

A new taxon of the genus *Salvia* (Lamiaceae) from Turkey

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Background and aims – Turkey is one of the major centers of diversity for *Salvia*, with 97 species of which 54% are endemic. The aims of this study are to give detailed taxonomical, morphological and ecological accounts of *S. cadmica* and *S. smyrnaea*.

Methods – Based on herbarium studies and field observations, numerical and morphological studies have been conducted on the taxa.

Key results – The main morphological characters such as calyx structure, shape, colour, size and corolla colour are diagnostic. Additionally, pollen and nutlet characteristics provide taxonomically distinctive characters for the taxa.

Conclusion – The new variety *S. cadmica* var. *bozkirensis* from Turkey is described. Amended and expanded descriptions, with notes on distribution, phenology, ecology, palynology and nutlet features of the taxa are given.

Key words – Lamiaceae, new variety, *Salvia*, Turkey.

INTRODUCTION

Salvia L., the largest genus of Lamiaceae, represents an enormous and cosmopolitan assemblage of nearly 1000 species displaying remarkable variation. It has undergone marked species radiations in three regions of the world: Central and South America (500 spp.), Central Asia/ Mediterranean (250 spp.) and Eastern Asia (90 spp.) (Walker et al. 2004).

The latest comprehensive treatment for *Salvia* in Turkey, Hedge (1982a) recognised 87 species, one of them doubtful. Since 2005, as part of a revision of the genus in Turkey, the authors have described two new species (İlçim et al. 2009, Celep & Doğan 2010), one new variety (Celep et al. 2009a) and two new records (Celep et al. 2009b, Kahraman et al. 2009). *S. aucheri* Benth. var. *canescens* Boiss. & Heldr. has been also raised to subspecies rank (Celep et al. in press). Moreover, two synonyms have been evaluated as valid species (Kahraman et al. 2010).

During a field trip near Bozkır, South of Konya (C4, sensu Davis 1965) in the context of this revision, we encountered an unusual population of *S. cadmica* Boiss. within the area of its known population. The unusual specimens resemble *S. smyrnaea* Boiss. in terms of their calyx and corolla colour. Later on, similar unusual specimens were found in other populations of *S. cadmica* in South, West and Central Anatolia. The specimens were identified using the relevant literature (Boissier 1879, Hedge 1972, 1982a, 1982b, Pobedimova 1954) and compared with the types and other representative

collections present at ANK, BM, E, G, GAZI, HUB, ISTE, ISTE, K and W herbaria.

The objectives of this study are to present the taxonomic revision of *S. cadmica* and *S. smyrnaea* analysing their populations by means of field, herbarium and numerical taxonomic methods, to determine the key characters for distinguishing the taxa, to give their amended and expanded description, phenology, ecology and distribution, and to report their pollen and nutlet characteristics.

MATERIAL AND METHODS

For morphometric analysis, four populations of *S. cadmica* and one population of *S. smyrnaea* were studied (appendix 1). For each population up to six individuals were investigated. Selection of specimens was undertaken according to the following criteria: well-preserved and dried specimens with well-developed flowers. In the field, we also noted some morphological characters, such as colour and length of corolla and calyx, which are hard to infer from dried specimens. The morphometric analysis was carried out on specimens of the taxa stemming from our own collections by measuring 27 morphological and palynological characters (thirteen quantitative, fourteen qualitative; appendix 2) to investigate their taxonomic delimitations. For all OTU's (= specimens), characters were scored for a multivariate analysis (Sneath & Sokal 1973). All 27 characters for each OTU were measured on a single individual.

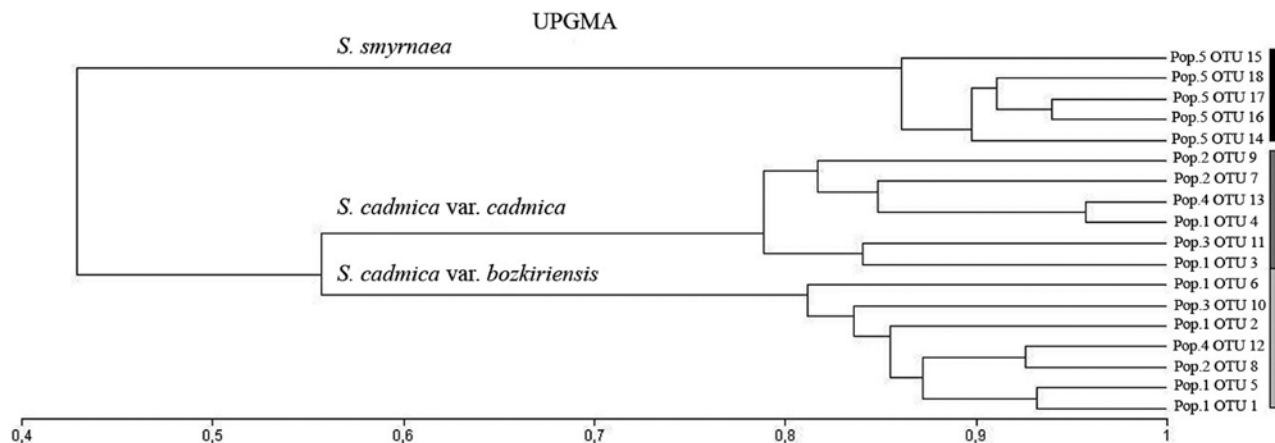


Figure 1 – Dendrogram constructed by means of the UPGMA algorithm and Gower General Similarity Coefficient. For populations and OTU numbers see appendix 1.

Pollen slides for morphological examination by light microscopy were prepared according to Wodehouse (1935) and the measurements were made with a Leica DM1000 microscope. Twenty pollen grains per OTU were measured and the observations are presented in appendix 2.

For studying pollen wall texture and ornamentation, dry pollen grains were mounted on double-sided carbon tape affixed to aluminum stubs, coated with gold and observed with a Jeol JSM-6400 scanning electron microscope. S.E. micrographs were used to describe the pollen surface. The descriptive terminology of Punt et al. (2007) was followed.

For numerical analysis, a similarity matrix (table 2) was created first using Gower’s (1971) general similarity coefficient (Sneath & Sokal 1973). In the similarity matrix, average lengths of pollen grains for each OTU were used (appendix 2). This similarity matrix was then clustered (fig. 1) by using UPGMA (the unweighted pair-group method using arithmetic averages). MVSP 3.1 (<http://www.kovcomp.com/mvsp/index.html>) programme package for clustering analysis was applied (Kovach 2004).

RESULTS AND DISCUSSION

The taxa studied here are compared on the basis of their vegetative and reproductive organs in table 1. Our analyses show that it is more reasonable to treat the specimens, first found in Bozkır, as a new variety in *S. cadmica*. The population provides the type for this new var. *bozkiriensis*, which differs from the typical variety by having a smaller, (usually) light to dark purplish calyx in fruit and light lavender corollas (appendices 3 & 4). Our morphological results on *S. smyrnaea* are consistent with earlier published data (Boissier 1879, Hedge 1982a).

Comparing the pollen characteristics of these three taxa reveals some minor differences (appendix 5). According to P/E ratios, var. *bozkiriensis* has suboblate to subprolate (occasionally prolate) pollen (P/E: 0.80–1.35) but var. *cadmica* and *S. smyrnaea* have oblate-spheroidal to prolate pollen

(P/E: 0.85–1.55). In terms of average pollen size, var. *bozkiriensis* has smaller pollens than var. *cadmica* and *S. smyrnaea* and it has the thinnest intine and exine layers. Var. *cadmica* has the largest pollen grains and *S. smyrnaea* has the thickest intine layer and the deepest colpi. Moreover, the pollen grains is hexacolpate and the colpi are long (appendices 2 & 5). According to the morphological studies, the taxa were found to be different in terms of nutlet size and shape (table 1).

As a result of the numerical analysis, a cut-off line across the phenogram at 0.5 similarity level empirically distinguishes the species from each other. Populations 1–4 are corresponding to *S. cadmica* and population 5 is *S. smyrnaea* (appendix 1). The first cluster consisting of five OTUs represents *S. smyrnaea*. The second cluster consisting of thirteen OTUs consists of *S. cadmica* and distinguishes the varieties of the species from each other (fig. 1).

The separation among clusters is mainly determined by reproductive organs (calyx structure, shape, colour, size and corolla colour) and quantitative characteristics of pollen grains (P/E ratio, colpus length, exine and intine thickness) which are believed to represent useful diagnostic features (character numbers 11–27, appendix 2).

There are some differences among these taxa on the basis of the distribution pattern. While var. *cadmica* is distributed in (mainly) Central Anatolia, the Mediterranean and the Aegean regions of Turkey, var. *bozkiriensis* is distributed mainly in the Mediterranean and the Aegean regions of Turkey and rarely found in the central Anatolia. *S. smyrnaea* is restricted to İzmir and Aydın provinces in the western part of the Aegean geographic region of Turkey. IUCN conservation status of the species is evaluated by Celep et al. (2010).

Salvia cadmica Boiss. (Boissier 1844: 6) – Type: Turkey, Denizli, Honaz mountain, *Boissier* s.n. (holo-: G; iso-: W).

An amended and expanded description of the species is given in appendix 6.

***Salvia cadmica* Boiss. var. *bozkiriensis* Celep, Kahraman & Doğan, var. nov.**

Affinis *S. cadmica* var. *cadmica* sed ab illa differt calycibus brevioribus et in fructibus 14–20 mm longis, corollis leviter lavandulaceis. – Type: Turkey, C4 Konya, Bozkır, Erenler hill (Sivri), near İkidelik, on calcareous rocks, 37°11'604"N 32°14'782"E, alt. 1160 m, 2 May 2006, *A. Kahraman & F. Celep* 1034 (holo-: GAZI; iso-: ANK). Appendices 3, 4 & 5.

Etymology – The name refers to the type locality from where it was first collected.

Var. *bozkiriensis* differs from var. *cadmica* by its calyx 14–20 mm in fruit and by the colour of its corolla (light lavender).

Phenology – Flowering (April) May to June (July).

Ecology – *S. cadmica* grows in Central, South and West Anatolia where it grows on calcareous rocks, cliffs, screes and among *Quercus* shrubs at an altitude of 800–2000 m. The vegetation in this place is formed by herbaceous and woody plants including *Pinus* spp., *Quercus* spp., *Vicia* spp., *Aegilops* spp., *Scandix* spp., *Galium* spp., *Euphorbia* spp., *Alkanna* spp., *Fumaria* spp., *Sedum* spp., *Alyssum* spp., *Parananchia* spp., *Geranium* spp., *Erodium* spp., *Clypeola* spp., *Crepis* spp., *Helianthemum* spp., *Euphorbia* spp., *Arum* spp., *Acinos* spp. and *Origanum* spp.

Examined representative specimens of the taxa and phenology and ecology of *S. smyrnaea* are given in appendix 6.

SUPPLEMENTARY DATA

Supplementary data are available in pdf format at *Plant Ecology and Evolution*, Supplementary Data Site (<http://www.ingentaconnect.com/content/botbel/plecevo/supp-data>), and consist of the following: (1) list of populations and OTUs selected for the multivariate analysis; (2) data matrix of 27 characters of the taxa examined; (3) herbarium specimen of *S. cadmica* var. *bozkiriensis*, OTU1 and OTU2 in appendix 1; (4) habit in the field of *S. cadmica* var. *bozkiriensis*, *S. cadmica* var. *cadmica* and *S. smyrnaea*; (5) SE micrographs of the pollen grains of *S. cadmica* var. *bozkiriensis*, *S. cadmica* var. *cadmica* and *S. smyrnaea*; (6) taxonomic treatment of *Salvia cadmica* and *S. smyrnaea*.

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Table 1 – Comparison of *Salvia cadmica* var. *bozkiriensis* var. *cadmica* and *Salvia smyrnaea*.

	var. <i>bozkiriensis</i>	var. <i>cadmica</i>	<i>S. smyrnaea</i>
stem length (cm)	8–40	8–35	9–25
stem hairs	glandular pilose and eglandular villose	glandular pilose and eglandular villose	mainly glandular pilose and a few eglandular villose
leaf blade	densely glandular pilose with sessile glands	densely glandular pilose with sessile glands	scarcely glandular pilose with sessile glands
pedicel length (mm)	1–4	2–4	3–6
calyx colour	mainly purplish-green (rarely green)	green (rarely purplish-green)	purplish
calyx structure	membranous	membranous	thick textured
calyx in fruit	expanded	widely expanded	scarcely expanded
upper lip of calyx	subentire or (more or less) tridentate	subentire	clearly tridentate
calyx size in flower (mm)	9–16	13–20	10–15
calyx size in fruit (mm)	14–20	20–28	13–18
corolla	light lavender, (sometimes) with dark to light violet striped	entirely white, (sometimes) with yellow spotted lower lip	pinkish to light violet-blue without spots on lower lip
pollen size (µm, mean ± standart deviation), shape, sculpturing	45.6 ± 3.7 × 53.8 ± 2.6, suboblate to subprolate (occasionally prolate), reticulate	56.2 ± 4.4 × 63.6 ± 3.6, oblate-spheroidal to prolate, reticulate	51.0 ± 3.2 × 56.72 ± 3.2, oblate-spheroidal to prolate, reticulate
nutlet size (mm), shape	2.0–3.2 × 1.5–2.7, broadly ovate	2.7–3.5 × 2–.5, broadly ovate	3.0–3.7 × 2.7–3.5, rounded

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