Bieb. var. *pallidum*, *Asphodeline lutea* (L.) Reichb., *Isatis buschiana* Schischk. and *Alyssum repens* Baumg. ssp. *trichostachyum* (Rupr.) Hayek.

Astragalus depressus is generally distributed in the western and southern regions of Anatolia (Mediterranean Region) on high mountain steppes at elevations between 1500–2800 m a.s.l. (Fig. 4). It is also distributed in Europe and on the island of Cyprus. *Astragalus bartinense* is distributed in a different region from the other, related, taxa (Fig. 4).

Conservation status: The new species was collected from a single location and the IUCN assessment was not evaluated, because there was not much information about the population. With the available data, it should be kept in the NE category (IUCN 2020).

Discussion

The characteristic features of the section are acaulescent to caulescent, scapose habit with basifixed hairs; stipules obliquely, adnate to the petiole or free from it; bracts and bracteoles are present; legume usually bilocular. The new species is evaluated in section *Tapinodes* because of the section's characters.

The section is represented by three species in the Old World, *A. depressus*, *A. tetuanensis* and *A. froedinii*.

Astragalus bartinense is close to *A. froedinii* in leaflet pairs and stem structure, but has longer stipules (10–12 mm

long, not 2–5 mm); peduncle 10–15 mm long (not 2–5 cm); flowers spreading to nodding with age, (not erect); fruit nodding, sessile, linear, slightly falcate and hairy (not glabrous). On the other hand, it is close to *A. depressus*, but leaves shorter or longer peduncle; flowers pale violet or pink bluish, neither white nor yellow, usually cream when in dried condition; spike raceme cylindrical, not globose to shortly cylindrical.

Astragalus depressus is a polymorphic species. *Astragalus depressus* is a common species of the genus *Astragalus* in Europe, Turkey and Morocco. Therefore, its variations are quite wide. Over time, these differences were expressed and published as different taxa and in fact it has eight synonyms in recent studies of Podlech and Zarre (2013). While this new species was being described and after a review of the differences and synonyms, it was given as a new taxon. There are three important differences that distinguish this new species from the others. The first is the stipitate and glabrous ovaries, the second long spike inflorescence and the third one is the petals, pale violet to bluish pink. Other variations are given in Tab. 2. In the future, phylogenetic research on all the taxa of the section (*Tapinodes*) will contribute to the solution of these problems.

However, the distribution of *A. depressus* is generally of Mediterranean phytogeographical origin and distributed in the southern part of Anatolia (in the Mediterranean Region), while the new species is in the North of Anatolia (Euro-Siberian Region, Fig. 4).

The identification key of the section *Tapinodes* species

- 1a. Legumes hairy; bracts 3–7 mm.....2
- 1b. Legumes glabrous; bracts 1–3 mm.....3
- 2a. Peduncle 0.3–8 cm; inflorescence globose to shortly cylindrical.....*A. depressus*
- 2b. Peduncle 10–25 cm; inflorescence spike raceme.....*A. bartinense*
- 3a. Leaflets 9–14 pairs; bracts brownish to whitish membranous, 1–1.5 mm.....*A. froedinii*
- 3b. Leaflets 4–7 pairs; bracts whitish membranous, 2–3 mm.....*A. tetuanensis*

Tab. 2. Comparison of diagnostic characteristics of *Astragalus bartinense*, *A. depressus* and *A. froedinii*.

Characters	<i>A. bartinense</i>	<i>A. depressus</i>	<i>A. froedinii</i>
Stem	5–30 cm, glabrous at base, sparsely hirsute towards apex	Absent to very short, rarely up to 15 cm, glabrous	1.5–15 cm, glabrous at base, sparsely appressed upper part
Stipule	10–12 mm; lanceolate acuminate, sparsely hairy below, ± glabrous upper side, ciliate margin	3–10 mm; lanceolate acuminate, the upper ones sometimes also hairy at the tip, ciliate at margin	2–5 mm, triangular, ciliate at margin
Leaves	10–20 cm, petiole at least 1/3 times longer than lamina	3–22 cm, longer peduncle, petiole shorter or nearly as long as blade	2–6 cm, nearly sessile
Leaflets	8–14 pairs, oblong to obovate, glabrous on upper side, 5–15 × 3–10 mm	5–15 pairs, triangular to obovate, glabrous to spreading hairy on upper side, 3–10 × 2–6 mm	9–14 pairs, elliptic to obovate, glabrous on upper side, 2–6 × 1–3 mm
Peduncles	10–25 cm; densely spread hairy	0.3–8 cm, loosely to rather densely appressed to spreading hairy	2–5 cm; sparsely to loosely hairy
Inflorescence	spike raceme, cylindrical, 10–30 flowered	globose to shortly cylindrical, 15–25 flowered	globose, elongated up to 4 cm when later, (4–) 8–13 flowered
Bracts	5–7 mm, completely black hairy	3–6 mm, black ciliate	1–1.5 mm, ciliate
Calyx	3–4 mm	4–7.5 mm	3–5 mm
Calyx teeth	2–2.5 mm, linear	1–3.5 mm, subulate	1.5–2.5 mm, triangular to linear
Standard	12 mm, rounded at apex	(7–) 10–12 mm, rounded to deeply emarginate at apex	8–9 (–12) mm, emarginate at apex;
Ovary	stipitate, glabrous	sessile, very short hairy	sessile, glabrous
Legumes	15–16 mm, linear, slightly falcate, with short curved beak, sparsely spreading hairy	6–18 mm, linear, slightly curved, or straight with a short beak, appressed or rarely spreading hairy	9–15 mm, ellipsoid without to shortly curved beak, glabrous
Seed	2–3 × 1–1.5 mm, red brown	2–2.5 × 1.5–2 mm, olive green	3 × 1–2 mm, red brown

Comparison of diagnostic characteristics of the taxa is given in Tab. 2.

Specimens examined: Turkey: *A. depressus*: 29.06.1952, Davis, P.H., Dodds, J.G. & Çetik, R., 19526 (E-image: E00343338!); 12.05.1965, Coode, M.J.E. & Jones, B.M.G., 877 (E-image: E00343344!); Adana: Karsanti-Torasan Dağı, Kanlıkavak District, Kepirlik, 2150 m, 15.06.1977, Ekim 1578 (ANK!); Antalya: Gömbe-Uçarsu, 10 km, meadows, 1260 m a.s.l., 18.05.2011, F. Taeb 1016 (GAZI!); Alanya: Aktaş plateau, forest scree, 1700–1750 m a.s.l., 15.05.2006, B. Bilgili 1799 (GAZI!); Akseki, Güzelsu village, scree of forest, 1450 m a.s.l., 16.05.1995, A. Duran 2465 (GAZI!); Mersin: Mut, Kirobaşı-Silifke, scree of forest, calcareous rocks, 19.05.2011, Z. Aytaç et al. 9777 (GAZI!); Isparta: Gelendost, Gelendost-Akşehir, W Passhöhe, bergrücken mit fels, 1850 m, 29.05.1992, M. Nydegger 46119 (GAZI!); Beyşehir, Kurucaova, Radar-Karagöl, calcareous rocks, alpine, 2000–2500 m a.s.l., 24.07.1975, Peşmen 1976 (ANK!). Kahramanmaraş: Engizek Dağı, around Kavurmaçukuru, alpine steppe, 2200 m a.s.l., 17.06.1987, H. Duman 3402 (GAZI!); Kayseri: Pınarbaşı, Mezgitli-Değirmentaş villages, Soğanlı Dağı, Aslanbeyli plateau, Kurubel-Kırinsivri hills, 1800 m, 27.5.2008, B. Bani 5967 (GAZI!); Karaman: Ermenek-Kuruseki, 1200–1300 m a.s.l., rocky places, 29.04.1990, H. Duman 4462 (GAZI!).

Other countries: *A. depressus*: 05.13.1965, Coode, M.J.E. & Jones, B.M.G., 945 (E-image: E00343340!); Grisebach,

H.R.A., Greece (M-image: M0174795); 15.06.1895, Siehe, 262 (W-image: W0025424!); 15.06.1912, Siehe, 395 (E-image: 00343345!); Linnean Society of London Herbarium (LINN), LINN-HL 926–53, (original elements) Anon., Sweden (LINN-image: LINN2081514!); 04.1836, Chesney, F.R., 66, Syria (K-image: K000895621!); 07.1924, Embeger, L., Morocco (RAB-image: 182782!); 19.5.1883, Mouillefarine, E., France (RAB-image: 182782!); 20.5.1851, Bourgeau, Spain (RAB-image: RAB008703!). *A. froedinii*: 06.05.1921, Frödin, J., ca. 1350 m, Lund University Botanical Museum (LD), (LD-image: 1085572!), Morocco (RAB-image: RAB0405097!); 1921.6.8., Jahandiez, E., 666 Morocco (RAB-image: RAB0405097!); 1921.7.13., Maire, R.P., (MPU-image: MPU132107!). *A. tetuanensis*: 30.05.1981, Castroviejo, S., Fernández Casas, J., Muñoz Garmendia, F., Susanna, A., 5379, Morocco (MSB-image: MSB348321!).

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