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A synopsis of genus *Astragalus* L. sect. *Stereothrix* Bunge (Fabaceae)

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Abstract

A synopsis of *Astragalus* sect. *Stereothrix* Bunge (Fabaceae) is presented and the relationships between the species are discussed within the section. A description for the section and a key to its 15 species in Iran are given. Also two ignored species belonging to the section in Flora Iranica, *Astragalus badelehensis* Maassoumi & Taheri and *A. mahneshanensis* Maassoumi & Moussavi, are reviewed again here. *A. savanatensis* and *A. andabilensis* collected from Fars and Ardebil Provinces of Iran, respectively are described as new species, illustrated are compared with their nearest relatives. *A. savanatensis* is a rare species in the subalpine areas of Estahban and closely related to *A. ledinghamii* Barneby occurs in the same area. The habit, shape of calyx and petals are very similar in both species, but *A. savanatensis* differs sufficiently from its relative by having peachy flower (vs. yellowish white), plant length 24.5 -- 34 cm (vs. 7 -- 20 cm), stem length up to 20 cm (vs. 1 -- 3 cm), leaflet in 4–6 (vs. 2 -- 4) pairs, leaflet size 5 -- 45 × 1 -- 3 mm (vs. 7 -- 25 × 1.3 -- 2 mm), keel length 8 -- 10 mm (vs. 6.8 -- 7.6 mm) and peduncle length 9.3 -- 18.5 cm (vs. 2 -- 6 cm). *A. andabilensis* is a rare species occurs in the subalpine areas of Khalkhal and closely related to *A. capito* Boiss. & Hohen. occurs in Tehran province. The habit, shape of calyx and petals are very similar in both species, but *A. andabilensis* differs sufficiently from its relative by plant length 11.5 -- 21.5 cm (vs. 4 -- 9 cm), white stem hairs toward the nodes increasingly black (vs. all white stem hairs), appressed hairs on the upper sides of leaflets (vs. spreading hairs), white peduncle hairs toward the raceme increasingly black (vs. all white hairs) and peduncle length 5 -- 14.5 cm (vs. 0.5 -- 2 cm). In addition, meiotic chromosome number and behavior were studied in the new species. This report is the first cytogenetic analysis of these taxa. Both species are diploid plants and possess 2n = 2x = 16 chromosome numbers, consistent with the proposed base number of x = 8. The general meiotic behavior of the species was regular, with bivalent pairing and normal chromosome segregation at meiosis. However, some meiotic abnormalities in *A. savanatensis* include varied degrees of ring and fragmented chromosomes, precocious migration in metaphase I and II, bridges and laggards in anaphase I and II, micronuclei in telophase I, binucleate in telophase I and II and tripolar cells in telophase II. In *A. andabilensis*, fragmented chromosomes in metaphase I and II were observed. Asynchronism in meiosis was seen in both species.

Key words: *Astagalus savanatensis*, *A. andabilensis*, Iran, Meiotic behavior, *Astragalus*, Sect. *Stereothrix*

1. Introduction

The genus *Astragalus* L. is belonging to the tribe Astragaleae of Papilionoideae in the family Fabaceae, occurring in cold mountainous regions of Europe, Asia, and North America, and is the most numerous in Central Asia (Ranjbar and Karamian, 2003; Polhill, 1981). In terms of species number, *Astragalus* may be the largest genus of vascular plants, represented by a total of ca. 2500 taxa (Lock and Simpson, 1991; Mabberley, 1997; Maassoumi, 1998; Ranjbar and Karamian, 2002). Iran has more than 840 species and is one of the main centers of diversity of the genus (Lock and Simpson, 1991; Mabberley, 1997; Maassoumi, 1998; Ranjbar and Karamian, 2002; Ranjbar et al., 2012). *Astragalus* has been divided into approximately 150 sections, of which *Astragalus* sect. *Stereothrix* is one of the most diverse and variable. *A.* sect. *Stereothrix* was established by Bunge (1868/69), naturally placed in the *A.* subgen. *Hypoglottis*, which is characterized by perennial growth and the presence of simple hairs (Bunge, 1868-1869). The entire section was revised by Podlech (2009) for the Flora Iranica. *Astragali* such as *A.* sect. *Dasyphyllium*, *A.* sect.

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Stereothrix, *A.* sect. *Hypoglottoidei* along with *A.* sect. *Malacothrix* classified under *A.* subgen. *Hypoglottis* Bunge. Recently, two sections, *A.* sect. *Hemiphaca* and *A.* sect. *Hemiphragmium* have been transferred into *A.* subgen. *Hypoglottis* (Ranjbar and Karamian, 2002).

Chromosome counts, based on x = 8 have been reported in the vast majority of Old World species. In addition, counts based on base numbers of x = 6 or x = 7 have been encountered in few species (Maassoumi, 1987; Bader et al., 1996). Meanwhile, studies on the cytology of *Astragalus* in America (Ledingham and Rever, 1963; Pretel Martinez, 1974; Liston, 1990; Dopchiz et al., 1995) confirmed the existence of basic numbers ranging between 11 and 15. The preponderance of species with a basic number of x = 8 led to conclude that it is the primary basic number in *Astragalus* (Maassoumi, 1987, 1989; Badr et al., 1996). They further assumed that the x = 6 and x = 7 numbers have been derived from x = 8 by aneuploid loss of chromosomes. However, comprehensive studies on the karyotype criteria of *Astragalus* species in relation to their systematic treatment are generally lacking. The importance of chromosomal information in plant systematics and evolution has attracted the attention of several workers. At the generic level and below chromosome features have provided a range of possibilities for understanding the affinities of taxa. Examples illustrating the role of chromosomal data in solving systematic problems in plant genera are found in *Onobrychis* (Ranjbar et al., 2009, 2010a, 2010b, 2010c). At the generic level and below in *Astragalus* chromosomes features have provided a range of possibilities for understanding the affinities of taxa. As reported by several authors, Ledingham (1957, 1960), Aryavand (1983), Maassoumi (1987), Maassoumi (1989), Bader and Sherif (2007) and Al-Turki et al. (2000), variation in chromosome number in the genus *Astragalus*, differentiates Old World species from those of America. Most of the cytological studies in the tribe Astragaleae have concentrated on the chromosome count (Aryavand, 1983; Maassoumi, 1987, 1989; Sheidai et al., 1996, 2000, 2007; Aytaç 1997; Ekici et al., 2005; Bader and Sherif, 2007; Ranjbar et al., 2010c, 2011a, 2011b). The basic chromosome number (x = 8) and five ploidy levels (2n = 2x = 16, 2n = 4x = 32, 2n = 6x = 48, 2n = 8x =64 and 2n = 12x = 96) are present in the genus. However, studies on the impact of cytogenetic data on the interspecific and phylogenetic relationships in the genus are still limited. Also, little is known about the nature of genetic variability in diploid species and the taxonomic relationships of the different taxa in the genus.

2. Materials and methods

2. 1. Morphology

A. savanatensis and *A. andabilensis* were collected from the field in different regions of their natural geographical distributions during several excursions in Iran. The collected materials were in vegetative phase and deposited at BASU, Hamedan, Iran. Also several sheets and photo specimens belonging to *A.* sect. *Stereothrix* have been examined for each taxon from the following herbaria: B, G, PR, W and WU.

2. 2. Cytogenetic study

Chromosome number and meiotic behavior were analyzed in only two populations of *A. savanatensis* and *A. andabilensis*. Voucher specimens were kept at BASU, Hamedan, Iran. 15 flower buds from at least 2 plants at an appropriate stage of development were fixed in 70% ethanol, chloroform and propionic acid (6:3:2) for 24 h at room temperature and then stored in 70% ethanol at 4°C until used. Anthers were squashed and stained with 2% acetocarmine. All slides were made permanent by the Venetian turpentine. Photographs of chromosomes were taken on an Olympus BX-41 photomicroscope at initial magnification of X 1000. Chromosome counts were made from well-spread metaphases in intact cells, by direct observation and from photomicrographs.

3. Results and discussion

3. 1. Morphology

***Astragalus* sect. *Stereothrix* Bunge. Astrag geront. I (1868) 53**

Low or fairly tall short-stemmed herbaceous perennials, vested with simple or rarely mixed white and black hairs. Stipules shortly adnate to petiole, connate or free, herbaceous. Leaves imparipinnate or simple in *A. koelzii*. Inflorescence in dense heads; corolla white, yellow or purple. Bracteoles none except in *A. damghanensis*. Calyx infundibular-cylindric; teeth setiform plumose-pubescent, slightly shorter to longer than the tube. Pods small, sessile, rarely stipitate, linear to oblong, included in the calyx, carinate ventrally, grooved dorsally, coriaceus, bilocular, many-seeded.

3. 2. Key to the species of astragalus sect. stereothrix in Iran

1a - Plants up to 34 cm long; peduncles 5 -- 18.5 cm long……..…...……..……..2
1b - Plants up to 20 cm long; peduncles 0.3 -- 7 cm long……...……..…….3
2a - Plant 24.5 -- 34 cm long, stems thick, up to 20 cm long, peduncles 9.8 -- 18 cm long, stems covered with appressed, white hairs 0.5 -- 0.9 mm long, leaves 4.5 -- 20.5 cm long, leaflets 4–6 pairs, stipules 6 -- 15 mm long, peduncles 9.3 -- 18.5 cm long, standard 11 -- 12.5 × 6 -- 6.5 mm long, wings 9 -- 10 × 1 -- 1.7 mm long…….……..……*A. savanatensis*
2b - Plant 11.5 -- 21.5 cm long, stems slender, up to 7.6 cm long, peduncles 5 -- 14.5 cm long, stems covered with spreading, white and black hairs up to 1.5 mm long, leaves 1.7 -- 4.7 cm long. leaflets 9 -- 15 pairs, stipules 2 -- 7 mm long, peduncles 5 -- 14.5 cm long, standard 13 -- 17 × 7 -- 8 mm long, wings 10 -- 13 × 2 mm long……...……..……..…..….*A. andabilensis*
3a - Petals violet……...……..……..……...……..…..……4
3b - Petals white to yellow (except *A. montis-varvashti* with lilac keel)……...……...……..…...……6
4a - Bracteole developed, 0.5 -- 0.8 mm long, peduncles 2.5 -- 5 cm long, bracts 6 -- 10 mm long, standard emarginated at the apex, keel 9 -- 10 mm long, wings limbs obliquely emarginated ……..……..……..……*A. damghanensis*
4b - Bracteole absent……...……..……5
5a - Stem 1.5 -- 2 cm long, leaflets 6 -- 7 pairs, leaves greenish, peduncles ± 1 cm long, bracts 11 -- 12 mm long, standard rounded at the apex …...…….……...…..*A. pseudocapito*
5b - Stem 4 -- 7 cm long, leaflets 12 -- 13 pairs, leaves reddish, peduncles 2.5 -- 3.5 cm long, bracts ca. 14 mm long, standard emarginated at the apex ..…….……...……*A. mahneshanensis*
6a - Leaves unifoliolate ……..……...……..……..……..*A. koelzii*
6b - Leaves imparipinate ……...……..……...……..…...……..…….7
7a - Standard truncated at the apex …...……...……..…...……..……..*A. bavanatensis*
7b - Standard rounded or emarginated at the apex …….……..……...…….8
8a - Leaflets 2 -- 4 pairs ……..……..……..…..…*A. ledinghamii*
8b - Leaflets 5 -- 12 pairs …..……...……..……...……..……..9
9a - Calyx 12 ≤ mm long …...……..……..……..……10
9b - Calyx up to 12 mm long …..……...……..……..……13
10a - Peduncle 0.5 -- 1 cm long, leaflets 6 -- 7 pairs, bract 6 -- 7 mm long .....……*A. podosphaerus*
10b - Peduncle 0.5 -- 6 cm long, leaflets 7 -- 12 pairs, bract 7 -- 13 mm long ….....11
11a - Leaves 1.3 -- 2 cm long, petiole 0.4 -- 0.6 cm long, leaflets 3 -- 4 × ca. 1 mm long, all petals deep yellow ……...……..……...……*A. badelehensis*
11b - Leaves 1.5 -- 5 cm long, petiole 0.5 -- 1.5 cm long, leaflets 3 -- 9 × 1 -- 4 mm long, petals not as above
……..……...……...……...……...…..……12
12a - Plant 4 -- 12 cm long, stem hairs up to 0.5 mm long, stipules unimorphic, linear-acuminate, 4 -- 8 mm long, up to 1 mm adnate to petiole, peduncle 0.5 -- 6 cm long, bract narrowly ovate, acuminate, 9 -- 13 mm long ...…..……...……...…..…*A. montis-varvashti*
12b - Plant 4 -- 8 cm long, stem hairs up to 1 mm long, stipules heteromorphic, lower stipules 3 -- 4 mm long, linear-acuminate, upper stipules up to 10 mm long, narrowly triangular, up to 2 mm adnate to petiole, peduncle 0.5 -- 3 cm long, bract subulate, 7 -- 10 mm long ...……...…..*A. sphaeranthus*
13a - Bract up to 2 mm long ….……...…..……...…....*A. doshman-ziarensis*
13b - Bract up to 10 mm long ….……..…..……...…….14
14a - Stems with spreading hairs, calyx 9 -- 10 mm long, glabrous at the base, toward the teeth up to rather densely covered with white and black hairs, standard 8 -- 9 mm long, blade up to 2.5 mm wide ……..…..……...……...……..*A. altimontanus*
14b - Stems with appressed hairs, calyx 10 -- 12 mm long, densely covered with white hairs and occasionally some shorter black hairs, standard 13 -- 14 mm long, blade 6 -- 7 mm wide ……*A. capito*

3. 3. Two new species for flora of Iran

Astragalus savanatensis Ranjbar, Vitek & Mahmoudian, sp. nova. (Figure 1) (sect. *Stereothrix*)

Differt ab *A. ledinghamii* Barneby caulibus pilis appressis (nec semiappressis), ad 0.9 mm (nec ad 1.5 mm) longis obtectis, 24.5 -- 34 cm (nec 7 -- 20 cm) longis, stipulis 6 -- 15 mm (nec 2.5 -- 6 mm) longis, petiole 2 -- 7 mm longo (nec 1 -- 1.5 mm longis, foliis petiole 4.5 -- 20.5 cm longo suffultis (nec ad 4 cm longo), foliolis ad 6-jugis (nec 2 -- 4 jugis), 5 -- 45 × 1 -- 3 mm (nec 7 -- 25 × 1.3 -- 2 mm), pedunculis 9.3 -- 18.5 cm (nec 2 -- 6 cm) longis, bracteis ad 7 mm (nec 2 -- 4.5 mm) longis, obtectis, vexillo 7.8 -- 9 mm longo et 3.2 -- 4 mm lato (nec 11 -- 12.5 mm longo et 6 -- 6.5 mm lato).

Type: Iran, Prov. Fars, Estahban, 1633 m, 9. 4. 2010, *Ranjbar & Mahmoudian 22641* (holotype: BASU!, isotype: W!).
Plants 24.5 -- 34 cm tall, caudex divided, with short branches, densely covered with remnants of old leaves. Stems several, nearly prostrate at the base, ca. 20 cm long, densely covered with appressed white hairs 0.5 -- 0.9 mm long. Stipules greenish, narrowly triangular to linear, acute to acuminate, 6 -- 15 mm long, shortly adnate to petiole, densely covered with appressed white hairs. Leaves 4.5 -- 20.5 cm long; petiole 2 -- 7 cm long. Leaflets in 4 -- 6 pairs, linear to lanceolate, 5 -- 45 × 1 -- 3 mm, acute to acuminate at the tip, densely covered with appressed white hairs up to 2.2 mm long on both sides. Peduncle 9.3 -- 18.5 cm long, densely white hairy like the stem, 0.3 -- 1.2 mm long. Raceme ovoid to cylindrical, densely many flowered, 3 -- 5 × ca. 2.5 cm. Bracts greenish, 4 -- 7 mm long, linear-acute, with merely white hairs. Flowers sessile. Calyx 11 -- 13 mm long; campanulate-tubular; in lower part of the tube sparsely to loosely, in upper part and at the teeth densely covered with long spreading white hairs; teeth linear, 5 -- 8 mm long, hairy on outer side. Petals peachy. Standard 11 -- 12.5 mm long, limbs obovate, 6 -- 6.5 mm wide, emarginated at the apex. Wings 9 -- 10 mm long; blades oblong, rounded at the apex, 4 -- 4.5 × 1 -- 1.7 mm; auricle 0.5 -- 0.6 mm long; claw 5 -- 5.5 mm long. Keel 8 -- 10 mm long; with gibbously curved lower edge and nearly straight upper edge, shortly acute at the apex, 4 -- 4.5 × 2 -- 2.5 mm; auricle minute, claw 4 -- 5.5 mm. ovary with a stipe 1 -- 2 mm long, elliptic, glabrous; style glabrous. Legumes unknown.

3. 4. Phenology. Flowering was observed to occur in March and April; fruit ripening occurred from May to June.

3. 5. Suggested conservation status

Astragalus savanatensis is a narrow endemic. It is very rare and known only from the type locality in Estahban. The estimated area of occupancy is less than 500 m^2 and the number of individuals below one hundred. It should be classified as Endangered (EN) according to criterion (IUCN 2001).

3. 6. Etymology

The specific epithet is named after the type-locality, an ancient name for "Estahban", Fars Province, Iran.

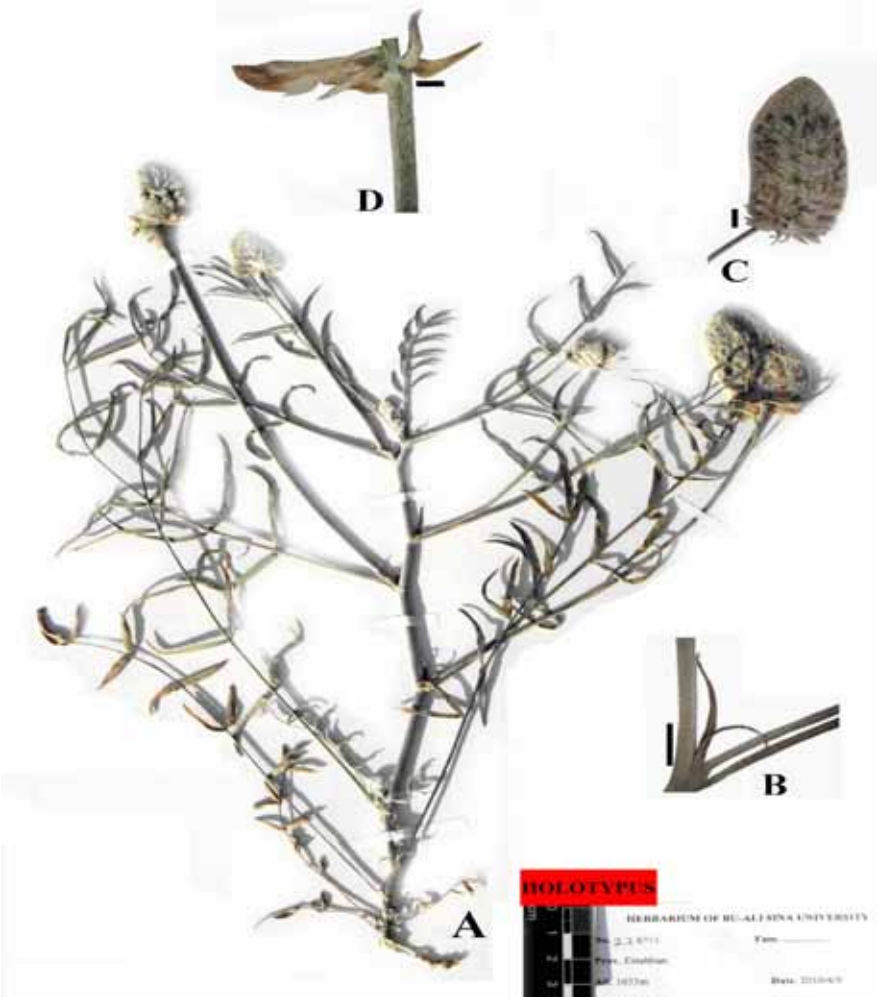

Figure 1. *Astragalus savanatensis* (Ranjbar & Mahmoudian 22641, BASU). (A) Type specimen; (B) Close up of leaflet; (C) Close up of stipules; (D) Close up of a flower with bracts; (E) Close up of cylindrical inflorescence. Scale (B-E): 5 mm. Photograph provided by Ranjbar & Negaresh

3. 7. Taxonomic remarks

Astragalus savanatensis it is related to *A. ledinghamii* in similar habit, shape of calyx and petals, but these taxa are well separated by flower color, plant length, stem and stipule lengths, the number and size of leaflets, peduncle length and size of standard, keel and wings (Table 1).

Astragalus andabilensis Ranjbar & Mahmoudian sp. nova. (Figure 2) (sect. *Stereothrix*)

Differt ab *A. capito* Boiss. & Hohen. Caulibus pilis patentibis albis nigrisque (nec subappressis albis), ad 1.5 mm (nec ad 0.5 mm) longis obtectis, 5 -- 7.6 cm (nec 1 -- 4 cm) longis, stipulis 2 -- 4 mm (nec ad 7 mm) longis, foliolis ad 9 -- 15 jugis (nec 6 -- 9 jugis), utrimque dense pilis subappressis (nec dense pilis appressis) obtectis, pedunculis 5 -- 14.5 cm (nec 0.5 -- 2 cm) longis, pilis albis nigrisque (nec albis), obtectis.

Type: Iran, Ardebil, Khalkhal, Andabil, 1900 m, 4. 6. 2010, *Ranjbar & Mahmoudian 20946* (holotype: BASU!; isotype W!).

Plants 11.5 -- 21.5 cm tall, caudex divided, with short branches, densely covered with remnants of old leaves. Stems several, nearly prostrate at the base, somewhat flexuse, 5 -- 7.6 cm long, densely covered with spreading white and especially below the nodes densely black hairs up to 1.5 mm long. Stipules 2 -- 4 mm long, pale yellowish, papery, triangular to narrowly triangular, adnate to the petiole for ca. 2 mm, densely white hairy, sometimes also with some black hairs, toward the base densely black hairs. Leaves 1.7 -- 4.7 cm long; petiole 0.3 -- 0.5 cm long. Leaflets in 9 -- 15 pairs, narrowly elliptic, 3 -- 8 × 2 -- 2.5 mm, acute to acuminate at the apex, densely covered with appressed white hairs 0.2 -- 1.2 mm long on both sides. Peduncle 5 -- 14.5 cm long, densely covered with spreading white hairs, toward the raceme also with increasing black hairs 0.3 -- 1.5 mm long. Raceme ovoid-globose, densely many flowered, 2 -- 2.5 × 2 -- 2.5 cm. Bracts greenish to dark brownish, 4 -- 9 mm, very narrowly triangular to linear-acute, white and black hairy. Flowers sessile. Calyx 11 -- 12 mm long; campanulate-tubular; in lower part of the tube sparsely to loosely, in upper part and at the teeth densely covered with long spreading white and sometimes black hairs; teeth linear, 4 -- 7 mm long, hairy on outer side. Petals all white, in dry state often yellowish. Standard 13 -- 17 mm long obovate-elliptic, 7 -- 8 mm wide, narrowed at the base, emarginated at the apex. Wings 12 -- 13 mm long; blades narrowly oblong, rounded at the apex, 6 × 2 mm; auricle 0.5 -- 1 mm long; claw ca 7 mm long. Keel 9 -- 11 mm long; with in upper part widely curved lower edge and nearly straight upper edge, obtuse at the apex, ca. 4 × 2.5 -- 3 mm; auricle indistinct, claw 5 -- 7 mm. ovary with a stipe 1 -- 2 mm long, narrowly elliptic, glabrous; style glabrous. Legumes unknown.

3. 8. Phenology

Flowering was observed to occur in June and July; fruit ripening occurred from July to August.

3. 9. Suggested conservation status

Astragalus andabilensis is a narrow endemic. It is very rare and known only from the type locality in Khalkhal. The estimated area of occupancy is less than 500 m^2 and the number of individuals below fifty. It should be classified as Endangered (EN) according to criterion (IUCN 2001).

3. 10. Etymology

The specific epithet is named after the type-locality, “Andabil”, Ardebil Province, Iran.

3. 11. Taxonomic remarks

Astragalus andabilensis is a rare and local endemic NW Iran and known from four specimens collected at a single locality. It occurs in open forest zone in the sub-mountainous region near the village Andbil, south of Khalkhal in Ardebil Province. It is closely related to *A. capito* by having large bracts and size of calyx, calyx teeth, corolla and leaflets. However, they are well separated by plant height, stem, peduncle and stipule length, number of leaflets, color, size and arrangement of stem hairs, color and size of peduncle hairs (Table 2).

3. 12. Addition of two ignored taxa in Flora Iranica

Astragalus badelehensis Maassoumi & Taheri (sect. *Stereothrix*) 2005, in Maassoumi, The genus *Astragalus* in Iran, vol. 5: 417 - *A.* sect. *Stereothrix* - Holotype: Iran, prov. Semnan, Damghan, Gardaneh-e Badeleh, 1600 m, 29.06.1996, *Maddah 2874* (holotype TARI!, isotype BASU!).

Differt ab *A. capito* Boiss & Hohen. Caulibus pilis patentibus (nec appressis) obtectis, calyce 9 -- 10 mm longo, tubo basi glabro ceterum pilis in tuberculis minutis insidentibus obtectis (nec ad 12 mm longis, omnino dense pilis non in tuberculis insidentibus obtectis), vexillo 8 -- 9 mm longo et c. 2.5 mm lato (nec 13 -- 14 mm longo et 6 -- 7 mm lato).

Figure 2. *Astragalus andabilensis* (*Ranjbar & Mahmoudian 20946*, BASU). (A) Type specimen; (B) Close up of stem, nodes and leaves in type specimen; (C) Close up of inflorescence and flowers in type specimen; (D) Close up of leaves and stem indumentum in type specimen; (E) Habit and habitat of *A. andabilensis* in field; (F) Close up of inflorescence and flowers of *A. andabilensis* in field. Photograph provided by Ranjbar & Negaresh

Astragalus mahneshanensis Maassoumi & Moussavi (sect. *Stereothrix*) 2005, in Maassoumi, Some interesting new species of the genus *Astragalus* from Iran. -Iran. Journ. Bot. 11 (1) 101-109. Tehran. - *A.* sect. *Stereothrix* - Holotype: Iran, prov. Zanjan, Mahneshan, N W Alam Kandi village, 2950 m, 21.09.2002, *Moussavi 3957* (holotype TARI, isotype Zanjan Research center).

Differt ab *A.pseudocapito* Podlech foliolis 13 jugis (nec 6 -- 7 jugis); ab *A. leucothrichus* corolla intense violacea (nec flava), vexillo c. 17 mm longo (nec 22 mm longo); ab *A. hakkariensis* Podlech foliolis 13 jugis (nec 7 jugis).

Plants up to 14 cm tall, caudex up to 4.5 cm long, repeatedly branched in upper part, covered with remnants of old stipules. Stems of the year up to 7 cm long, densely covered with appressed white, near the nodes also with black hairs up to 1 mm long. Stipules pale yellowish, papery, triangular to narrowly triangular, adnate to the petiole for 1 -- 2 mm, densely white hairy, sometimes also with some black hairs, especially at the base. Leaves 1.3 -- 2 cm long; petiole 0.4 -- 0.6 cm long. Leaflets in 8 -- 13 pairs, narrowly elliptic, 3 -- 4 × ca 1 mm, acute at the apex, densely covered with appressed white hairs 0.5 -- 0.7 mm long on both sides. Peduncle up to 4.5 cm long, densely covered with spreading white hairs, toward the raceme also with increasing black hairs 0.5 -- 1.5 mm long. Raceme ovoid-globose, densely many flowered, ca. 3 × 2.5 cm. Bracts greenish, ca 7 mm, very narrowly triangular to linear-acute, white and black hairy. Flowers sessile. Calyx 12 -- 13 mm long; campanulate-tubular; in lower part of the tube sparsely to loosely covered with black hairs, in upper part and at the teeth densely covered with long spreading white and shorter black hairs; teeth linear, 5 -- 6 mm long, hairy on outer side. Petals all deep yellow. Standard 13 -- 15 mm long ovate-elliptic, ca 8 mm wide, narrowed at the base, emarginated at the apex. Wings 11 -- 12.5 mm long; blades narrowly oblong, rounded at the apex, ca 6 × 2 -- 2.5 mm; auricle ca. 1 mm long; claw 5 -- 6.5 mm long. Keel 10 -- 11 mm long; with in upper part widely curved lower edge and nearly straight upper edge, acutish at the apex, 4 -- 5 × ca 3 mm; auricle indistinct, claw ca 5.5 mm. ovary narrowly elliptic, glabrous; style glabrous. Legumes unknown.

3. 13. Cytogenetic study

The meiotic irregularities observed in *A. savanatensis* include fragmented chromosomes in D/MI; chromosome bridges, laggard chromosomes, micronuclei and binucleate in AI/TI, asynchronism and precocious chromosomes migrating to the poles in MII and AII/TII, laggard, bridge, and triad in AII/TII (Figure 3). The ranges of meiotic stages

Table 1. Diagnostic morphological characters of *A. ledinghamii* and *A. savanatensis*. Data are based on the type photo and original description.

Morphological characters	*A. ledinghamii*	*A. savanatensis*
Plant height (cm)	7 -- 20	24.5 -- 34
Stem length (cm)	1 -- 3	up to 20
Hair length on stem (mm)	up to 1.5	up to 0.9
Leaf length (cm)	up to 4	4.5 -- 20.5
Petiole length (mm)	1 -- 1.5	2 -- 7
Leaflets number	2 -- 4	4 -- 6
Hair length on leaflet (mm)	0.5 -- 1.5	0.7 -- 2.2
Stipule length (mm)	2.5 -- 6	6 -- 15
Peduncle length (cm)	2 -- 6	9.3 -- 18.5
Bract length (mm)	2 -- 4.5	up to 7
Calyx tube size	4 -- 4.5 × 1.6 -- 1.9	5 -- 6 × 4 -- 6
Standard size	7.8 -- 9 × 3.2 -- 4	11 -- 12.5 × 6 -- 6.5
Keel size	6.8 -- 7.6 × 1.6	8 -- 10 × 2 -- 2.5
Wing length (mm)	7 -- 7.8	9 -- 10
Wing claw length (mm)	4.2 -- 4.7	5 -- 5.5

Table 2. Diagnostic morphological characters of *A. capito* and *A. andabilensis*. Data are based on the type photo and original description.

Morphological characters	*A. capito*	*A. andabilensis*
Plant height (cm)	4 -- 9	11.5 -- 21.5
Stem length (cm)	1 -- 4	5 -- 7.6
Stem indumentum	subappressed	spreading
Stem indumentum color	white	white and black, below the nodes densely black
Hair length on stem (mm)	up to 0.5	up to 1.5
Leaflet number	6 -- 10	9 -- 15
Leaflet indumentum on lower surface	subappressed	appressed
Leaflet blade	elliptic to obovate	narrowly elliptic
Peduncle length (cm)	0.5 -- 2	5 -- 14.5
Peduncle indumentum color	white	white, toward the raceme increasingly black
Bract indumentum color	white	white and black
Petal color	white-yellow, rarely violet	white, in dry state yellowish

were found in anthers within the same flower in *A. savanatensis*. A total of 189 diakinesis/metaphases I (D/MI) (24.9%), 172 anaphase I/telophase I (AI/TI) (22.72%), 51 metaphase II (MII) (6.73%) and 345 anaphase II/telophase II (AII/MII) (45.57%) cells were analysed. The D/MI cells were usually regular with predominant bivalent (II) pairing. ring/rod bivalents were found in 25.92% of diakinesis cells and varied degrees of fragmented chromosomes were observed in 38.62% of diakinesis and metaphase I cells (Figure 3C, D, G-I). Chromosome bridges and laggard chromosomes were observed in 3.48% and 5.23% of anaphase I cells, respectively (Figure 3K-M). The thickness of bridges observed and the number of chromosomes involved in their formation varied among different meiocytes. Genetic as well as environmental factors have been considered as the reason for chromosome stickiness in different plant species (Nirmala and Rao, 1996). Pagliarini (1990) reported that laggards may result from late chiasma terminalization. Ascending chromosomes are the result of precocious migration and, according to Utsunomiya et al. (2002), generally consist of univalent chromosomes formed during late prophase stages by precocious chiasma terminalization in early metaphase I or may even result from low chiasma frequency or from the presence of asynaptic or desynaptic genes (Pagliarini, 2000). Abnormalities such as precocious chromosome migration to the poles in

metaphase I (Figure 3F) and laggards in Anaphase I (Figure 3K, M), leading to the formation of micronuclei in telophase I (Figure 3O). Asynchronism and precociously migration of chromosomes to the poles were observed in 47.05% and 9.80% of Metaphase II cells, respectively (Figure 3Q-S), laggard, bridge, and precociously migration of chromosomes to the poles were found in 0.86%, 0.57%, and 0.28% of AII/TII cells, respectively (Figure 3U, V). Triad showing equally sized microspores was also observed (Figure 3X).

The meiotic irregularities observed in *A. andabilensis* include: Fragmented chromosomes in D/MI and Asynchronism and fragmented chromosomes in MII (Figure 4). A total of 118 diakinesis/metaphases I (D/MI) (12.93%), 317 anaphase I/telophase I (AI/TI) (34.75%), 99 metaphase II (MII) (10.85%) and 378 anaphase II/telophase II (AII/MII) (41.44%) cells were analysed. Fragmented chromosomes were found in 33.89% of D/MI cells (Figure 4C, D) and also chromosome stickness and precociously migration of chromosomes to the poles can be observe in these figures. Fragmented chromosomes were found in 7.07% of MII cells (Figure 4G) and asynchronism which cells presenting one of the groups of chromosomes in metaphase while the other group are disorganized were observed in 92.92% of MII cells (Figure 4H, I). It should be considered that there was no metaphase II cell without any irregularity in the studied population and also there was just one laggard cell among 378 cells (0.26%) in AII/TII stages.

3. 13. Cytogenetic study

The meiotic irregularities observed in *A. savanatensis* include fragmented chromosomes in D/MI; chromosome bridges, laggard chromosomes, micronuclei and binucleate in AI/TI, asynchronism and precocious chromosomes migrating to the poles in MII and AII/TII, laggard, bridge, and triad in AII/TII (Figure 3). The ranges of meiotic stages were found in anthers within the same flower in *A. savanatensis*. A total of 189 diakinesis/metaphases I (D/MI) (24.9%), 172 anaphase I/telophase I (AI/TI) (22.72%), 51 metaphase II (MII) (6.73%) and 345 anaphase II/telophase II (AII/MII) (45.57%) cells were analysed. The D/MI cells were usually regular with predominant bivalent (II) pairing. ring/rod bivalents were found in 25.92% of diakinesis cells and varied degrees of fragmented chromosomes were observed in 38.62% of diakinesis and metaphase I cells (Figure 3C, D, G-I). Chromosome bridges and laggard chromosomes were observed in 3.48% and 5.23% of anaphase I cells, respectively (Figure 3K-M). The thickness of bridges observed and the number of chromosomes involved in their formation varied among different meiocytes. Genetic as well as environmental factors have been considered as the reason for chromosome stickiness in different plant species (Nirmala and Rao, 1996). Pagliarini (1990) reported that laggards may result from late chiasma terminalization. Ascending chromosomes are the result of precocious migration and, according to Utsunomiya et al. (2002), generally consist of univalent chromosomes formed during late prophase stages by precocious chiasma terminalization in early metaphase I or may even result from low chiasma frequency or from the presence of asynaptic or desynaptic genes (Pagliarini, 2000). Abnormalities such as precocious chromosome migration to the poles in metaphase I (Figure 3F) and laggards in Anaphase I (Figure 3K, M), leading to the formation of micronuclei in telophase I (Figure 3O). Asynchronism and precociously migration of chromosomes to the poles were observed in 47.05% and 9.80% of Metaphase II cells, respectively (Figure 3Q-S), laggard, bridge, and precociously migration of chromosomes to the poles were found in 0.86%, 0.57%, and 0.28% of AII/TII cells, respectively (Figure 3U, V). Triad showing equally sized microspores was also observed (Figure 3X).

The meiotic irregularities observed in *A. andabilensis* include: Fragmented chromosomes in D/MI and Asynchronism and fragmented chromosomes in MII (Figure 4). A total of 118 diakinesis/metaphases I (D/MI) (12.93%), 317 anaphase I/telophase I (AI/TI) (34.75%), 99 metaphase II (MII) (10.85%) and 378 anaphase II/telophase II (AII/MII) (41.44%) cells were analysed. Fragmented chromosomes were found in 33.89% of D/MI cells (Figure 4C, D) and also chromosome stickness and precociously migration of chromosomes to the poles can be observe in these figures. Fragmented chromosomes were found in 7.07% of MII cells (Figure 4G) and asynchronism which cells presenting one of the groups of chromosomes in metaphase while the other group are disorganized were observed in 92.92% of MII cells (Figure 4H, I). It should be considered that there was no metaphase II cell without any irregularity in the studied population and also there was just one laggard cell among 378 cells (0.26%) in AII/TII stages.

3. 14. Geographical distributional and ecology

Almost all members of *A.* sect. *Stereothrix* are Irano-Turanian elements. Iran with 15 species, of which 14 are endemic (*A. altimontanus* Podlech & Maassoumi, *A. andabilensis* Ranjbar & Mahmoudian, *A. badelehensis* Maassoumi & Taheri, *A. bavanatensis* Zarre & Podlech**,** *A. capito* Boiss. & Hohen, *A. damghanensis* Podlech, *A. doshman-ziarensis* Maassoumi & Podlech, *A. savanatensis* Ranjbar, Vitek & Mahmoudian, *A. koelzii* Barneby, *A. ledinghamii* Barneby, *A. mahneshanensis* Maassoumi & Moussavi, *A. montis-varvashti* Podlech, *A. podosphaerus* Boiss. & Hausskn., *A. pseudocapito* Podlech, *A. sphaeranthus* Boiss.) and Turkey with 13 species (9 endemic) are centers of diversity of the section. Nearly 33.3% of the species (5) belonging to this section in Iran are distributed in southern Zagros mountains in Fars Province and about 53% of species (8) are distributed in central Alborz mountains (Figure 5). The widest ranging species of the section are *A. capito*, *A. ledinghamii*, *A. sphaeranthus* and *A. podosphaerus*. Almost the remaining species have narrow distribution patterns include *A. altimontanus* (between Karaj and Chalus), *A. andabilensis* (Ardebil,

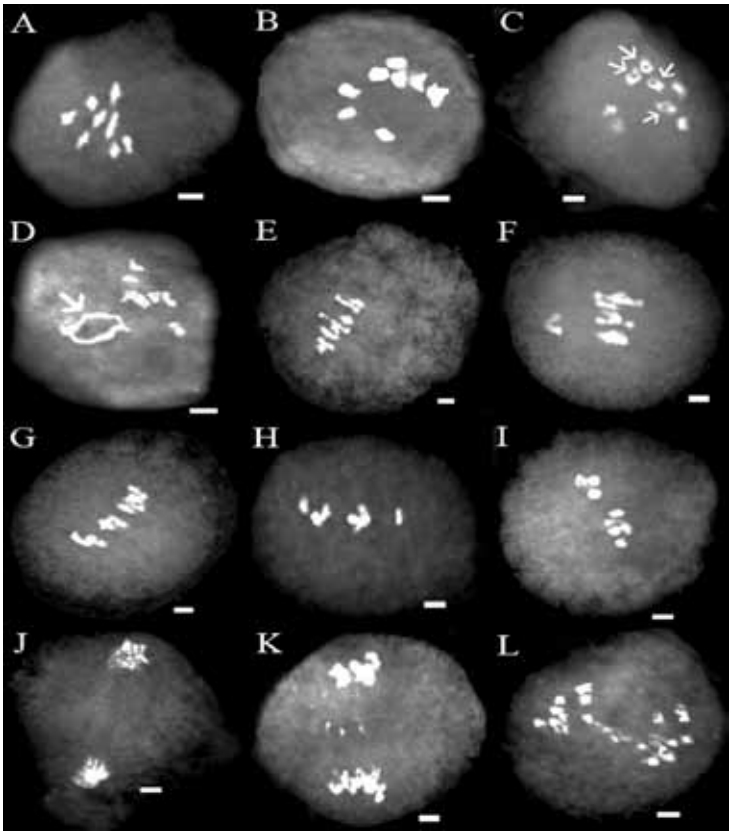

Figure 3. Meiotic behavior in A. savanatensis: A, B) Diakinesis with 8 bivalents; C) Diakinesis with 4 ring chromosomes and fragmented chromosomes; D) Diakinesis with 6 II + 1 IV (bold arrow); E) Metaphase I; F) Metaphase I with a bivalent migrating precociously to the pole; G-I) Fragmented chromosomes in metaphase I; J) Anaphase I; K) Anaphase I with thin bridges and laggards; L) Anaphase I with bridge. Scale: 3 µm.

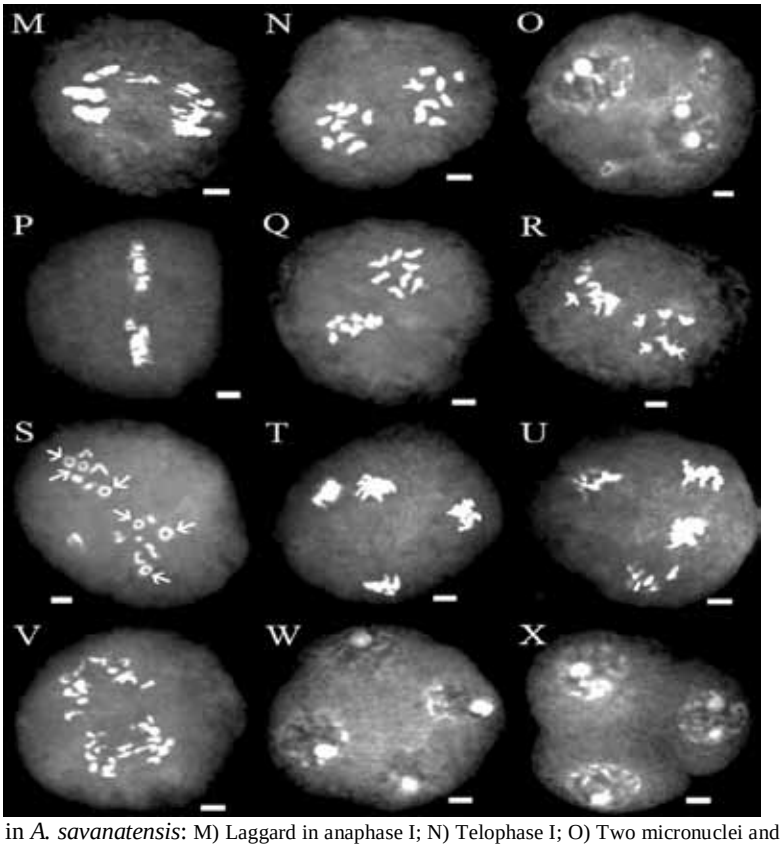

Figure 3. Meiotic behavior in *A. savanatensis*: M) Laggard in anaphase I; N) Telophase I; O) Two micronuclei and binucleate in telophase I; P) Metaphase II; Q) Asynchronism in meiosis; R) Metaphase II with precocious chromosomes migration to the poles; S) Metaphase II with 3 ring chromosomes in both plates and precocious chromosome migration to the pole; T) Anaphase II; U) Anaphase II with laggard; V) Anaphase II showing a thin bridge, laggard and precocious chromosomes migration to the poles; W) Telophase II; X) Triad showing equally sized microspores and binucleate in one microspore. Scale:3 µm.

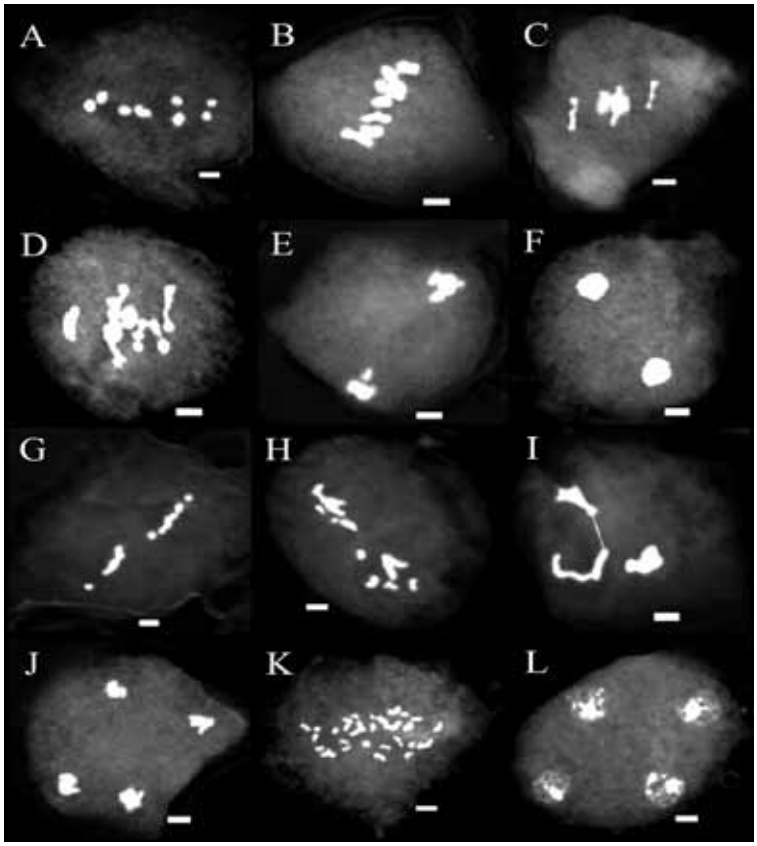

Figure 4. Meiotic behavior in *A andabilensis*: A) Diakinesis with 8 bivalents; B) Metaphase I; C) Fragmented chromosomes and chromosome stickiness in metaphase I; D) Fragmented chromosome and precocious migration of chromosomes to the poles in metaphase; I, E) Anaphase I; F) Telophase I; G) Metaphase II with fragmented chromosome; H, I) Asynchronism in meiosis; J) Anaphase II; K) Late anaphase II; L) Telophase II. Scale: 3 µm.

Table 3. Number of pollen mother cells (PMCs) analyzed and percentage of PMCs meiotic behavior in populations of *A. savanatensis* and *A. andabilensis*.

Meiotic characters	*A. savanatensis*	*A. andabilensis*
Cell number	757	912
D/MI	24.9	12.93
% Fragmented chromosome	38.62	33.89
% Ring & rod bivalents	25.92	0
AI/TI	22.72	34.75
% Laggard chromosome	5.23	0
% Bridge	3.48	0
MII	6.73	10.85
% Asynchronism	47.05	92.92
% Precocious chromosomes	9.80	0
% Fragmented chromosome	0	7.07
AII/TII	45.57	41.44
% Laggard chromosome	0.86	0.26
% Bridge	0.57	0
% Precocious chromosomes	0.28	0

Abbreviations: D/MI: Diakinesis/Metaphase I, AI/TI: Anaphase I/Telophase I, MII: Metaphase II, AII/TII: Anaphase II/Telophase II.

Khalkhal, Andbil), *A. badelehensis* (Semnan, Badeleh), *A. bavanatensis* (Fars, Abadeh, Bavanat), *A. damghanensis* (Semnan, Dameghan), *A. doshman-ziarensis* (Fars, Doshman-ziary area), *A. savanatensis* (Fars, Estahban), *A. koelzii* (Bakhtiari), *A. montis-varvashti* (Mazandaran, Alborz mountains), *A. mahneshanensis* (Zanjan, Mahneshan) and *A. pseudocapito* (Azarbaijan-e-sharghi, Sarab). Most species grow on slopes at 1500-3500 m. But *A. montis-varvashti* is distributed in Alborz Mountains of Mazandaran at 3500-4100 m and *A. damghanensis* is distributed at 450 m. In general, it appears that local endemism play an important role in the Iranian species of this section (Lock & Simpson, 1991; Podlech, 2009 and Maassoumi, 1998).

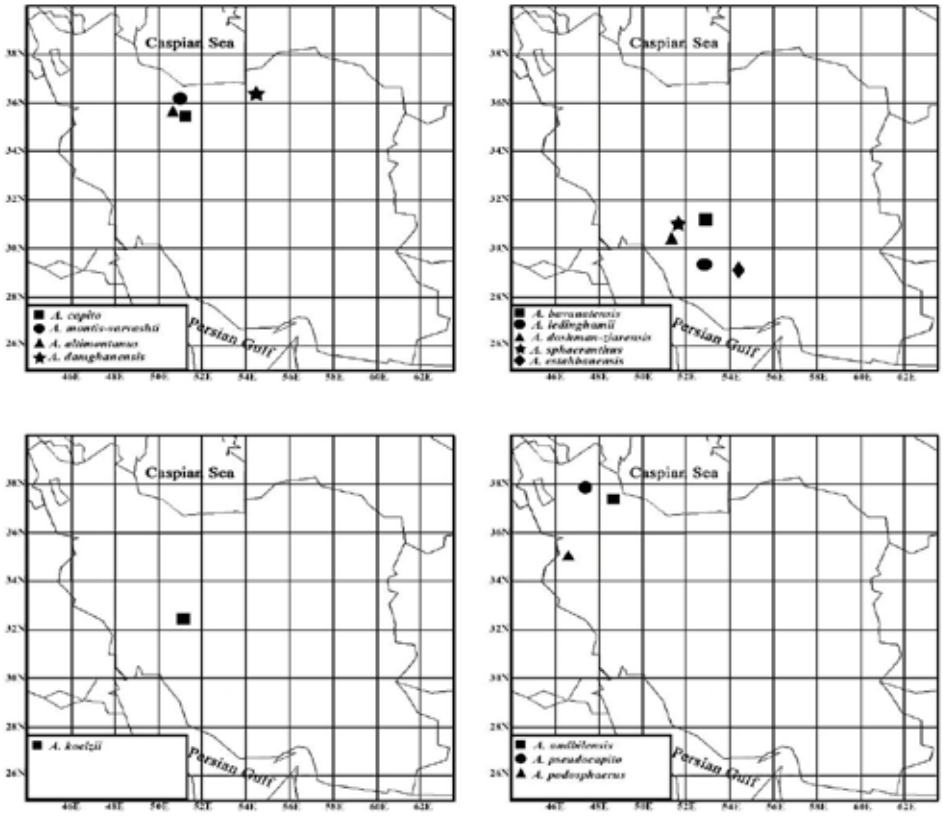

Figure 5. Distribution of *Astragalus* sect. *Stereothrix* in Iran

3. 15. An index for all taxa described within Astragalus sect. Stereothrix

1) *A. altimontanus* Podlech & Maassoumi 2003, Feddes Repert. 114: 348 - *Stereothrix* - Holotype: 68 km from Karaj to Chalus, 2250 m, 18.6.1973, *Babakhanlu & Amin 15417* (TARI; iso: MSB, W!).

It is a narrowly distributed endemic species. It is known from a single locality and deposed at TARI, MSB and W (photo in BASU!). It occurs in Kandavan mountain of Alborz Province (Figure 6). *A. altimontanus* grows in steppe to forest clay zones between Karaj and Chalus (Maassoumi, 2005). Its validity is confirmed here.

Figure 6. Type specimen of *A. altimontanus*

2) *A. badelehensis* Maassoumi & Taheri 2005, in Maassoumi, The genus *Astragalus* in Iran, vol. 5: 417 - *Stereothrix* - Holotype: Iran, Prov. Semnan, Damghan, Gardaneh-e Badeleh, 1600 m, 15.4.1375 (persian. calend.), *Maddah 2874* (TARI!; iso: BASU!).

A. badelehensis is a narrowly distributed endemic species. It is known from a single locality and deposed at TARI and BASU. It occurs around Siahkuh mountain in Semnan Province (Figure 7). *A. badelehensis* grows in dry-steppe and stony clay zones around Damghan (Maassoumi, 2005). In "Flora Iranica", *A. badelehensis* has not been mentioned from Iran by Podlech (2009). Its validity is confirmed here.

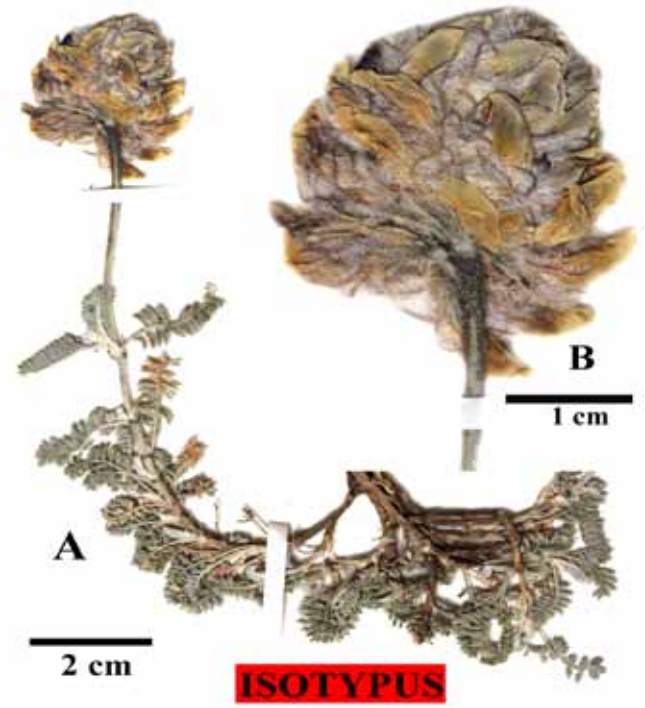

Figure 7. *A. badelehensis* (Maddah 2874, BASU): (A) Type specimen; (B) Close up of inflorescence and flowers

3) *A. barbatus* Lam. 1785, Encycl. Méth. Bot. 1: 314- *Stereothrix* - Lectotype (Podlech, Sendtnera 5: 250. 1998): *Astragalus* armenus villosissimus, capitulis rotundioribus, fl. purpureis', Armenia, *Tournefort* (P-LA: foto MSB; iso: B-W 14051, BM, FI-W, M, P: Hb. Vaillant, P-TRF nr. *3630*: foto MSB, BASU!).

Astragalus barbatus is distributed in Armenia, Anatolia and Libanon. As it is widely distributed and also found in northwestern parts of Iran, it shows considerable variation in morphology (Figure 8), especially in the type of indumentum (Chamberlain and Matthews, 1969; Maassoumi, 1998; Podlech, 2008). In "Flora Iranica", *A. barbatus* has not been mentioned from Iran by Podlech (2009).

Figure 8. Type specimen of *A. barbatus*

4) *A. bavanatensis* Zarre & Podlech 2005, Feddes Repert. 116: 77 - *Stereothrix* - Holotype: Iran, Prov. Fars, Abadeh, Bavanat, Sourian, 24.6.1969, *Termeh & Izadyar 14718*-E (IRAN!; iso: MSB, W!).

A. bavanatensis is a narrowly distributed endemic species. It is known from a single locality and deposed at IRAN, MSB and W (Podlech, 1999; Zarre et al., 2005). It occurs in Bavanat mountain of Fars Province (Figure 9). *A. bavanatensis* grows in dry-steppe and stony clay zones between Safashar and Sourian. Its validity is confirmed here.

5) *A. brachypetalus* Trautv. 1886, Trudy Imp. S.-Petersburgsk. Bot. Sada 9: 446 - *Hypoglottidei* - Lectotype (Podlech and Sytin, Sendtnera 3: 152. 1996): [Kasikibaran distr. Karabach: locality wrong, the plant does not occur in Caucasus], *Smirnow* (LE: sheet marked as lectotypus; iso: LE) (Figure 10).

This species was transferred from *A.* sect. *Stereothrix* to *A.* sect. *Hypoglottidei* by Podlech (2008). It is distributed in mountain slopes, witch-grass steppes and woodland-scrub associations, at the altitudes of (800) 1000-1850 m. - Caucasus: S. Transc. (Karabakh); Soviet Centr. Asia: Mtn. Turkm. (Kopet-Dagh); Turkey: Kars, Aras valley.

Figure 9. Type specimen of *A. bavanatensis*

Figure 10. Type specimen of *A. brachypetalus*

6) *A. capito* Boiss & Hohen. 1849, in Boissier, Diagn. pl. orient., ser. 1, 9: 40 - *Stereothrix* - Holotype: [Iran] in monte Totschal prope Teheran, 23.7.1843, *Kotschy 571* (G-BOIS; iso: BM, BP, E, FI-W, G, GOET, H, K, LE, MSB, OXF, P, PRC, REG, TUB, W!: foto MSB, BASU!, WAG) (Figure 11A).

- var. *violaceus* Bornm. & Gauba 1935, Repert. Spec. Nov. Regni Veg. 39: 99 - Holotype: [Iran] Elburs, Kandevan, 6.7.1935, *Gauba 642* (W!: foto MSB, BASU!) (= *A. capito* Boiss. & Hohen.)

- var. *ulodjensis* (Širj. & Rech.f.) Parsa 1966, Fl. Iran 9: 25 - Basion.: *A. ulodjensis* Širj. & Rech.f. (= *A. capito* Boiss. & Hohen.) (Figure 11B).

A. ulodjensis Širj. & Rech.f. 1953, Anz. Österr. Akad. Wiss., Math.-Naturwiss. Kl. 90: 115 - *Stereothrix* -Holotype: [Iran] Mazanderan, Distr. Kudjur, in monte Ulodj, 3200-3400 m, 9.8.1948, *Rechinger 6524* (W!: foto MSB, BASU!) (= *A. capito* Boiss. & Hohen.) (Figure 11C).

A. capito is the most problematic species of *A.* sect. *Stereothrix*. It was described in 1849 originally based of collection *Kotschy 571* of Totschal mountain in N Teheran. Then, *A. capito* var. *violaceus* Bornm. & Gauba was described as a variety of *A. capito* (Bornmuller and Gauba, 1935) (Figure 11B). In 1953 *A. ulodjensis* was described by Širjaev and Rechinger as a new species (Figure 11C). *A. ulodjensis* was reduced to a variety by Parsa (1966). However, because of differences are not sufficient for separating them, they were treated as a synonym of *A. capito* Boiss. & Hohen. (Chamberlain and Matthews, 1969; Maassoumi, 1998; Podlech, 2009).

7) *A. chamberlainianus* Sümbül 1991, Edinb. J. Bot. 48: 27. *Stereothrix* - Holotype: Turkey, C4 Içel, Anamur-Kazanci road, Kizilalan mevkii, 1300 m, 24.6.1984, H. Sümbül 3110 (E; iso: HUB).

A. chamberlainianus is a local endemic Anatolia. It occurs in C4 Içel in south Anatolia (Podlech, 2008; Maassoumi, 1998).

8) *A. coodei* (sphalm. 'coodie') Chamb. & Matthews 1969, Notes Roy. Bot. Gard. Edinburgh 29: 290 -Hypoglottidei - Holotype: Turkey, A4 Ankara, Karagöl, 40 miles N Ankara, 1100 m, J.J.E. *Coode & Jones 2184* (E).

A. coodei is a local endemic to Anatolia. It occurs around Ankara mountain (Chamberlain and Matthews, 1969; Maassoumi, 1998). This species was transferred from *A.* sect. *Stereothrix* to *A.* sect. *Hypoglottidei* by Podlech (2008).

9) *A. damghanensis* Podlech 2005, Feddes Repert. 116: 78 - *Stereothrix* - Holotype: Iran, Mazanderan, 41 km from Damghan on road to Sari, 450 m, 17.5.1978, *Wendelbo & Assadi 29574* (MSB; iso: TARI).

It is a narrowly distributed endemic species. It is known from a single locality and deposed at TARI & MSB (Podlech, 2008). It occurs in the north slope of Sepheid kuh mountain in Semnan Province. *A. damghanensis* grows in dry-steppe and clay zones between Damghan and Sari.

10) *A. doshman-ziariensis* Maassoumi & Podlech 1989, Iran. J. Bot. 4: 74 (1988) - *Stereothrix* - Holotype: Iran, Fars, Nurabad, Doshman-Ziary region, Ab-Zalou village, Kuh-e Tasak, 1900-2500 m, 31.5.1983, *Mozaffarian 45827* (TARI!: foto MSB; iso: MSB) (Figure 12).

A. doshman-ziariensis is a narrowly distributed endemic species. It is known from a single locality and deposed at TARI & MSB (Podlech, 2008). It occurs in east slope of Tashak mountain in Fars Province. Just above this area its population grows in dry-steppe and stony clay zones between Nurabad and Shiraz. Its validity is confirmed here.

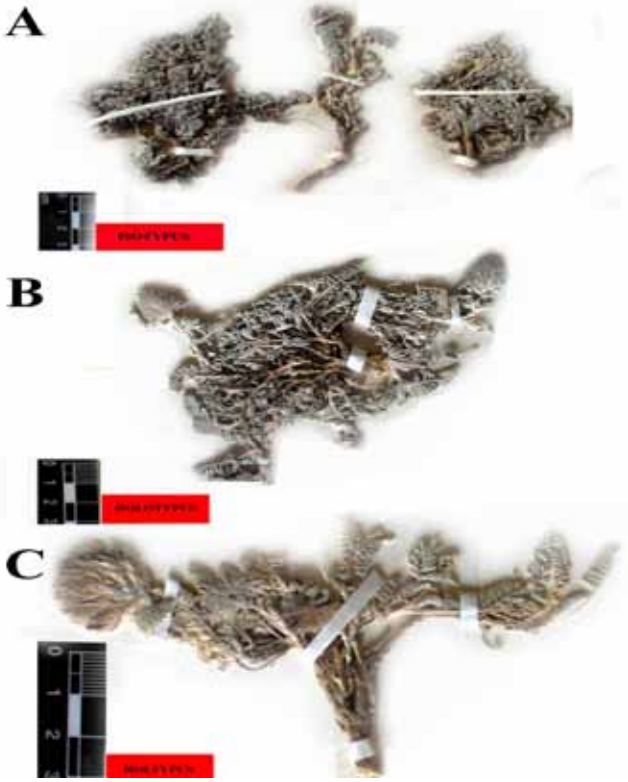

Figure 11. (A) Type specimen of *A. capito*, (B) Type specimen of *A. capito* var. *violaceus*, (C) Type specimen of *A. ulodjensis*

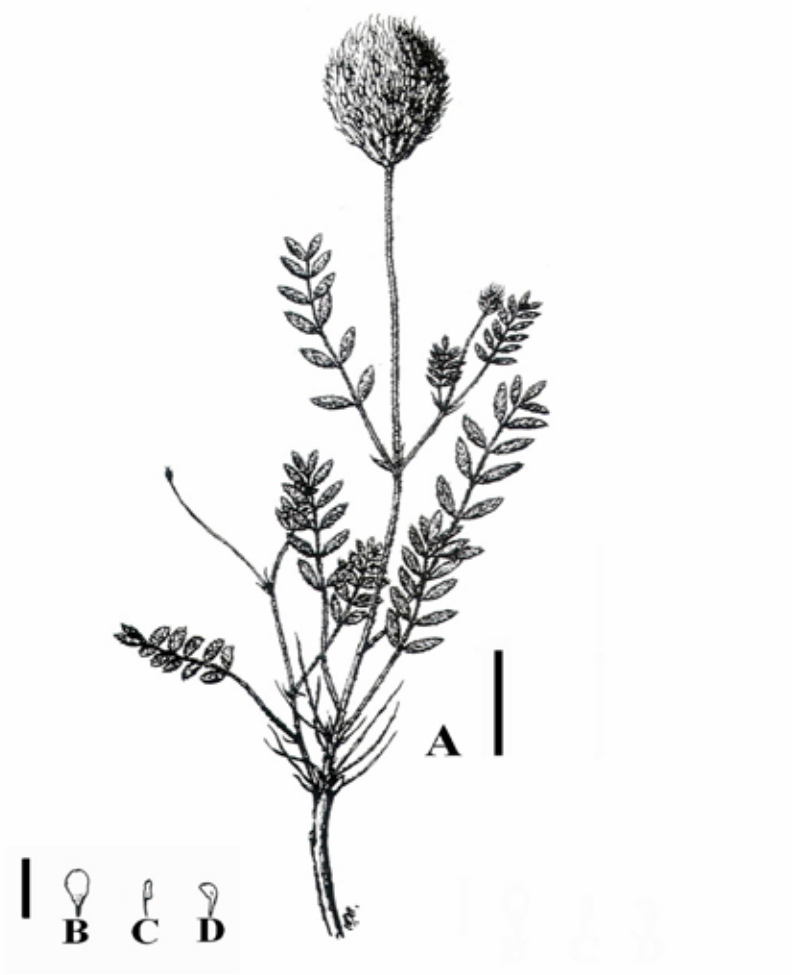

Figure 12. *A. doshman-ziariensis*. (A) Habit. Scale: 2.5 cm, (B) Standard, (C) Wing, (D) Keel. Scale: 1 cm. Illustration from Iran. J. Bot. 4: 74 (1988)

11) *A. hakkariensis* Podlech 1999, Sendtnera 6: 168 - *Stereothrix* - Holotype: Türkei, C10 Prov. Hakkari, 5 km W Esendere gegen Yüksekova, 1720 m, 24.7.1983, *Nydegger 18427* (MSB; iso: BASBG).
A. hakkariensis is a narrow endemic to Hakkari in C10 Anatolia (Podlech, 2008).

12) *A. hirtus* Bunge 1868, Mém. Acad. Imp. Sci. Saint Pétersbourg 11(16): 54 in clave [et l.c. 15 (1): 87. 1869] -*Malacothrix* - Holotype: Persia media inter Gäs et Murtschehar, N Isfahan, *Bunge & Bienert* (P: in juvenile state, without flowers); Epitype (Zarre and Podlech, Rostaniha 7, suppl. 2: 238. 2006): Iran, Prov. Esfahan, at the beginning of road from Golpeyegan to Muteh, 1850 m, 20.7.1998, *Maassoumi* & *Mozaffarian 76711* (MSB; iso-epitype TARI).

A. hirtus Bunge originally described from the type specimen at juvenile state without flowers and placed in *A.* sect. *Stereothrix*. It was collected from Golpeyegan to Muteh (*Maassoumi & Mozaffarian 76711*) and treated as the epitype of *A. hirtus* by Zarre & Podlech (Podlech, 2008).

13) *A. koelzii* Barneby 1974, Brittonia 26: 113 - *Stereothrix* - Typonym: *A. unifoliolatus* Širj. & Rech.f. non Bunge.
Originally it was placed in the monotypic section of *Koelziana*, but linked to *A.* sect. *Stereothrix* by *A. ledinghamii* (Barneby, 1974; Maassoumi, 1998; Lock and Simpson, 1991; Podlech, 2008; Podlech, 2009).

With an interesting systematic position, it is a very rare endemic and known only from the type collection from Bakhtiari, Peshmshurun. Although the shape of leaf or leaflets in this species is similar to some other species of *A.* sect, *Incani*, the shape and size of its leaf or leaflets is very conspicuous (Figure 13). As *A. koelzii* is not related to *A.* sect, *Incani*, it seems that its similarity in leaf or leaflets shape most probably resulted from a convergence.

14) *A. kurnet-es-saudae* Eig 1955, Syst. Stud. Astrag. Near East: 36 - *Stereothrix* - Syntypes: N Lebanon, Jebel Matrafe, near Kurnet-es-Sauda, 2400 m, 13.7.1934, *Eig, Feinbrun & Zohary* (HUJ); contre bas à l'est des grands sommets de Kornet Saouda, 7.7.1933, *Mouterde* (= *A. hispidus* Labill.).
A. kurnet-es-saudae is a narrowly distributed endemic species. It is known from a single locality and deposed at HUJ (Podlech, 2008). It occurs in Jebel Matrafe, near Kurnet-es-Sauda from Lebanon. This name was reduced to synonymy under *A. hispidus* Labill. by Podlech (2008).

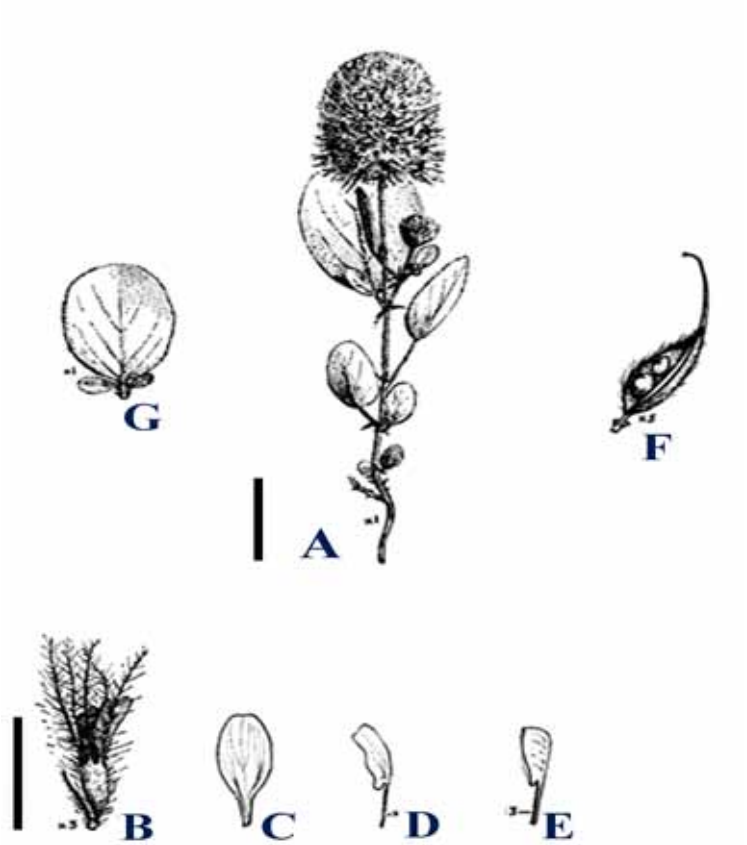

Figure 13. *A. koelzii*. (A) Habit, (B) Calyx, (C) Standard, (D) Wing, (E) Keel. Illustration from Barneby 1974, Brittonia 26: 113. Scale (A): 2 cm, (B-F): 1 cm

15) *A. ledinghamii* Barneby 1974, Brittonia 26: 111- *Stereothrix* - Holotype: Iran, Fars, about Shiraz and Firuzabad, 12 km N Shiraz, 1000-2000 m, 30.5.1965, *Ledingham & Assefi* 4070 (NY; iso: W!, foto BASU!).

A. ledinghamii is a narrow endemic to N Shiraz in Fars Province of Iran. It is morphologically close related to *A. doshman-ziariensis* (Figure 14), especially because of its prostrate habit and more or less large leaflets (Barneby, 1974; Maassoumi, 1998; Lock and Simpson, 1991; Podlech, 2008; Podlech, 2009).

Figure 14. Type specimen of *A. ledinghamii*

16) *A. leucothrix* Freyn & Bornm. 1891, Österr. Bot. Z. 41: 406 - *Stereothrix* - Lectotype (Podlech, Sendtnera 6: 183. 1999): [Turkey] Pontus australis, Amasia, ex gr. Logman et Kirklar ad arcem, 600-800 m, 28.5.1890, *Bornmüller 1840* (B: sheet marked as lectotypus; iso: B, BRNM, G, JE, W!: foto BASU, MSB, WU!).

This species is a narrow endemic from Turkey. It is growing in Amasyai çankırı and Sivas provinces (Podlech, 2008). *A. leucothrix* is closely related to *A. barbatus* and *A. nanus* (Figure 15), but distinguished well by its violet flowers (Chamberlain and Matthews, 1969).

Figure 15. Type specimen of *A. leucothrix*

17) *A. mahneshanensis* Maassoumi & Moussavi 2005, Iran. J. Bot. 11: 104 - *Stereothrix* - Holotype: Iran, prov. Zanjan, Mahneshan NW, Alam Kandi village. 2950 m, 30.5.1381 (persian. calend.), *Mouusavi 3957* (TARI; iso: Zanjan Research Center).

A. mahneshanensis is a narrow endemic to NW Mahneshan in Zanjan Province of Iran. It is known from a single locality and deposed at TARI & Zanjan Research Center (Maassoumi, 2005). In "Flora Iranica", *A. mahneshanensis* has not mentioned from Iran by Podlech (2009).

18) *A. mahmutlarensis* Podlech 2008, Feddes Repert. 119: 32 - *Stereothrix* - Holotype: Turkey, C4 Antalya, ca. 35 km NE Mahmutlar (Alanya), 1270 m, 11.6.2002, *Ulrich A/20* (MSB).

A. mahmutlarensis is a narrow endemic to Anatolia. It is known from a single locality and deposed at MSB (Podlech 2008).

19) *A. montis-varvashti* Podlech 1999, Sendtnera 6: 169 - *Stereothrix* - Holotype: Iran, Prov. Mazanderan, Elburz, Elika, Varvasht mountains, 3500-4100 m, 4.8.1972, *Terme 15240-E* (W!; iso: IRAN!, MSB, foto BASU!) (Figure 16).

A. montis-varvashti is a narrowly distributed endemic species. It is known from a single locality and deposed at W, IRAN and MSB (photo in BASU). It occurs in Siah kuh mountain in Semnan Province and grows in dry-steppe and stony clay zones around Damghan (Maassoumi, 2005).

Figure 16. Type specimen of *montis-varvashti*

20) *A. nabelekii* Czeczott 1932, Acta Soc. Bot. Poloniae 9: 36 - *Hypoglottidei* - Type: [Turkey] Paphlagonia, mt. Kush-Kayasy (jugum Ilgaz-Dagh), 2400 m, 26.7.1925, *Czeczott 495* (KRAM).

A. nabelekii is a local endemic to Anatolia. It occurs in steppe zone of Kush-Kayasy mountain, (Chamberlain & Matthews, 1969; Maassoumi, 1998).

21) *A. nanus* DC. 1802, Astragalogia: 143, t. 17 - *Stereothrix*, illeg. [homotypic with *A. hispidus* Labill.] – Holotype: in Syria, Labillardière (in herb. Desfontaines: FI-W!) (≡ *A. hispidus* Labill.).
- subsp. *nanus* (DC.) Ponert 1973, Feddes Repert. 83: 620 - Basion.: *A. nanus* DC. (= *A. hispidus* Labill.).

A. nanus is the most widespread species of *A.* sect. *Stereothrix*. It occurs in Anatolia, Syria and Lebanon (Rechinger, 1961; Chamberlain and Matthews, 1969; Maassoumi, 1998).

22) *A. podosphaerus* Boiss. & Hausskn. in Boiss. 1872, Fl. Or. 2: 255 - *Stereothrix* - Lectotype (Podlech, Sendtnera 5: 259. 1998): [Iran] in monte Schahu Kurdestaniae, 11000', vii.1867, *Haussknecht* (G-BOIS; iso: JE, LE, P).

A. podosphaerus is a narrowly distributed endemic species. It occurs in Schahu mountain in Kurdistan Province. *A. podosphaerus* grows in dry-steppe and stony clay zones around Tazehabad (Maassoumi, 2005).

23) *A. pseudocapito* Podlech 2004, Ann. Naturhist. Mus. Wien 105 B: 594 - *Stereothrix* - Holotype: Iran. Azarbaijan, Sarab, Gharieh-ye Mir-Kuh-Hadji, 1700-1900 m, 11.-12.6.1986, *Termeh & Daneshpajouh* 41369-E (MSB; iso: IRAN!, W!, foto BASU!).

A. pseudocapito is a rare and local endemic to NW Iran and known from three specimens collected only from a single locality. It occurs in dry-steppe zone of sub-mountainous regions near the village Sarab in Azarbaijan Garbi Province (Podlech, 2009).

24) *A. robertianus* Kit Tan & Sorger 1987, Aliso 11: 622 - *Onobrychoidei* - Holotype: Turkey, Agri, SW of Balik Gölü, 2400 m, 4.8.1983, *Sorger 83-36-18* (LI: foto MSB).

This species was transferred from *A.* sect. *Stereothrix* to *A.* sect. *Onobrychoidei* by Podlech (2008) and then treated as a synonym of *A. psoraloides* Lam. (Aytaç 2012).

25) *A. saganlugensis* Trautv. 1858, Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 16: 323 -*Hypoglottidei* - Lectotype (Podlech & Sytin, Sendtnera 3: 170. 1996): [Turkey] In Turcia asiatica, inter montes saganlugenses et Arserum [Erzerum], 19.8.1855, *Lagowski* (LE: sheet marked as lectotypus, foto MSB; iso: G-BOIS, LE: foto E).

This species was transferred from *A.* sect. *stereothrix* to *A.* sect. *Hypoglottidei* by Podlech (2008).

26) *A. setosulus* Gontsch**.** 1947, Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 10: 33 - *Stereothrix* -Lectotype (Podlech and Sytin, Sendtnera 3: 172. 1996): [Ukraine] Tauria, in monte Demerdshi, in vic. opp. Aluschta, 25.7.1894, *Alexeenko* (LE: sheet marked as lectotypus; iso: LE, MSB).

It is a narrowly distributed endemic species. It is known from a single locality and deposed at LE and MSB. It occurs in Demerdzhi mountain near Alushta.

27) *A. sikaramensis* Širjaev & Rech. F. Biol. Skr. Dan. Vid. Selsk. 9, 3: 39 (1957), Figure 31 et 32. - Afghanistan orientalis: In valle Kurram, Sikaram, 2300-4000 m (*Aitchison 435*, 916, sub nomine *A. leucocephalo* Grah., iso: C).

A. sikaramensis is a narrowly distributed endemic species of *A.* sect. *Stereothrix*. It occurs in the mountainous region of Sikaram, in Kurram valley (Podlech, 2008). In "Flora Iranica", *A. sikaramensis* has not been mentioned from Afghanistan by Podlech (2009).

28) *A. sorgerae* Hub.-Mor. & Chamb. 1969, Notes Roy. Bot. Gard. Edinburgh 29: 289 - *Stereothrix* -Holotype: Turkey, C3 Isparta, Dedegöldag, ca. 1600 m, 3.7.1965, *Sorger 65-43-129* (LI: foto MSB; iso: G).

A. sorgerae is an endemic species to SW Anatolia (Chamberlain and Matthews, 1969).

29) *A. sparsipilis* Hub.-Mor. & Chamb. 1969, Notes Roy. Bot. Gard. Edinburgh 29: 290 - *Stereothrix* - Holotype: Turkey, C4 Konya, ob dem Wald von Gevne bei Hadim, 1800 m, 18.6.1948, *Renz & Huber-Morath 9473* (G!).

A. sparsipilis is endemic to Anatolia (Chamberlain and Matthews, 1969).

30) *A. sphaeranthus* Boiss**.** 1846, Diagn. pl. orient., ser. 1, 6: 37 - *Stereothrix* - Holotype: [Iran] mt. Kuh-Daena, 2.8.1842, *Kotschy 799* (G-BOIS; iso: BM, FI-W, G, K: foto MSB, LE, MSB, OXF, P, PR, PRC, W!: foto BASU, MSB, ZT).

A. sphaeranthus is a narrowly distributed endemic species of *A.* sect. *Stereothrix* (Figure 17). It occurs in steppe zone of the mountain Daena near Yassuj, in Khogilouyeh and Boirahmad Province (Podlech, 2009).

Figure 17. Type specimen of *A. sphaeranthus*

31) *A. stridii* Kit Tan 1987**,** Aliso 11: 621 - *Malacothrix* - Holotype: Turkey, C5 Nigde, Narpiz valley, NW part of Aladag, 6 km SE Demirkazik köyü, 2300-3000 m, 23.7.1984, *Görk, Hartvig & Strid 23923* (C; iso: E: foto MSB, MSB).
It is a narrow endemic from Turkey. This species was collected from Niğde Province and transferred from *A.* sect. *Stereothrix* to *A.* sect. *Malacothrix* by Podlech (2008).

32) *A. subhanensis* Gharemani-nejad & Behçet 2003, Ann. Bot. Fennici 40: 209 - *Stereothrix* - Holotype: Turkey, Van Province, B9 Bitlis, Adilcevaz, Subhan Dağli [Subhan Mt.], Sote Yaylasi [highland], east of Çanakyayla village, 2300 m, 21.6.1987, *Behçet 41* (FAR; iso: FAR, VANF).

Astragalus subhanensis is endemic to Turkey and was collected from Van Province. It is well separated from other species of the section by presence of a few hairs on the wings. The closest relative of *A. subhanensis* is *A. barbatus* (Ghahremani-nejad and Behçet, 2003).

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