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A new species of *Astragalus* L. (section *Onobrychoidei* DC.: Fabaceae) from Turkey

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A new species of *Astragalus* L., ***A. trabzonicus*** (section *Onobrychoidei* DC.), is described and illustrated from north-east Anatolia in Turkey. The diagnostic, pollen morphological, and chromosomal characteristics are discussed. A distribution map and conservation status are given. © 2008 The Linnean Society of London, *Botanical Journal of the Linnean Society*, 2008, **157**, 741–747.

ADDITIONAL KEYWORDS: *Astragalus* – Leguminosae – taxonomy – Turkey.

INTRODUCTION

The genus *Astragalus* L., which is one of the largest genera of vascular plants in the world, is distributed in semi-arid steppe regions. It is represented by *c*. 3000 taxa in the world. It is also the largest genus in Turkey, represented by *c*. 425 species belonging to 62 sections (Chamberlain & Matthews, 1970; Davis, Mill & Tan, 1988; Maassoumi, 1998; Podlech, 1999, 2001; Aytaç, 2000; Aytaç, Ekici & Açık, 2001; Podlech & Sytin, 2002; Duman & Akan, 2003; Ekici & Ekim, 2004). When the revision of section *Onobrychoidei* was being studied by the authors, some specimens of *Astragalus* were collected between Bayburt and Trabzon in 2002. After comparisons with the fairly similar taxa *A. adzharicus* Popov and *A. arguricus* Bunge, it was concluded that the specimens represented a hitherto undescribed species.

MATERIAL AND METHODS

The specimens of the new species were collected between Trabzon (near Araklı) and Bayburt in 2002, and deposited at GAZI. They were compared with allied taxa deposited at ANK, E, GAZI, HUB, M and MSB.

In this study, the pollen of the new and closely related species was examined using light (LM) and scanning electron microscopy (SEM). For LM, the pollen slides were prepared according to the technique developed by Woodhouse (1959). An Olympus B2-2 microscope was used for examination. For SEM, dry pollen grains were transferred to double-sided, tape-affixed stubs and vacuum-coated with gold. Photomicrographs were taken with a JEOL 200 CXII scanning electron microscope at Kırıkkale University. In this study, the terminology of Punt *et al*. (1994) was used. The morphological measurements of the pollen grains are given in Table 1.

Chromosome preparations were obtained from root tips pretreated with α-mono-bromo-naphthalene (16 h) at 4 °C and then fixed in 3 : 1 absolute alcohol–glacial acetic acid. Roots were hydrolysed in 1 M HCl at 25 °C for 12 min, and stained in 2% aceto-orcein for 2 h. Squashes were prepared in 45% acetic acid. Permanent slides were prepared in Depex.

SPECIES DESCRIPTION

ASTRAGALUS TRABZONICUS M. EKICI, AYTAÇ & H. AKAN, **SP. NOV.** (FIGS 1–4)

SECTION *ONOBRYCHOIDEI* DC.

Holotype: A8: Bayburt–Araklı (Trabzon) 41 km, steppe, 2300 m, 10.vii.2002, 40°29′273″N, 39°58′677″E, *M. Ekici 3046, Z. Aytaç & H. Akan* (GAZI).

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Table 1. Pollen morphological data of *Astragalus trabzonicus*, *A. adzharicus*, and *A. arguricus*

Species	*P*	*E*	*P/E*	Pollen shape	Aperture	Clg	Clt	Plg	Plt	Ex	Int
A. trabzonicus	35.1	26.8	1.30	Prolate	Tricolporate	27.1	2.1	7.3	9.4	1.60	0.3
A. adzharicus	34.1	27.7	1.23	Subprolate	Tricolporate	30.2	2.6	6.2	7.3	1.04	0.3
A. arguricus	31.1	25.0	1.24	Subprolate	Tricolporate	26.0	2.1	6.2	7.7	1.60	0.3

All measurements are given in micrometres. Clg, colpus length; Clt, colpus width; *E*, equatorial axis; Ex, exine thickness; Int, intine thickness; *P*, polar axis; Plg, pore length; Plt, pore width.

Diagnosis: Affinis *A. adzharicus* sed pedunculis 5–10 cm longus (non 1–4 cm). Vexillo 14–15 mm longus et retusus (non 17–20 mm longus et late emarginate). Legumina adpressus bifurcate ater et scattered expansus albus pilis (non tantum albus pilis). Pollinis grana prolate (non subprolate), chromosomatum numerus $2n = 16$ (non $2n = 32$). Ab. *A. arguricus* sed stipulis 2–4 mm longus (non 4–8 mm longus). Vexillo 14–15 mm longus et retusus (non (18–)20–25 mm longus et late emarginate). Pollinis grana prolate (non subprolate), chromosomatum numerus $2n = 16$ (non $2n = 32$) differt.

Description: PLANTS 10–40 cm tall, adpressed to spreading hairs. STEMS several to many, ascending to erect, angular-sulcate, predominantly black hairs and sparse long white bifurcate hairs. STIPULES greenish, 2–4 mm long, free from the petiole, vaginate-connate behind the stem, the free tips greenish, narrowly triangular, sparse to loose black hairs with few white hairs mixed in, especially at the base, at the margins also with simple hairs. LEAVES 3–5 cm long; petiole 1–1.5 cm long, like the rachis slender, sparse to loose predominantly white hairs. LEAFLETS in 5–13 pairs, linear to linear elliptic, 3–8 mm × 0.5–1 mm, obtuse at the apex, on upper side sparse, on underside dense adpressed white hairs 0.5–1 mm long. PEDUNCLES 5–10 cm long, sparse white hairs. RACEMES globose, densely 10–20–flowered, elongating in fruit. BRACTS 2–3 mm long, linear to lanceolate with simple hairs at margins, otherwise sparse bifurcate black hairs. PEDICELS 0.5–1 mm long, almost dense black hairs. CALYX 5–6(–7) mm long, tubular, densely covered adpressed black hairs and sparse long sub-bifurcate white hairs; teeth 2–3 mm long, linear, outer side like the calyx tube, inner side predominantly white hairs. PETALS violet. Standard 14–15 mm long, 6–7 mm wide in middle part, ± gradually narrowed into the short claw at the base, retuse at the apex. WINGS 11–12 mm long; blades narrowly oblong, obtuse to slightly retuse at the apex, 7–8 × 2–2.5 mm; auricle 1 mm long; claw 4–5 mm long. KEEL 9–10 mm long; blades oblong to oblique-ovate, obtuse to subacute at the apex, 4–4.5 × 2–3 mm; auricle 0.5 mm long; claw 4.5–5.5 mm. Staminal tube with straight mouth. STAMENS 8.5–9 mm, the upper 2.5–3 mm, free. OVARY narrowly oblong, dense hairs; style glabrous. LEGUMES pendulous, stipitate, oblong, 10–12 × 1.5–2 mm; grooved dorsally, at the apex a slightly recurved beak 2–2.5 mm long, bilocular; densely covered with adpressed short bifurcate black hairs and sparse spreading long white hairs.

Flowering time: June–July, fruiting time: July–August.

Distribution: The new species is currently known only from the type locality of north-east Anatolia (Turkey). Most species of section *Onobrychoidei* are concentrated in the centre and east of Turkey (70%). Their number decreases rapidly in the west of Turkey (30%). Endemic.

Status: Known only from the type locality. Around 100 mature specimens of the new species were observed in an area of occupancy of less than 10 km^2. The data gained from field studies were evaluated according to the World Conservation Union (IUCN) categories (Criteria B1 and B2) (IUCN, 2006), and a 'Critically Endangered (CR)' status has been proposed for the species.

Ecology: The species grows in alpine steppe, between 2300 and 2400 m altitude. Found in association with *Medicago falcata* L., *Sedum pilosum* Bieb., *Stachys macrantha* (C. Koch) Stearn, *Campanula latifolia* L., *Geranium tuberosum* L. ssp. *tuberosum*, *Pimpinella rhodantha* Boiss., *Linum hypericifolium* Salisb., etc.

RESULTS AND DISCUSSION

Amongst the section members, *A. arguricus* and *A. adzharicus* are two species with pendulous legumes in Turkey. Moreover, the fruit of the newly described species is pendulous. However, it was observed that the examined specimens of *A. arguricus* and *A. adzharicus* were insufficient. The type and other specimens of these two species were examined from different herbaria, such as E, K, GAZI, M, MSB

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Figure 1. ***Astragalus trabzonicus*** (*M. Ekici 3046*): A, habitus; B, calyx; C, standard; D, wings; E, keel; F, stamens; G, ovary.

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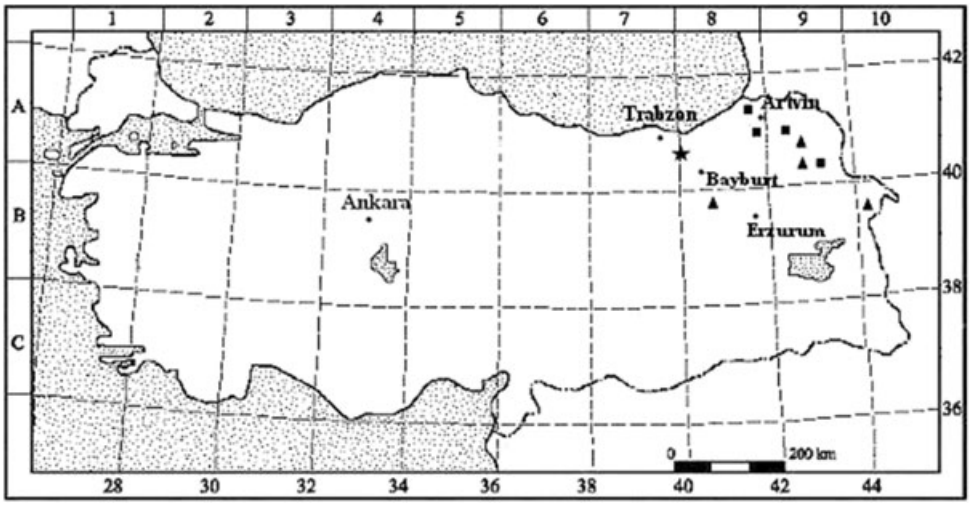
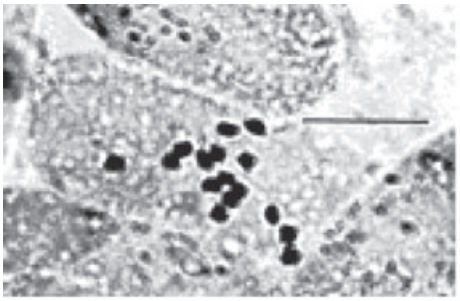
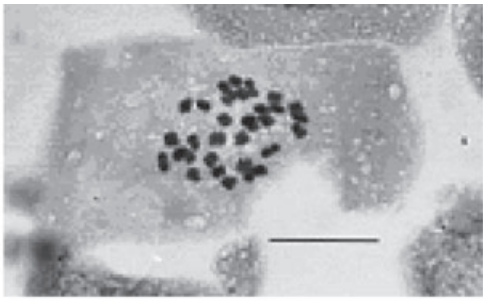


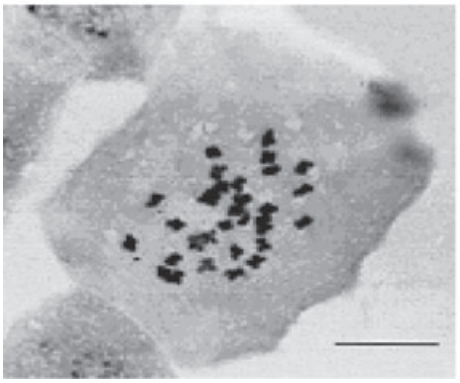
Figure 2. Distribution of ***Astragalus trabzonicus*** (★), *A. adzharicus* (■), and *A. arguricus* (▲) in Turkey.



A. trabzonicus (M. Ekici 3046)



A. arguricus (M. Ekici 3151)



A. adzharicus (M. Ekici 2444)

Figure 3. Chromosome numbers of the species (bar, 10 μm).

and W. The specimens examined in herbaria and the collected materials from the field are given in the Appendix.

For the species of *A. adzharicus*, the standard length is given as *c*. 15 mm in the *Flora of the USSR* and 15–20 mm in the *Flora of Turkey and the East Aegean Islands* (Shishkin, 1965; Chamberlain & Matthews, 1970). However, from the studies on specimens collected in different parts of Turkey and outside Turkey, the standard length was measured to be a minimum of 17 mm. The standard is widely emarginate at the apex.

For the species of *A. arguricus*, the calyx length is given as 10–12 mm in the *Flora of Turkey and the East Aegean Islands* and (6–)8–10 mm in the *Flora of the USSR*. Thus, there is a definite difference for the

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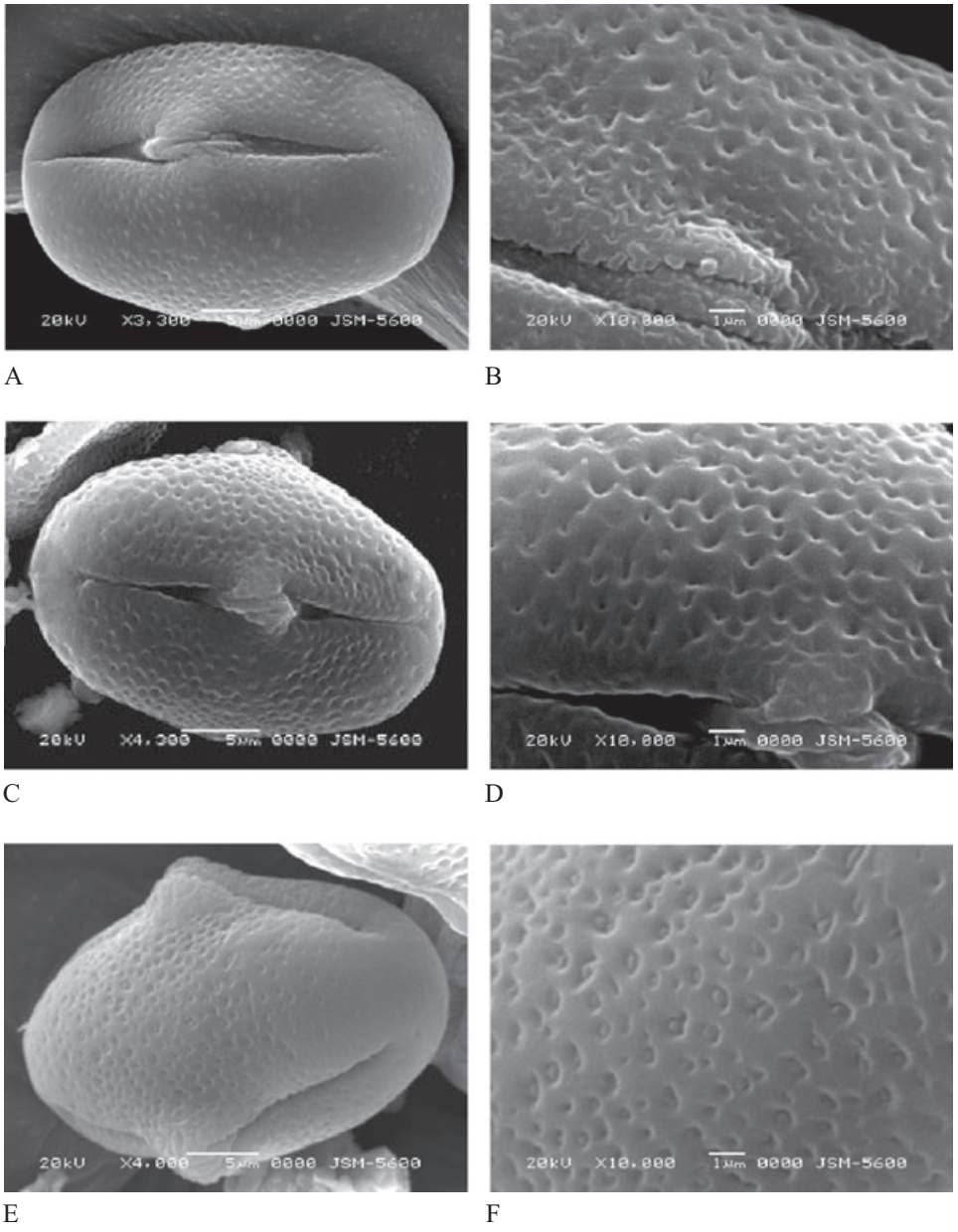


Figure 4. A–F, Pollen grains (scanning electron microscopy, SEM) of ***Astragalus trabzonicus***, *A. adzharicus*, and *A. arguricus.* A, B, SEM of pollen grain of ***A. trabzonicus*** (*M. Ekici 3046*) and detail of ornamentation. C, D, SEM of pollen grain of *A. adzharicus* (*M. Ekici 2442*) and detail of ornamentation. E, F, SEM of pollen grain of *A. arguricus* (*M. Ekici 2409*) and detail of ornamentation.

same species in the two references (Shishkin, 1965; Chamberlain & Matthews, 1970). However, as a result of examining the type specimen and the samples taken from the type localities, as well as the samples collected from abroad, it was established that the calyx length is 8–10 mm. Taking into consideration the differences between the data obtained and those given in Table 2, it was decided that the sample collected between Araklı (Trabzon) and Bayburt is a species new to science.

From an examination of herbarium materials, the diagnostic characters of these three species are given in Table 2. The three species can be distinguished from each other by the following key.

CYTOLOGICAL FINDINGS

The chromosome numbers in section *Onobrychioidei* show variations between $2n = 16$ and $2n = 64$. In *A. trabzonicus*, $2n = 16$. In *A. arguricus* and *A. adzha-*

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Table 2. Comparison of the characteristics of *Astragalus trabzonicus* with those of its two nearest allies

Character	***A. trabzonicus***	*A. adzharicus*	*A. arguricus*
Stipules	2–4 mm long	2–3 mm long	4–8 mm long
Leaves	3–5 cm long	1.2–4 cm long	5–12 cm long
Leaflets	3–8 × 0.5–1 mm, linear to linear-elliptic	2–8 × 1–2 mm, narrowly elliptic to elliptic	4–13 × 1.5–3 mm, narrowly oblong to narrowly ovate
Peduncles	5–10 cm long	1–4 cm long	5–18 cm long
Calyx	5–6(–7) mm long	7–9 mm long	8–10(–12) mm long
Standard	14–15 mm long, retuse at the apex	18–20 mm long, widely emarginate at the apex	(18–)20–25 mm long, deeply and widely emarginate at the apex
Legume	10–12 × 1.5–2 mm, densely covered with adpressed short bifurcate black hairs and sparse spreading long white hairs	8–10 × 2–3 mm, loosely to densely covered by subadpressed to spreading white hairs	12–20 × 1.5–2 mm, subadpressed to spreading long white hairs and with sparse short bifurcate black hairs
Chromosome number	$2n = 16$	$2n = 32$	$2n = 32$
Pollen type	Prolate	Subprolate	Subprolate

1. Peduncle 1–4 cm long; legume 8–10 mm, covered only by white hairs..... *A. adzharicus*
1. Peduncle at least 5 cm long; legume 10–20 mm long, covered by black and white hairs
2. Leaflets linear to linear-elliptic; standard 14–15 mm long, retuse at the apex..... *A. trabzonicus*
2. Leaflets narrowly oblong to narrowly ovate; standard (18–)20–25 mm long, deeply and widely emarginate at the apex..... *A. arguricus*

ricus, $2n = 32$ (Fig. 3). All section species in Turkey are diploid, based on $x = 8$.

POLLEN MORPHOLOGY

The pollen grains of the studied taxa are radially symmetrical, isopolar, and zonotricolporate. The sizes of the pollen grains [polar axis (*P*) × equatorial axis (*E*)] are as follows: *A. trabzonicus*, 35.1 × 26.8 μm; *A. adzharicus*, 34.1 × 27.7 μm; *A. arguricus*, 31.1 × 25.0 μm. The ratio of *P* to *E* is 1.30 (prolate in shape) for *A. trabzonicus* and *A. adzharicus*, and 1.23–1.24 for *A. arguricus*. Exine sculpturing of all three species is microreticulate. The exine thickness is 1.6 μm in *A. trabzonicus* and *A. arguricus*, and 1.04 μm in *A. adzharicus*. Tectum pertectate; ectexine thicker than endexine. Intine thickness of all species is 0.3 μm (Table 1, Fig. 4).

The pollen grains of *Astragalus* species occurring in Turkey are usually stenopalynous. The pollen grains of the studied taxa are radially symmetrical, isopolar, and tricolporate, and the ornamentation is microreticulate. The pollen type is prolate for *A. trabzonicus*, and subprolate for *A. adzharicus* and *A. arguricus*. The pollen characteristics of the three species are given in Table 1. The photographs of the pollen grains (SEM) are given in Figure 4A–F.

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APPENDIX

SPECIMENS OF *A. ADZHARICUS* AND *A. ARGURICUS* EXAMINED

Astragalus adzharicus Popov

Type: [Gruzia] in Adzharia, ad fl. Adzhariszkali, prope Kedy, 21.v.1939, *M. Popov* (TBI: photo K).

Turkey: A8 Artvin: stony bank, 500 m, 15.iv.1960, *Stainton 8188* (E); Borçka–Murgul road, Tiryal Mt., Kokolet dere mevki, orman içi, *c*. 450 m, 18.iv.1976, *A. Düzenli 584* (E); Chachila-Dere near Artvin, 15.iv.1996, *Khokhrjakov & Sytin* (MSB); surroundings of Artvin, 13.iv.1996, *Khokhrjakov & Sytin* (MSB); 12.iv.1996, *Khokhrjakov & Sytin* (MSB); Şavşat–Artvin 62 km, steppe, 350 m, 11.vi.2001, *M. Ekici 2444 & H. Akan* (GAZI). A9 Kars: 10 km from Kağızman to Iğdır road, 43°8′E, 40°10′N, 2.vii.1963, *E. Jardine 552* (E); Ardahan: Ardahan–Ardanuç 2 km, steppe, 1850 m, 11.vi.2001, *M. Ekici 2442, H. Akan* (GAZI).

Georgia: *Adzharia*: in fauce fl. Adzhariszkali, prope pag. Hulo, 11.vi.1986, *Sytin* in Herb. Fl. SSSR *7129* (MSB).

Astragalus arguricus Bunge ≡ Tragacantha argurica (Bunge) Kuntze

Type: [Turkey] in valle Arguri in monte Ararat, 2.vi.1856, *N. von Seidlitz* (P: photo MSB; iso: G-BOIS photo, MSB).

Turkey: A9 Kars: between Kars and Susuz, 1800 m, 1.vi.1957, *Davis 29582 & Hedge* (K); Kağızman–Cumaçay 26 km, 1800 m, meadows, 14.vii.2002, 40°04.662′N, 43°16.916′E, *M. Ekici 3151, Z. Aytaç, H. Akan* (GAZI). B8 Erzurum: Erzurum to Ispir, 20 km west of Ilıca, 1930 m, 29.vi.1992, *Nydegger 46513* (MSB). B10 Kars: in valle Arguri [Ahuri] in monte Ararat, 2.vi.1856, *Seidlitz* (MSB); 34 km from Doğubeyazıt to Iğdır, on north side of Pamuk Mt., 1750 m, rocky igneous slopes, 24.v.1966 *Davis 43497* (E); Ağrı: Doğubeyazıt–Iğdır 20 km, scree places, 1700 m, 9.vi.2001, *M. Ekici 2409 & H. Akan* (GAZI).

Azerbaijan: Azerbaijan: Karabaghla distr., prope Dagmas [Daralagez Mts.], 7.v.1949, *Akhverdov* (W); near Dzhabrail vill., Dagtumas, Karabagh Range, 11.vi.1982, *Sytin* (MSB); Nakhichevan: Daralagez Range, Bichenekh Pass, 9.vii.1981, *Sytin & Shanzer* (MSB); Buzgov, 2.vi.1982, *Sytin* (MSB).

Armenia: Foothills on Mt. Aragats, village Aparan, 22.vi.1982, *Sytin & Shanzer* (MSB); Mt. Aragatz, canyon of river Kasach, 22.vi.1982, *Sytin & Shanzer* (MSB).

Georgia: Prope opp. Achaltziche, p. Minadze, in valle fl. Kura, 2.vi.1981, *Sytin* in Herb. (M); near Akhalsikhe, 13.vii.1982, *Sytin* (MSB); near town Akhalkalaki, south slopes of valley of river Toparavani, 15.vii.1981, *Sytin & Schanzer* (MSB).

Iran: Azerbaijan Garbi: in valle fluvii Qotur W Khvoy versus fines Turcicas, 1800–2000 m, 10.vi.1971, *Rechinger 41573* (M); Azerbaijan Sharqi: Pass 29 km south-east of Asheqli (Asheglou) in the Aras valley at road to Kaleibar, Arasbaran protected area, 2600 m; 46°49′E, 38°50′N, 20.vi.2001, *Podlech, Maassoumi & Zarre 55307* (MSB); 20 km north of Ahar at road to Kaleibar, 1770 m, 20.vi.2001, *Podlech et al. 55335* (MSB); Astara to Ardabil, Gardaneh-ye Heyran, 1450–1650 m, 24.v.1977, *Termeh & Matine 36778-E* (W); 15 km from Ardabil to Khalkhal, 1500–2000 m, 23.v.1974, *Termeh & Moussavi 16473-E* (W); 10 km from Khalkhal to Asalem, 30.vi.1977, *Moussavi 36807-E* (W); in jugo Goja Bel 30 km south-west of Ahar, 1800 m, 30.v.1971, *Rechinger 40635* (M, W); 22 km south-west of Ahar, 1550 m, 19.v.1960, *Pabot 3250* (MSB).

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