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Source: Willdenowia, 37(1) : 297-304

Published By: Botanic Garden and Botanical Museum Berlin (BGBM)

URL: https://doi.org/10.3372/wi.37.37118

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Two new species of *Astragalus* sect. *Anthylloidei (Fabaceae)*

Abstract

Sabaii, T., Zarre, S. & Podlech, D.: Two new species of *Astragalus* sect. *Anthylloidei (Fabaceae)*. – Willdenowia 37: 297-304. – ISSN 0511-9618; © 2007 BGBM Berlin-Dahlem.
doi:10.3372/wi.37.37118 (available via http://dx.doi.org/)

Astragalus fissicalyx and *A. veiskaramii* are described as species new to science and illustrated. Based on gross morphology and petiole anatomy the relationships between the new species and their closest relatives, i.e. *A. diopogon* and *A. anthylloides,* respectively, are discussed.

Key words: *Leguminosae,* taxonomy, *Astragalus fissicalyx, Astragalus veiskaramii,* Iran, Pakistan.

Introduction

Astragalus sect. *Anthylloidei* DC. *(Fabaceae)* as circumscribed by Podlech & Zarre (2001) includes *A.* sect. *Halicacabus* Bunge and *A.* sect. *Megalocystis* Bunge. The species of this section are cushion forming plants, mostly with paripinnate leaves and inflated fruiting calyces. They are distributed in several SW Asian countries, but Iran with 24 species is the centre of diversity of this section; some diversity of species are found also in Turkey (five species) and Afghanistan (four species). As one of the most heterogeneous and difficult groups of spiny *Astragali*, the section has been revised several times as a whole (Bunge 1868-69, Boissier 1872, Tietz & Zarre 1994) and for the area of Flora Iranica (Podlech & Zarre 2001). However, in these studies some specimens were treated as doubtful, because of deficiency of material or lack of adequate data. Cladistic studies based on morphology (Zarre 2000) and molecular systematics (Kazempour Ossaloo & al. 2003, 2005) show that *A.* sect. *Anthylloidei* in its present form is polyphyletic.

In order to solve the problems regarding the morphological heterogeneity of the section and of the doubtful specimens, a detailed morphological and anatomical study has been conducted by the first author on the species attributed to this section and other related groups. As a part of the results of this analysis *A. fissicalyx* Sabaii, Zarre & Podlech and *A. veiskaramii* Zarre, Podlech & Sabaii are described here as new species.

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Material and methods

This study is mainly based on observation and measurement of morphological and anatomical characters in all available samples of *Astragalus* sect. *Anthylloidei,* especially *A. anthylloides* DC., *A. diopogon* Bunge and *A. halicacabus* Lam. as well as the new species related to them and described here. The material studied is mainly deposited in M, MSB and TUH (abbreviations according to Holmgren & Holmgren 1998-).

Drawings were made using a Camera Lucida attached to an "Olympus SZH-10 Research Stereo" dissecting microscope.

For anatomical studies the middle part of the leaf petiole, which previously has been reported as the most characteristic part of the leaf (Haddad & Barnett 1989, Engel 1990, 1991, Pirani & al. 2006) was selected for cross sectioning. Mature spine rachides on the youngest stems were removed and boiled in a mixture of glycerin/lactic acid/absolute ethanol (1:1:1) for a few minutes (Radford & al. 1974). Cross sections were made by hand using commercial razor blades. The sections were stained with safranin-crystal violet-fast green (Gerlach 1977). The cross sections were dehydrated through an ethanol gradient and finally toluene (99.5 %) and then mounted on slides using Canada balsam. They were studied using an Olympus VANOX AHBS3 light microscope with 125× to 412.5× magnifications. Anatomical characters were selected and quantified, i.e. diameter of the cross section, diameter of the median vascular bundle including the surrounding sclerenchymatous sheath, diameter of the lateral ventral bundles including their surrounding sclerenchymatous sheath, and thickness of the pith (Fig. 2, Table 1). At least five sections were selected and measured for each species in order to ensure about the constancy of spine characters among the samples studied.

The distribution map of the new species (Fig. 3) is provided using the DMAP program package version 10 (Morton 2004).

Results and discussion

Astragalus fissicalyx Sabaii, Zarre & Podlech, **sp. nov.**
Holotypus: [Pakistan], Dera Ghazi Khan, Montes Sulaiman, Fort Munro, 1600-1800 m, 18.5. 1965, *Rechinger 29758* (M!; isotypus: W!) – Fig. 1, 2A.

Differt ab *Astragalo diopogon* Bunge calyces fissilis non inflatus, 7-8 mm (nec 8-13 mm) longus et inflorescencis 8-15-floris (nec 3-5-floris).

Perennial cushion forming plants, c. 25 cm tall, densely crowded from the base. *Hairs* 0.2-1.5 mm long, exclusively white. *Stems* ascending, up to 20 cm long, growing 5-6 cm per year, in current year 1-1.5 mm in diam. *Stipules* papery, whitish yellow, 10-13 mm long, 5-6 mm adnate to petiole, otherwise 3 mm connate to each other, lanceolate, long-acuminate, ciliate. *Leaves* paripinnate, 1.5-3 cm long; rachides dense, rigid, ± straight, densely subappressed-hairy; petiole $^1/_2$-$^1/_3$ as long as the rachid; terminal spine 1.5-2 times as long as the uppermost leaflet; leaflets in 4-6 pairs, dense, 2-7 × 0.75-1.5 mm, lanceolate to narrowly ovate, acute, with a mucro up to 1 mm long, very densely covered by appressed or subappressed hairs. *Inflorescence* distinctly shorter than the leaves, densely few-flowered, 1.5-2.5 cm long and 0.75 cm in diam., globose; *peduncle* 0.2-0.5 cm long, densely covered by subappressed hairs; *pedicels* 0.2-1 mm long. *Bracts* papery, 1.5-3.5 × 0.7-1.5 mm, lanceolate to ovate, acuminate, glabrous at base, sparsely subappressed-hairy further up. *Calyx* yellowish, tubular, 7-8 × 5-6 mm, with 12-13 parallel veins, densely subappressed-villous; teeth subulate-filiform, 2-3 mm long. *Corolla* purple; *standard* 9-11 mm long, limb 5.5 × 5.5-6 mm, orbicular, retuse at apex, ± rounded at base, claw 5.5 mm long; *wings* as long as or slightly longer than standard, limb 4-5.5 × c. 2.5 mm, obovate, obtuse at tip, auricle c. 0.5 mm long, claw 5.5-6 mm long; *keel* 8.5-10.5 mm long, limbs 3.5 × 2 mm, triangular, with curved lower edge and curved upper edge, acute, claw 6.5 mm long. *Stamens* at upper 2.5 mm free from each other. *Pods* coriaceous, 3-6 mm long, 1.5-3 mm high and 2-4 mm wide, dorsiventrally compressed, densely appressed-hairy. *Seeds* 3-6?, immature.

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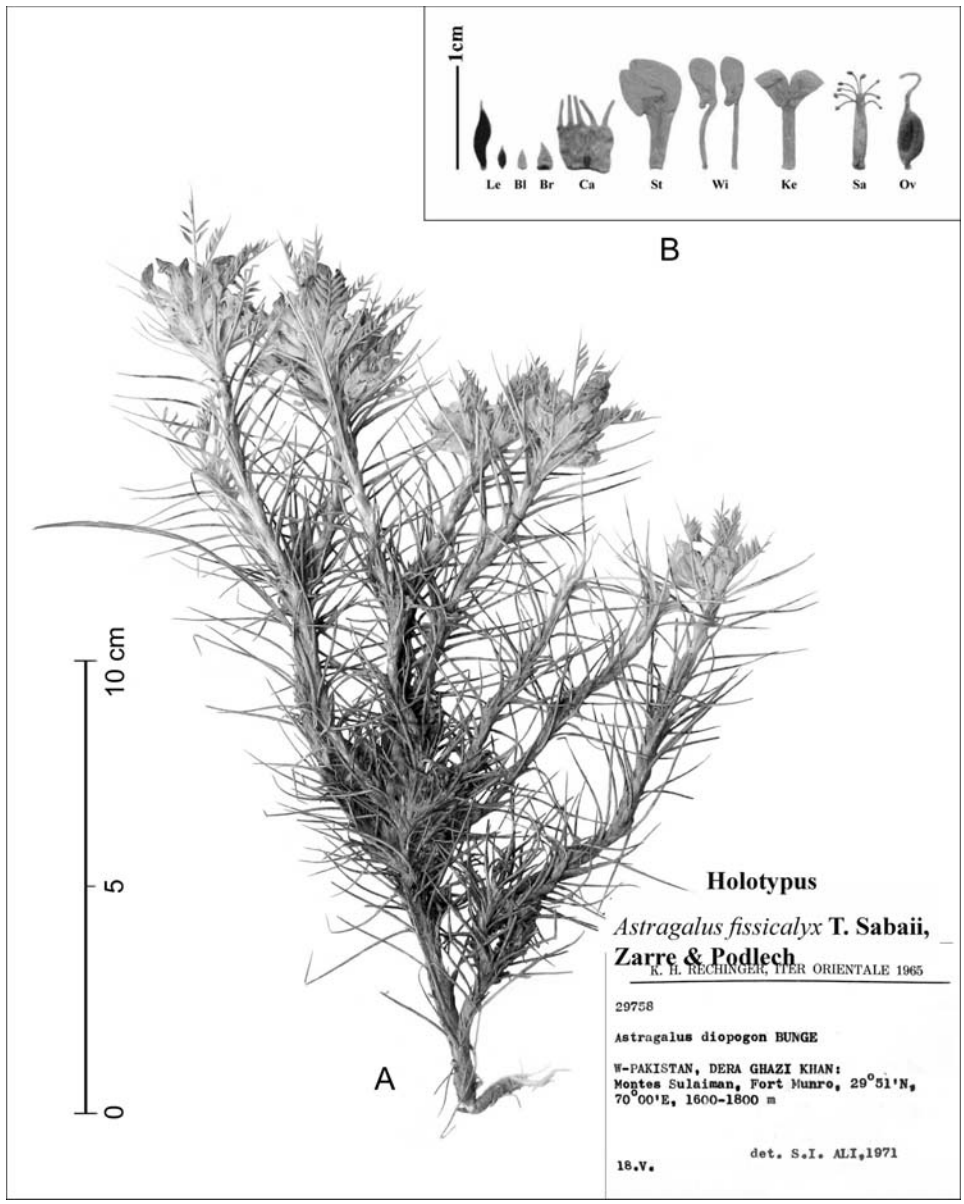


Fig. 1. *Astragalus fissicalyx,* holotype (M) – A: habit; B: leaflets and flower dissection. – Abbreviations: Le = leaflets, Bl = bracteoles, Br = bract, Ca = calyx, St = standard, Wi = wing, Ke = keel, Sa = stamen, and Ov = ovary.

Etymology. – The specific epithet refers to the rupturing calyx, which is an important diagnostic character in separate this new species from *A. diopogon*.

Comparison with related species. – *Astragalus fissicalyx* is closely related to *A. diopogon* known from Afghanistan and Pakistan. The differences in calyx size and the type of calyx opening (calyx rupturing at fruiting time instead of inflating) separate these species from each other.

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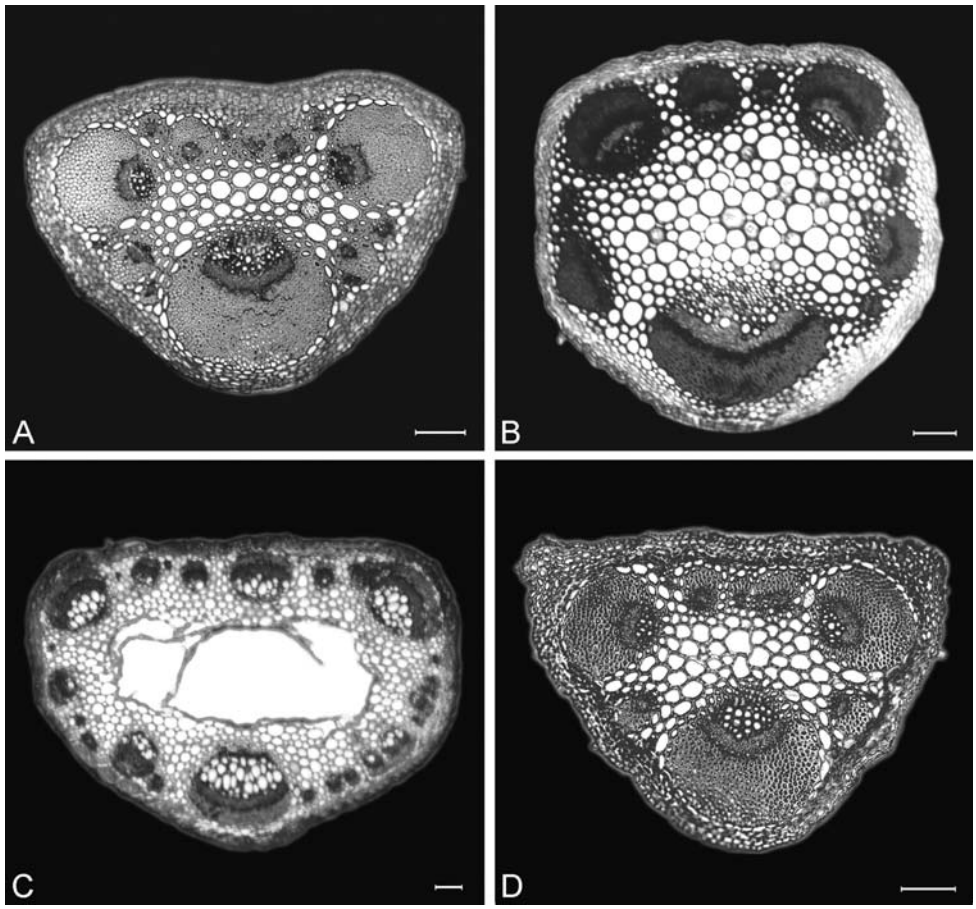


Fig. 2. Cross section of the spine petiole in species of *Astragalus* sect. *Anthylloidei* – A: *A. fissicalyx;* B: *A. halicacabus;* C: *A. veiskaramii;* D: *A. diopogon*. – Scale bars: = 0.1 mm.

The calyx shape and the reduced peduncles and pedicels suggest a relationship of *A. fissicalyx* to the species of *A.* sect. *Adiaspastus*. However, the new species is not comparable with any species belonging to the latter section. *A. fissicalyx* can be considered as a taxon connecting two sections with each other, and produces further evidence on lacking sharp borders between sections in spiny *Astragali* (see also Zarre & Podlech 1997). The petiole anatomy shows no signifi-

Table 1. Selected characters from cross sections of spine petioles (near middle) of 6 taxa of *Astragalus* sect. *Anthylloidei* distributed in Iran. The measures represent means. – Abbreviations: DMB = dorsal median bundle, LDV = length of dorsi-ventral axis, LVA = length of ventral axis, VLB = ventral lateral bundle.

Species	LVA [mm]	LDV [mm]	Diameter of DMB [µm]	Diameter of VLB [µm]	Diameter of the pith (cell layers)
A. diopogon	0.8	0.58	300	200	4
A. fissicalyx	0.9	0.65	340	220	5
A. halicacabus	1.52	1.27	360	290	12
A. veiskaramii	1.72	1.21	410	330	12-14

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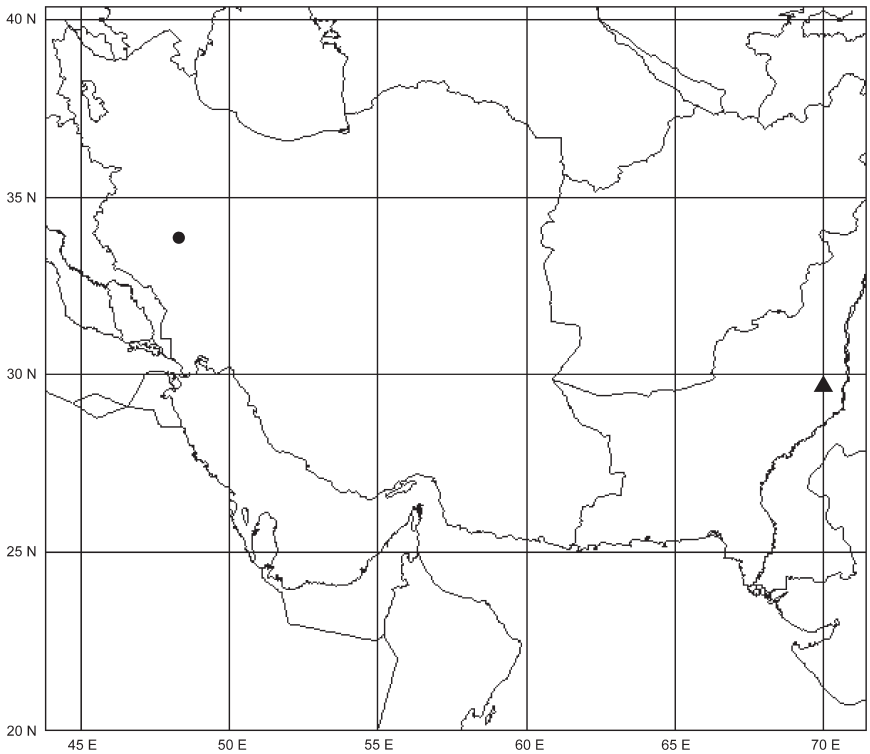


Fig. 3. Distribution of *Astragalus fissicalyx* (▲) and *A. veiskaramii* (●).

cant difference between *A. diopogon* and *A. fissicalyx,* thus confirming their close relationship with one another (Table 1, Fig. 2A, D).

Astragalus veiskaramii Zarre, Podlech & Sabaii, **sp. nov.**
Holotypus: Iran, Prov. Lorestan, Khorramabad, Veissian, Chal-e Ahmad, 1600 m, 10.5.1999, *Veiskarami 23727* (TUH!; isotypus: MSB!) – Fig. 4.

Differt ab *Astragalo anthylloide* Lam. stipulis magnis (ad 30 mm nec 6-10 mm longis), bracteis linearis, 9-12 mm (nec lanceolato-ovatis, 4-6 mm) longis et tepalis violaceo-purpureis (nec palide sulfureis ad roseis), ab *A. halicacabo* Lam. pilis densis longis appressis (nec sparsis, patule et brevis), bracteis linearis (nec ovatis) et inflorescencis densis (nec remotifloris).

Perennial herbaceous plants with woody base and remainders of last year's rachids, 12-35 cm tall, subacaulescent. *Hairs* white or on the inflorescence mixed also with black ones, 0.1-1.5 mm long. *Stipules* 15-30 mm long, narrowly triangular, adnate to the petiole for c. ½ of their length, at the base connate; papery, yellowish white, with distinct parallel nerves, densely appressed-hairy, becoming glabrescent. *Leaves* imparipinnate, 10-30 cm long; *petiole* 5-8 cm long, densely spreading-hairy; *Leaflets* in 12-30 pairs, ± remote, elliptic-oblong, 3.5-12 × 1-4 mm, retuse to rarely obtuse, with mid vein prominent on lower surface, both surfaces covered by ± dense, appressed hairs and among them with some spreading ones. *Inflorescence* dense, 10-25-flowered; *peduncle* ascending, 6-25 cm long, spreading-hairy; raceme 3-7 cm long, densely cylindrical. *Bracts* papery, linear, 9-12 × 0.7-1.5 mm, densely covered with appressed to subappressed, white and black hairs. *Pedicels* 0.5-2 mm long, with black hairs. *Bracteoles* subulate to linear, c. 3 mm long, at the

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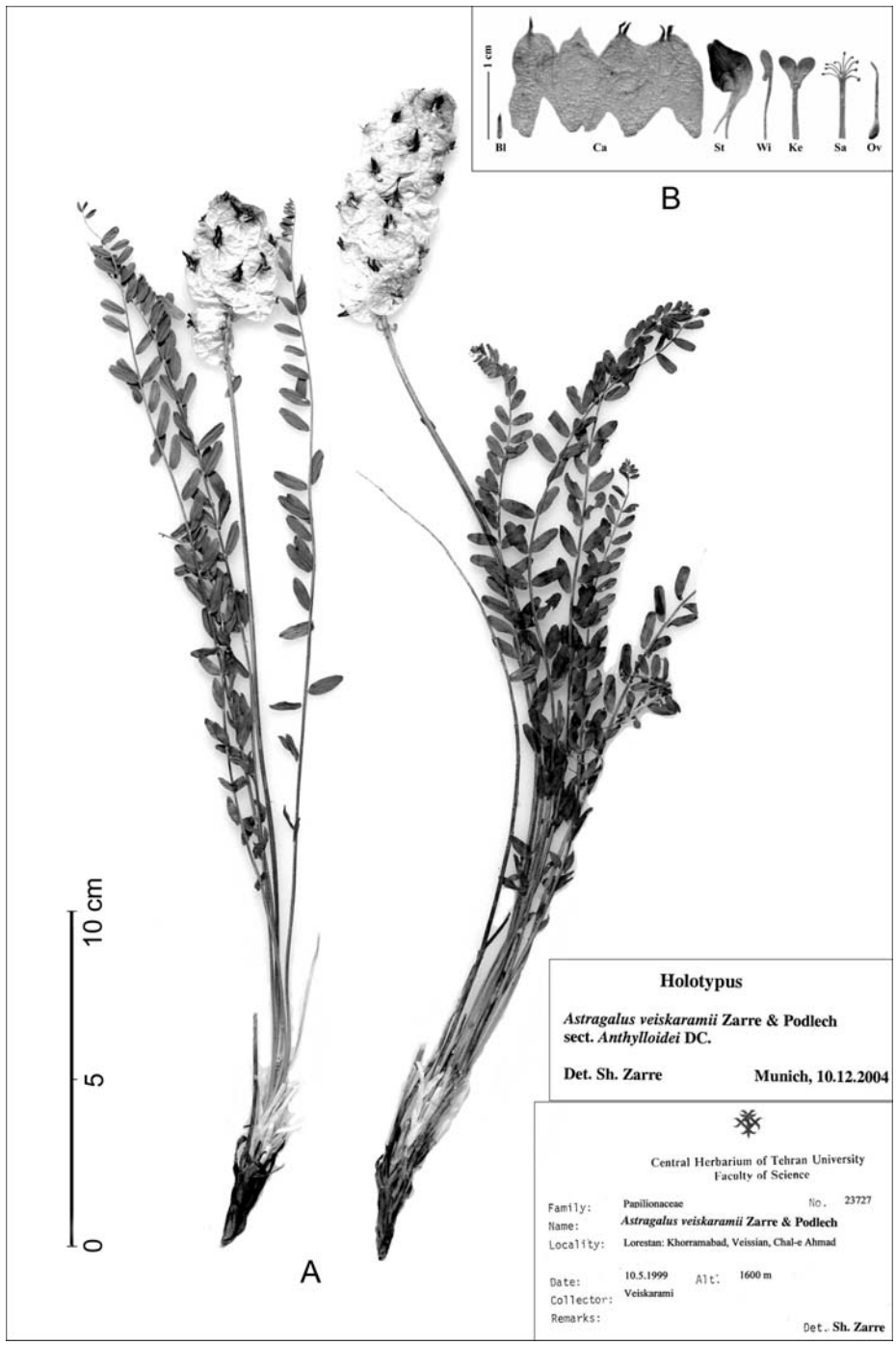


Fig. 4. *Astragalus veiskaramii,* holotype (TUH) – A: habit; B: flower dissection. – Abbreviations: Ca = calyx, St = standard, Wi = wing, Ke = keel, Sa = stamen, and Ov = ovary.

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Table 2. Comparison of *Astragalus veiskaramii* with its close relatives.

	Stipule length [mm]	Bract shape	Bract length [mm]	Petal colour	Inflorescence	Length of calyx hairs [mm]
A. anthylloides	6-10	ovate	4-6	yellowish to pink	loose	1.5
A. halicacabus	6-12	lanceolate	3-4	yellowish to pink	loose	0.7
A. veiskaramii	15-30	ovate	9-12	dark purple	loose	2

base of the calyx. *Calyx* considerably inflating after anthesis, reticulately veined, with 14-20 main veins, ovoid to ellipsoid, sparsely covered with spreading black hairs up to 1 mm long and among them with some longer (up to 1.5 mm) white ones; teeth subulate with triangular base, 2-3 mm long. *Corolla* purple; *standard* 17-24 mm long, limb ovate, 7-8 mm wide, emarginate at apex, subabruptly contracted into the long and in upper part widely cuneate, in basal part narrow claw; *wings* 15-22 mm long, limbs oblong to narrowly obovate, obtuse, 5-6 × 2-3 mm, auricle c. 0.5 mm long, claw 10.5-16.5 mm long; *keel* 14-19 mm long, limbs 5-6 mm long, obovate to triangular, with tiny mucro, claw 9-13 mm long. *Stamen* at upper 2.5-3 mm free from each other. *Pods* coriaceous, shortly stipitate, narrowly ellipsoid, 8-9 mm long, ± keeled ventrally and dorsally, with a straight beak c. 1 mm long, densely appressed-hairy.

Eponymy. – The species is named in honour of Mr A. Veiskarami, the collector of the type material.

Comparison with related species and distribution of the species. – *Astragalus veiskaramii* is an interesting species representing another example of disjunct distribution within *A.* sect. *Anthylloidei*. The closest relative to the new species is *A. anthylloides* distributed in Turkey. *A. anthylloides* and its allies are completely absent from Zagros mountain range in Iran, except for *A. veiskaramii,* which is distributed in the south of Zagros (Fig. 3). The major differences between *A. veiskaramii* and *A. anthylloides* are given in Table 2. *A. coluteoides* DC., distributed in Lebanon and Syria, is another example of disjunction within *A.* sect. *Anthylloidei*. The relation between elements of Zagros mountain range and that of Anatolian highland have been shown also in the case of *A. kordloricus* Zarre, a species known from central Zagros and closely related to *A. noeanus* Boiss. from central Anatolia (Zarre 2000).

The new species can also be compared with *Astragalus halicacabus*, another species of the section with large stipules and imparipinnate leaves and distributed in Iran. The indumentum of *A. halicacabus* is composed of sparse, short and flattened hairs not longer than 0.7 mm, whereas spreading hairs of about 1.5 mm length on the calyx are characteristic for *A. veiskarami*.

The petiole anatomy shows significant differences between *A. veiskaramii* and *A. halicacabus* (Table 1, Fig. 2B, C). The leaf petioles of *A. veiskaramii* are larger in diameter (mean of ventral axis = 1.72 mm against 1.52 mm in *A. halicacabus*) the main vascular bundles are larger (mean diameter of the dorsal main bundle = 410 µm against 360 µm in *A. halicacabus*) and the pit cells are in 9-11 rows (compared with 12-14 cells rows in *A. halicacabus*).

Acknowledgement

The authors are grateful to an anonymous referee for useful suggestions and improvements.

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