

A taxonomic revision of *Salvia euphratica* sensu lato and its closely related species (sect. *Hymenosphace*, Lamiaceae) using multivariate analysis

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Received: 13.10.2009

Accepted: 31.01.2010

Abstract: As an initial part of a revisional study based on the genus *Salvia* L. (Lamiaceae), extensive field studies, herbarium and literature surveys, and multivariate analysis have been conducted on the basis of the *Salvia euphratica* sensu lato (*S. cerino-pruinosa*, *S. euphratica*, *S. leiocalycina*, and *S. pseudeuphratica*) and its closely related species (*S. kronenburgii* and *S. sericeo-tomentosa*) in order to understand their taxonomic status. For the multivariate analysis, 35 OTUs (Operational Taxonomic Units) representing 24 populations of the species were investigated and scored on the basis of 25 character states by means of MVSP software. Principle coordinate analysis (PCO) utilizing the Gower coefficient on standardized data was conducted on the specimens to see their distribution as 3-dimensional plots. In the Flora of Turkey, *S. euphratica*, *S. kronenburgii*, and *S. sericeo-tomentosa* were evaluated as separate species. On the other hand, *S. cerino-pruinosa* and *S. pseudeuphratica* were regarded as synonyms of *S. euphratica*. As a result of the present study, *S. cerino-pruinosa* and *S. pseudeuphratica* are accepted as distinct species. Turkish endemic *S. cerino-pruinosa* and its closest relative Iranian endemic *S. kermanshahensis* are also discussed in terms of their morphological and taxonomical relationships. Literature surveys and herbarium studies indicated that *S. pseudeuphratica* has been rediscovered once again since it was first collected 117 years ago. A diagnostic key for the species studied is given and their diagnostic morphological characters are discussed. Moreover, their amended and expanded descriptions, distributions, phenology, ecology, and photographs are provided.

Key words: Lamiaceae, *Salvia euphratica*, taxonomy, Turkey

Salvia euphratica sensu lato ve yakın türlerinin çok değişkenli analizler kullanılarak taksonomik revizyonu

Özet: *Salvia* L. (Lamiaceae) cinsi üzerine temel alınan revizyon çalışmasının ilk bölümü olarak, *Salvia euphratica* sensu lato (*S. cerino-pruinosa*, *S. euphratica*, *S. leiocalycina*, ve *S. pseudeuphratica*) ve yakın türlerinin (*S. kronenburgii* ve *S. sericeo-tomentosa*) taksonomik statülerini anlamak için kapsamlı arazi çalışmaları, herbaryum ve literatür araştırmaları ve çok değişkenli analizler gerçekleştirildi. Çok değişkenli analizler için türlerin 24 popülasyonunu temsil eden 35 OTU araştırıldı ve MVSP yazılımını kullanarak 25 karakter durumu değerlendirildi. Türlerin dağılımlarını üç boyutlu kümeler halinde görmek için standart veriler üzerine Gower katsayısını kullanarak temel koordinat analizleri (PCO) yapıldı. Türkiye Florası'nda *S. euphratica*, *S. kronenburgii* ve *S. sericeo-tomentosa* ayrı türler olarak değerlendirildi. Diğer taraftan

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S. cerino-pruinosa ve *S. pseudeuphratica*, *S. euphratica*'nın sinonimleri olarak sayıldı. Bizim güncel çalışmamızın sonucu olarak, *S. cerino-pruinosa* ve *S. pseudeuphratica* farklı türler olarak kabul edildi. Ayrıca, Türk endemiği *S. cerino-pruinosa* ve onun en yakın akrabası İran endemiği *S. kermanshahensis* morfolojik ve taksonomik ilişkiler açısından tartışıldı. Literatür araştırmaları ve herbaryum çalışmaları ilk kez 117 yıl önce toplanan *S. pseudeuphratica*'nın tekrar keşfedildiğini gösterdi. Çalışılan türler için bir teşhis anahtarı verildi ve onların ayırt edici karakterleri tartışıldı. Ayrıca, düzeltilmiş ve genişletilmiş tanımları, dağılımları, fenoloji, ekoloji ve fotoğrafları verildi.

Anahtar sözcükler: Lamiaceae, *Salvia euphratica*, taksonomi, Türkiye

Introduction

The genus *Salvia* L. represents nearly 1000 species displaying a remarkable diversity in growth forms, secondary compounds, floral morphology, and pollination biology. The genus has distributed extensively in 3 regions of the world: Central and South America (500 spp.), western Asia (200 spp.), and eastern Asia (100 spp.) (Walker & Sytsma, 2007).

The first revision of *Salvia* in Turkey was made by Hedge (1982a), who recognized 86 species, 1 hybrid and 1 doubtful species. Since 2005, as part of a revisional study of *Salvia* in Turkey, the authors have carried out extensive field studies and collected a large number of specimens. Population sizes and phenological and ecological properties were also observed in the field. The studies have revealed 2 new species (İlçim et al., 2009; Celep & Doğan, 2010), 2 new varieties (Celep et al., 2009a; Celep et al., 2010), and 2 new records (Celep et al., 2009b; Kahraman et al., 2009a). Additionally, the authors have examined morphology, anatomy, trichome, nutlet, and pollen micromorphology of some Turkish *Salvia* species (Kahraman et al., 2009b, c; Kahraman et al. 2010a, b).

Section *Hymenosphace* that includes *S. euphratica* sensu lato and its closely related species consists of herbaceous and woody semi-shrubs with a relatively primitive stem structure. The characteristic feature of this section is to have calyces greatly enlarging after anthesis and they often contain 4 nutlets but only 1 or 2 of them reaching maturity. The largest number of species in the section *Hymenosphace* grows in Turkey (Hedge, 1965). In the section, Hedge (1982a) recognized 12 species, 9 of which are endemic to Turkey.

Turkish endemic *S. euphratica* was first published by Montbret and Aucher in 1836. Later, Rechinger (1952) described 6 new endemic species, which are closely related to *S. euphratica*, namely Turkish

endemics *S. leiocalycina* Rech. f., *S. cerino-pruinosa* Rech. f., *S. pseudeuphratica* Rech. f., *S. sericeo-tomentosa* Rech. f., *S. kronenburgii* Rech. f., and Iranian endemic *S. kermanshahensis* Rech. f.

While preparing Turkish and Iranian *Salvia* accounts, Hedge (1982a, 1982b) changed the taxonomic status of the species. In the accounts, *S. euphratica*, *S. sericeo-tomentosa*, *S. kronenburgii*, and *S. kermanshahensis* were all treated as distinct species whereas *S. leiocalycina* was treated as a variety of *S. euphratica*. Moreover, *S. pseudeuphratica* and *S. cerino-pruinosa* were treated as synonyms. In the Flora of Turkey (Hedge, 1982a), the former was evaluated as a synonym of *S. euphratica* var. *euphratica* while the latter was regarded as a synonym of *S. euphratica* Montbret & Aucher ex Benth. var. *leiocalycina* (Rech. f.) Hedge.

The main objectives of this study were to clarify the taxonomic status of *S. euphratica* sensu lato in relation with its closely related species based on field studies, herbarium surveys, and multivariate analysis and to provide their emended and expanded descriptions, distributions, phenology, ecology, and photographs.

Materials and methods

During the field investigations conducted between 2005 and 2009, specimens of *S. euphratica* sensu lato and the closely related species were gathered from their natural habitats in the East and South Anatolia and photos of the type specimens of *S. kermanshahensis* were also obtained from herbarium Berolinense (B) (Ropert, 2000). All the specimens were first cross-checked with the key given by Hedge (1982a) and also consulted with the accounts of various relevant literatures, such as Rechinger (1952), Flora Orientalis (Boissier, 1879), and Flora Iranica

(Hedge, 1982b). Furthermore, they have been compared with type specimens and other ones housed at various herbaria (AEF, ANK, B, BM, E, G, GAZI, HUB, ISTE, ISTF, K, KNYA, and W).

The morphometric analyses were carried out on the specimens of *S. euphratica* sensu lato and the closely related species, except for *S. kermanshahensis*, by measuring 25 diagnostic vegetative, reproductive, and nutlet characters (Table 1). For the morphometric

analyses, 24 populations of the species were chosen and studied (Table 2). In these populations, 35 specimens were selected as OTUs (Operational Taxonomic Units, the specimens) and scored for the multivariate analysis (Sneath & Sokal, 1973). The basic units of comparison in numerical phenetics were termed as OTUs (Ward, 1993). From each population, at least one or more specimens were selected and represented in the phenogram (Figure 1).

Table 1. Morphological characters scored for the statistical analysis.

1. Stems length up to 15-20 (-30) cm	0	13. Pedicel length up to 3 mm	0
Stems more than 30 cm	1	Pedicel length 3-5 mm	1
		Pedicel length more than 5 mm	2
2. Stems both glandular and eglandular hairy	0	14. Calyx texture coriaceous	0
Stems glabrous	1	Calyx texture membranous	1
Stems eglandular pilose to villous	2		
Stems eglandular lanate	3	15. Calyx length in flower up to 15 mm	0
Stems densely eglandular sericeo-tomentose	4	Calyx length in flower more than 15 mm	1
3. Leaves simple	0	16. Calyx green to light purplish	0
Leaves with one pair	1	Calyx totally dark purplish	1
		Calyx yellowish green	2
4. Leaves narrowly oblong	0	17. Calyx glabrous	0
Leaves oblong to ovate-oblong	1	Calyx pilose to villous	1
Leaves elliptic	2		
5. Leaves attenuate at base	0	18. Corolla length up to 20 mm	0
Leaves cordate or rounded at base	1	Corolla length more than 20 mm	1
6. Leaves glabrous	0	19. Corolla pinkish	0
Leaves pilose to villous	1	Corolla bluish	1
Leaves lanate	2	Corolla entirely white	2
Leaves sericeo-tomentose	3	Corolla white upper lip yellow	3
7. Leaves length/width ratio up to 2	0	20. Upper lip of corolla straight	0
More than 2	1	Upper lip of corolla crescent	1
8. Petiole length up to 7 mm	0	21. Fertile anther length up to 2.5 mm	0
More than 7 mm	1	Fertile anther length more than 2.5 mm	1
9. Verticillasters distant (when fruiting)	0	22. Anthers hairy	0
Verticillasters approximating (when fruiting)	1	Anthers hairless	1
10. Inflorescence axis glabrous	0	23. Length of upper theca up to 3 mm	0
Inflorescence axis clearly pilose to villous	1	Length of upper theca more than 3 mm	1
11. Inflorescence branched	0	24. Nutlet shape broadly oblong	0
Inflorescence non-branched	1	Nutlet shape ovate	1
		Nutlet shape spherical	2
12. Bracts shorter than calyx	0	25. Nutlet length up to 4 mm	0
Bracts equal or longer than calyx	1	Nutlet length more than 4 mm	1

Table 2. List of OTUs (operational taxonomic units) and populations selected for the multivariate analysis.

OTUs	Pop. Num.	Species	Locality
1	1	<i>S. cerino-pruinosa</i> (glabrous form)	Sivas: Divriği to Kemaliye, near Çobandurağı village, 1050 m, 6.6.2006, <i>A.Kahraman</i> 1188(A)
2	1	<i>S. cerino-pruinosa</i> (glabrous form)	Sivas: Divriği to Kemaliye, near Çobandurağı village, 1065 m, 6.6.2006, <i>A.Kahraman</i> 1188(B)
3	1	<i>S. cerino-pruinosa</i> (glabrous form)	Sivas: Divriği to Kemaliye, near Çobandurağı village, 1100 m, 6.6.2006, <i>A.Kahraman</i> 1188(C)
4	1	<i>S. cerino-pruinosa</i> (glabrous form)	Sivas: Divriği to Kemaliye, 30 km to Gümüşçeşme, 850 m, 6.6.2006, <i>A.Kahraman</i> 1189(A)
5	2	<i>S. cerino-pruinosa</i> (glabrous form)	Sivas: Divriği to Kemaliye, 30 km to Gümüşçeşme, 900 m, 6.6.2006, <i>A.Kahraman</i> 1189(B)
6	2	<i>S. cerino-pruinosa</i> (glabrous form)	Sivas: From Divriği to Kemaliye, 15 km to Adatepe village, 1030 m, 2.6.2008, <i>A.Kahraman</i> 1524
7	3	<i>S. cerino-pruinosa</i> (glabrous form)	Elazığ: 20 km from Elazığ to Pertek, 915 m, 3.6.2008, <i>A.Kahraman</i> 1530(C)
8	4	<i>S. cerino-pruinosa</i> (pilose form)	Elazığ: 20 km from Elazığ to Pertek, 915 m, 3.6.2008, <i>A.Kahraman</i> 1530(A)
9	4	<i>S. cerino-pruinosa</i> (pilose form)	Elazığ: 18 km from Elazığ to Pertek, 850 m, 3.6.2008, <i>A.Kahraman</i> 1530(B)
10	5	<i>S. euphratica</i> var. <i>leiocalycina</i>	Malatya: Malatya to Yeşilyurt, Beydağı, 950 m, 16.5.2006, <i>A.Kahraman</i> 1114(A)
11	6	<i>S. euphratica</i> var. <i>leiocalycina</i>	Sivas: Karasarbeli pass to Kayaburun village, 1505 m, 6.6.2006, <i>A.Kahraman</i> 1155(B)
12	7	<i>S. euphratica</i> var. <i>leiocalycina</i>	Sivas: Divriği to Kemaliye, near Maltepe village, 1350 m, 6.6.2006, <i>A.Kahraman</i> 1178
13	8	<i>S. euphratica</i> var. <i>leiocalycina</i>	Sivas: near Gedikbaşı village, 1275 m, 6.6.2006, <i>A.Kahraman</i> 1184
14	9	<i>S. euphratica</i> var. <i>leiocalycina</i>	Malatya: 64 km from Darende to Malatya, near Develi village, 1325 m, 7.6.2006, <i>A.Kahraman</i> 1216
15	10	<i>S. euphratica</i> var. <i>leiocalycina</i>	Sivas: 9 km from Gürün to Gökpınar, 1525 m, 7.6.2006, <i>A.Kahraman</i> 1226(B)
16	11	<i>S. euphratica</i> var. <i>leiocalycina</i>	Sivas: 10 km from Divriği to Kangal, 1450 m, 13.7.2005, <i>F.Celep</i> 879
17	12	<i>S. euphratica</i> var. <i>leiocalycina</i>	Erzincan: Kemaliye, near Gümüşçeşme village, river, 1120 m, 13.7.2005, <i>F.Celep</i> 883(A)
18	13	<i>S. euphratica</i> var. <i>euphratica</i>	Malatya: 1-1.5 km from Darende to Malatya, 1000 m, 16.5.2006, <i>A.Kahraman</i> 1098(A)
19	13	<i>S. euphratica</i> var. <i>euphratica</i>	Malatya: 1-1.5 km from Darende to Malatya, 1030 m, 16.5.2006, <i>A.Kahraman</i> 1098(B)
20	14	<i>S. euphratica</i> var. <i>euphratica</i>	Malatya: Beydağı Mountain, between Gündüzbey and Kozluk, 1400 m, <i>A.Kahraman</i> 1116
21	15	<i>S. euphratica</i> var. <i>euphratica</i>	Sivas: between Karasarbeli pass to Kayaburun village, 1505 m, 16.5.2006, <i>A.Kahraman</i> 1155(A)
22	16	<i>S. euphratica</i> var. <i>euphratica</i>	Malatya: Malatya to Adıyaman, above Gözene road, 1060 m, 19.5.2007, <i>A.Kahraman</i> 1366
23	17	<i>S. euphratica</i> var. <i>euphratica</i>	Erzincan: Kemaliye, near Gümüşçeşme village, river, 1120 m, 13.7.2005, <i>F.Celep</i> 883(B)
24	18	<i>S. pseudeuphratica</i>	Elazığ: 5 km from Keban to Elazığ, 900 m, 24.5.2006, <i>A.Kahraman</i> 1200(B) & <i>S. Bagherpour</i>
25	19	<i>S. pseudeuphratica</i>	Elazığ: 1.5-2 km from Keban to Elazığ, 750 m, 24.5.2007, <i>A.Kahraman</i> 1384(A) & <i>E.Cabi</i>
26	19	<i>S. pseudeuphratica</i>	Elazığ: 1.5-2 km from Keban to Elazığ, 775 m, 24.5.2007, <i>A.Kahraman</i> 1384(B) & <i>E.Cabi</i>
27	20	<i>S. pseudeuphratica</i>	Elazığ: After 3-4 km from Keban to Elazığ, 800 m, 24.5.2007, <i>A.Kahraman</i> 1385(A) & <i>E.Cabi</i>
28	20	<i>S. pseudeuphratica</i>	Elazığ: After 3-4 km from Keban to Elazığ, 830 m, 24.5.2007, <i>A.Kahraman</i> 1385(B) & <i>E.Cabi</i>
29	20	<i>S. pseudeuphratica</i>	Elazığ: After 4 km from Keban to Elazığ, 850 m, 24.5.2007, <i>A.Kahraman</i> 1385(C) & <i>E.Cabi</i>
30	20	<i>S. pseudeuphratica</i>	Elazığ: After 4 km from Keban to Elazığ, 860 m, 24.5.2007, <i>A.Kahraman</i> 1385(D) & <i>E.Cabi</i>
31	21	<i>S. kronenburgii</i>	Van: 5 km from Köşebaşı village to Van, 1975 m, 8.6.2008, <i>A.Kahraman</i> 1575 & <i>S.Kahraman</i>
32	22	<i>S. kronenburgii</i>	Van: near Gürpınar, 1798 m, 16.7.2006, <i>A.Kahraman</i> 1326 & <i>S.Kahraman</i>
33	23	<i>S. kronenburgii</i>	Van: Van to Gürpınar, near Kurubaş pass, 2120 m, 11.7.2007, <i>A.Kahraman</i> 1454 & <i>S.Kahraman</i>
34	24	<i>S. sericeo-tomentosa</i>	Hatay: Samandağ, Samandağ to Arsuz, about 10-15 km, 20-30 m, 19.6.2007, <i>F.Celep</i> 1232A
35	24	<i>S. sericeo-tomentosa</i>	Hatay: Samandağ, Samandağ to Arsuz, about 10-15 km, 20-30 m, 19.6.2007, <i>F.Celep</i> 1232B

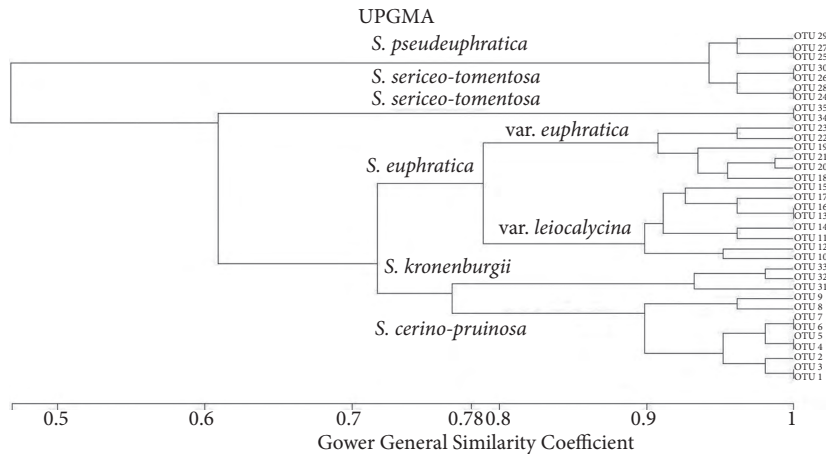


Figure 1. Dendrogram constructed by means of UPGMA algorithm and Gower's General Similarity Coefficient (for OTU numbers see Table 2).

The selection was undertaken according to well-preserved and dried specimens, and well-developed flowers and nutlets. Some important morphological characters of the specimens, such as indumentum and inflorescence properties, and population structure were also noted in the field.

For the multivariate analysis, a similarity matrix was created first using Gower's (1971) general coefficient similarity (Sneath & Sokal, 1973), which can be used directly with a mixture of character types (binary, qualitative, and quantitative characters) as well as taking into account missing values (St-Laurent et al., 2000). These similarity matrices were then clustered using UPGMA (Unweighted Pair-Group Method Using Arithmetic Averages) and the results are shown in the phenogram (Figure 1). UPGMA is the most frequently used method (Romesburg, 1984) and also appears to produce the best results (Radford, 1986) in terms of following criteria: accurate reflection of the similarity matrix, symmetrical hierarchical structure, and congruence with classification derived by traditional methods (Ward, 1993). The characters used in the analysis were assumed to be as important as each other and were unweighted. Principle coordinates analysis (PCO), using Gower general similarity coefficients, was performed to summarize relationship among specimens. For these analyses, the MVSP for Windows v. 3. 13d (a multivariate statistics package

for IBM PC and compatibles) program package was applied (Kovach, 1999).

Results and discussion

The current study has showed that *S. pseudoeuphratica* and *S. cerino-pruinosa* should be evaluated as 2 distinct species like Rechinger's (1952) treatment. The treatments have been confirmed by cluster analysis, principle coordinate analysis, and field and herbarium studies. Taxonomical history of the species according to previous treatments and our results are given in Table 3.

The phenogram obtained from UPGMA clustering of similarity matrix is presented in Figure 1. A line across the phenogram at 0.78 similarity level empirically distinguishes 5 subgroups or phenons corresponding to the species, namely *S. pseudoeuphratica*, *S. sericeo-tomentosa*, *S. euphratica*, *S. kronenburgii*, and *S. cerino-pruinosa*.

According to the phenogram, the first phenon represents *S. pseudoeuphratica* (OTUs 24-30) previously treated as a synonym of *S. euphratica* var. *euphratica* in the Flora of Turkey. However, it clearly differs from *S. euphratica* on its densely white lanate indumentum, shorter and erect stems, denser inflorescences in fruiting, smaller, greyish, and non-membranous bracts, smaller, and entirely dark purplish calyces, and smaller corollas and nutlets.

Table 3. Taxonomical comparison of the species according to treatments of Boissier (1879), Rechinger f. (1952), Hedge (1982a), and our results.

Boissier	Rechinger	Hedge	The present study
<i>S. euphratica</i>	<i>S. euphratica</i>	<i>S. euphratica</i> var. <i>euphratica</i>	<i>S. euphratica</i> var. <i>euphratica</i>
	<i>S. leiocalycina</i>	<i>S. euphratica</i> var. <i>leiocalycina</i>	<i>S. euphratica</i> var. <i>leiocalycina</i>
	<i>S. cerino-pruinosa</i>	Synonym of <i>S. euphratica</i> var. <i>leiocalycina</i>	<i>S. cerino-pruinosa</i>
	<i>S. pseudeuphratica</i>	Synonym of <i>S. euphratica</i> var. <i>euphratica</i>	<i>S. pseudeuphratica</i>
	<i>S. kronenburgii</i>	<i>S. kronenburgii</i>	<i>S. kronenburgii</i>
	<i>S. sericeo-tomentosa</i>	<i>S. sericeo-tomentosa</i>	<i>S. sericeo-tomentosa</i>

Moreover, calyces of the *S. pseudeuphratica* appear more similar to those of *S. multicaulis* Vahl than *S. euphratica* in the field. *S. pseudeuphratica* is only confined to Keban (Elazığ) and known from a single population collected first by Sintenis in 1889. Since that date, we have collected it from 3 different stations in Keban for the second time.

The second phenon represents the specimens of *S. sericeo-tomentosa* (OTUs 34-35) described as a new species by Rechinger in 1952. It is a local endemic species growing in Hatay province in the Mediterranean Region of Turkey. *S. sericeo-tomentosa* clearly differs from *S. euphratica* and the other closely related species on its clearly attenuate, narrowly oblong, and sericeo-tomentose leaves, white or cream corollas with yellow upper lips, and always branched inflorescence.

The third phenon represents *S. euphratica* (OTUs 10-23) composed of 2 varieties, var. *leiocalycina* and var. *euphratica*. The former variety was previously treated as a species by Rechinger (1952). However, it differs from the typical *S. euphratica* with glabrous inflorescence, bract, and calyx (Hedge, 1982a). Because of their overall similarities and overlapping distribution areas in Sivas, Erzincan, Malatya, Elazığ, and Tunceli provinces, *S. leiocalycina* was treated as a variety in the Flora of Turkey. Our present study also supports the treatment.

The fourth phenon represents *S. kronenburgii* (OTUs 31-33) described as a new species by Rechinger (1952). It differs from its closely related species on its totally yellowish green calyces and bracts, entirely white flowers (Hedge, 1982a), and broadly oblong nutlets.

The fifth phenon represents *S. cerino-pruinosa* (OTUs 1-9) treated as a synonym of *S. euphratica* var. *leiocalycina* in the Flora of Turkey, but it clearly differs from *S. euphratica* by having erect and shrubby habit, mainly glabrous-pruinose indumentum, oblong-lanceolate to elliptic with always one pair of very small lateral lobes, very short petiole, and sessile stem leaves. Additionally, while conducting field work in Elazığ-Pertek, the authors detected one rather exceptional population of *S. cerino-pruinosa* (OTUs 8-9), which was first noticed by Hedge & Davis 29161 (ANK) in 1957. The population comprises both a typical glabrous-pruinose form and a pilose form. According to our special field observation, *S. cerino-pruinosa* has been only collected from Sivas and Pertek (Elazığ) provinces as very local populations.

Iranian endemic species *S. kermanshahensis* was first collected by Bornmueller in 1904. Since that time, the species has not been found again. After careful examinations based on the type specimens obtained from herbarium B, we concluded that *S. kermanshahensis* is very similar to Turkish endemic *S. cerino-pruinosa*. According to the literature (Rechinger, 1952), *S. kermanshahensis* differs from *S. cerino-pruinosa* with pilose to villous leaves. However, we have recently found a pilose form of *S. cerino-pruinosa* from Pertek (Elazığ). Therefore, more materials and field studies are needed to determine taxonomic status of *S. kermanshahensis*. According to nomenclatural rules, it may be evaluated under *S. cerino-pruinosa*.

The multivariate PCO analysis of *S. euphratica* sensu lato and the closely related species using Gower's general similarity coefficient revealed a

significant discontinuous distribution of the OTUs and distance among them. PCO analysis supported the findings of the research. Based on the analysis, there are 5 clusters corresponding to the species (Figure 2).

Morphological comparison of all the species is given in Table 4. According to the results obtained from multivariate statistical analysis and field and herbarium studies, we found that the most important diagnostic morphological characters among the species are indumentum, leaf characters and presence/absence of pairs, petiole length, calyx and corolla length and colour, and nutlet shape and length.

On the stem, *S. pseudeuphratica* has always densely white eglandular lanate and *S. sericeo-tomentosa* has always densely eglandular sericeo-tomentose. However, both (e)glandular pilose and villous hairs have been observed in the same populations of *S. euphratica*. Stem indumentum of *S. euphratica* var. *leiocalycina* is mainly glabrous or eglandular pilose to villous, but that of *S. euphratica* var. *euphratica* is always (e)glandular pilose to villous. *S. kronenburgii* stems have sparsely eglandular lanate; however, *S. cerino-pruinosa* ones have completely glabrous stems, except for Elazığ-Pertek population.

Among the species, leaf properties, such as shape, small lateral lobes, hair types, and petiole length, are the most important diagnostic characters. *S. pseudeuphratica* has always ovate to oblong leaves

with no pairs of small lateral lobes and with always densely eglandular lanate hairs, and the petiole length is about (7-) 10-20 mm. *S. sericeo-tomentosa* has always narrowly oblong leaves which are attenuate at base and have always densely sericeo-tomentose hairs. *S. euphratica* has oblong to ovate-oblong (elliptic) leaves rarely with a pair of small lateral lobes, and with pilose to villous hairs and the petiole length (8-) 10-25 (-30) mm. *S. kronenburgii* has ovate-oblong to oblong leaves rarely with a pair of small lateral lobes and with pilose pubescent hairs. *S. cerino-pruinosa* exhibits elliptic (oblong-lanceolate) leaves with always one pair of very small lateral lobes and with sessile stem leaves, and the petiole length is 2-5 (-7) mm. It has glabrous or cerino-pruinose leaves, except for Pertek populations.

S. pseudeuphratica has the smallest calyces and corollas, and its calyces are entirely dark purplish and clearly membranous. The remaining species have usually longer calyces and corollas and their calyces are yellowish green to greenish-purple and more or less coriaceous. *S. euphratica* and *S. cerino-pruinosa* has pinkish to violet-blue corollas, *S. pseudeuphratica* has only violet-blue corollas, *S. kronenburgii* has entirely white corollas, and *S. sericeo-tomentosa* has white or cream corollas with yellow upper lip.

In order to determine the average seed sizes, 30 mature nutlets were measured from each of the taxa. According to seed shape, there are 2 types of seeds

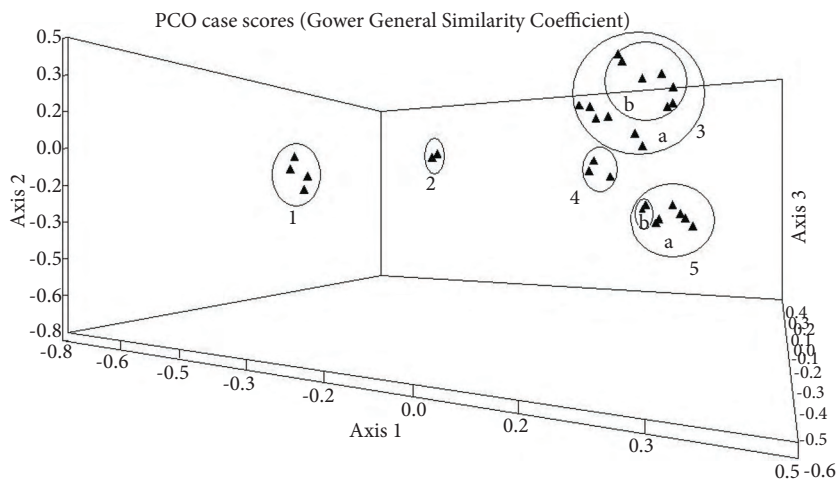


Figure 2. Principle coordinate analysis of *S. pseudeuphratica* (1), *S. sericeo-tomentosa* (2), *S. euphratica* var. *euphratica* (3a), *S. euphratica* var. *leiocalycina* (3b), *S. kronenburgii* (4), *S. cerino-pruinosa* (5a, glabrous form; 5b, pilose form).

Table 4. Main morphological differences among *S. euphratica* sensu lato and its closely related species.

	<i>S. pseudeuphratica</i>	<i>S. sericeo-tomentosa</i>	<i>S. euphratica</i>	<i>S. kronenburgii</i>	<i>S. cerino-pruinosa</i>
Stem length (cm)	20-30 (-35)	20-70	25-50 (-60)	25-50	25-45
Stem indumentum	Densely lanate	Densely sericeo-tomentose	Glabrous or glandular pilose to villous	Sparsely lanate	Glabrous (rarely pilose in Pertek)
Leaves indumentum	Densely lanate	Densely sericeo-tomentose	Pilose to villous	Pilose to pubescent	Glabrous (rarely pilose in Pertek)
Leaves shape	Ovate to oblong, with no pair of small lateral lobes	Narrowly oblong	Ovate to oblong, (elliptic), rarely with a pair of small lateral lobes	Ovate-oblong to oblong, rarely with a pair of small lateral lobes	Elliptic (oblong-lanceolate), always with a pair of small lateral lobes
Petiole length (mm)	(7-) 10-20	Attenuate at base	(8-) 10-25 (-30)	15-35	Sessile or 2-5 (-7)
Inflorescence indumentum	Densely lanate	Glabrous	Glabrous or glandular pilose to villouse	Glabrous	Glabrous (rarely pilose in Pertek)
Bracts indumentum	Lanate	Glabrous	Glabrous or pilose	Glabrous	Glabrous (pilose in Pertek)
Bracts length (mm)	5-15 (-25) × 4-10 (-16)	5-20 × 5-20	10-45 (-50) × 10-30 (-35)	15-25 × 17-28	6-15 × 5-16
Bracts/ Calyx ratio	Always bracts shorter than calyx	Always bracts shorter than calyx	Usually bracts shorter (in var. <i>euphratica</i>) or longer (in var. <i>leiocalycina</i>) than calyx	Always bracts shorter than calyx	Always bracts shorter than calyx
Calyx length in fruiting (mm)	(12-) 15-20	15-30	17-32 (-40)	20-35	19-25
Calyx indumentum	Sparsely pilose to villous	Glabrous	Glabrous or glandular pilose to villouse	Glabrous	Glabrous (pilose only in Pertek)
Corolla length (mm)	15-20	25-32	25-35 (-40)	30-50	25-35

observed as broadly oblong (*S. kronenburgii*) and spherical (*S. euphratica*, *S. cerino-pruinosa* and *S. pseudeuphratica*). *S. sericeo-tomentosa* has both broadly oblong and spherical seeds. According to the measurements, the largest seeds are observed in *S. euphratica* and the smallest seeds are observed in *S. sericeo-tomentosa* and *S. pseudeuphratica*. Nutlet measurements of the species are given in Table 5 and comparison of their nutlet length is presented in Figure 3.

S. pseudeuphratica, *S. sericeo-tomentosa*, *S. euphratica*, *S. kronenburgii* and *S. cerino-pruinosa* may have been formed by means of sympatric speciation. With respect to morphological similarities and their distribution patterns in East Anatolia, *S. euphratica*

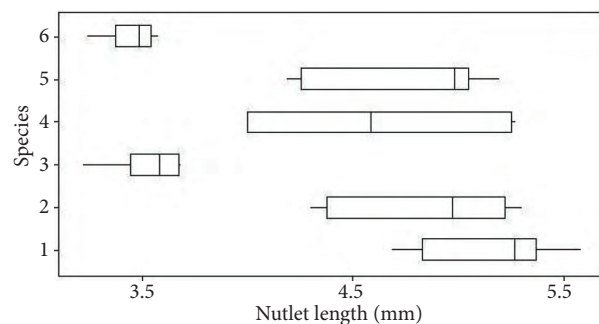


Figure 3. Boxplots of the nutlet length of *S. euphratica* sensu lato and its closely related species (for numbers see Table 5).

seems to be the progenitor of the other species. A distribution map of the species is given in Figure 4.

Table 5. Nutlet size and shape of *S. euphratica* sensu lato and its closely related species showing mean value ± standard deviation. All measurements are in mm.

Taxa Number	Taxa	Nutlet length	Nutlet width	Hilum diameter	Nutlet shape
1	<i>S. euphratica</i> var. <i>euphratica</i>	5.17±0.32	4.07±0.26	1.23±0.2	Spherical
2	<i>S. euphratica</i> var. <i>leiocalycina</i>	4.86±0.42	4.02±0.3	1.22±0.2	Spherical
3	<i>S. pseudeuphratica</i>	3.54±0.17	3.23±0.28	1.1±0.1	Spherical
4	<i>S. cerino-pruinosa</i>	4.62±0.59	4.02±0.4	1.2±0.2	Spherical
5	<i>S. kronenburgii</i>	4.78±0.4	3.69±0.3	1.32±0.3	Broadly oblong
6	<i>S. sericeo-tomentosa</i>	3.46±0.12	2.92±0.1	1.15±0.06	Spherical and broadly oblong

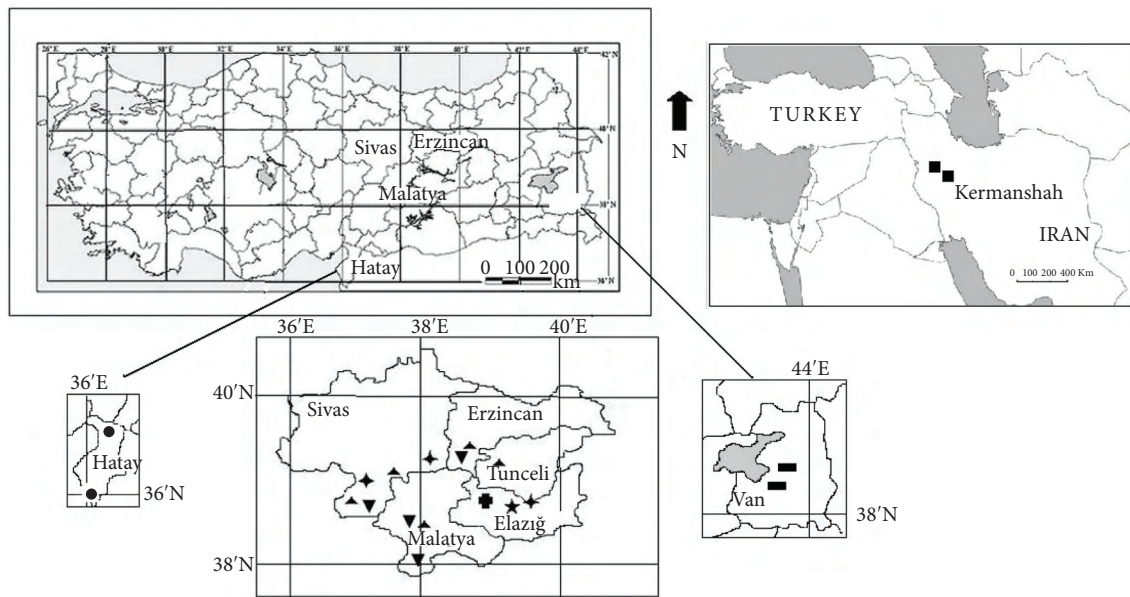


Figure 4. Distribution map of (✚) *S. pseudeuphratica*, (●) *S. sericeo-tomentosa*, (▼) *S. euphratica* var. *euphratica*, (▲) var. *leiocalycina*, (■) *S. kronenburgii*, (◆) *S. cerino-pruinosa* (glabrous form), (★) *S. cerino-pruinosa* (pilose form) and (■) from Kermanshah (Iran).

Key for the species of *S. euphratica* sensu lato and its closely related species in Turkey

- 1. Corolla white or cream 2
- 1. Corolla pinkish to violet-blue 3
- 2. Leaves ovate-oblong to oblong, rarely one small lateral lobed, pilose-pubescent; inflorescence simple; bracts and calyces yellowish green; corolla entirely white (only in Van province)
.....*S. kronenburgii*
- 2. Leaves narrowly oblong, attenuate at base, densely sericeo-tomentose; inflorescence branched; bracts

- and calyces green to purplish; corolla white or cream with yellow upper lip (only in Hatay province)*S. sericeo-tomentosa*
- 3. Indumentum densely white lanate, inflorescence dense in fruit, calyces totally dark purplish, corolla 15-20 mm, nutlet length less than 4 mm
.....*S. pseudeuphratica*
- 3. Indumentum glabrous or pilose to villous, inflorescence lax in fruit, calyces green to purplish, corolla 25-35 (-40) mm, nutlet length more than 4 mm 4

4. Leaves elliptic (oblong-lanceolate), always with a pair of small lateral lobes, petiole 2-5 (-7) mm, upper leaves sessile, mainly glabrous-pruinose (rarely pilose), corolla usually violet-blue
.....*S. cerino-pruinosa*

4. Leaves mainly ovate-oblong, rarely with a pair of small lateral lobes, petiole (8-) 10-45 mm, upper leaves clearly petiolate, always pilose to villous, corolla usually pinkish
.....*S. euphratica*

S. pseudeuphratica Rech. f. in Öst. Bot. Zeitschr. 99: 49-50 (1952!). (Figures 5A-B)

Type: Turkey, B7 Elazığ: Keban-Maden, in declivibus saxosis, 20.6.1889, *Sintenis* no. 817 (in hb. Mus. Wien, E!).

Tuft-forming aromatic perennial suffruticose herbs. Stems ascending erect, eglandular lanate hairs, 20-30 (-35) cm, branched below with sterile shoots. Leaves simple, ovate to oblong, 1.5-4 × (0.8-) 1-3.5 cm with no pair of small lateral basal lobes, white lanate with sessile glands, crenulate to serrate, petiole (7-) 10-20 mm. Inflorescence unbranched, rarely branched, eglandular lanate hairs; verticillasters 4-16-flowered, usually approximating. Bracts of upper verticillasters broadly ovate, shorter than calyces, 5-15 (-25) × 4-10 (-16) mm, lanate, greyish, lowermost leaf-like, bracteoles absent. Pedicels 2-4 (-5) mm, eglandular lanate hairs. Calyx dark purplish, eglandular sparsely pilose to villous, broadly campanulate, fruiting calyces membranous, 10-15 × 10-16 mm in flowering, broadening and expanding to (12-) 15-20 × (12-) 15-25 mm in fruit. Corolla violet-blue, 15-20 mm, with simple hairs on outside of upper lip; tube 10-15 mm, slightly curved and widening towards throat ± annulate, upper lip straight. Stamens 2, stem connectives shorter than filaments, filaments 2.8-4.7 (-5.2) mm, fertile anthers hairless, 1.8-2.9 mm, and sterile anthers 0.9-1.3 mm; upper thecae 1.6-3 mm and lower thecae (0.8-) 1-2 (-2.3) mm. Style (15-) 17-23 mm.

Habitat, Ecology, and Phenology: *S. pseudoeuphratica* grows on calcareous rocks, stony slopes, dry areas, and roadsides between 750 and 900 m. Flowering occurs in May and fruiting occurs in June. The vegetation in this area is formed by herbaceous plants including *Aegilops geniculata* Roth,

Poa bulbosa L., *Verbascum* sp., *Avena* sp., *Medicago* sp., *Ziziphora* sp., *Helianthemum* sp., *Crupina* sp., *Alyssum* sp., *Aethionema* sp., *Bromus* sp., *Papaver* sp., *Teucrium* sp., *Astragalus* sp., *Anchusa* sp., *Euphorbia* sp., and *Tragopogon* sp.

S. sericeo-tomentosa Rech. f. in Öst. Bot. Zeitschr. 99: 52 (1952!). (Figures 5C-D)

Type: Turkey C6 Hatay: Amanus, ascent to Achagi Zarkoun, from the Karakisieh side, 800-1000 m, *Pinetum halepense*, 30 June 1932, *Eig* and *M. Zohary* (isotype, E!).

Perennial suffruticose herbs. Stems ascending erect, 20-70 cm, densely sericeo-tomentosa and short glandular pilose with sessile glands. Leaves simple, mostly basal, narrowly oblong, attenuate at base, 10-60 × 6-18 mm, densely sericeo-tomentosa and short glandular pilose with sessile glands, margins minute crenulate, petiole attenuate. Verticillasters 2-4 flowered, distant. Bracts broadly ovate to cordate, acuminate, always shorter than calyx, 5-20 × 5-20 mm, green or green to purplish. Pedicels 3-7 mm. Calyx membranous, glabrous, green to purplish, broadly campanulate, 12-22 mm, broadening and expanding to 30 mm in fruit, upper lip entire. Corolla white to cream with yellow upper lip, 25-32 mm, tube c. 20-23 mm, slightly curved and widening towards throat, upper lip ± straight. Stamens 2, stem connectives shorter than filaments. Style white, glabrous, 20-25 mm.

Habitat, Ecology, and Phenology: *S. sericeo-tomentosa* grows on calcareous slopes and open *Pinus* forests, roadsides with *Quercus* scrubs between 20 and 1000 m. Flowering occurs in May to June and fruiting occurs in June to July. The vegetation in this area is formed by *Pinus* sp., *Quercus* sp., *Centaurea* sp., *Avena* sp., *Verbascum* sp., *Isatis* sp., and *Bromus* sp.

S. euphratica Montbret. & Aucher ex Benth in Ann. Sci. Nat. Ser. 2, 6:40 (1836).

Tuft-forming aromatic perennial suffruticose herbs. Stems ascending erect, glabrous or glandular pilose to villous, rarely eglandular, 25-50 (-60) cm, branched below, with sterile shoots. Leaves simple, oblong to ovate-oblong, elliptic, (1.5-) 2-7.5 × (0.7-) 1.3-4 cm, rarely with a pair of small lateral basal lobes, pilose to villous with sessile glands, rugose, crenulate

to serrate. Petiole (8-) 10-25 (-30) mm. Inflorescence unbranched, glandular pilose to villous, rarely eglandular, verticillasters (2-) 4-10 (-12) flowered, clearly distant. Bracts of upper verticillasters broadly ovate, bracts shorter than calyces (in var. *euphratica*), bracts longer than calyx (in var. *leicalycina*), 10-45 (-50) × 10-30 (-35) mm, pilose, green to purplish, lowermost leaf-like. Pedicels 3-7 mm, densely (e)glandular pilose to villous. Calyx green to purplish, glandular pilose to villous, rarely eglandular, broadly campanulate, (13-) 15-20 (-25) × (10-)15-20 (-23) mm in flowering, broadening and expanding to 17-32 (-40) × 17-25 (-45) mm in fruit, fruiting calyces membranous. Corolla violet-blue to pinkish, 25-35 (-40) mm, with simple hairs on outside of upper lip; tube 21-30 mm, slightly curved and widening towards throat ± annulate. Stamens 2, stem connectives shorter than filaments, filaments 4-6.8 mm, fertile anthers hairless, 2.5-4.1 mm and sterile anthers 1.2-2.1 mm; upper thecae 2.2-4 mm and lower thecae 2-3.7 mm. Style (26-) 30-40 (-44) mm.

1. Calyx, bract and inflorescence axis with a ± dense indumentum, usually bracts shorter than calyxvar. *euphratica*

1. Calyx, bract and inflorescence axis ± glabrous, usually bracts longer than calyxvar. *leicalycina*

var. *euphratica* (Figures 5E-F)

Syntypes: Turkey, B6/7 Malatya: in Cappadocia orientalis (*Aucher* no. 1516, holotypes G!)

var. *leicalycina* (Rech. f.) Hedge, *Flora of Turkey*, vol 7: 431. (Figures 5G-H)

Synonym: *S. leicalycina* Rech. f. in *Öst. Bot. Zeitschr.* 99: 51 (1952!).

Type: Turkey B7 Erzincan: Eğin (Kemaliye), Salihli, in siccis montium, 25.6.1890, *Sintenis* 1890: 2753 p.p. (holo. W!, iso, LD, WU).

Habitat, Ecology, and Phenology: *S. euphratica* grows on gypsum areas, calcareous slopes, roadsides, and limestone slopes with *Quercus* scrubs between 800 and 1800 m. Flowering occurs in May to June and fruiting occurs in June to July. The vegetation in this area is formed by herbaceous plants including *S. suffruticosa* Montbret & Aucher et Bentham, *S.*

suffruticosa × *S. bracteata*, *S. cryptantha* Montbret & Aucher et Bentham, *S. multicaulis* Vahl, *S. virgata* Jacq., *S. hypargeia* Fisch. & Mey., *S. aethiopsis* L., *S. ceratophylla* L., *S. verticillata* L., *S. palaestina* Bentham, *S. divaricata* Montbret & Aucher et Bentham, *Bromus japonicus* Thunb., *B. tectorum* L., *Poa bulbosa* L., *Aegilops geniculata* Roth, *Eremopyrum bonaepartis* (Sprengel) Nevski, *Neotchihatchewia isaditea* (Boiss.) Rauschert, *Teucrium polium* L., *Alyssum* sp., *Cirsium* sp., *Iris* sp., *Reseda* sp., *Onobrychis* sp., *Scrophularia* sp., *Verbascum* sp., *Galium* sp., *Astragalus* sp., *Crupina* sp., *Hypericum* sp., *Vicia* sp., *Senecio* sp., and *Centaurea* sp.

S. kronenburgii Rech. f. in *Öst. Bot. Zeitschr.* 99: 50 (1952!). (Figures 5I-J)

Type: Turkey B9 Van: Wan, auf vulkanischem Boden, 2500 m, 27. 6.1899, *Kronenburg* 167 (holo. WU).

Close to *S. euphratica*, but differing by yellowish-green bracts and calyces, entirely white corollas (Hedge, 1982a) and broadly oblong nutlets.

Habitat, Ecology, and Phenology: It grows on hills, dry areas, and roadsides between 1800 and 2600 m. Flowering occurs in June to July and fruiting occurs in July to August. The vegetation in this area is formed by herbaceous plants including *Cousinia* sp., *Euphorbia* sp., *Bromus* sp., *Verbascum* sp., *Adonis* sp., *Achillea* sp., *Convolvulus* sp., *Lathyrus* sp., *Thymus* sp., *Phlomis* sp., *Linum* sp., and *Anchusa* sp.

S. cerino-pruinosa Rech. f. in *Öst. Bot. Zeitschr.* 99: 51 (1952!) (Figures 5K-P).

Type: Turkey, Kharput, Karatasch, in declivibus supra Pekenik, *Sintenis* 698 (W!).

Tuft-forming perennial suffruticose herbs. Stems ascending erect, 25-45 cm, glabrous (rarely sparsely pilose), branched below. Leaves simple, elliptic (oblong to elliptic), 2.3-6 × 1.1-2.4 cm, always with a pair of small lateral basal lobes, glabrous to glaucous with sessile glands (rarely pilose), rugose, crenulate to serrate, petiole 2-5 (-7) mm, upper leaves sessile. Inflorescence usually unbranched, glabrous (rarely pilose to villous), verticillasters 2-8 (-10) flowered, clearly distant. Bracts of upper verticillasters broadly ovate, always shorter than calyces, 6-15 × 5-16 mm, usually green, glabrous (pilose only in Pertek

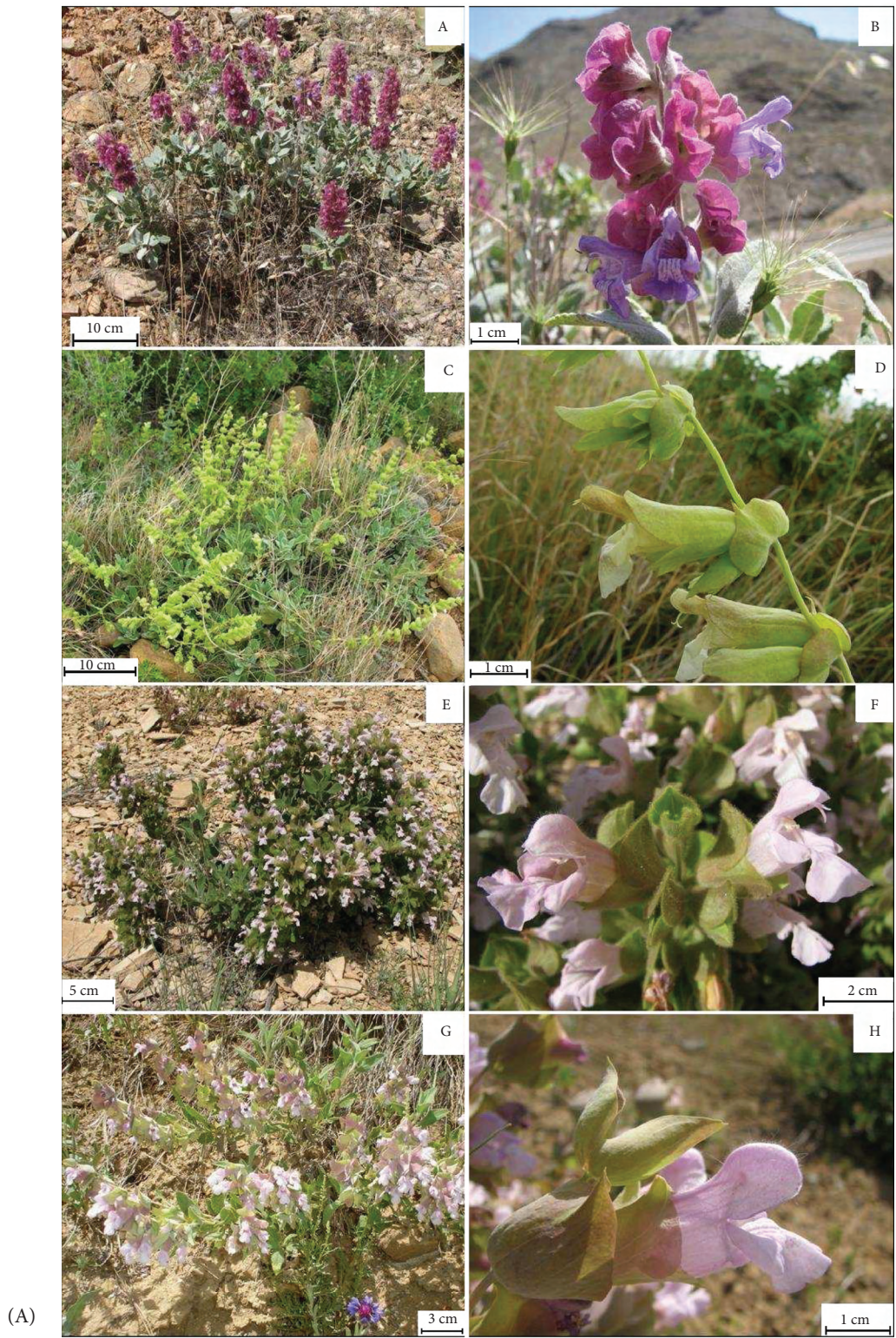


Figure 5. (A) A-P General appearance of *S. euphratica* sensu lato species and its closely related species. A-B *S. pseudeuphratica* (A.Kahraman 1384A), C-D *S. sericeo-tomentosa* (F.Celep 1402), E-F *S. euphratica* var. *euphratica* (A.Kahraman 1098B), G-H *S. euphratica* var. *leiocalycina* (A.Kahraman 1114A).

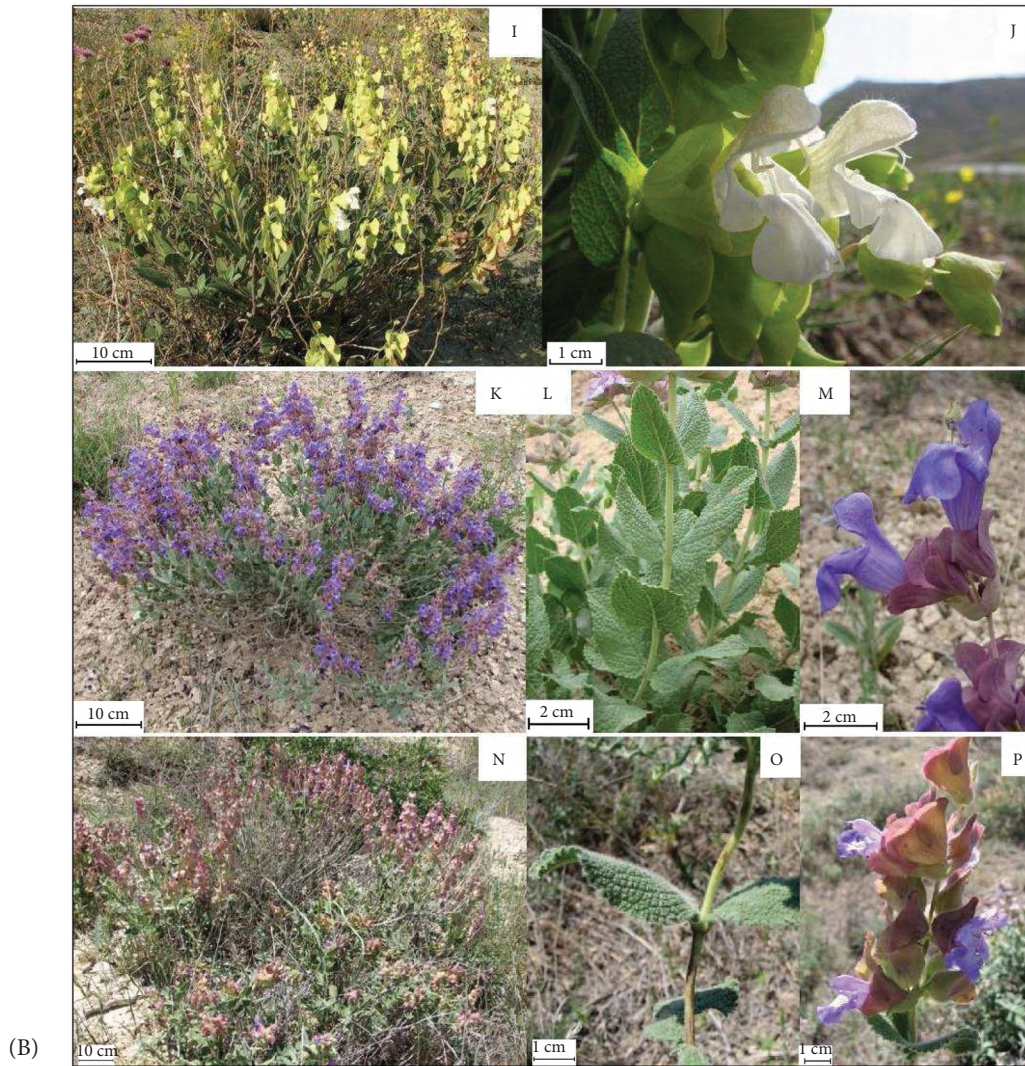


Figure 5. (B) I-J *S. kronenburgii* (A.Kahraman 1575), K-L-M *S. cerino-pruinosa* (glabrous form, A.Kahraman 1188C), N-P *S. cerino-pruinosa* (pilose form, A.Kahraman 1530A).

population), lowermost leaf-like, bracteoles absent. Pedicels (2.5-) 3-7 (-10) mm, erecto-patent, glabrous. Calyx purplish to green, glabrous, fruiting-calyces membranous, broadly campanulate, 15-20 × 12-20 mm in flowering, broadening and expanding to 19-25 × 18-30 mm in fruit, glabrous (rarely sparsely pilose). Corolla violet-blue, 25-35 mm, outside of upper lip hairless; tube 20-25 mm; slightly curved and widening towards throat ± annulate. Stamens 2, stem connectives shorter than filaments; filaments 4.3-8 mm, fertile anthers with usually long villous hairs,

rarely glabrous, 3.0-3.8 mm, and sterile anthers 1.1-1.7 mm; upper thecae 3.1-4.6 mm and lower thecae 2.7-4.3 mm; Style (25-) 27-35 (-40) mm.

Habitat, Ecology, and Phenology: *S. cerino-pruinosa* grows on limestone slopes, roadsides, and marly banks between 850 and 1450 m. Flowering occurs in May to June and fruiting occurs in June to July. The vegetation in this area is formed by herbaceous plants including *S. syriaca* L., *S. candidissima* Vahl. subsp. *candidissima*, *S. hedgeana* Dönmez, *S. palaestina* Bentham, *Poa bulbosa* L.,



Figure 6. Habit of *Salvia pseudeuphratica*.



Figure 7. Habit of *Salvia cerino-pruinosa*.

Ebenus sp., *Alyssum* sp., *Eremurus* sp., *Onobrychis* sp., *Arenaria* sp., *Scrophularia* sp., *Hypericum* sp., *Pimpinella* sp., *Euphorbia* sp., *Cerasus* sp., *Bunium* sp., *Verbascum* sp., *Thymus* sp., and *Crataegus* sp.

Photos of herbarium specimens of *S. pseudeuphratica*, *S. cerino-pruinosa*, and *S. kermanshahensis* are given in Figure 6-8, respectively.

Other specimens studied (except for specimens given in Table 2)

***S. pseudeuphratica*:** B7 Elazığ: Elazığ-Keban, after 5 km from Keban, 888 m, 7 June 2006, *A. Kahraman* 1200 & *S. Bagherpour*.

***S. euphratica* var. *euphratica*:** B6 Malatya: Malatya-Gürün, c. 1100 m, 19 June 1954, *Davis* 21872 (ANK); Malatya-Kayseri road, after 34 km from Malatya, 9 June 1971, *E. Tuzlacı* 20175 (ISTE); Malatya: between Darende and Malatya, after 12 km from Darende, 1050 m, 9 June 1981, *E. Tuzlacı* 46423 (ISTE); Malatya: between Gürün and Darende, before 11 km from Darende, 1460 m, 9 June 1981, *E. Tuzlacı*

46416 (ISTE); Sivas: Gürün, 1309 m, 17 May 2008, *A. Kahraman* 1497(A); Sivas: Kangal-Gürün, 1455 m, 1 June 2008, *A. Kahraman* 1510(B); Sivas: 9 km from Gürün to Gökpınar, 1544 m, 1 June 2008, *A. Kahraman* 1511(B); Sivas: Kangal-Divriği, near Kayaburun village, 1450 m, 2 June 2008, *A. Kahraman* 1517(B). B7 Malatya: Beydağı, 950 m, 7 July 2007, *A. Kahraman* 1413; Malatya: Arapkir to Divriği, near Çiğnir village, 1268 m, 25 July 2008, *A. Kahraman* 1585(B); Erzincan: İliç to Refahiye, before 3 km from Kuzkışla village, 1344 m, 25 July 2008, *A. Kahraman* 1592(B). -var. ***leiocalycina*:** B7 Erzincan: İliç to Refahiye, before 3 km from Kuzkışla village, 1344 m, 25 July 2008, *A. Kahraman* 1592(A); Erzincan: between Erzincan and Kemah, before 6 km from Kemah, 1100 m, 2 June 1975, *E. Tuzlacı* 31866 (ISTE); Sivas: Divriği, 30 May 1968, *E. Tuzlacı* 12846 (ISTE); Sivas: Gürün, 1309 m, 17 May 2008, *A. Kahraman* 1497(B); Sivas: Kangal-Gürün, 1455 m, 1 June 2008, *A. Kahraman* 1510(A); Sivas: 9 km from Gürün to Gökpınar, 1544 m, 1 June 2008, *A. Kahraman* 1511(A);



Figure 8. Habit of *Salvia kermanshahensis* (from isotype).

Sivas: Kangal-Divriği, near Kayaburun village, 1450 m, 2 June 2008, *A.Kahraman* 1517(A); Malatya: Arapkir to Divriği, near Çiğnir village, 1268 m, 25 July 2008, *A.Kahraman* 1585(A); Malatya, 19 May 1935, *Balls* 2299 (ANK).

S. kronenburgii: B9 Van: near Gürpınar, 1798 m, 16 July 2006, *A.Kahraman* 1327 & *S.Bagherpour*; Van:

Çatak, 2 km north of Micinger suyu, 1900 m, 25 July 1954, *Polunin & Davis* 23234 (ANK); Van: Gürpınar, foot of Başet mountain, 2200 m, 4 July 1993, *Y.Altan* 5302 (GAZI); Van: Toprakkale, 1700 m, 8 June 2001, *M.Ekici* 2360 (GAZI).

S. cerino-pruinosa: B7 Tunceli: Tunceli-Pertek, 27 miles from Elazığ, c. 1400 m, 6 June 1957, *Davis* 29136

(ANK); Tunceli: between Elazığ and Tunceli, before 23 km from Tunceli, 910 m, 10 June 1981, *E. Tuzlacı* 46666 (ISTE); Elazığ: Elazığ-Pertek, c. 12 miles from Elazığ, c. 1000 m, 6 June 1957, *Davis* 29161 (ANK).

***S. kermanshahensis*: Iran** (Islamic Republic of): Ditionis fluvii Saimerre ad Dscham-Tuch. 14.05.1904, Leg.: T. Strauss s.n. Herbar J. Bornmüller. Barcode number: B 10 0279053, isotype, at the herbarium Berolinense (B).

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- ## Acknowledgement
- We wish to thank the curators of herbaria AEF, ANK, B, BM, E, G, GAZI, HUB, ISTE, ISTF, K, KNYA, and W who allowed us to study their *Salvia* specimens and to the Scientific and Technical Research Council of Turkey (TÜBİTAK-TBAG-104 T 450) for their financial assistance for the study. We would like to thank anonymous referees for their constructive criticisms.
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