

Morphology and typification of *Szovitsia callicarpa* (Apiaceae)

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Abstract. The poorly known monotypic genus *Szovitsia* Fisch. & C.A.Mey. in the Apiaceae family, is here revised. *Szovitsia callicarpa* Fisch. & C.A.Mey. is an annual herb with a restricted distribution in the Caucasus region and adjacent areas of northwestern Iran and northeastern Turkey. The genus is unusual within the family because of the transverse plicae covering its fruits. In this study, morphological, micromorphological, and anatomical characters of *S. callicarpa* are reviewed. In addition, a previous lectotypification of the name *S. callicarpa* is discussed and amended.

Keywords. Anatolia, anatomy, Caucasus, lectotype, monotypic genus, *Szovitsia*.

Resumen. Se revisa *Szovitsia* Fisch. & C.A.Mey. un género monotípico y poco conocido en la familia de las Apiaceae. *Szovitsia callicarpa* Fisch. & C.A.Mey. es una hierba anual con una distribución restringida a la región del Cáucaso y áreas adyacentes del noroeste de Irán y noreste de Turquía. El género es inusual dentro de la familia debido a los pliegues transversales que cubren sus frutos. En este estudio se revisan los caracteres morfológicos, micromorfológicos y anatómicos de esta especie. También se discute y modifica una lectotipificación previa del nombre *S. callicarpa*.

Palabras clave. Anatolia, anatomía, Cáucaso, género monotípico, lectótipo, *Szovitsia*.

How to cite this article: Çelik M., Güner Ö., Çetin Ö., Şahin B. & Ferrer-Gallego P.P. 2020. Morphology and typification of *Szovitsia callicarpa* (Apiaceae). *Anales del Jardín Botánico de Madrid* 77: e101. <https://doi.org/10.3989/ajbm.2521>

Title in Spanish: Morfología y tipificación de *Szovitsia callicarpa* (Apiaceae).

Associate Editor: Carlos Aedo. Received: 14 February 2019; accepted: 23 October 2020; published online: 21 December 2020.

INTRODUCTION

Southwest Asia is an area of great interest because of its high plant diversity and endemism. The level of endemism is generally used to indicate the uniqueness of a flora and is a major criterion for conservation (Sales & Hedge 2013). According to Sales & Hedge (2013), there are 161 endemic genera in southwest Asia and 70% of these are monotypic. Most of these endemic species belong to the families Apiaceae, Asteraceae, and Brassicaceae (Sales & Hedge 2013). Different researchers have documented Apiaceae richness in the area (Davis 1972; Rechinger 1987; Ekim 2009; Sales & Hedge 2013), with 281 genera and 2115 species reported from Asia by Pimenov & Leonov (2004a). The family Apiaceae has the highest number of genera endemic to Asia (60), of which 45 are monotypic (Sales & Hedge 2013).

The distribution of species and generic diversity among Asian countries is extremely uneven. The countries with the greatest biodiversity of Apiaceae are China (672 spp.),

Turkey (Asian area, 453 spp.), Iran (362 spp.), Russia (Asian area, 276 spp.), Kazakhstan (234 spp.), and India (227 spp.). Asian Turkey (Anatolia), with its relatively small area, has the highest concentration of species of Apiaceae not only in Asia, but possibly in the entire world (Pimenov & Leonov 2004b).

Szovitsia is a monotypic genus, and the species *S. callicarpa* is distributed in a very restricted area of the Caucasus region and surrounding areas, covering NW Iran, Armenia, Karabagh, Nakhichevan, and NE Anatolia. The only reports on the morphology of *Szovitsia* are those included in regional floras. Detailed morphological, anatomical, and palynological studies on the genus are practically nonexistent in the botanical literature. Therefore, the purpose of this study was to revise the genus and provide a detailed account of the morphological, palynological, anatomical, and micromorphological characteristics of *S. callicarpa*, and assess their taxonomic significance. The lectotypification of *S. callicarpa* is also discussed.

MATERIAL AND METHODS

The two specimens used in the morphological analysis were collected in Turkey: Iğdır, northeast of Tuzluca, 1075 m, 19 May 2018, *Ö. Güner 6643* (GAZI); 1–3 km from Tuzluca to Kağızman, 1100 m, 3 Jun. 2018, *B. Şahin 7367* (GAZI). Plant samples were identified according to Peşmen (1972), Shishkin (1973) and Rechinger (1987).

For the micromorphological study, pollen slides were prepared according to Wodehouse (1935). Measurements, based on 20 samples, were taken with a Leica microscope. For Scanning Electron Microscope (SEM) investigations, fruit and pollen grains were mounted directly onto the prepared stubs and coated with gold, using a Polaron SC7620 sputter coater. Photographs of the specimens were taken using an incorporated Zeiss LS-10 camera, and the terminologies of Erdtman (1952) and Faegri & Iversen (1975) were used for the micromorphological features.

Mericarps, for the anatomical study, were rehydrated and placed in formalin-acetic acid-alcohol (1:1:8) for at least 24 h. Rehydrated materials were embedded into paraffin blocks following the traditional paraffin section method. Transverse sections were cut about 10 µm thickness using a microtome and stained with safranin solution. Micrographs were taken using a Leica stereomicroscope.

RESULTS

Typification and emended description

Fischer & Meyer (1835: 39) described *Szovitsia callicarpa* as follows: “Herba annua, glabra, foliis compositis v. decompositis, laciniis elongatis filiformibus, umbellis lateralibus, involucris nullis, involucellis 5-6-phyllis membranaceis, floribus albis”. They also included the provenance of the species: “Hab. in desertis salsis prope Nakitschiwan, nec non in locis lapidosis provinciae Karabagh”.

On the other hand, Peşmen (1972: 420) indicated: “Type: [Soviet Armenia] in desertis salsis prope Nakitschiwan?; nec non in locis provinciae Karabagh, *Szovits* (iso. K!)”. Johann Nepomuk Szovits, after Ivan Osipovich Sovich, was a pharmacist who collected extensively during 1828–1830 in Armenia, Karabakh, Imeretia, Mingrelia, and Iranian Azerbaidzhan. In the herbarium of the Royal Botanic Gardens, Kew (K) there are three relevant herbarium sheets, K 000681162, K 000681163, and K 000681165. The sheet K 000681162 was collected by Fischer and it bears a complete plant with leaves and flowers. This sheet (K 000681162) has the label “*Szovitsia callicarpa* / E. prov: Karabagh et prope Nakitschi- / wan” and the annotation “D. Fischer”. The sheet K 000681163 bears a complete plant, with leaves and fruits, and also a plant fragment. It is annotated as

“*Szovitsia callicarpa* / (bis) / D. Fischer” (K 000681163). Clearly, the specimen K 000681163 can be treated as a duplicate of the specimen K 000681162. Finally, the third specimen (K 000681165) (Fig. 1) bears a plant with leaves and fruits, and also a plant fragment, and it has the label “408 / Ex herbario horti Petropolitani [printed] / *Szovitsia callicarpa* F. et M. / Karabagh / Szovits”.

These three specimens (K 000681162, K 000681163, and K 000681165) can be treated as original material of *Szovitsia callicarpa*. However, as Peşmen (1972: 420) mentioned the collector name, as “Szovits”, the sheet indicated in the typification is clearly the specimen K 000681165, and therefore it must be treated as the type of the name *S. callicarpa*, in this case as a lectotype. On the other hand, Shishkin (1973: 364) indicated: “Type in Leningrad”, and Leute (1987: 158) mentioned “Typus: Karabagh, A.J. Szovits 408, W!”. However, these two “typifications” are ineffective and superfluous. Furthermore, there are some specimens of *S. callicarpa* in several herbaria that can be treated as part of the original material, and concretely as duplicate specimens of the lectotype (e.g., C, G, K, L, LE, P, U, W).

Szovitsia Fisch. & C.A. Mey., Index Sem. Hort. Petrop. 1: 39. 1835.

Type: *Szovitsia callicarpa* Fisch. & C.A. Mey.

Szovitsia callicarpa Fisch. & C.A. Mey., Ind. Sem. Hort. Petrop. 1: 39. 1835. Type: [Armenia] Nakitschiwan, Karabagh, Szovits 408 (lectotype designated by Peşmen 1972: 420 as “iso.” [isotype], and corrected here according to ICN Art. 9.10: K 000681165; isotypes: C 10008569, G 00359601, L.2589242 (Herb. Lugd. Bat. N° 908.265-1240), LE 01043593, P 03214069, U 1090342, W-Rchb. 1889-0308677).

Annual herbs with slender roots, spreading-erect, branching from the base, rarely from the middle or upper part. Stem (15–)25–60 cm, thin, up to 2.5 mm diameter, completely glabrous. Radical leaves soon withering; lamina triangular-ovate in outline, 2- to 3-pinnate, 3.5–6.5 × 3–5 cm; petiole shorter than rachis with small sheathing at the base; ultimate segments linear, 3–8 × ca. 0.5 mm. Basal and middle cauline leaves broadly ovate in outline, 3.5–8 cm long (incl. petiole); ultimate segments linear-filiform, up to 35 mm long. Upper cauline leaves pinnatisect with filiform segments. Umbel compound, 3–8(–11) rayed, (1–)2–3.5 cm long, nearly equal, thin, glabrous. Bracts absent or rarely 1. Bracteoles 5–6, lanceolate, widely membranous margin, ciliate in the upper part, acuminate to subulate, 2–5 × 0.8–1.2 mm. Umbellula (3–)5–11 flowered, pedicels unequal, 6–14 mm in fruit. Flowers hermaphrodite. Calyx teeth obsolete or minute, triangular. Petals white, obovate, inwardly curved ligule, up to 3 mm, rough on the base of dorsal surface. Fruits oblong-elliptic, slightly laterally compressed, 3–6 × 2–3.5 mm. Mericarps 2, homomorphic,



Fig. 1. Lectotype of *Szovitsia callicarpa* Fisch. & C.A. Mey. (K 000681165). Image courtesy of the K herbarium.

elliptic with primary and secondary ribs; primary ribs filiform, secondary ribs covered by imbricate plicae, broadly elevated. Stylopodium depressed or short conical, styles spreading or recurved, ca. 1 mm long. Vallecular vitta 1, commissural vittae 2. Figs. 2–3.

Flowering time.—May–June.

Chromosome number.— $n = 10$ (Shner & al. 2005).

Distribution.—Northwestern Iran, Armenia, Karabagh, Nakhichevan, and northeastern Anatolia (Turkey).

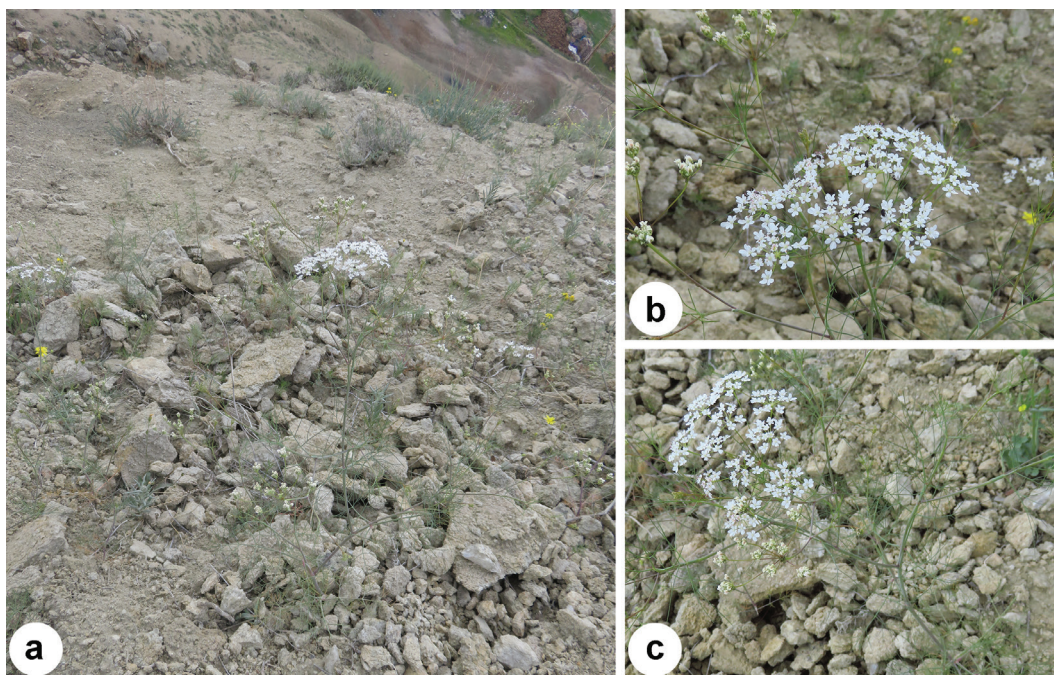


Fig. 2. *Szovitsia callicarpa* in its natural habitat: a, habit; b, detail of the umbel; c, fertile branch.

Fruit anatomy and morphology

In the transverse section, mericarps of *Szovitsia callicarpa* are nearly semi-circular. The fruits have five indistinctly primary ribs. Secondary ribs are also present. The exocarp is a single-layered with the exocarp cells radially elongated or rarely square. The outer cell walls are slightly thickened and covered with a cuticle layer. The mesocarp consists of parenchymatous cells. Vittae are elliptic and relatively large. The number of the vallecular vittae is 1, and the number of the commissural vittae is 2. The vascular bundle is small and solitary in each primary rib. The endosperm, in transverse section, has an oval shape, slightly impressed on commissural side (Fig. 4).

In addition to the features included in the description above, the fruits of *S. callicarpa* have primary ribs that are barely discernible, because they are nearly completely covered by the edges of the secondary ribs. Moreover, the primary ribs and base of the fruit are setulose (Fig. 5a). There are four distinct, broad, and elevated secondary ribs that are covered by imbricate plicae that completely fill the furrows. The plicae are narrower at both the base and top (Fig. 5c), and they are concave and papillose (Fig. 5d). A beak-shaped structure has been observed in the middle part of plicae. The stylopodium is depressed or short and conical and is situated at a considerable height because it expands from the area in which the plica ends. The styles are 1 mm long and spreading or recurved (Fig. 5a). Calyx teeth are obsolete or minute and triangular (Fig. 5b).

Palynology

The pollen grains of *Szovitsia callicarpa* are monad, isopolar, radially symmetric and tricolporate. The polar axis (P) ranges from 28.77 to 32.99 μm and the equatorial axis (E) ranges from 13.02 to 15.08 μm . The exine thickness ranges from 0.71 μm to 1.03 μm and the intine thickness ranges from 0.43 μm to 0.63 μm . The ratio of the length of the polar axis to the equatorial diameter (P/E) averaged 2.13 ± 0.07 making the pollen grain shape perprolate. In polar view, the pollen grains are nearly triangular with obtuse angles. In equatorial view, the grains are narrowly oblong, having a slightly equatorial constriction and obtuse polar caps. The colpus extends to the near poles. The pore area is slightly protruding and is located in the middle of the colpus. The sculpturing pattern is irregularly rugulate, sometimes psilate between the pole and the equatorial area (Fig. 6).

DISCUSSION

Turkey is one of the richest countries in the world in Apiaceae species. A recent account, indicated that the family is represented by 104 genera and 486 species, with three monotypic endemic genera to the country (*Aegokeras* Raf., *Postiella* Kljuykov, and *Crenosciadium* Boiss. & Heldr. ex Boiss.). Of the 182 taxa endemic to Turkey, 45 belong to Apiaceae (Güner & al. 2012).

Szovitsia callicarpa has a limited geographical extension and is distributed in NW Iran, Armenia, Karabagh,

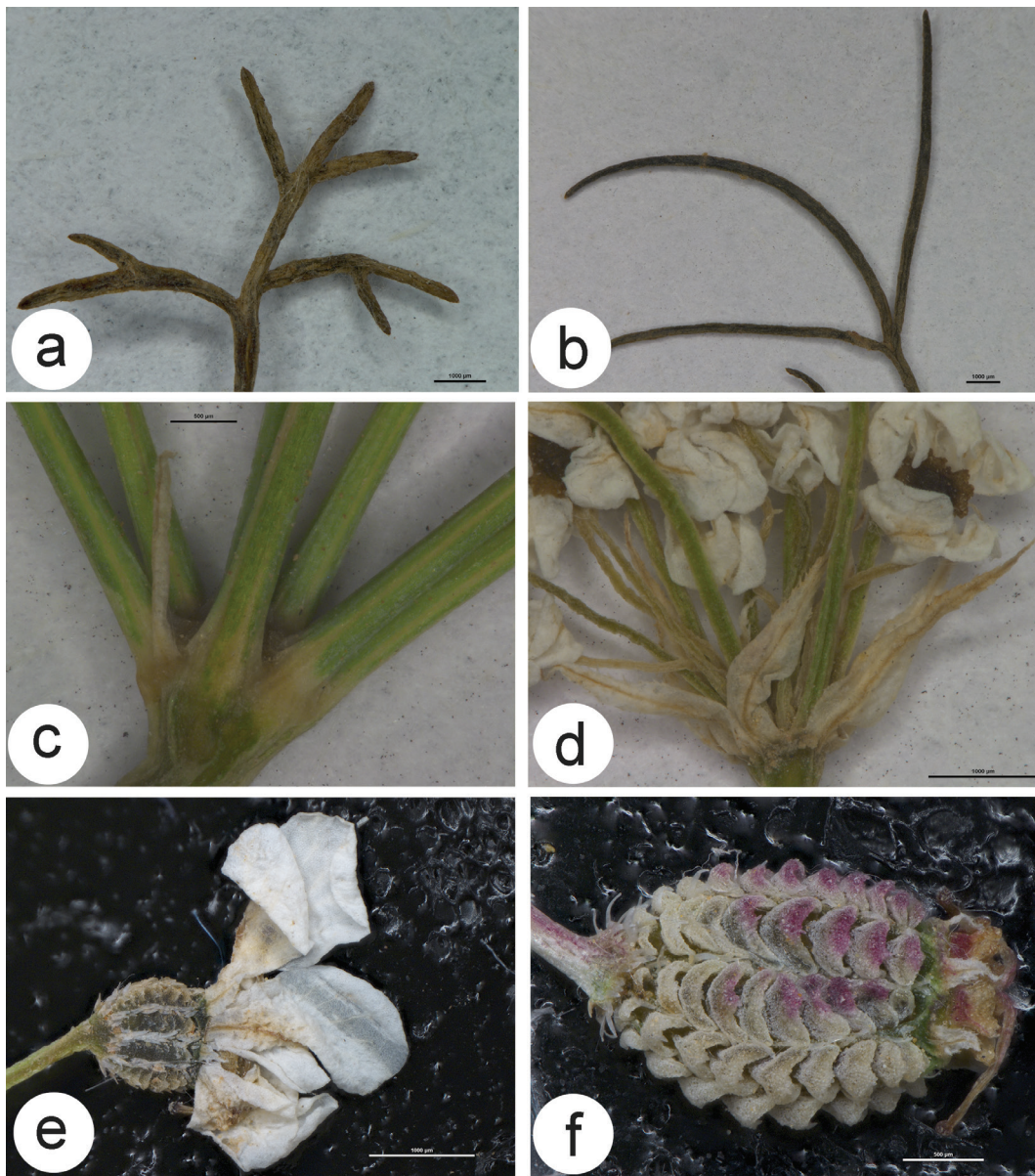


Fig. 3. Detail of leaf, flower, and fruit of *Szovitsia callicarpa*: **a**, basal leaf segments; **b**, cauline leaf segments; **c**, bract; **d**, bracteoles; **e**, dorsal surface of petals; **f**, general view of fruit and plicae.

Nakhichevan, and Turkey (NE Anatolia). The species is known only from the salty-gypseous soils in İğdir and Kars in Turkey (Fig. 7) and has not been collected in the central-western part the country. The İğdir-Yerevan basin was formed by stratification with alluvium materials carried by the Aras River and the precipitated sediments in stagnant water over cenozoic (Davis 1965). This sedimentary basin is composed of soils with high mineral and salt contents. The average annual rainfall is 250 mm, and the average maximum temperature is 12°C in the basin. Most of the annual precipitation falls during spring and early summer, and severe drought begins after the rainy period. These

climate and environmental characteristics determine the species' extremely short growing season. Pressure from overgrazing and erosion, has resulted in the reduction of the vegetation coverage on the slopes around the basin. The vegetation in this area is dominated by *Atraphaxis spinosa* L., a shrub resistant to the severe environmental conditions. Ephemeral plants that must complete their life cycles before the high summer temperatures and grazing pressure, grow under this spiny shrub on the slopes. *Szovitsia callicarpa* is one of these plants. It grows in semi-arid deserts and steppe slopes that are characterized by eroded, overgrazed, and saline soils. Other species co-

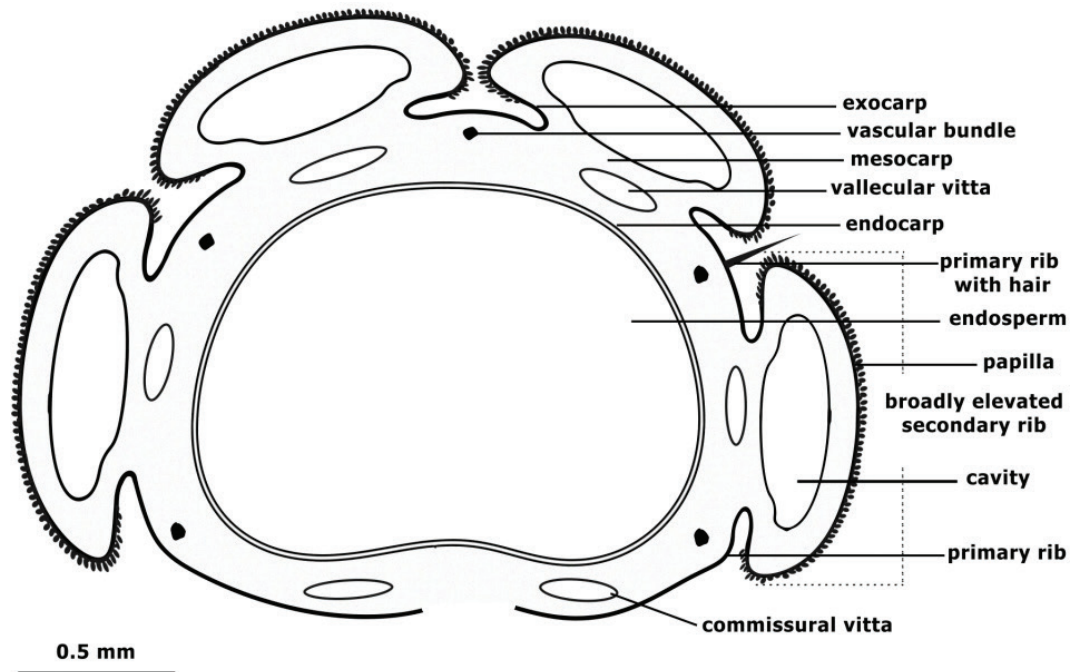


Fig. 4. Schematic structure of the fruit cross-section of *Szovitsia callicarpa*, indicating the main features.

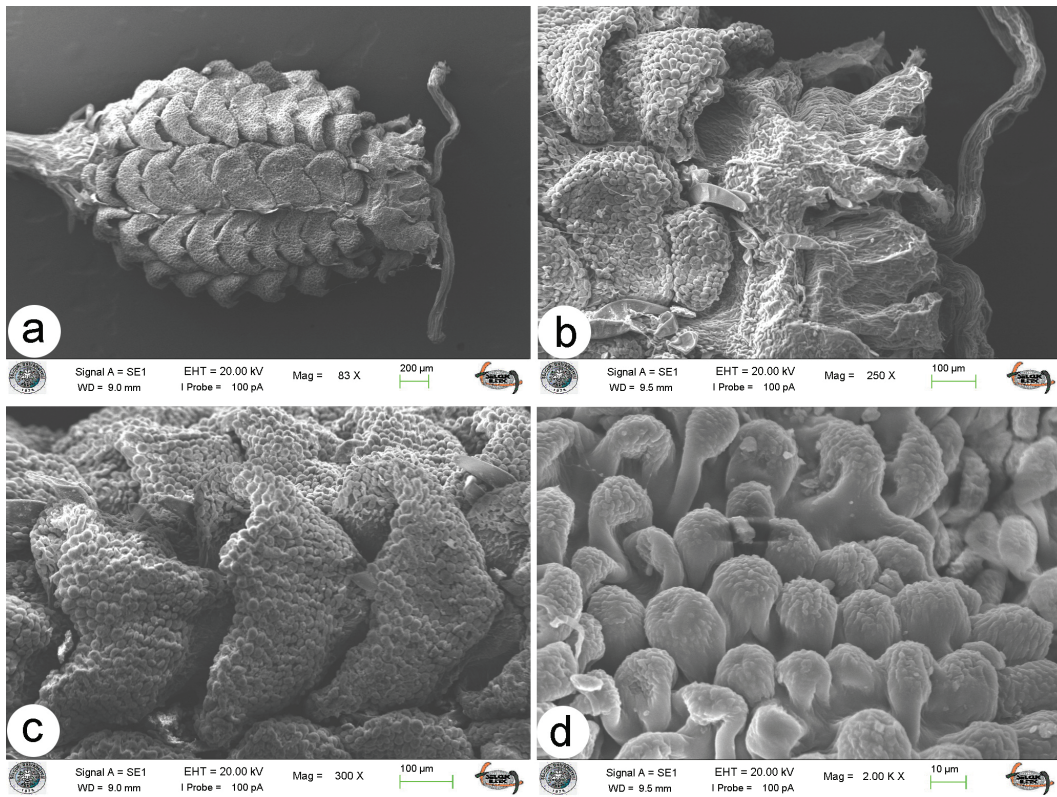


Fig. 5. SEM images of fruits of *Szovitsia callicarpa*: a, general shape of fruit; b, close view of the calyx teeth, stylopodium and base of the style; c, close view of the plicae; d, view of papillae on the surface of a plica.

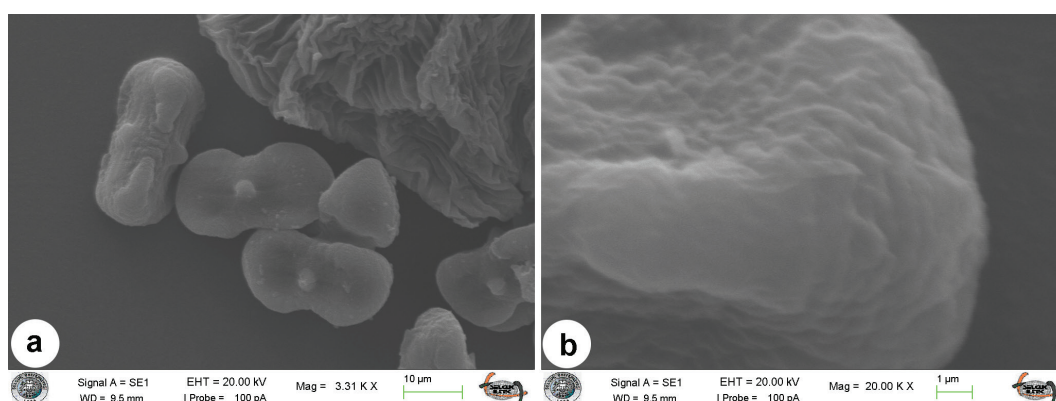


Fig. 6. SEM images of pollen grains of *Szovitsia callicarpa*: a, general view; b, detail of pollen grain surface.

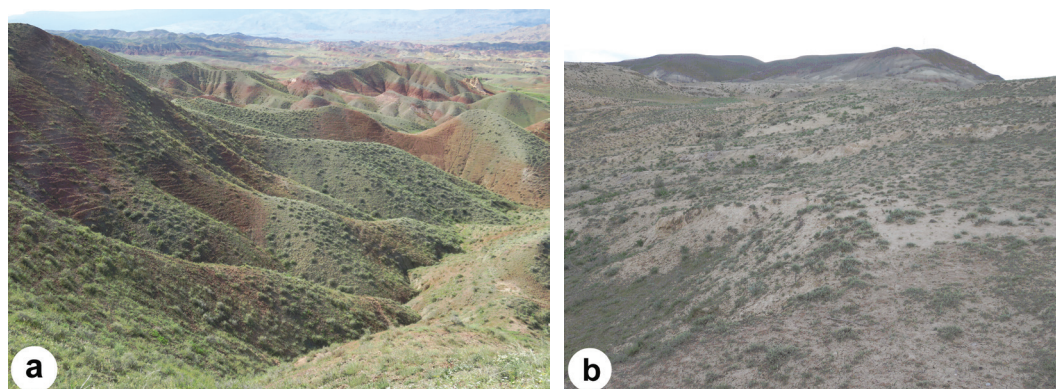


Fig. 7. Habitats of *Szovitsia callicarpa* in Turkey: a, View of site between Tuzluca and Kağızman; b, Site located northeast of Tuzluca.

occurring with *S. callicarpa* are: *Allochrysa versicolor* (Fisch. & C.A.Mey.) Boiss., *Arnebia pulchra* (Willd. ex Roem. & Schult.) J.R.Edm., *Artemisia santonicum* L., *Asphodeline prolifera* (M.Bieb.) Kunth, *Astragalus dictyophysus* Reut. ex Bunge, *Astragalus latifolius* Lam., *Atraphaxis spinosa*, *Brachypodium distachyon* (L.) P.Beauv., *Bunium microcarpum* (Boiss.) Freyn & Bornm., *Matthiola odoratissima* (M.Bieb.) R.Br., *Phlomis laciniata* (L.) Kamelin & Makhm., *Polygala supina* Schreb. subsp. *rhodopea* (Velen.) McNeill, *Stachys araxina* Kopell., and *Stipa pulcherrima* K.Koch.

The most traditional classifications of Apiaceae have relied almost exclusively on fruit characters (Plunkett & Downie 1999). The genus *Szovitsia* is unusual within the family Apiaceae by its fruit with secondary ribs that are covered by plicae. Ledebour (1844) has considered *Szovitsia* to be closely related to *Caucalis* L., *Turgenia* Hoffm., and *Torilis* Adans. and placed it in the Caucalineae tribe. Later on, *Szovitsia* was placed in the Caucalineae tribe

in Haplozygiae along *Ormosciadium* Boiss., *Coriandrum* L., *Bifora* Hoffm., *Cuminum* L., *Trepocarpus* Nutt ex DC., *Ammiopsis* Boiss., *Exoacantha* Labill., *Artedia* L., *Daucus* L., *Caucalis*, and *Psammogeton* Edgew. in the classification of Bentham (1867).

A comprehensive molecular phylogenetic analysis of Caucalideae, Scandiceae, and related taxa, based on DNA sequences, showed that *Glochidotheca* Fenzl. is sister to the *Turgenia*, *Lisaea* Boiss., *Caucalis* clades and that *Szovitsia* allies with *Astrodaucus* Drude (Lee & Downie 1999; Lee & Downie 2000). Lee & Downie (2000) indicated that the group can be characterized by two synapomorphies—the presence of curved primary hairs and the presence of peg-like projections on the surface of secondary appendages. Further studies on species relationships within the spiny-fruited umbellifers (Scandiceae subtribes Daucinae and Torilidinae) (Lee & al. 2001) show that subtribe Torilidinae includes three major lineages—*Astrodaucus*, *Torilis*, and *Caucalis*.

The *Astrodaucus* subclade comprises *Astrodaucus*, *Glochidotheca*, and *Szovitsia* and share the two synapomorphies mentioned above, although these taxa are remarkably different morphologically (Lee & al. 2001). *Astrodaucus* has double rows of pyramid-shaped spines on its secondary ridges, which nearly completely conceal the thread-like primary ridges, whereas *Szovitsia* is characterized by unique spatulate pouches for the secondary appendages, and *Glochidotheca* has strongly laterally compressed fruits (Lee & Downie 1999; Lee & Downie 2000; Lee & al. 2001).

ACKNOWLEDGEMENTS

We thank Ivan Tatanov and the officials at the Leningrad Herbarium for sharing pictures of herbarium samples with us and the Ministry of Agriculture and Forestry, Republic of Turkey, for financial support.

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